

VOLUME 11 ISSUE 1 2025

ISSN 2454 – 3055



**INTERNATIONAL
JOURNAL OF
ZOOLOGICAL
INVESTIGATIONS**

***Forum for Biological and
Environmental Sciences***

Published by Saran Publications, India



Checklist of Tri-Trophic Associations of Aphidophagous Predators of the Tribe Chilacorini (Coccinellinae: Coccinellidae: Coleoptera) in India

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Received: 2nd May, 2025; **Accepted:** 21st June, 2025; **Published online:** 25th June, 2025

<https://doi.org/10.33745/ijzi.2025.v11i01.084>

Abstract: A checklist of tri-trophic relationships involving aphidophagous species of the Chilacorini tribe (Coccinellinae: Coccinellidae: Coleoptera) is provided, highlighting their essential role in the natural regulation of aphid populations across various terrestrial ecosystems in the states and union territories of India, alongside the aphid prey species (Hemiptera: Aphididae) that infest different host plants. Eleven species of aphidophagous Chilacorini were identified: 8 species of *Chilocorus* Leach and one species each of *Brumoides* Chapin, *Curinus* Mulsant, and *Priscibrumus* Kovar. All these species of Chilacorini were documented as aphidophagous in 23 states/union territories of India feeding on 38 species of aphids infesting 80 plant species, with *Brumoides suturalis* (Fabricius) being the most polyphagous, feeding on 26 aphid species infesting 54 plant species across 21 states/union territories of India, followed by *Priscibrumus uropygialis* (Mulsant), which preys on 11 aphid species infesting 17 plant species in 7 states/union territories. All 8 *Chilocorus* species consume 1-8 species of aphids that infest 1-12 species of plants. *Aphis craccivora* Koch and *Aphis gossypii* Glover are preyed upon by a maximum of 4 predator species, while *Aphis pomi* De Geer and *Myzus persicae* (Sulzer) are consumed by 3 predator species, primarily found on apple, brinjal, and brassica oil seeds. Indeed, no efforts have been made to record the tri-trophic interactions of these aphid predators in various regions of India; thus, a thorough survey strategy is essential to catalogue them in those undiscovered states/union territories.

Keywords: Aphids, Biological control, Checklist, Chilacorini, Coccinellidae, Ladybird beetles, Predators, Tri-trophic association

Citation: Sharma Akhilesh, Acharya Shelley and Singh Rajendra: Checklist of tri-trophic associations of aphidophagous predators of the tribe Chilacorini (Coccinellinae: Coccinellidae: Coleoptera) in India. Intern. J. Zool. Invest. 11(1): 803-820, 2025.

<https://doi.org/10.33745/ijzi.2025.v11i01.084>



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Introduction

The family Coccinellidae, commonly referred to as ladybird beetles is by far the largest within the superfamily Coccinelloidea (Coleoptera:

Arthropoda). The family comprises many important predators of insect pests such as aphids, scales and other soft-bodied insects, thereby

contributing significantly to the advancement of biological control approaches. Around 6000 ladybird species have been identified (Hodek *et al.*, 2012), with 550 species documented in 90 genera within India (Poorani, 2019). The feeding habits of both larvae and adults are similar. When their favorite prey is not easily accessible, they look for other food options like honeydew, extrafloral nectar, and pollen. Many coccinellids exhibit strong predatory abilities and act as biocontrol agents against specific phytophagous pests (DeBach, 1964; Obrycki *et al.*, 2009; Kumar and Omkar, 2023). Traditionally, on the basis of morphology, seven subfamilies of Coccinellidae are recognised (Chilocorinae, Coccidulinae, Coccinellinae, Epilachninae, Scymninae, Sticholotidinae, Ortaliinae). Based on phylogenetic studies, Che *et al.* (2021) revised the subfamily classification of Coccinellidae comprising only three subfamilies: Microweiseinae, Monocoryninae and Coccinellinae. The subfamily Coccinellinae includes several tribes. The members of tribe Chilocorini predominantly prey on scale insects. They also feed on aphids, mealy bugs, psyllids and other soft insects. They are typically glossy and frequently lack spots or designs on their elytra. Their bodies are shaped like round helmets (Poorani, 2023).

In the agro-ecosystem, members of aphidophagous Chilocorini significantly contribute to safeguarding crops that are particularly vulnerable to aphid infestations, such as apples, brinjals, brassica crops, cowpeas, guava, okra, peas, potatoes, sorghum, tomatoes, wheat etc. (Rasool *et al.*, 2019; Singh, 2024, 2025a, b; Singh and Ahmad, 2025; Singh and Pandey, 2025; Tiwari and Singh, 2025a, b). Despite the valuable roles insects play in natural and biological control, there is growing evidence that human-induced factors (including pollution, land-use changes, habitat fragmentation, and climate change) are adversely affecting insect populations globally. Tackling these issues requires a holistic strategy that incorporates the conservation and enhancement of aphidophagous species of these tribes in agricultural ecosystems, potentially aiding in the management of aphid populations (Obrycki *et al.*,

2009). Recent checklists of Indian aphidophagous Chilocorini reveal their distribution across various states and union territories (Agarwala and Ghosh, 1988; Omkar and Pervez, 2004; Majumder *et al.*, 2013; Kundoo *et al.*, 2018; Das *et al.*, 2020; Poorani, 2023), but do not address their tri-trophic relationships.

The aphids (Hemiptera: Aphididae) are soft-bodied insects that suck plant sap. Out of 794 species of aphids recorded in India (Singh and Singh, 2019; Singh *et al.*, 2023), nearly 250 aphid species are significant threats to both farming and gardening crops (Emden and Harrington, 2007; Singh and Singh, 2016). Several species of aphids harm plants by extracting their nutrients, leading to the curling and twisting of young shoots and overall weakening of plants and also transmit more than 200 plant viruses particularly those significant for agriculture and horticulture (Singh and Singh, 2021). This article addresses the cataloguing of tri-trophic relationships among the members of the tribes Chilocorini of the subfamily Coccinellinae. The perusal of literature demonstrated that the available information on the tri-trophic relationships involving these aphidophagous predators in India is scattered and about 50% of the area has not yet been surveyed. For taxonomists, researchers, academics, conservation managers, and policymakers, this checklist would serve as an essential tool for confirming that these natural foes can be employed in the natural or biological management strategies for these aphids.

Materials and Methods

This checklist is based on the primary data from existing literature related to aphidophagous predators, including books/book chapters, journals, conference proceedings, review articles, and various reputable theses up to June 20, 2025. The inaccuracies in the scientific names of the predators, their aphid preys, and food plants are corrected because of their changed status and various nomenclatural decisions and explanations. The names of aphids, as well as the misspelled plant names in the original documents, have been

Table 1: Number of species of Chilochorini preying on aphids infesting different number of host plants in different states/union territories of India

Predator species	Number of			
	Species of aphid preys	Species of host plants	Triplets	States/union territories
1. <i>Brumoides suturalis</i>	26	54	86	22
2. <i>Chilocorus circumdatus</i>	5	4	6	3
3. <i>Chilocorus hauseri</i>	1	2	2	3
4. <i>Chilocorus infernalis</i>	5	4	5	3
5. <i>Chilocorus melas</i>	1	1	1	1
6. <i>Chilocorus nigrita</i>	9	13	21	9
7. <i>Chilocorus pakistanensis</i>	1	1	1	1
8. <i>Chilocorus politus</i>	4	2	4	2
9. <i>Chilocorus rubidus</i>	7	7	8	4
10. <i>Curinus coeruleus</i>	1	1	1	1
11. <i>Priscibrumus uropygialis</i>	11	17	20	7
Sub total	38	80	155	23

corrected where we can reasonably identify the intended species. The present checklist strives to provide the correct scientific names of the predators based on GBIF (2025) and Poorani (2023), the aphids as per Favret (2025), and the plants according to WFO (2025). Only the synonyms of aphid predators are included, and for the synonyms of aphids and their host plants, the cited sources should be consulted.

Results and Discussion

Table 1 displays the tri-trophic associations and distribution of aphidophagous Chilochorini. The members of this tribe of ladybird beetles are predominantly prey on scale insects but also feed aphids and other soft-bodied insects. Chilochorini contains more than 30 species, however, only 11 species are known aphidophagous in India. Among them, *Brumoides suturalis* (Fabricius) is highly polyphagous preying on 26 species of aphids infesting 51 species of plants.

The tribe Chilochorini mainly consumes scale insects that infest various crops of significant economic value. Generally, they have a shiny appearance and often lack spots or patterns on their elytra, with a helmet-like body. Multiple species of *Icerya* Signoret, 1875, especially the cottony cushion scale, *Icerya purchasi* Maskell, 1878, primarily on *Citrus* spp, and San Jose scale,

Comstockaspis perniciosus (Comstock, 1881) on various fruit crops, along with other scale insects, and bugs have been effectively managed by *Chilocorus* species in biological control trials (DeBach, 1964). These predatory ladybird beetles also consume various aphid species, damaging agricultural and horticultural crops and fruit trees. In India, there are 11 species of the tribe Chilochorini under 4 genera that were recorded preying on 38 species of aphids infesting 78 species of plants, resulting in 155 tri-trophic associations across 23 states and union territories of India, mostly in Punjab and Uttar Pradesh (each 23 triplets) followed by West Bengal (22 triplets), Jammu and Kashmir (17 triplets), Manipur and Tamil Nadu (each 14 triplets), Uttarakhand (13 triplets), Himachal Pradesh (12 triplets), Kerala (10 triplets) and less than 10 triplets in rest of the states and union territories (Fig. 1). One species, *Chilocorus renipustulatus* (Scriba, 1791), noted as a predator on *Calotropis procera* (Aiton) Dryand in Maharashtra (Sawarkar, 2021), seems to be misidentified and hence excluded. Photograph of all recorded aphidophagous Chilochorini species are given (Figs. 2A-K) (source: <https://www.inaturalis.org>).

Following is the detailed list of the aphidophagous ladybirds along with their aphid preys and food plants recorded from different

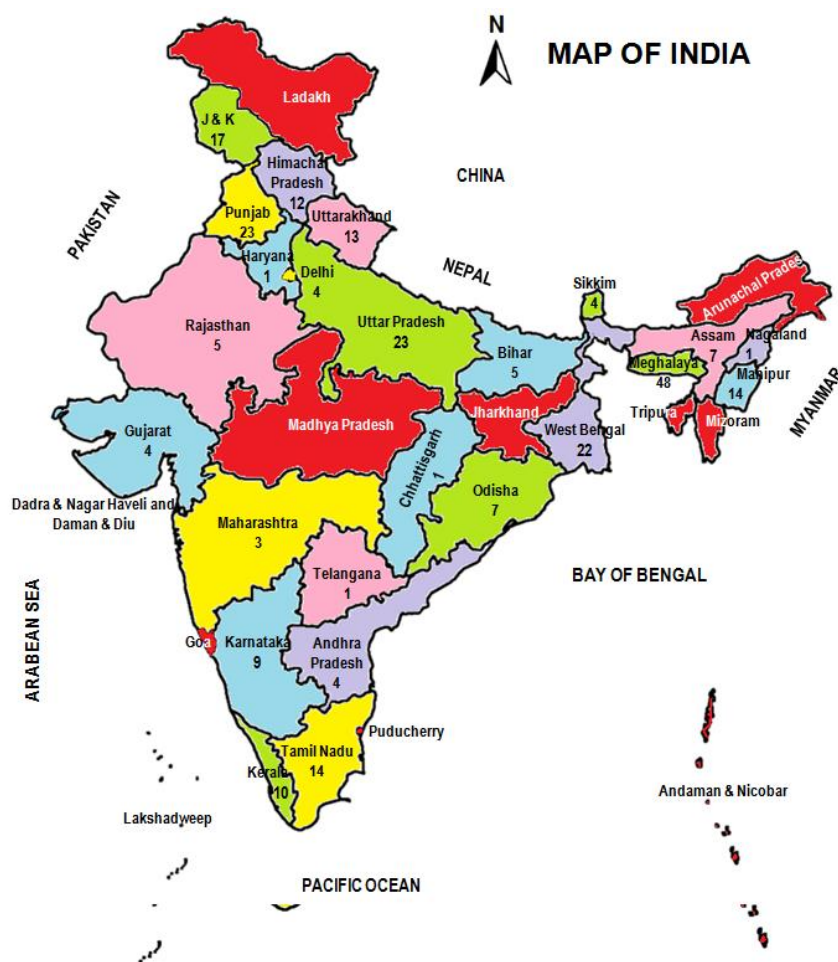


Fig. 1: Map showing the number of tri-trophic associations (triplets) of the tribe Chilocorini in different states/union territories of India. No species of the predators was recorded in the red shaded states/union territories of India.

states/union territories of India:

(A) *Brumoides suturalis* (Fabricius, 1798) [syn. *Brumoides kolhapurensis* Sathe and Bhosale, 2001; *Brumus daldorfii* Crotch, 1874; *Brumus suturalis* (Fabricius, 1798); *Coccinella suturalis* Fabricius, 1798]

Brumoides suturalis, commonly known as three-striped lady-beetle, is a moderate sized beetle measuring 3.50-3.80 mm in length and 2.70-3.00 mm wide. The body is oval with convex dorsum. Head and pronotum are orange yellow while scutellar shield is black. (Fig. 2A). Detail morphology was well illustrated by Poorani (2023). It is widely distributed in India, Nepal, Bhutan, Pakistan, Sri Lanka, and Hawaii (Poorani, 2023) and is polyphagous and feeds on aphids,

whiteflies, psyllids, scales, mealybugs, mites and also on pollen.

In India, aphid preys of *Brumoides suturalis* were recorded in 22 states/union territories preying on 26 species of aphids infesting 54 species of food plants with 86 tri-trophic associations (Table 1). Most of the tri-trophic associations were recorded in Uttar Pradesh (17 triplets) followed by Tamil Nadu and West Bengal (12 triplets each), Kerala (10 triplets) and 1-9 triplets in other states. Biology, hosts, predatory potential, mass production and use in biological control (Kapur, 1942; Gautam, 1990; Bista *et al.*, 2012) demonstrated that this species may be exploited to manage several species of aphids, particularly *Aphis craccivora*, *Aphis*



Fig. 2: (A) Photograph of aphidophagous Chilocorini: *Brumoides suturalis*, (B) *Chilocorus circumdatus*, (C) *Chilocorus hauseri*, (D) *Chilocorus infernalis*, (E) *Chilocorus melas*, (F) *Chilocorus nigrita* (G) *Chilocorus pakistanensis*, (H) *Chilocorus politus*, (I) *Chilocorus rubidus*, (J) *Curinus coeruleus*, (K) *Priscibrumus uropygialis*. (Courtesy: <https://www.inaturalist.org>)

gossypii and *Myzus persicae* damaging several agricultural crops. The detail prey species and their host plant associations in different states and union territories of India are given below:

1. *Acyrtosiphon pisum* (Harris, 1776)

- *Pisum sativum* L. - Manipur (Chakrabarti *et al.*, 2012); Uttar Pradesh (Bista *et al.*, 2012; Chaudhary and Singh, 2012)
- *Vigna unguiculata* (L.) Walp. - Uttar Pradesh (Chaudhary and Singh, 2012)

2. *Aphis affinis* del Guercio, 1911

- *Hyoscyamus muticus* L. - Himachal Pradesh

(Singh and Bali, 1993); Uttar Pradesh (Singh and Bali, 1993)

- *Mentha arvensis* L. - Himachal Pradesh (Singh and Bali, 1993); Uttar Pradesh (Singh and Bali, 1993)

3. *Aphis aurantii* Boyer de Fonsc., 1841

- *Citrus* spp. - Punjab (Singh *et al.*, 2016)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)
- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)

4. *Aphis craccivora* Koch, 1854

- *Aeschynomene indica* L. - Kerala (Thamilvel, 2009)
- *Cajanus cajan* (L.) Millsp. - Tamil Nadu (Rekha *et al.*, 2009)
- *Indigofera tinctoria* L. - Kerala (Thamilvel, 2009)
- *Lablab purpureus* (L.) Sweet - Kerala (Jose, 2003); Tamil Nadu (Rekha *et al.*, 2009); Uttar Pradesh (Chaudhary and Singh, 2012; Tiwari *et al.*, 2024); West Bengal (Gurung *et al.*, 2019)
- *Lens culinaris* Medik. - West Bengal (Poddar, 1982)
- *Psophocarpus tetragonolobus* (L.) DC. - Kerala (Thamilvel, 2009)
- *Vicia faba* L. - Manipur (Devi, 1989); Sikkim (Chakrabarti *et al.*, 2012); Uttar Pradesh (Tiwari *et al.*, 2024)
- *Vigna mungo* (L.) Hepper - Tamil Nadu (Rekha *et al.*, 2009); Uttar Pradesh (Tiwari *et al.*, 2024); Uttarakhand (Joshi and Sharma, 2008)
- *Vigna radiata* (L.) R.Wilczek - Odisha (Shailaja *et al.*, 2014)
- *Vigna unguiculata* (L.) Walp. - Karnataka (Megha *et al.*, 2015); Kerala (Sheena, 2003; Thamilvel, 2009); Tamil Nadu (Rekha *et al.*, 2009); Uttar Pradesh (Tiwari *et al.*, 2024)
- Unidentified plant - Uttarakhand (Sharma and Joshi, 2010)

5. *Aphis fabae* Scopoli, 1763

- *Quercus* sp. - Sikkim (Chakrabarti *et al.*, 2012)
- *Solanum nigrum* L. - Himachal Pradesh (Sharma *et al.*, 2009)

6. *Aphis gossypii* Glover, 1877

- *Abelmoschus esculentus* (L.) Moench - Chhattisgarh (Chaturvedani *et al.*, 2023); Karnataka (Aravinda *et al.*, 2024); Kerala (Thamilvel, 2009); Odisha (Mohapatra *et al.*, 2022); Tamil Nadu (Rekha *et al.*, 2009); West Bengal (Gurung *et al.*, 2019; Maji *et al.*, 2023)
- *Cajanus cajan* (L.) Millsp. - Uttar Pradesh (Chaudhary and Singh, 2012)

- *Capsicum annum* L. - Kerala (Thamilvel, 2009)
- *Capsicum chinense* Jacq. - Assam (Begam *et al.*, 2016; Thangjam *et al.*, 2020)
- *Capsicum frutescens* L. - Tamil Nadu (Rekha *et al.*, 2009)
- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)
- *Commelina benghalensis* L. - Kerala (Thamilvel, 2009)
- *Duranta erecta* L. - Manipur (Chakrabarti *et al.*, 2012)
- *Gossypium hirsutum* L. - Gujarat (Chakraborty, 2012); Rajasthan (Dhaka, 2013); Telangana (Mallesh and Sravanthy, 2021)
- *Lagenaria siceraria* (Molino) Standl. - Uttar Pradesh (Bista *et al.*, 2012)
- *Plantago ovata* Forssk. - Rajasthan (Ola *et al.*, 2024)
- *Portulaca oleraceae* L. - Kerala (Thamilvel, 2009)
- *Solanum lycopersicum* L. - Haryana (Khokhar and Rolania, 2021)
- *Solanum melongena* L. - Assam (Kalita *et al.*, 1998; Das and Ahmed, 2021); Kerala (Gokul *et al.*, 2024); West Bengal (Gurung *et al.*, 2019)
- *Solanum tuberosum* L. - Uttar Pradesh (Raj, 1989)
- Unknown plant - Uttarakhand (Sharma and Joshi, 2010)

7. *Aphis nerii* Boyer de Fonsc, 1841

- *Calotropis gigantea* (L.) W.T Aiton - Karnataka (Puttarudriah and Channa Basavanna, 1956)
- *Calotropis procera* (Aiton) Dryand. - Maharashtra (Sawarkar, 2021); Odisha (Behura, 1963)
- Unknown plant - Manipur (Chakrabarti *et al.*, 2012)

8. *Aphis odinae* (van der Goot, 1917)

- *Anacardium occidentale* L. - Karnataka (Vanitha *et al.*, 2022)

9. *Aphis pomi* De Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Jammu and Kashmir (Bhagat *et al.*, 1988)

10. *Aphis solanella* Theobald, 1854

- *Capsicum frutescens* L. - Uttar Pradesh (Chaudhary and Singh, 2012)

11. *Brachycaudus helichrysi* (Kaltenbach, 1843)

- *Brassica rapa* L. - West Bengal (Nath and Sen, 1976)

12. *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica oleracea* L. var. *botrytis* - Odisha (Shailaja *et al.*, 2014); Tamil Nadu (Debbarma *et al.*, 2017)
- *Brassica oleracea* L. var. *capitata* - Odisha (Shailaja *et al.*, 2014)
- *Brassica rapa* L. - West Bengal (Nath and Sen, 1976)

13. *Ceratovacuna lanigera* Zehntner, 1897

- *Saccharum officinarum* L. - Karnataka (Patil *et al.*, 2006)

14. *Eriosoma lanigerum* (Hausmann, 1802)

- *Malus domestica* (Suckow) Borkh. - Punjab (Rahman and Khan, 1941)

15. *Hayhurstia atriplicis* (Linnaeus, 1761)

- *Chenopodium album* L. - Delhi (Kapur, 1942)
- Unknown plant - Manipur (Chakrabarti *et al.*, 2012)

16. *Hyadaphis coriandri* (Das, 1918)

- *Coriandrum sativum* L. - Punjab (Sagar and Kumar, 1996); Rajasthan (Kant *et al.*, 2019); Uttar Pradesh (Chaudhary and Singh, 2012); Uttarakhand (Karki *et al.*, 2024)
- Unknown plant - Manipur (Chakrabarti *et al.*, 2012)

17. *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica carinata* A. Braun - Punjab (Kumar, 2015)

- *Brassica juncea* (L.) Czern. - Assam (Das, 2020); Odisha (Shailaja *et al.*, 2014); Punjab (Soni *et al.*, 2004; Kumar, 2015); Uttarakhand (Sharma and Joshi, 2010); West Bengal (Ghosh, 1983)

- *Brassica napus* L. - Punjab (Kumar, 2015)

- *Brassica oleracea* L. var. *botrytis* - Tamil Nadu (Debbarma *et al.*, 2017)

- *Brassica rapa* L. - Bihar (Karthik *et al.*, 2022); Himachal Pradesh (Gautam, 1990); Punjab (Kumar, 2015)

- *Eruca vesicaria* (L.) Cav. - Punjab (Kumar, 2015)

- Unknown plant - Manipur (Chakrabarti *et al.*, 2012)

18. *Melanaphis sacchari* (Zehntner, 1897)

- *Cenchrus americanus* (L.) Morrone - Andhra Pradesh (Seshu Reddy and Davies, 1979)
- *Sorghum bicolor* (L.) Moench - Andhra Pradesh (Seshu Reddy and Davies, 1979); Tamil Nadu (Rekha *et al.*, 2009)

19. *Myzus persicae* (Sulzer, 1776)

- *Abelmoschus esculentus* Moench - West Bengal (Gurung *et al.*, 2019)
- *Brassica oleracea* L. var. *botrytis* - Delhi (Kapur, 1942); Tamil Nadu (Debbarma *et al.*, 2017)
- *Brassica rapa* L. - Bihar (Karthik *et al.*, 2022)
- *Capsicum annuum* L. - Punjab (Kaur and Sangha, 2016)
- *Capsicum chinense* Jacq. - Assam (Thangjam *et al.*, 2020)
- *Cuminum cyminum* L. - Rajasthan (Gupta and Yadav, 1989)
- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)
- *Solanum lycopersicum* L. - Delhi (Kapur, 1942);

Tamil Nadu (Rekha *et al.*, 2009); Uttar Pradesh (Chaudhary and Singh, 2012)

- *Solanum melongena* L. - Assam (Borah and Saikia, 2017); Delhi (Kapur, 1942); West Bengal (Gurung *et al.*, 2019)

- *Solanum tuberosum* L. - Uttar Pradesh (Raj, 1989)

20. *Myzus persicae nicotianae* Blackman, 1987

- *Nicotiana tabacum* L. - Andhra Pradesh (Joshi *et al.*, 1979)

21. *Rhopalosiphum maidis* (Fitch, 1856)

- *Sorghum bicolor* (L.) Moench - Tamil Nadu (Rekha *et al.*, 2009); Uttar Pradesh (Tiwari *et al.*, 2024)

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

- *Zea mays* L. - Himachal Pradesh (Ankita *et al.*, 2021); Maharashtra (Verghese, 2013); Odisha (Shailaja *et al.*, 2014); Rajasthan (Swami and Bajpai, 2009; Swaminathan *et al.*, 2015)

22. *Rhopalosiphum nymphaeae* (Linnaeus, 1761)

- *Euryale ferox* Salisb. - Bihar (Saraswati and Ghosh, 1996)

23. *Sitobion avenae* (Fabricius, 1775)

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

24. *Sitobion miscanthi* (Takahashi, 1921)

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

25. *Therioaphis trifolii* (Monell, 1882)

- *Medicago sativa* L. - Uttar Pradesh (Chaudhary and Singh, 2012)

26. *Uroleucon compositae* (Theobald, 1915)

- *Carthamus tinctorius* L. - Maharashtra (Sathe and Bhosale, 2001)

(B) *Chilocorus circumdatus* (Gyllenhal, 1808) [syn. *Coccinella circumdatus* Gyllenhal, 1808]

Chilocorus circumdatus, commonly known as red

chilocorus, is slightly bigger than *Brumoides suturalis* measuring 4.50-5.10 mm in length and 4.10-4.70 mm wide. The body is oval to almost circular, dorsum hemispherical, strongly convex and glabrous. Dorsal side is uniformly bright orange-yellow to reddish brown, lateral margins of elytra with a narrow black border (Fig. 2B). Detailed morphology is well illustrated by Poorani (2023). It is distributed in 9 states/union territories of India (Assam, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Manipur, Tamil Nadu, Uttar Pradesh and West Bengal), Sri Lanka, Nepal, Pakistan, Laos, Indonesia, Australia, China, Cook Islands, Hawaii, Israel, Cyprus, South Africa, Bermuda, USA (Poorani, 2023). It is highly polyphagous and feeds on aphids, and scale insects infesting tea, coffee, pepper, mulberry, citrus, etc.

In India, aphid preys of *Chilocorus circumdatus* were recorded only in Assam, Uttar Pradesh and West Bengal, preying on 5 species of aphids infesting 4 plants (Table 1). The detail prey species and their host plant associations in India are given below:

1. *Aphis aurantii* Boyer de Fonsc, 1841

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

2. *Aphis craccivora* Koch, 1854

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

3. *Aphis gossypii* Glover, 1977

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

4. *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* L. - Uttar Pradesh (Ali, 2016)

5. *Myzus persicae* (Sulzer, 1776)

- *Machilus gamblei* King ex Hook.f. - Assam (Deori *et al.*, 2021)

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

(C) *Chilocorus hauseri* Weise, 1895

Chilocorus hauseri, is moderate sized ladybird beetle measuring 4.20-4.45 mm in length and 3.70-4.08 mm wide. The body is elongate oval with dorsum strongly convex and glabrous. Head and pronotum are black while elytra are yellow or reddish brown, lateral margins with black borders (Fig. 2C). Detailed morphology is well illustrated by Poorani (2023). It is distributed in India (Manipur, Sikkim, West Bengal), China, Laos, Myanmar, Vietnam (Poorani, 2023). It is polyphagous and mostly feeds San José and other scales infesting tea, mulberry, rose, citrus, etc. Only one species of aphid, *Aphis odinae* is reported as prey of this ladybeetle on two food plant species in three states as mentioned below:

1. *Aphis odinae* (van der Goot, 1917)

- *Anacardium occidentale* L. - Sikkim (Chakrabarti *et al.*, 2012)
- *Wendlandia glabrata* DC. - Manipur (Devi, 1989; Chakrabarti *et al.*, 2012); Nagaland (Devi, 1989)

(D) *Chilocorus infernalis* Mulsant, 1853 [syn. *Chilocorus bijugus* Mulsant, 1853; *Chilocorus bijugus infernalis* Mulsant, 1853]

Chilocorus infernalis is a medium-sized ladybird beetle that measures 4.30-6.00 mm long and 4.00-5.00 mm wide. The body is egg-shaped and tapering toward the back with a highly curved and smooth upper surface. The body is glossy black, occasionally having a greenish hue, with each elytron featuring a pair of usually dissimilar sized reddish-brown or bright yellow spots located slightly before the midpoint (Fig. 2D). It is mostly coccophagus species preying on scale insects, such as San Jose scale, plum scale etc. Its biology and predatory potential were studied by Jalali and Singh (1989), Rasheed *et al.* (2019), and Ahmad *et al.* (2021) on different economically important scale insects.

Chilocorus infernalis is distributed in 7 states/union territories of India (Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Meghalaya, Punjab, Uttarakhand, Uttar Pradesh), Bhutan, Nepal and Russia (Rahman and Khan, 1941; Poorani, 2023). However, 5 species of

aphids were recorded feeding on 4 species of plants only in three states of India as mentioned below:

1. *Aphis pomi* De Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Jammu and Kashmir (Bhagat *et al.*, 1988)

2. *Brachycaudus helichrysi* (Kaltenbach, 1843)

- *Prunus persica* (L.) Stokes - Jammu and Kashmir (Ahmad and Ghani, 1966)

3. *Eriosoma lanigerum* (Hausmann, 1802)

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Rawat and Sangal, 1993; Sharma *et al.*, 2015); Jammu and Kashmir (Wani and Masoodi, 2001; Rasool *et al.*, 2019); Punjab (Rahman and Khan, 1941)

4. *Lipaphis erysimi* (Kaltenbach, 1843)

- *Raphanus sativa* L. - Himachal Pradesh (Sharma *et al.*, 2015)

5. Unknown aphid species

- *Euonymus* sp. - Jammu and Kashmir (Khan and Zaki, 2007)

(E) *Chilocorus melas* Weise, 1898 [syn. *Chilocorus gressitti* Miyatake, 1970]

Chilocorus melas is a relatively small ladybird beetle that measures 3.10-3.80 mm long and 2.90-3.70 mm wide. The body is round with hemispherical and strongly convex dorsum. Head is dark brown to blackish with an anterior yellowish brown area in females, largely yellowish in males (Poorani, 2023) (Fig. 2E). It is mostly coccophagus feeding on scale insects. Its biology is not known. *Chilocorus melas* is distributed in India (Karnataka, Sikkim, West Bengal), Bhutan, China, Indonesia, Malaysia, Thailand, Vietnam) (Poorani, 2023). However, only one aphid prey was recorded in Karnataka as mentioned below:

1. *Aphis craccivora* Koch, 1854

- *Gliricidia maculata* (Kunth) Steud. - Karnataka (Megha *et al.*, 2015)

(F) *Chilocorus nigrita* (Fabricius, 1798) [syn.

Coccinella nigrita Fabricius, 1798; *Chilocorus nigritus* (Fabricius, 1798)]

Chilocorus nigrita is a small ladybird beetle that ranges from 3.20 to 4.00 mm in length and 2.90 to 3.90 mm in width. The body is somewhat rounded with a very convex hemispherical, glossy and smooth back. Pronotum is dark brown to black in the centre, lighter on the sides. Elytra are glossy black and have fine punctures (Poorani, 2023) (Fig. 2F). It is primarily coccophagous species that devour various scale insect species, especially armoured scale insects that affect multiple crops. The biology, foraging habits, economic significance, predatory capabilities, utility in biological control of *Chilocorus nigrita* were studied by several workers (Samways, 1984; Ponsonby and Copland, 1996; Boothe and Ponsonby, 2006). It has been effectively implemented for the biological management of scale insects in, and naturally spread to, numerous climatically suitable areas globally, such as South America and Africa (Samways *et al.*, 1999).

Chilocorus nigrita is widely distributed in India (Andaman and Nicobar, Andhra Pradesh, Assam, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal), Sri Lanka, Bangladesh, Pakistan, Nepal, Myanmar, Malaysia, Chagos Archipelago, Indonesia, Oman, Madagascar, Reunion, Mauritius, Seychelles, Togo, Ghana, East Africa, Kenya, Tanzania, South Africa, Brazil, Dominica, USA. However, in India, its aphidophagy was recorded in 9 states feeding on 9 species of aphids infesting 13 species of plants (Table 1) as mentioned below:

1. *Aphis aurantii* (Boyer de Fonscolombe, 1841)

- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)

2. *Aphis craccivora* Koch, 1854

- *Lablab purpureus* (L.) Sweet - Uttar Pradesh (Kumar *et al.*, 2017)

3. *Aphis gossypii* Glover, 1977

- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)
- *Psidium guajava* L. - Karnataka (Mani and Krishnamoorthy, 1989)
- *Solanum lycopersicum* L. - Tamil Nadu (Rekha *et al.*, 2009)

4. *Aphis nerii* Boyer de Fonsc, 1841

- *Calotropis procera* (Aiton) Dryand. - Uttarakhand (Joshi and Sharma, 2008); Uttar Pradesh (Omkar and Bind, 1995)

5. *Aphis punicae* Passerini, 1863

- *Punica granatum* L. - Karnataka (Mani and Krishnamoorthy, 1995)

6. *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica* sp. - Uttar Pradesh (Omkar and Bind, 1995); Uttarakhand (Joshi and Sharma, 2008)

7. *Ceratovacuna silvestrii* (Takahashi, 1927)

- *Bambusa* sp. - Manipur (Devi, 1989)
- *Brassica juncea* (L.) Czern. - Uttarakhand (Sharma and Joshi, 2010)
- *Brassica rapa* L. - Bihar (Karthik *et al.*, 2022); Uttar Pradesh (Omkar and Bind, 1995)

8. *Melanaphis sacchari* (Zehntner, 1897)

- *Sorghum bicolor* (L.) Moench - Andhra Pradesh (Gilstrap, 1980)

9. *Myzus persicae* (Sulzer, 1776)

- *Brassica rapa* L. - Bihar (Karthik *et al.*, 2022)
- *Brassica* sp. - Uttar Pradesh (Omkar and Bind, 1995)
- *Citrus reticulata* Blanco - Punjab (Singh and Sharma, 2010)
- *Citrus ×sinensis* (L.) Osbeck - Punjab (Singh and Sharma, 2010)
- *Machilus gamblei* King ex Hook.f. - Assam (Deori *et al.*, 2021)

- *Solanum lycopersicum* L. - Tamil Nadu (Rekha *et al.*, 2009)
- Unknown plant - Uttarakhand (Joshi and Sharma, 2008)

(G) *Chilocorus pakistanensis* (Ahmad and Ghani, 1966) [syn. *Simmondsius pakistanensis* Ahmad and Ghani, 1966]

Chilocorus pakistanensis is a little known species of ladybird beetle and measures 3.60 to 4.50 mm in length and 2.90 to 3.20 mm in width. The body is elongate oval with dorsum moderately convex. Head is blackish blue with greyish hairs and pronotum and elytra metallic greenish blue to blue, and glabrous (Poorani, 2023) (Fig. 2G). It is distributed only in India (Jammu and Kashmir and Uttarakhand) and Pakistan but aphid prey is only recorded in Jammu and Kashmir as mentioned below:

1. *Aphis pomi* De Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Jammu and Kashmir (Maqbool *et al.*, 2020)

(H) *Chilocorus politus* Mulsant 1850

Chilocorus politus is a moderate-sized species of ladybird beetle that measures 4.50 to 6.50 mm in length and 3.90 mm in width. The body is broad oval to almost circular with dorsum strongly convex. Dorsal and ventral surfaces are uniform orange-yellow to ochreous to reddish-orange (Poorani, 2023) (Fig. 2H). It is distributed in India (Manipur, Meghalaya, Sikkim, West Bengal), Bhutan, Nepal, Thailand, Laos, Indonesia, Réunion, introduced in Mauritius (Satpathi and Mandal, 2006; Chakrabarti *et al.*, 2012; Poorani, 2023). However, in India, the aphidophagous *Chilocorus politus* was recorded only in Manipur and West Bengal feeding on 4 species of aphids as mentioned below:

1. *Aphis craccivora* Koch, 1854

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

2. *Aphis gossypii* Glover, 1977

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

3. *Myzus persicae* (Sulzer, 1776)

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

4. *Nippolachnus piri* Matsumura, 1917

- Unknown plant - Manipur (Chakrabarti *et al.*, 2012)

(I) *Chilocorus rubidus* Hope, 1831 [syn. *Coccinella tristis* Faldermann, 1835; *Chilocorus tristis* (Faldermann, 1835); *Chilocorus rubidus* ab. *tristis*]

Chilocorus rubidus, commonly known as twice-stabbed lady beetle or twice-stabbed ladybird is relatively larger measuring 5.80-7.20 mm in length and 4.50-6.00 mm in width. The body is somewhat heart- or dome-shaped with strongly convex dorsum. Head, pronotum and scutellar shield are black. Two distinctive red or reddish-testaceous spots are present on the elytra (Poorani, 2023) (Fig. 2I). It is distributed in India (Himachal Pradesh, Jammu and Kashmir, Manipur, Nagaland, Uttar Pradesh, Uttarakhand, West Bengal), Nepal, Pakistan, Malaysia, Vietnam, China, Mongolia, and Japan. It is polyphagous and feeds on aphids, and scale insects (Poorani, 2023). In India, aphid preys of *Chilocorus rubidus* were recorded only in Jammu and Kashmir, Manipur, Uttarakhand and West Bengal, preying on 7 species of aphids infesting 7 species of plants (Table 1). Its biology on aphids is not known. The detail prey species and their host plant associations in India are given below:

1. *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. - Manipur (Nonita *et al.*, 2006)

2. *Aphis pomi* De Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Jammu and Kashmir (Bhagat *et al.*, 1988)

3. *Brachysiphoniella montana* (van der Goot, 1917)

- *Cynodon dactylon* (L.) Pers. - Manipur (Chakrabarti *et al.*, 2012)

- *Louisiella paludosa* (Roxb.) Landge - Manipur (Devi, 1989)

4. *Macrosiphum rosae* (Linnaeus, 1758)

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

5. *Micromyzodium filicium* David, 1958

- *Cheilanthes* sp. - Uttarakhand (Raychaudhuri *et al.*, 1979; Ghosh *et al.*, 1991)

6. *Nippolachnus piri* Matsumura, 1917

- *Pyrus communis* L. - West Bengal (Ghosh and Raychaudhuri, 1982)

7. *Sitobion rosaeiformis* (Das, 1918)

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

(J) *Curinus coeruleus* (Mulsant, 1850) [syn. *Orcus (Curinus) coeruleus* Mulsant, 1850]

Curinus coeruleus, also known as the metallic blue lady beetle, is relatively large beetle measuring 4.90-5.20 mm in length and 4.50-4.75 mm in width. The body of male is round, whereas oval in female with a prominently convex hemispherical back. The head is partially orange yellow in males and dark pitchy brown to black in females. The pronotum is a deep purplish blue, with the anterolateral flanks being a vibrant orange-yellow or reddish-orange (Poorani, 2023) (Fig. 2J). It is native to South America and introduced in south India from Thailand in 1988 (Jalali and Singh, 1989). It was also introduced in Indonesia, Hawaii, and the Philippines to manage the subabul psyllid, *Heteropsylla cubana* Crawford, 1914. It feeds mainly on whiteflies, psyllids, scale insects, thrips etc. Only a single species of sugarcane aphid was recorded as prey in south India as mentioned below:

1. *Ceratovacuna lanigera* Zehntner, 1897

- *Saccharum officinarum* L. - Karnataka (Alfred *et al.*, 2020)

(K) *Priscibrumus uropygialis* (Mulsant, 1853) [syn. *Brumus uropygialis* (Mulsant, 1853); *Exochomus uropygialis* Mulsant, 1853]

Priscibrumus uropygialis is a beetle of moderate size, measuring 3.80-4.30 mm long and 2.82-3.00 mm wide. The head, pronotum, and scutellar shield are all black. Elytra range from yellowish to reddish-brown, featuring a small, black patch at the apex (Poorani, 2023) (Fig. 2K). It is mainly distributed in India (Arunachal Pradesh; Gujarat, Himachal Pradesh, Jammu and Kashmir, Manipur, Punjab, Sikkim, Uttar Pradesh, Uttarakhand, West Bengal), Bhutan, Nepal and Pakistan preying mostly on adelgids, scales, psyllids and aphids.

In India, its aphid preys were recorded only in 7 states feeding on 11 species of aphids infesting 17 species of plants as mentioned below:

1. *Aphis craccivora* Koch, 1854

- *Pisum sativum* L. - Jammu and Kashmir (Mir, 2013)
- *Vicia faba* L. - Jammu and Kashmir (Mir, 2013)

2. *Aphis gossypii* Glover, 1977

- *Fagopyrum esculentum* Moench - Gujarat (Bhat *et al.*, 1986)
- *Fagopyrum kashmirianum* Munshi - Gujarat (Bhat *et al.*, 1986)
- *Fagopyrum tataricum* (L.) Gaertn. - Gujarat (Bhat *et al.*, 1986)
- *Lagenaria siceraria* (Molino) Standl. - Jammu and Kashmir (Bhat, 2017)
- *Malus domestica* (Suckow) Borkh. - Manipur (Chakrabarti *et al.*, 2012)
- *Solanum melongena* L. - Jammu and Kashmir (Bhat, 2017)

3. *Aphis pomi* de Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Kumari *et al.*, 2006; Kumari, 2019)
- *Malus sylvestris* Mill. - Himachal Pradesh (Karki *et al.*, 2024)

4. *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica oleracea* L. var. *gongylodes* - Jammu and Kashmir (Mir, 2013)

5. *Eriosoma lanigerum* (Hausmann, 1802)

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Sharma *et al.*, 2015); Jammu and Kashmir (Wani and Masoodi, 2001); Punjab (Rahman and Khan, 1941); Sikkim (Singh, 1993); Uttarakhand (Ghosh *et al.*, 1991)

6. *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* L. - Jammu and Kashmir (Mir, 2013)
- *Brassica rapa* L. - Jammu and Kashmir (Mir, 2013)
- *Raphanus sativa* - Himachal Pradesh (Sharma *et al.*, 2015)

7. *Myzus ornatus* (Laing, 1932)

- Unknown plant - Himachal Pradesh (Das and Raychaudhuri, 1983)

8. *Prociphilus* sp.

- *Lonicera quinquelocularis* Hardw. - Uttarakhand (Ghosh *et al.*, 1991)

9. *Pterochloroides persicae* (Cholodkovsky, 1899)

- *Prunus dulcis* (Mill.) D.A. Webb. - Jammu and Kashmir (Mahendiran *et al.*, 2018)

10. *Pterochloroides persicae* (Cholodkovsky, 1899)

- *Prunus persica* (L.) Stokes - Jammu and Kashmir (Mahendiran *et al.*, 2018)

11. *Shinjia orientalis* (Mordvilko, 1929)

- *Pteris* sp. - Uttarakhand (Ghosh *et al.*, 1991)

Ethical Statement

No animal or microbes have been used or sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Each author has contributed equally to the study's planning, analysis, writing, and editing. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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