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A catalogue of tri-trophic associations of Aphidophagous species of the ladybird beetle *Oenopia* Mulsant, 1850 (Coccinellinae: Coccinellidae: Coleoptera) in different states and union territories of India

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Abstract

The present study addresses the tri-trophic relationships involving nine species of *Oenopia* Mulsant (Coccinellidae: Coleoptera): *Oenopia billieti* (Mulsant), *Oenopia conglobata* (Linnaeus), *Oenopia kirbyi* Mulsant, *Oenopia manipurensis* Shantibala, *Oenopia mimica* Weise, *Oenopia quadripunctata* Kapur, *Oenopia sauzeti* Mulsant, *Oenopia sexareata* (Mulsant), and *Oenopia signatella* (Mulsant), identified as aphidophagous in India. The most polyphagous species, *Oenopia sauzeti* Mulsant, feeds on 44 aphid species, while *Oenopia kirbyi* Mulsant and *Oenopia sexareata* (Mulsant) feed on 41 and 30 aphid species, respectively. All these species have been recorded as predators of 72 aphid species that infest 109 plant species across 13 states and union territories in India. Most tri-trophic associations (triplets) of *Oenopia* species are documented in Manipur (105 triplets), followed by Uttarakhand (66 triplets), West Bengal (36 triplets), Himachal Pradesh (39 triplets), Nagaland (21 triplets), and several other states with 1-18 triplets. The result reveals that the mealy plum aphid, *Hyalopterus pruni* (Geoffroy), was preyed upon by the most *Oenopia* species (7 species), followed by *Aphis craccivora* Koch, *Aphis fabae* Scopoli, *Aphis gossypii* Glover, and *Macrosiphum rosae* (6 species each). In contrast, *Aphis aurantii* Boyer de Fonsc. and *Myzus persicae* (Sulzer) were attacked by 5 species each, while other aphid species faced predation from 1 to 4 predator species. The *Oenopia* are mainly associated with aphids that attack *Artemisia vulgaris* L. (17 triplets), followed by *Quercus serrata* Murray and *Malus domestica* (Suckow) Borkh. (13 triplets each); *Prunus persica* (L.) Stokes (9 triplets), *Alnus nepalensis* D. Don and *Solanum melongena* L. (8 triplets each); *Brassica oleracea* L. var. *botrytis* (7 triplets); and on various other plants with 1-5 triplets. The findings indicate that tri-trophic interactions involving these aphidophagous predators remain largely unexplored across several regions of India. Hence, systematic surveys are required to document these ladybird predators in the understudied states and union territories. Such a checklist would provide a

valuable reference for taxonomists, researchers, academicians, conservationists, and policymakers, facilitating the effective use of these natural enemies in aphid management through biological control strategies.

key words: Aphid, biological control, checklist, Coccinellidae, distribution, *Oenopia,* predator, *Propylea,* tri-trophic associations

1. Introduction

The Coccinellidae (Coleoptera: Arthropoda) is a family of beetles, commonly called ladybird beetles, that includes many important predators of insect pests such as aphids, coccids, scales, and other soft-bodied insects, thereby serving a vital role in advancing biological control strategies. Taxonomically, coccinellids rank among the extensively researched families in Coleoptera due to their distinctive appearance, which includes many species with a reddish hue and black spots. Approximately 6,000 species of ladybirds have been identified (Robertson et al., 2015), with 550 species documented across 90 genera in India (Poorani, 2019). Approximately 90% of these species are helpful predators, while the rest are either pestiferous on crops or fungus-eating. Omkar & Pervez (2004) identified 261 species of predatory coccinellids across 57 genera in India. The feeding habits of both larvae and adult forms of these beetles are similar. When their favoured prey is not easily accessible, ladybirds look for other food options like honeydew, extrafloral nectar, and pollen. Numerous coccinellids have strong predation ability and can act as biocontrol agents for specific phytophagous pests (Obrycki & Kring, 1998; Pervez et al., 2020a; Kumar & Omkar, 2023). Coccinellids are also recognised as bioindicators (Iperti & Paoletti, 1999) and provide wider perspectives on their ecosystem (Andersen, 1999). They are also recognised as a component of biological services because they offer their services to establish a biological equilibrium at the tri-trophic levels (Landis et al., 2008). Within our agroecosystem, they play a crucial role in protecting crops that are especially susceptible to aphid invasions, including cereal crops (Singh & Ahmad, 2025); vegetables like brinjals (Singh, 2025a), cabbage and cauliflower (Pal & Singh, 2013), cucurbits (Singh, 2025b), okra (Singh & Pandey, 2025), potatoes (Tiwari & Singh, 2025a), and tomatoes (Tiwari & Singh, 2025b); oilseeds crops (Singh, 2024a); pulses (Singh, 2024b); cotton (Singh, 2024c) etc. Although insects perform essential functions in biological and natural control, increasing evidence suggests that human-induced factors such as pollution, land-use alterations, habitat fragmentation, and climate change are negatively impacting insect populations worldwide. Addressing these challenges demands a comprehensive approach that includes the preservation and improvement of aphidophagous Recent catalogues of Indian Coccinellidae, including species that prey on aphids, indicate their distribution throughout different states and union territories (Agarwala & Ghosh, 1988; Omkar & Pervez, 2004; Poorani, 2023a, b, 2024), yet they do not cover their tri-trophic interactions.

Aphids (Hemiptera: Aphididae) are soft-bodied insects that extract sap from all parts of the plants. Out of the 794 species reported from India (Singh et al., 2023), nearly 250 are considered serious pests of agricultural and horticultural crops (Singh & Singh, 2016). Their successes can be attributed to various distinct traits, including polyphagy, an atypical reproductive strategy, growth behaviours, and polymorphism. Their remarkable success as pests is linked to certain unique traits such as polyphagy, unusual reproductive strategies, diverse growth patterns, and polymorphism. Depending on environmental conditions and food availability, aphids can reproduce through parthenogenesis, zygogenesis, or paedogenesis, and may exhibit both viviparity and oviparity (Singh & Singh, 2022). By draining nutrients from host plants, many species cause significant weakening of crops of economic importance. Additionally, they are recognised as vectors of over 200 plant viruses

(Singh & Singh, 2021). In natural ecosystems, their numbers are regulated by a variety of predators and parasitoids. Effective natural enemies include ladybird beetles, hover flies (Syrphidae: Diptera) (Singh, 2025c, d), predatory bugs (Singh & Srivastav, 2024), lacewings (Neuroptera) (Singh et al., 2024a), and spiders (Singh et al., 2024b). Many of these natural enemies have also been deliberately used in biological control programs to manage aphid infestations (Singh & Singh, 2022).

The genus *Oenopia* Mulsant comprises a group of aphidophagous ladybird beetles widely distributed in agricultural and natural ecosystems (Poorani, 2002, 2023a). These beetles are recognised for their predatory efficiency on soft-bodied insect pests, particularly aphids, which are among the most destructive pests of field crops, vegetables, fruits, and ornamentals. By regulating aphid populations, *Oenopia* species contribute significantly to the ecological balance of agroecosystems and provide vital ecosystem services in the form of natural pest suppression. The ecological importance of *Oenopia* lies in their role as key components of tri-trophic interactions involving host plants, herbivorous aphids, and natural enemies (Obrycki et al., 2009). Both larvae and adults are active predators, capable of reducing pest populations and thus limiting yield losses and virus transmission associated with aphid infestations. Furthermore, their presence enhances the sustainability of Integrated Pest Management (IPM) programs by reducing the reliance on chemical pesticides, conserving biodiversity, and maintaining long-term crop health. Several species of *Oenopia* have been reported as effective natural enemies in diverse cropping systems. Their wide adaptability, feeding versatility, and reproductive potential underline their importance in biological control strategies. Hence, understanding the ecological role of *Oenopia* species not only broadens knowledge of predator-prey dynamics but also highlights their potential in environmentally sustainable agriculture.

The present article deals with the tri-trophic associations of the aphidophagous species of the genus of ladybird beetle, *Oenopia* Mulsant, which comprises around 30 species found in Europe, Asian Russia, Africa, India, Sri Lanka, China, Japan, the Philippines, New Guinea, and Australia (Ślipiński et al., 2020). Both adults and larvae feed on aphids and other soft-bodied insects. Recent catalogues of aphidophagous *Oenopia* Mulsant highlight their distribution across various states and union territories, yet fail to address their tri-trophic relationships (Agarwala & Ghosh, 1988; Omkar & Pervez, 2004; Poorani, 2002, 2023a).

The primary objective of this article is to record the tri-trophic interactions of *Oenopia* species throughout different states and union territories in India. The data presented suggest that the tri-trophic interactions of these aphidophagous predators are mostly unexamined in many regions of India. This checklist is a vital resource for taxonomists, researchers, academics, conservation managers, and policymakers, ensuring these natural enemies can be used in natural or biological management approaches for aphids.

2. Materials and methods

The published literature on tri-trophic associations of aphidophagous *Oenopia* species, such as research articles, reviews, books, monographs, dissertations, and technical reports using digital databases such as Web of Science, Scopus, CAB Abstracts, Shodhganga, and Google Scholar, was retrieved and consulted up to May 31, 2025. The scientific names of each species of predators, aphids and food plants are cross-checked with authoritative databases, e.g., Catalogue of Life (https://www.catalogueoflife.org), GBIF (https://www.gbif.org), ZooBank (https://www.zoobank.org), ITIS (www.itis.gov), Aphid Species File (http://Aphid.SpeciesFile.org) and WFO (www.worldfloraonline.org). The names of aphids, as well as the wrongly spelt plant names in the original records, have been corrected where we can reasonably identify the intended species. Doubtful or misidentified species were

excluded. The text includes only the synonymy of *Oenopia* species, and for the synonymy of aphids and their host plants, sources cited can be consulted.

3. Results and Discussion

Poorani (2002, 2023a) reviewed the taxonomy and described the species of *Oenopia* Mulsant, 1850 recorded from the Indian subcontinent and also provided the key for their identification, along with their distribution and host records. The species of *Oenopia* Mulsant are widely distributed in Europe, Asiatic Russia, Africa, India, Nepal, Sri Lanka, China, Japan, the Philippines, New Guinea and Australia. Species of *Oenopia* are mostly aphidophagous. Nine species of *Oenopia* Mulsant were identified as aphidophagous in India among 13 recorded species (Poorani, 2023a): *Oenopia billieti* (Mulsant) (Figure 1A), *Oenopia conglobata* (Linnaeus) (Figure 1B), *Oenopia kirbyi* Mulsant (Figure 1C), *Oenopia manipurensis* Shantibala (Figure 1D), *Oenopia mimica* Weise (Figure 1E), *Oenopia quadripunctata* Kapur (Figure 1F), *Oenopia sauzeti* Mulsant (Figure 1G), *Oenopia sexareata* (Mulsant) (Figure 1H), and *Oenopia signatella* (Mulsant) (Figure 1I), with five being endemic; and are associated with agroecosystems and orchards and other coniferous vegetation in north and northeastern India. The most polyphagous species, *Oenopia sauzeti* Mulsant, preys on 44 aphid species, while *Oenopia kirbyi* Mulsant and *Oenopia sexareata* (Mulsant) consume 41 and 30 aphid species, respectively. All these species have been documented preying on 72 aphid species that infest 109 food plant species across only 13 states and union territories in India (Table 1). The majority of tri-trophic associations (triplets) of *Oenopia* species are concentrated in the northeastern and northwestern states of India, with Manipur contributing the highest number (105 triplets), followed by Uttarakhand (66), Meghalaya (46), Himachal Pradesh (39), West Bengal (36), Nagaland (21), and other states with 1–18 triplets (Figure 2). This dominance is attributed to the rich floral diversity of these regions, as Northeast India hosts the maximum number of aphid species/subspecies (414), while Northwest India records 310 species. In comparison, the Peninsular region, Gangetic plain, and Indus plain contribute relatively fewer aphid species, with 73, 45, and 32 species, respectively (Ghosh & Singh, 2000). The high aphid diversity in the northeastern and northwestern zones is closely linked to their exceptional plant diversity, which accounts for nearly 50% of India's total floral richness (Hajra & Rao, 1990; Handique, 2000).

Table 2 summarises the distribution of *Oenopia* species across states/union territories, along with the number of aphid species and host plants they are associated with. The highest diversity of *Oenopia* species was found in Manipur and Sikkim (6 species each), followed by Uttarakhand and West Bengal (5 species each). In terms of prey range, *Oenopia* predators fed on the greatest number of aphid species in Manipur (32), Uttarakhand (31), and Himachal Pradesh (24), with other states reporting 1–17 species. Plant diversity associated with these triplets was also richest in Manipur (51 plant species), followed by Uttarakhand (27), Himachal Pradesh (19), and 1–17 species in other regions. The data analysis shows that the mealy plum aphid, *Hyalopterus pruni* (Geoffroy), was attacked by the highest number of *Oenopia* spp. (7 species), followed by *Aphis craccivora* Koch, *Aphis fabae* Scopoli, *Aphis gossypii* Glover, and *Macrosiphum rosae* (6 species each), while *Aphis aurantii* Boyer de Fonsc. and *Myzus persicae* (Sulzer) were preyed upon by 5 species each, and other species were targeted by 1 to 4 predator species. The *Oenopia* spp. are primarily linked to aphids that infest *Artemisia vulgaris* L. (17 species of aphids), then to *Quercus serrata* Murray (13 species of aphids); *Malus domestica* (Suckow) Borkh. (11 species of aphids); *Alnus nepalensis* D. Don, *Prunus persica* (L.) Stokes and *Solanum melongena* L. (8 aphid species each); *Prunus amygdalus* Batsch (7 aphid species) and other plants with 1-5 aphid species.

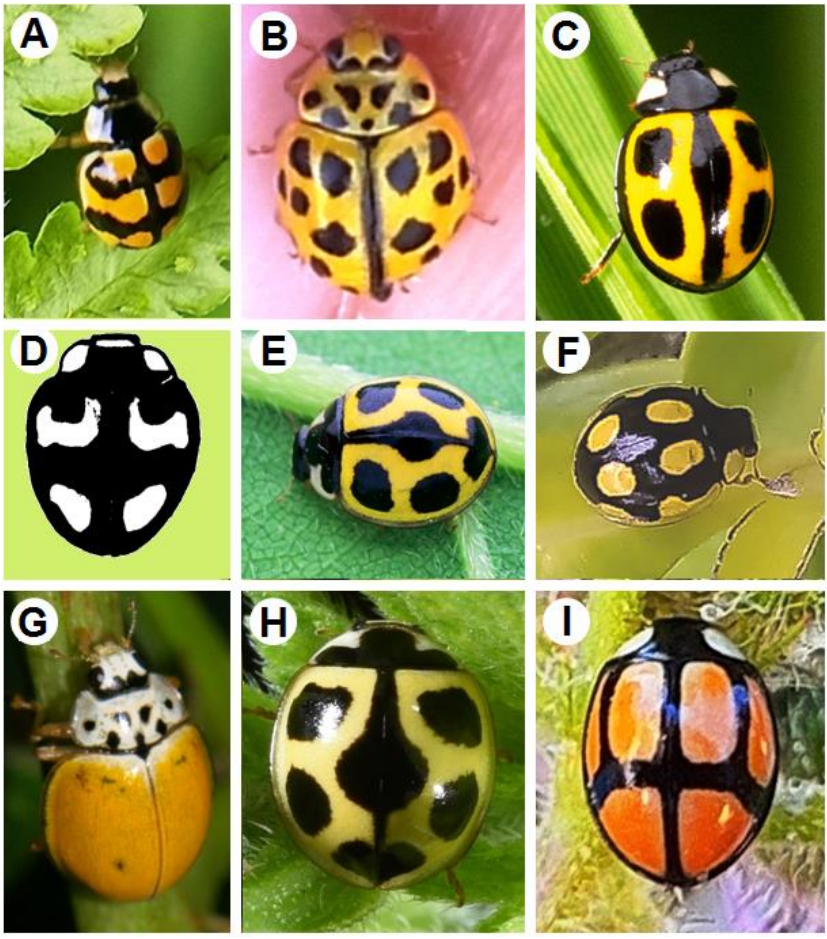

Figure 1 (A-I). Photographs of adult *Oenopia billieti* (A), *Oenopia conglobata* (B), *Oenopia kirby* (C), *Oenopia manipurensis* (D), *Oenopia mimica* (E), *Oenopia quadripunctata* (F), *Oenopia quadripunctata* (G), *Oenopia sexareata* (H), and *Oenopia signatella* (I). Courtsey: https://inaturalist.org for figures A-C and E-I and Devi (1989) for figure D.

Table 1. Number of species of *Oenopia* preying on aphids infesting different number of host plants and tri-trophic associations (triplets; predator-prey-host plant) in number of states/union territories (ST/UT) of India.

Predator species	Number of			
	Species of aphid preys	Species of host plants	Triplets	ST/UT
1. *Oenopia billieti*	8	8	9	3
2. *Oenopia conglobata*	13	17	22	4
3. *Oenopia kirbyi*	41	54	89	9
4. *Oenopia manipurensis*	7	7	7	1
5. *Oenopia mimica*	2	2	2	1
6. *Oenopia quadripunctata*	16	21	29	4
7. *Oenopia sauzeti*	44	42	66	8
8. *Oenopia sexareata*	30	46	77	8
9. *Oenopia signatella*	2	2	2	2
10. *Oenopia* spp.	7	7	8	3
Total	72	109	311	13

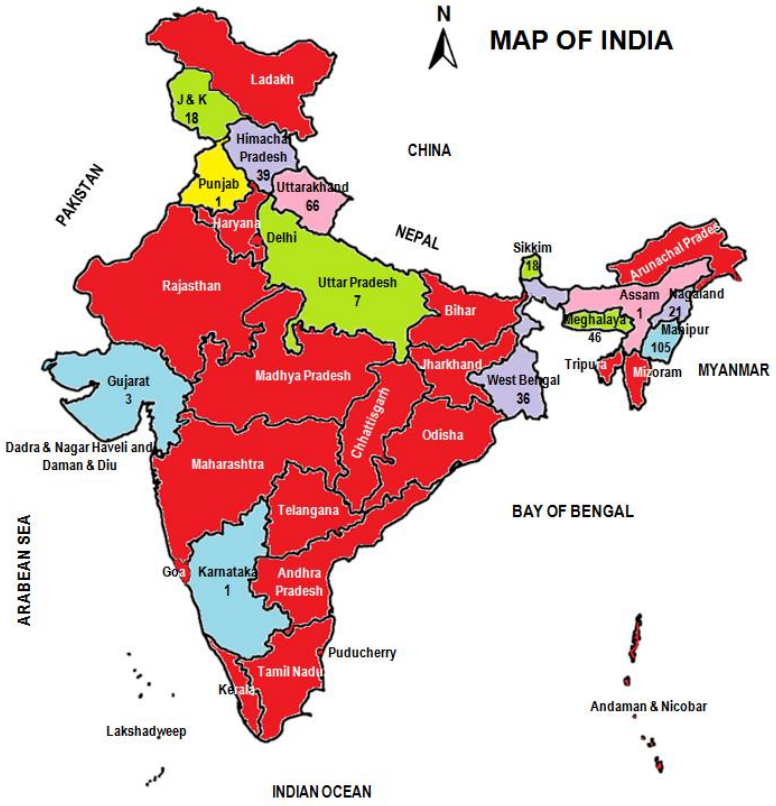

Figure 2. Map showing the number of tri-trophic associations (triplets; predator-prey-host plant) of *Oenopia* species preying on different species of aphids in different states/union territories of India. No species of the predators was recorded in the red shaded states/union territories of India.

Table 2. Number of *Oenopia* species preying on different number of aphid species and host plants and tri-trophic associations (triplets; predator-prey-host plant) in different states/union territories of India.

States/Union Territories	Number of			
	Oenopia species	Aphid species	Host plant species	Triplets
Assam	1	1	1	1
Karnataka	1	1	1	1
Punjab	1	1	1	1
Gujarat	1	1	3	3
Uttar Pradesh	2	6	5	7
Jammu & Kashmir	2	11	11	18
Sikkim	6	12	13	18
Nagaland	4	10	11	21
West Bengal	5	17	17	36
Himachal Pradesh	4	24	19	39
Meghalaya	2	7	16	46
Uttarakhand	5	31	27	66
Manipur	6	32	51	105
Total	**9**	**72**	**109**	**311**

A. *Oenopia billieti* (Mulsant, 1853) [syn. *Adalia indica* Crotch, 1874; *Coccinella (Synharmonia) billieti* var. *pruthii* Kapur, 1958; *Coccinella (Synharmonia) billieti* var. *testacea* Kapur, 1958; *Coccinella transgressa* Mulsant, 1853; *Coccinella billieti* (Mulsant, 1853); *Harmonia billieti* Mulsant, 1853; *Oenopia gonggarensis* Jing, 1992.; *Oenopia picithoroxa* Jing, 1992; *Oenopia pomiensis* Jing, 1987; *Propylea kehamae* Crotch, 1874; *Protocaria billieti* (Mulsant, 1853); *Synharmonia billieti* (Mulsant, 1853)].

Oenopia billieti (Mulsant) (Figure 1A) is described from "les provinces boréales des Indes Orientales" (the boreal provinces of the East Indies), being *Harmonia billieti* Mulsant, 1853 as the type species. It is a moderate-sized beetle measuring 3.00-4.15 mm long and 2.10-2.9 mm wide. The body is elongate oval, weakly convex, with black markings on the head, with a transverse black marking in the basal half. The head is anteriorly yellow or with a triangular black macula, pronotum with a large, trapezoidal median black macula. Elytra are immaculate yellow or with a double anchor-shaped pattern, sometimes coalesced to form a larger pattern with rows of spots (Poorani, 2023a). Biologically, it is a voracious predator of several soft-bodied insects, especially aphids, which are serious pests of agricultural and horticultural crops. Its predatory efficiency, adaptability to varied habitats, and role in reducing pest densities make it an important component of natural biological control (Savoiskaya, 1983; Kontodimas et al., 2007). It is distributed in India (Assam, Himachal Pradesh, Jammu & Kashmir, Karnataka, Meghalaya, Punjab, Sikkim, Uttar Pradesh, Uttarakhand), Nepal and China (Tibet) (Poorani, 2023a). In India, aphid preys were recorded only in 3 states, Himachal Pradesh, Sikkim and Uttarakhand, preying on 8 species of aphids infesting 8 species of food plants with 9 tri-trophic associations (Table 1). The details of prey species and their host plant associations in different states and union territories of India are given below.

1. ***Brachycaudus helichrysi* (Kaltenbach, 1843)**

- *Prunus persica* (L.) Stokes - Himachal Pradesh (Verma & Chowdhuri, 1975)

2. ***Macrosiphum rosae* (Linnaeus, 1758)**

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

3. ***Myzus sorbi* Bhattacharya & Chakrabarti, 1982**

- *Sorbaria tomentosa* (Lindl.) Rehder - Uttarakhand (Ghosh et al., 1991)

4. ***Prociphilus* sp.**

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

5. ***Sappaphis* sp.**

- *Cotoneaster obtusus* Wall. ex Lindl. - Uttarakhand (Ghosh et al., 1991)

6. ***Shinjia orientalis* (Mordvilko, 1929)**

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

7. ***Sitobion rosaeiformis* (Das, 1918)**

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

8. **Unidentified aphid**

- *Artemisia* sp. - Sikkim (Poorani, 2002)

- *Spiraea* sp. - Himachal Pradesh (Poorani, 2002)

B. *Oenopia conglobata* (Linnaeus, 1758) [syn. *Coccinella conglobata* Linnaeus, 1758; *Harmonia conglobata* (Linnaeus, 1758); *Synharmonia conglobata* (Linnaeus, 1758)]

Oenopia conglobata (Linnaeus), commonly known as the poplar ladybird beetle, is a moderate-sized beetle measuring 3.50-5.40 mm long and 2.80-4.60 mm wide. The body is oval, moderately convex, with a pale creamy yellow head, with a transverse black marking in the basal half. Pronotum is creamy yellow with seven black spots, sometimes variously fused or reduced. Ground colour of elytra is pinkish or pale yellow, with eight irregular spots; elytral spots variable, fused or reduced or completely absent (Figure 1B). The larvae are highly voracious, consuming large numbers of aphids daily, and are capable of rapidly reducing aphid colonies in orchards and crop fields, while the adults feed continuously and contribute to long-term suppression of aphid populations while also reproducing, ensuring population persistence of the predator (Kontodimas et al., 2007). It is distributed in India (Assam, Gujarat, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, West Bengal), Afghanistan, Pakistan, the Palaearctic, North Africa, and North America (Bhat et al., 1986; Chakrabarti et al., 2012; Poorani, 2023a). In India, its aphid preys were recorded only in 4 states, Gujarat, Jammu & Kashmir, Manipur and West Bengal, preying on 12 species of aphids infesting 15 species of food plants with 16 tri-trophic associations (Table 1). The detailed tri-trophic associations in different states and union territories of India are given below.

1. *Acyrthosiphon pisum* (Harris, 1776)

- *Pisum sativum* L. - Jammu & Kashmir (Bhat, 2008)

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

- *Citrus 'aurantium* L. - Manipur (Chakrabarti et al., 2012)

3. *Aphis craccivora* Koch, 1854

- *Phaseolus vulgaris* L. - Jammu & Kashmir (Bhat, 2017)

4. *Aphis fabae* Scopoli, 1763

- *Euonymus* sp. - Jammu & Kashmir (Khan et al., 2009)

- *Malus domestica* (Suckow) Borkh. - Jammu & Kashmir (Khan et al., 2009)

- *Pyrus pashia* Buch.- Ham. ex D. Don - Jammu & Kashmir (Khan et al., 2009)

- *Rumex acetosella* L. - Jammu & Kashmir (Bhat, 2017)

5. *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)

- *Solanum melongena* L. - Jammu & Kashmir (Bhat, 2008)

6. *Aphis pomi* De Geer, 1773

- *Euonymus* sp. - Jammu & Kashmir (Khan et al., 2009)

- *Malus domestica* (Suckow) Borkh. - Jammu & Kashmir (Khan et al., 2009; Khan & Shah, 2018)

- *Pyrus pashia* Buch.- Ham. ex D. Don - Jammu & Kashmir (Khan et al., 2009)

7. ***Chromaphis juglandicola*** **(Kaltenbach, 1843)**

- *Juglans regia* L. - Jammu & Kashmir (Gull & Rasheed, 2024)

8. ***Eriosoma lanigerum*** **(Hausmann, 1802)**

- *Malus domestica* (Suckow) Borkh. - Jammu & Kashmir (Wani & Masoodi, 2001; Rasool et al., 2019)

9. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Arundo donax* L. - Manipur (Chakrabarti et al., 2012)

10. ***Lipaphis erysimi*** **(Kaltenbach, 1843)**

- *Brassica rapa* L. - Jammu & Kashmir (Bhat, 2017)

11. ***Macrosiphum rosae*** **(Linnaeus, 1758)**

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

13. ***Panaphis juglandis*** **(Goeze, 1778)**

- *Juglans regia* L. - Jammu & Kashmir (Gull & Rasheed, 2024)

14. ***Pterochloroides persicae*** **(Cholodkovsky, 1899)**

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

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

C. *Oenopia kirbyi* Mulsant, 1850 [syn. *Gyrocaria kirbyi* (Mulsant, 1850)]

Oenopia kirbyi Mulstant is a moderate-sized beetle measuring 3.70-3.90 mm long and 3.00-3.20 mm wide. The body is oval, moderately convex and glabrous with a black head. Pronotum is black with anterolateral corners yellow. Ground colour of elytra is bright lemon yellow, with four black spots and black margins, sutural black stripe broad and medially wider (Figure 1C). It is distributed in India (Arunachal Pradesh, Assam, Himachal Pradesh, Karnataka, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttar Pradesh, Uttarakhand, West Bengal), Bhutan, Nepal, and Myanmar (Rao, 1969; Devi, 1989; Poorani, 2023a). In India, its aphid preys were recorded only in 9 states: Himachal Pradesh, Karnataka, Manipur, Meghalaya, Nagaland, Sikkim, Uttar Pradesh, Uttarakhand, and West Bengal, preying on 41 species of aphids infesting 52 species of food plants with 76 tri-trophic associations (Table 1). Most of the tri-trophic associations were recorded in Manipur (26 triplets), followed by Uttarakhand (24 triplets). It is an important aphidophagous ladybird beetle with considerable ecological value in natural and agricultural ecosystems. Both larvae and adults are voracious feeders on aphids of several species, which are serious pests of roses, vegetables, cereals, and fruit crops and act as a natural biological control agent, reducing dependence on chemical insecticides (Gaikwad et al., 2022). Biology, ecology and foraging behaviour of *Oenopia kirbyi* Mulstant have been studied by several workers (Ghosh et al.,

1986a; Kumari et al., 2021; Gaikwad et al., 2022). The detailed tri-trophic associations in different states and union territories of India are given below.

1. ***Acyrthosiphon pisum*** **(Harris, 1776)**

- *Pisum sativum* L. - Meghalaya (Azad Thakur & Barwal, 1987); Uttar Pradesh (Tiwari et al., 2024)

2. ***Aiceona titabarensis*** **(Raychaudhuri & Ghosh, 1964)**

- *Litsea monopetala* Pers. - Manipur (Devi, 1989)

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

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

- *Schima wallichii* (DC.) Korth. - Manipur (Devi, 1989); Nagaland (Devi, 1989)

4. ***Aphis craccivora*** **Koch, 1854**

- *Solanum melongena* L. - Uttar Pradesh (Tiwari et al., 2024); West Bengal (Satpathi & Mandal, 2006)

- *Vicia faba* L. - Meghalaya (Azad Thakur & Barwal, 1987)

5. ***Aphis fabae*** **Scopoli, 1763**

- *Solanum nigrum* L. - West Bengal (Poorani, 2002)

6. ***Aphis gossypii*** **Glover, 1977**

- *Boehmeria virgata* subsp. *macrophylla* (Hornem.) Friis & Wilmot- Dear - Manipur (Devi, 1989)

- *Bougainvillea spectabilis* Willd. - Manipur (Devi, 1989)

- *Chromolaena odorata* (L.) R.M.King & H.Rob. - Manipur (Devi, 1989)

- *Colocasia esculenta* (L.) Schott - Manipur (Devi, 1989); Meghalaya (Azad Thakur & Barwal, 1987); Nagaland (Devi, 1989)

- *Cucumis sativus* L. - Himachal Pradesh (Kumari et al., 2021); West Bengal (Poorani, 2002)

- *Duranta erecta* L. - Manipur (Devi, 1989)

- *Hibiscus cannabinus* L. - Manipur (Devi, 1989)

- *Hibiscus rosasinensis* L. - Manipur (Devi, 1989)

- *Jasminum* sp. - Manipur (Devi, 1989)

- *Osbeckia chinensis* L. - Manipur (Devi, 1989)

- *Psidium guajava* L. - Manipur (Chakrabarti et al., 2012)

- *Solanum betaceum* Cav. - Meghalaya (Azad Thakur & Barwal, 1987)

- *Solanum melongena* L. - West Bengal (Satpathi & Mandal, 2006); Uttar Pradesh (Tiwari et al., 2024)

- *Solanum* sp. - Manipur (Devi, 1989)

- Host plant not recorded - Sikkim (Agarwala et al., 1981); Uttarakhand (Sharma & Joshi, 2020)

7. *Aphis kurosawai* Takahashi, 1921

- *Artemisia* sp. - Uttarakhand (Ghosh et al., 1986a)

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

8. *Aphis paraverbasci* Chakrabarti, 1976

- Host plant not recorded - Himachal Pradesh (Das & Raychaudhuri, 1983)

9. *Aphis solanella* Theobald, 1854

- *Argemone mexicana* L. - West Bengal (Debnath, 2020)

- *Solanum nigrum* L. - Karnataka (Rao, 1969)

- Host plant not recorded - West Bengal (Chakrabarti et al., 2012)

10. *Aphis spiraecola* Patch, 1914

- *Solanum nigrum* L. - Himachal Pradesh (Das & Raychaudhuri, 1983)

11. *Brachycaudus helichrysi* (Kaltenbach, 1843)

- *Prunus persica* (L.) Stokes - Himachal Pradesh (Sharma et al., 2015); Uttarakhand (Ghosh et al., 1986a)

12. *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica juncea* (L.) Czern. - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *alboglabra* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *botrytis* - Himachal Pradesh (Sharma & Verma, 1993); Meghalaya (Firake et al., 2012); Uttar Pradesh (Tiwari et al., 2024)

- *Brassica oleracea* L. var. *capitata* - Meghalaya (Azad Thakur & Barwal, 1987; Firake et al., 2012)

- *Brassica oleracea* L. var. *italica* - Meghalaya (Firake et al., 2012)

- *Brassica* sp. - Uttarakhand (Ghosh et al., 1986a)

13. *Capitophorus elaeagni* (del Guercio, 1894)

- *Cirsium wallichii* DC. - Uttarakhand (Ghosh et al., 1991)

14. *Capitophorus formosartemisiae* (Takahashi, 1921)

- *Artemisia* sp. - Uttarakhand (Ghosh et al., 1986a)

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

15. ***Cavariella aegopodii*** **(Scopoli, 1763)**

- *Malus domestica* (Suckow) Borkh. - Uttarakhand (Ghosh et al., 1986b)

- *Salix tetrasperma* Roxb. - Uttarakhand (Ghosh et al., 1986a, b)

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

16. ***Cavariella indica*** **Maity & Chakrabarti, 1982**

- *Salix babylonica* L. - Uttarakhand (Ghosh et al., 1991)

17. ***Cervaphis quercus*** **Takahashi, 1918**

- *Quercus serrata* Murray - Manipur (Shantibala et al., 2009)

18. ***Cervaphis rappardi indica*** **Basu, 1961**

- *Cajanus cajan* (L.) Millsp. - Manipur (Shantibala et al., 1997)

19. ***Coloradoa rufomaculata*** **(Wilson, 1908)**

- *Chrysanthemum* sp. - Himachal Pradesh (Agarwala et al., 1981)

20. ***Eriosoma lanigerum*** **(Hausmann, 1802)**

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Sharma et al., 2015); Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

21. ***Eulachnus thunbergii*** **(Wilson, 1919)**

- *Pinus kesiya* Royle ex Gordon - Manipur (Devi, 1989)

22. ***Eutrichosiphum raychaudhurii*** **(Ghosh, 1969)**

- *Alnus nepalensis* D. Don - Nagaland (Devi, 1989)

23. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Prunus americana* Marshall - Manipur (Devi & Singh, 1987; Devi, 1989)

- *Prunus persica* (L.) Stokes - Manipur (Devi & Singh, 1987)

24. ***Liosomaphis himalayensis*** **Basu, 1964**

- *Berberis aristata* DC. - Uttarakhand (Ghosh et al., 1991)

25. ***Lipaphis erysimi*** **(Kaltenbach, 1843)**

- *Brassica juncea* (L.) Czern. - Meghalaya (Damitre, 2019; Firake et al., 2012)

- *Brassica napus* L. - Manipur (Devi, 1989); Meghalaya (Firake et al., 2012)

- *Raphanus sativus* L. - Meghalaya (Firake et al., 2012)

26. ***Macrosiphoniella pseudoartemisiae*** **Shinji, 1933**

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

27. ***Macrosiphoniella sanborni*** **(Gillette, 1908)**

- *Chrysanthemum* sp. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

28. ***Macrosiphoniella yomogifoliae*** **(Shinji, 1924)**

- *Artemisia vulgaris* L. - Manipur (Devi, 1989); Nagaland (Devi, 1989)

29. ***Macrosiphoniella*** **sp.**

- *Artemisia* sp. - Uttarakhand (Ghosh et al., 1986a)

30. ***Macrosiphum rosae*** **(Linnaeus, 1758)**

- *Rosa indica* L. - West Bengal (Gurung et al., 2019)

- *Rosa* sp. - Himachal Pradesh (Gaikwad et al., 2022); Uttarakhand (Ghosh et al., 1991); West Bengal (Ghosh & Raychaudhuri, 1982; Debnath, 2020)

31. ***Mollitrichosiphum*** **sp.**

- *Alnus nepalensis* D. Don - Uttarakhand (Ghosh et al., 1991)

32. ***Myzus dycei*** **Carver, 1961**

- *Urtica dioica* L. - Manipur (Devi, 1989); Nagaland (Devi, 1989); Uttarakhand (Ghosh et al., 1991)

33. ***Myzus siegesbeckicola*** **Strand, 1929**

- *Urtica dioica* L. - Uttarakhand (Ghosh et al., 1986a)

34. ***Myzus persicae*** **(Sulzer, 1776)**

- *Brassica juncea* (L.) Czern. - Meghalaya (Firake et al., 2012)

- *Brassica napus* L. - Manipur (Devi, 1989; Singh & Singh, 1991)

- *Brassica oleracea* L. var. *alboglabra* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *botrytis* - Himachal Pradesh (Sharma et al., 2020); Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *capitata* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *gongylodes* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *italica* - Meghalaya (Firake et al., 2012)

- *Brassica juncea* (L.) Czern. - Meghalaya (Firake et al., 2012)

- *Brassica napus* L. - Meghalaya (Firake et al., 2012)

- *Solanum betaceum* Cav. - Meghalaya (Azad Thakur & Barwal, 1987)

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

- *Solanum tuberosum* L. - Meghalaya (Azad Thakur & Barwal, 1987)

- Host plant not recorded - Uttarakhand (Sharma & Joshi, 2020)

35. ***Phorodon cannabis*** **Passerini, 1860**

- *Cannabis sativa* L. - Uttarakhand (Ghosh et al., 1986a, 1991)

36. ***Rhopalosiphum maidis*** **(Fitch, 1856)**

- *Hordeum vulgare* L. - Sikkim (Ghosh & Raychaudhuri, 1982; Chakrabarti et al., 2012); Uttar Pradesh (Tiwari et al., 2024)

- *Zea mays* L. - Himachal Pradesh (Ankita et al., 2021); Meghalaya (Azad Thakur & Barwal, 1987); Uttar Pradesh (Tiwari et al., 2024)

37. ***Rhopalosiphum nymphaeae*** **(Linnaeus, 1761)**

- *Prunus amygdalus* Batsch - Manipur (Devi & Singh, 1987)

- *Prunus dulcis* (Mill.) D.A. Webb. - Sikkim (Chakrabarti et al., 2012)

38. ***Sitobion rosaeiformis*** **(Das, 1918)**

- *Rosa bourboniana* L. - Himachal Pradesh (Kakkar & Sood, 1989)

- *Rosa* sp. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991); West Bengal (Raychaudhuri et al., 1979; Debnath, 2020)

39. ***Tuberculatus indicus*** **Ghosh, 1972**

- *Quercus acutissima* Carruth. - Manipur (Singh et al., 1991)

- *Quercus griffithii* Hook.f. & Thomson ex Miq. - Manipur (Singh et al., 1991)

- *Quercus serrata* Murray - Manipur (Singh & Singh, 1985; Chakrabarti et al., 2012)

40. ***Tuberculatus nervatus*** **Chakrabarti & Raychaudhuri, 1976**

- *Quercus serrata* Murray - Manipur (Shantibala et al., 2009)

41. Tuberculatus paiki Hille Ris Lambers, 1974

- *Quercus serrata* Murray - Manipur (Singh et al., 1985; Devi, 1989)

D. *Oenopia manipurensis* Devi, 1989

Oenopia manipurensis Devi is described in a Ph. D. thesis by Devi (1989). Singh & Singh (1991) mentioned the species as *Oenopia manipurensis* Devi, Singh & Singh (M/S name), but it was probably not formally published and accordingly appears to be a nomen nudum (Poorani, 2023a). It is a small beetle measuring 3.10-3.70 mm long and 2.30-3.20 mm wide. The body is oval, with a black head. Pronotum is black with anterior corner with yellowish spot. Elytra is black with yellowish spots, anterior spots are horseshoe-shaped and expanded at the extremities, and the posterior spot is rounded. She mentioned that it is closer to *Oenopia quadripunctata* Kapur, but it differs from it by elytral colour pattern and nature of male genitalia (Figure 1D). It is recorded only in Manipur, preying on 7 species of aphids infesting 7 species of food plants with 7 tri-trophic associations (Table 1). The detail prey species and their host plant associations are given below.

1. ***Aphis craccivora*** **Koch, 1854**

- *Lablab purpureus* (L.) Sweet - Manipur (Devi, 1989)

2. *Aphis gossypii* Glover, 1977

- *Psidium guajava* L. - Manipur (Devi, 1989)

3. *Cervaphis rappardi indica* Basu, 1961

- *Cajanus cajan* (L.) Millsp. - Manipur (Shantibala et al., 1997)

4. *Eulachnus thunbergii* (Wilson, 1919)

- *Pinus kesiya* Royle ex Gordon - Manipur (Devi, 1989)

5. *Hyalopterus pruni* (Geoffroy, 1762)

- *Prunus americana* Marshall - Manipur (Devi, 1989)

6. *Macrosiphoniella yomogifoliae* (Shinji, 1924)

- *Artemisia vulgaris* L. - Manipur (Devi, 1989)

7. *Tuberculatus paiki* Hille Ris Lambers, 1974

- *Quercus serrata* Murray - Manipur (Devi, 1989)

E. *Oenopia mimica* Weise, 1902 [syn. *Oenopia sauzeti* sensu Kapur, 1958; *Gyrocaria mimica* (Weise, 1902)]

Oenopia mimica Weise is a moderate-sized beetle measuring 3.00-4.30 mm long and 2.95-3.10 mm wide. The body is oval, dorsum convex and glabrous with the head black in females and yellow in males. Ground colour of pronotum and elytra is bright lemon yellow to creamy yellow. Pronotum is black with a hat-shaped macula on the posterior margin, the outer edges of which are extended posteriorly, touching the posterolateral corners of the pronotum (Figure 1E). It is distributed in India (Arunachal Pradesh, Assam, Himachal Pradesh, Sikkim, Uttarakhand, Uttar Pradesh, West Bengal), Bhutan, Nepal, Myanmar and Laos (Poorani, 2023a; Nautiyal & Pervez, 2024). In India, it is recorded on *Taoia indica* Ghosh & Raychaudhuri feeding on *Alnus nepalensis* D. Don and on an unknown aphid, on *Artemisia* sp. in Sikkim. In other states, it feeds usually on *Adelges* spp. infesting conifer trees. The detailed tri-trophic associations are given below.

1. *Taoia indica* (Ghosh & Raychaudhuri, 1972)

- *Alnus nepalensis* D. Don - Sikkim (Joshi & Sangma, 2015)

2. Unidentified aphid

- *Artemisia* sp. - Sikkim (Poorani, 2002)

F. *Oenopia quadripunctata* Kapur, 1963

Oenopia quadripunctata Kapur, also known as the four-spotted lady beetle, is a moderate-sized beetle measuring 3.00-3.50 mm long and 2.50-2.90 mm wide. The body is broadly rounded to slightly more elongate oval, dorsum moderately convex and glabrous with a black head in females, yellow in males. Pronotum is black, and its area extending from the anterolateral corners to the posterior margin is yellowish. Ground colour of elytra is black,

with four bright lemon yellow, oval spots and four semicircular or half spots near lateral margins (Poorani, 2023a) (Figure 1F). It is distributed in India (Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand, West Bengal), Bhutan, Myanmar, and China (Poorani, 2023a). In India, its aphid preys were recorded only in 4 states, Manipur, Nagaland, Sikkim and West Bengal, preying on 16 species of aphids infesting 19 species of food plants with 25 tri-trophic associations (Table 1). Most of the tri-trophic associations were recorded in Manipur (20 triplets). Poorani (2002) mentioned that it is also associated with aphids feeding on *Abelmoschus esculentus* (L.) Moench and *Duranta erecta* L. Singh et al. (1993) provided accounts of its prey, biology and feeding potential. The details of prey species and their host plant associations in different states and union territories of India are given below.

1. *Aiceona titabarensis* (Raychaudhuri & Ghosh, 1964)

- *Litsea monopetala* Pers. - Manipur (Devi, 1989)

2. *Aphis craccivora* Koch, 1854

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

- *Vicia faba* L. - Manipur (Devi, 1989)

3. *Aphis fabae* Scopoli, 1763

- Host plant not recorded - Sikkim (Ghosh & Raychaudhuri, 1982)

4. *Aphis gossypii* Glover, 1977

- *Artocarpus integer* (Thunb.) Merr. - Manipur (Devi & Singh, 1987)

- *Callicarpa macrophylla* Vahl - Manipur (Devi, 1989); Nagaland (Devi, 1989)

- *Malus domestica* (Suckow) Borkh. - Manipur (Devi & Singh, 1987)

- *Psidium guajava* L. - Manipur (Devi & Singh, 1987; Chakrabarti et al., 2012); Nagaland (Devi, 1989)

- *Solanum melongena* L. - Manipur (Nonita et al., 2006); West Bengal (Satpathi & Mandal, 2006)

5. *Aphis solanella* Theobald, 1914

- *Quercus* sp. - Sikkim (Raychaudhuri et al., 1979)

- Host plant not recorded - Manipur (Chakrabarti et al., 2012)

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

- *Camellia sinensis* (L.) Kuntze - Sikkim (Agarwala & Raychaudhuri, 1981)

- *Schima wallichii* (DC.) Korth. - Manipur (Chakrabarti et al., 2012)

7. *Ceratovacuna lanigera* Zehntner, 1897

- *Saccharum officinarum* L. - Manipur (Devi, 1989)

8. *Cervaphis quercus* Takahashi, 1918

- *Quercus acutissima* Carruth. - Manipur (Singh et al., 1991)

- *Quercus griffithii* Hook.f. & Thomson ex Miq. - Manipur (Singh et al., 1991)

- *Quercus serrata* Murray - Manipur (Shantibala et al., 2009)

9. ***Cervaphis rappardi indica*** **Basu, 1961**

- *Cajanus cajan* (L.) Millsp. - Manipur (Shantibala et al., 1997; Devi et al., 2002)

10. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Prunus amygdalus* Batsch - Manipur (Devi & Singh, 1987)

- *Prunus persica* (L.) Stokes - Manipur (Devi & Singh, 1987); Nagaland (Devi, 1989)

11. ***Myzus persicae*** **(Sulzer, 1776)**

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

- *Solanum tuberosum* L. - Manipur (Shantibala & Singh, 1985)

12. ***Phorodon cannabis*** **Passerini, 1860**

- *Cannabis sativa* L. - Manipur (Devi, 1989)

13. ***Sumatraphis celti*** **Takahashi, 1935**

- *Celtis tetrandra* Roxb. - Manipur (Devi, 1989)

14. ***Tuberculatus indicus*** **Ghosh, 1972**

- *Quercus acutissima* Carruth. - Manipur (Singh et al., 1991)

- *Quercus griffithii* Hook.f. & Thomson ex Miq. - Manipur (Singh et al., 1991)

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

15. ***Tuberculatus nervatus*** **Chakrabarti & Raychaudhuri, 1976**

- *Quercus serrata* Murray - Manipur (Singh et al., 1993; Shantibala et al., 2009)

16. Tuberculatus paiki Hille Ris Lambers, 1974

- *Quercus serrata* Murray - Manipur (Singh et al., 1985; Devi, 1989)

G. *Oenopia sauzeti* Mulsant, 1866 [syn. *Gyrocaria sauzeti* (Mulsant, 1866)]

Oenopia sauzeti Mulsant, also known as the black-spotted lady beetle, is a moderate-sized beetle measuring 3.40-4.60 mm long and 2.76-3.60 mm wide. The body is short and oval with a moderately convex and glabrous dorsum. The head of the female is black, while yellow of the male. Ground colour of pronotum and elytra is creamy yellow to bright lemon yellow with black markings. Pronotum with a hat-shaped black marking on the posterior margin, and its posterolateral ends never reach to posterolateral corners of the pronotum. Median sutural spot of elytra is broad, distinctly transverse-quadrate and rectangular, rarely with rounded edges (Figure 1G). The adults and grubs were observed among the key predators evaluated against the rose aphid, *Macrosiphum rosae,* in Himachal Pradesh (Sharma et al., 2025). However, their lifetime consumption values reported in the field were generally lower than lab estimates (Gaikwad, 2020). It is widely distributed in India (Assam, Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland,

Mizoram, Punjab, Sikkim, Tripura, West Bengal, Uttar Pradesh, Uttarakhand), Bhutan, Pakistan, Nepal, Myanmar, Thailand, China, Laos, Vietnam and Taiwan (Poorani, 2023a). In India, its aphid preys were recorded only in 8 states, Himachal Pradesh, Jammu & Kashmir, Manipur, Nagaland, Punjab, Sikkim, Uttarakhand and West Bengal, preying on 44 species of aphids infesting 41 species of food plants with 65 tri-trophic associations (Table 1). Most of the tri-trophic associations were recorded in Uttarakhand (31 triplets). Singh et al. (1993) provided accounts of its prey, biology and feeding potential. The details of prey species and their host plant associations in different states and union territories of India are given below.

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

- *Schima wallichii* (DC.) Korth. - Sikkim (Chakrabarti et al., 2012)

2. *Aphis craccivora* Koch, 1854

- *Lablab purpureus* (L.) Sweet - Uttarakhand (Pervez et al., 2020b)

- *Phaseolus vulgaris* L. - Uttarakhand (Pervez et al., 2020b)

3. *Aphis fabae* Scopoli, 1763

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

- Host plant not recorded - Sikkim (Ghosh & Raychaudhuri, 1982; Chakrabarti et al., 2012)

4. *Aphis gossypii* Glover, 1977

- *Colocasia esculenta* (L.) Schott - Manipur (Devi, 1989); Nagaland (Devi, 1989)

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

- *Helianthus annuus* L. - Manipur (Devi, 1989)

- *Malus domestica* (Suckow) Borkh. - Manipur (Chakrabarti et al., 2012)

- *Rumex nepalensis* Spreng. - Himachal Pradesh (Agarwala et al., 1981); Sikkim (Agarwala et al., 1981)

5. *Aphis kurosawai* Takahashi, 1921

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

- *Artemisia* sp. - Himachal Pradesh (Das & Raychaudhuri, 1983); Uttarakhand (Ghosh et al., 1986a)

6. *Aphis longisetosa* Basu, 1970

- Host plant not recorded - Himachal Pradesh (Agarwala et al., 1981)

7. *Aphis pomi* de Geer, 1773

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Kumari, 2019); Jammu & Kashmir (Bhagat et al., 1988)

- *Malus sylvestris* Mill. - Himachal Pradesh (Karki et al., 2024)

8. *Aphis spiraecola* Patch, 1914

- *Eupatorium* sp. - West Bengal (Poorani, 2002)

- Host plant not recorded - West Bengal (Agarwala et al., 1981)

9. ***Brachycaudus helichrysi*** **(Kaltenbach, 1843)**

- *Prunus amygdalus* Batsch - Himachal Pradesh (Bhardwaj, 1991; Chauhan et al., 2024)

- *Prunus persica* (L.) Stokes - Jammu & Kashmir (Arora et al., 2020); Uttarakhand (Ghosh et al., 1991)

10. ***Brachycaudus*** **sp.**

- *Crotalaria saltiana* Andrews - West Bengal (Poorani, 2002)

- *Eupatorium* sp. - West Bengal (Poorani, 2002)

- *Rumex hastatus* D. Don - Uttarakhand (Agarwala et al., 1981)

11. ***Brevicoryne brassicae*** **(Linnaeus, 1758)**

- *Brassica oleracea* L. var. *botrytis* - Himachal Pradesh (Sharma & Verma, 1993; Sharma et al., 2020)

- *Brassica* sp. - Uttarakhand (Ghosh et al., 1986b; Ghosh et al., 1986a)

12. ***Capitophorus elaeagni*** **(del Guercio, 1894)**

- *Cirsium wallichii* DC. - Uttarakhand (Ghosh et al., 1991)

13. ***Capitophorus formosartemisiae*** **(Takahashi, 1921)**

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

- *Artemisia* sp. - Himachal Pradesh (Das & Raychaudhuri, 1983); Uttarakhand (Ghosh et al., 1986a)

14. ***Capitophorus hippophaes javanicus*** **Hille Ris Lambers, 1953**

- *Persicaria orientale* (L.) Spatch - Sikkim (Chakrabarti et al., 2012)

15. ***Cavariella aegopodii*** **(Scopoli, 1763)**

- *Malus domestica* (Suckow) Borkh. - Uttarakhand (Ghosh et al., 1986b)

- *Rubus ellipticus* Sm. - Himachal Pradesh (Das & Raychaudhuri, 1983)

- *Salix tetrasperma* Roxb. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

- *Salix* sp. - Uttarakhand (Ghosh et al., 1986b)

16. ***Cavariella indica*** **Maity & Chakrabarti, 1982**

- *Salix babylonica* L. - Uttarakhand (Ghosh et al., 1991)

17. ***Cervaphis quercus*** **Takahashi, 1918**

- *Quercus serrata* Murray - Manipur (Devi, 1989; Chakrabarti et al., 2012); Nagaland (Devi, 1989)

18. ***Clethrobius dryobius*** **Chakrabarti & Raychaudhuri, 1976**

- *Prunus cerasus* L. - Sikkim (Chakrabarti et al., 2012)

19. ***Coloradoa artemisiae*** **(del Guercio, 1913)**

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

20. ***Coloradoa artemisicola*** **Takahashi, 1965**

- *Artemisia vulgaris* L. - Manipur (Agarwala et al., 1980)

21. ***Eriosoma lanigerum*** **(Hausmann, 1802)**

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Sharma et al., 2015); Punjab (Rahman, 1940); Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

22. ***Hayhurstia atriplicis*** **(Linnaeus, 1761)**

- *Chenopodium album* L. - Uttarakhand (Ghosh et al., 1991)

23. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Prunus persica* (L.) Stokes - Uttarakhand (Ghosh et al., 1991)

24. ***Liosomaphis atra*** **Hille Ris Lambers, 1966**

- *Berberis* sp. - Himachal Pradesh (Das & Raychaudhuri, 1983)

25. ***Liosomaphis himalayensis*** **Basu, 1964**

- *Berberis aristata* DC. - Uttarakhand (Ghosh et al., 1991)

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

26. ***Macrosiphoniella pseudoartemisiae*** **Shinji, 1933**

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

- *Glebionis coronaria* (L.) Cass. ex Spach - West Bengal (Raychaudhuri et al., 1978; Chakrabarti et al., 2012)

27. ***Macrosiphoniella sanborni*** **(Gillette, 1908)**

- *Chrysanthemum* sp. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991); West Bengal (Ghosh & Raychaudhuri, 1982; Chakrabarti et al., 2012)

28. ***Macrosiphoniella yomogifoliae*** **(Shinji, 1924)**

- *Artemisia vulgaris* L. - Manipur (Devi, 1989); Nagaland (Devi, 1989)

29. ***Macrosiphoniella*** **sp.**

- *Artemisia* sp. - Uttarakhand (Ghosh et al., 1986a)

- *Chrysanthemum* sp. - West Bengal (Poorani, 2002)

30. ***Macrosiphum euphorbiae*** **(Thomas, 1878)**

- *Solanum tuberosum* L. - Himachal Pradesh (Sharma et al., 2025)

31. *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa indica* L. - West Bengal (Gurung et al., 2019)

- *Rosa* sp. - Himachal Pradesh (Agarwala et al., 1981); Uttarakhand (Ghosh et al., 1991)

32. *Melanaphis donacis* (Passerini, 1862)

- Host plant not recorded - Himachal Pradesh (Das & Raychaudhuri, 1983)

33. *Melanaphis nr. arundinariae* (Takahashi, 1937)

- *Pyrus pashia* Buch.- Ham. ex D. Don - Uttarakhand (Ghosh et al., 1991)

34. *Mollitrichosiphum montanum* (van der Goot, 1917)

- *Alnus nepalensis* D. Don - Manipur (Devi, 1989); Nagaland (Devi, 1989; Chakrabarti et al., 2012)

35. *Mollitrichosiphum* sp.

- *Alnus nepalensis* D. Don - Uttarakhand (Ghosh et al., 1991)

36. *Myzus cerasi* (Fabricius, 1775)

- *Artemisia vulgaris* L. - Manipur (Devi, 1989); Nagaland (Chakrabarti et al., 2012)

37. *Myzus dycei* Carver, 1961

- *Artemisia vulgaris* L. - Manipur (Devi, 1989); Nagaland (Devi, 1989)

- *Urtica dioica* L. - Manipur (Devi, 1989); Uttarakhand (Ghosh et al., 1991)

38. *Myzus persicae* (Sulzer, 1776)

- *Brassica oleracea* L. var. *botrytis* - Himachal Pradesh (Sharma et al., 2020)

39. *Myzus siegesbeckicola* Strand, 1929

- *Urtica dioica* L. - Uttarakhand (Ghosh et al., 1986a)

40. *Phorodon cannabis* Passerini, 1860

- *Cannabis sativa* L. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

41. *Shinjia orientalis* (Mordvilko, 1929)

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

42. *Sitobion rosaeiformis* (Das, 1918)

- *Rosa* sp. - Uttarakhand (Ghosh et al., 1986a; Ghosh et al., 1991)

43. *Tuberculatus nervatus* Chakrabarti & Raychaudhuri, 1976

- *Quercus serrata* Murray - Manipur (Devi, 1989; Chakrabarti et al., 2012)

44. Unidentified aphid

- *Sonchus arvensis* L. - West Bengal (Poorani, 2002)

H. *Oenopia sexareata* (Mulsant, 1853) [syn. *Coelophora sexareata* Mulsant, 1853; *Coelophora sexareata* var. *lacerata* Sicard, 1913; *Gyrocaria sexareata* (Mulsant, 1853)]

Oenopia sexareata (Mulsant) is a moderate-sized beetle measuring 3.85-4.32 mm long and 3.25-3.80 mm wide. The body is broad, oval to almost circular, with a strongly convex and glabrous dorsum. The head is anteriorly creamy white to yellow in males, completely black in females. Pronotum is black, except that the anterior corners are light yellow. Elytra are bright carmine red, orange or yellowish in live specimens, yellowish brown in older specimens, with a characteristic areolate pattern having six cells, sometimes cell boundaries somewhat broken and not continuous (Poorani, 2023a) (Figure 1H). Biologically, it is a voracious predator that feeds on various species of aphids, whiteflies, and scale insects, thereby playing a crucial role in regulating pest populations. Its high fecundity, short developmental cycle, and efficient predatory potential make it a valuable natural enemy in both agricultural and horticultural ecosystems. It is widely distributed in India (Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Punjab, Sikkim, Uttarakhand, Uttar Pradesh, West Bengal), Bhutan, Myanmar, China, and Vietnam (Poorani, 2023a). In India, its aphid preys were recorded only in 8 states: Assam, Himachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Uttarakhand and West Bengal, preying on 30 species of aphids infesting 39 species of food plants with 50 tri-trophic associations (Table 1). Most of the tri-trophic associations were recorded in Manipur (26 triplets). The detailsof prey species and their host plant associations in different states and union territories of India are given below.

1. *Acyrthosiphon pisum* (Harris, 1776)

- *Pisum sativum* L. - Manipur (Devi, 1989); Meghalaya (Azad Thakur & Barwal, 1987); Nagaland (Devi, 1989)

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

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

- *Citrus limon* (L.) Osbeck - Assam (Das et al., 2010)

3. *Aphis craccivora* Koch, 1854

- *Vicia faba* L. - Manipur (Devi, 1989); Meghalaya (Azad Thakur & Barwal, 1987)

4. *Aphis fabae* Scopoli, 1763

- *Pyrus communis* L. - West Bengal (Sarkar & Chakrabarti, 2015)

5. *Aphis gossypii* Glover, 1977

- *Ageratum conyzoides* L. - Manipur (Devi, 1989); Nagaland (Devi, 1989)

- *Artocarpus heterophyllus* Lam. - Manipur (Chakrabarti et al., 2012)

- *Artocarpus integer* (Thunb.) Merr. - Manipur (Devi & Singh, 1987)

- *Chromolaena odorata* (L.) R.M.King & H.Rob. - Manipur (Devi, 1989)

- *Colocasia esculenta* (L.) Schott - Manipur (Devi, 1989); Meghalaya (Azad Thakur & Barwal, 1987); Nagaland (Devi, 1989)

- *Ficus* sp. - Manipur (Devi, 1989)

- *Jasminum* sp. - Manipur (Devi, 1989)

- *Malus domestica* (Suckow) Borkh. - Manipur (Devi & Singh, 1987)

- *Psidium guajava* L. - Manipur (Devi & Singh, 1987)

- *Solanum betaceum* Cav. - Meghalaya (Azad Thakur & Barwal, 1987)

- *Solanum melongena* L. - Meghalaya (Boruah & Pathak, 2023)

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

- *Blumea hieracifolia* Hayata - Manipur (Devi, 1989)

7. ***Aphis spiraecola*** **Patch, 1914**

- *Bidens pilosa* L. - Manipur (Chakrabarti et al., 2012)

8. ***Brachycaudus helichrysi*** **(Kaltenbach, 1843)**

- *Clerodendron* sp. - Manipur (Agarwala et al., 1980; Chakrabarti et al., 2012); West Bengal (Chakrabarti et al., 2012)

- *Prunus persica* (L.) Stokes - Himachal Pradesh (Sharma et al., 2015)

9. ***Brevicoryne brassicae*** **(Linnaeus, 1758)**

- *Brassica juncea* (L.) Czern. - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *alboglabra* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *botrytis* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *capitata* - Himachal Pradesh (Sharma & Verma, 1993); Meghalaya (Azad Thakur & Barwal, 1987; Firake et al., 2012)

- *Brassica oleracea* L. var. *gongylodes* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *italica* - Meghalaya (Firake et al., 2012)

- *Brassica rapa* L. - Meghalaya (Firake et al., 2012)

- *Brassica* sp. - Uttarakhand (Ghosh et al., 1986a)

10. ***Cervaphis quercus*** **Takahashi, 1918**

- *Quercus serrata* Murray - Manipur (Devi, 1989; Chakrabarti et al., 2012); Nagaland (Devi, 1989)

11. ***Eriosoma lanigerum*** **(Hausmann, 1802)**

- *Malus domestica* (Suckow) Borkh. - Himachal Pradesh (Sharma et al., 2015)

12. ***Eutrichosiphum raychaudhurii*** **(Ghosh, 1969)**

- *Alnus* sp. - Sikkim (Joshi & Sangma, 2015)

- Host plant not recorded - Sikkim (Ramanujam et al., 2005)

13. ***Eutrichosiphum*** **sp.**

- *Lithocarpus dealbatus* (Hook.f. & Thomson ex Miq.) Rehder - Manipur (Devi, 1989)

14. ***Indoidiopterus geranii* (Chowdhuri *et al.*, 1969)**

- Host plant not recorded - Himachal Pradesh (Das & Raychaudhuri, 1983)

15. ***Lipaphis erysimi* (Kaltenbach, 1843)**

- *Brassica juncea* (L.) Czern. - Meghalaya (Damitre, 2019)

16. ***Macrosiphoniella yomogifoliae* (Shinji, 1924)**

- *Artemisia vulgaris* L. - Manipur (Devi, 1989; Chakrabarti et al., 2012); Nagaland (Devi, 1989)

17. ***Macrosiphum rosae* (Linnaeus, 1758)**

- *Rosa canina* L. - West Bengal (Raychaudhuri et al., 1978; Gurung et al., 2019)

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

18. ***Matsumuraja capitophoroides* Hille Ris Lambers, 1966**

- *Rubus* sp. - Manipur (Devi, 1989)

19. ***Mollitrichosiphum montanum* (van der Goot, 1917)**

- *Alnus nepalensis* D. Don - West Bengal (Debnath, 2020)

- *Rosa* sp. - Manipur (Chakrabarti et al., 2012)

20. ***Myzus cerasi* (Fabricius, 1775)**

- *Artemisia vulgaris* L. - Manipur (Devi, 1989)

21. ***Myzus dycei* Carver, 1961**

- *Artemisia vulgaris* L. - Manipur (Devi, 1989)

- *Urtica dioica* L. - Manipur (Chakrabarti et al., 2012); Nagaland (Devi, 1989)

22. ***Myzus persicae* (Sulzer, 1776)**

- *Brassica juncea* (L.) Czern. - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *alboglabra* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *botrytis* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *capitata* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *gongylodes* - Meghalaya (Firake et al., 2012)

- *Brassica oleracea* L. var. *italica* - Meghalaya (Firake et al., 2012)

- *Brassica rapa* L. - Meghalaya (Firake et al., 2012)

- *Raphanus sativus* L. - Meghalaya (Firake et al., 2012)

- *Solanum betaceum* Cav. - Meghalaya (Azad Thakur & Barwal, 1987)

- *Solanum melongena* L. - Uttar Pradesh (Tiwari et al., 2024)

- *Solanum tuberosum* L. - Meghalaya (Azad Thakur & Barwal, 1987)

23. *Pemphigus napaeus* Buckton, 1896

- *Populus* sp. - Himachal Pradesh (Agarwala et al., 1981)

24. *Rhopalosiphum maidis* (Fitch, 1856)

- *Zea mays* L. - Himachal Pradesh (Sharma & Adlakha, 1981); Manipur (Chakrabarti et al., 2012); Meghalaya (Azad Thakur & Barwal, 1987); West Bengal (Agarwala et al., 1981; Debnath, 2020)

25. *Shinjia orientalis* (Mordvilko, 1929)

- Fern - Manipur (Agarwala et al., 1980)

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

26. *Sitobion miscanthi* (Takahashi, 1921)

- Host plant not recorded - Himachal Pradesh (Das & Raychaudhuri, 1983)

27. *Sitobion rosaeiformis* (Das, 1918)

- *Alnus nepalensis* D. Don - West Bengal (Debnath, 2020)

- *Rosa bourboniana* L. - Himachal Pradesh (Kakkar & Sood, 1989)

- *Rosa canina* L. - West Bengal (Raychaudhuri et al., 1978; Debnath, 2020)

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

28. *Taoia indica* (Ghosh & Raychaudhuri, 1972)

- *Alnus nepalensis* D. Don - West Bengal (Raychaudhuri et al., 1978; Ghosh & Raychaudhuri, 1982)

29. *Tuberculatus nervatus* Chakrabarti & Raychaudhuri, 1976

- *Quercus serrata* Murray - Manipur (Devi, 1989; Chakrabarti et al., 2012)

30. *Tuberculatus paiki* Hille Ris Lambers, 1974

- *Quercus semiserrata* Roxb. - Manipur (Devi, 1989)

I. *Oenopia signatella* (Mulsant, 1866) [syn. *Harmonia signatella* Mulsant, 1866; *Coccinella signatella* (Mulsant, 1866); *Coccinella (Synharmonia) signatella* (Mulsant, 1866); *Synharmonia signatella* (Mulsant, 1866); *Paramulsantina gratiosa* Hoang, 1982; *Paramulsantina ornata* Hoang, 1982]

Oenopia signatella (Mulsant) is a moderate-sized beetle measuring 4.30-4.80 mm long and 3.20-3.60 mm wide. The body is elongate oval with a weakly convex and glabrous dorsum. The head is black with a basal, medially emarginate black macula. Pronotum is whitish creamy yellow with seven black spots roughly forming a W-shaped pattern (Poorani, 2023a) (Figure 1I). Its biology is not properly known. It is distributed in India (Arunachal

Pradesh, Manipur, Meghalaya, Sikkim, Uttarakhand, West Bengal), Bhutan, Nepal and Myanmar (Poorani, 2023a). In India, its aphid preys were recorded only in 2 states: Sikkim and Uttarakhand, preying on only 2 species of aphids infesting only 2 species of food plants (Table 1). The details of prey species and their host plant associations in different states and union territories of India are given below.

1. ***Eriosoma lanigerum*** **(Hausmann, 1802)**

- *Malus domestica* (Suckow) Borkh. - Sikkim (Poorani, 2002)

2. ***Melanaphis*** **sp.**

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

J. *Oenopia* spp.

It may contain more than one species of *Oenopia.* In India, unidentified *Oenopia* were recorded only in 3 states: Himachal Pradesh, Manipur and Uttarakhand, preying on 7 species of aphids infesting 7 species of food plants (Table 1). The details of prey species and their host plant associations in different states and union territories of India are given below.

1. ***Aphis fabae*** **Scopoli, 1763**

- *Solanum nigrum* L. - Himachal Pradesh (Sharma et al., 2009)

2. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Prunus dulcis* (Mill.) D.A. Webb. - Manipur (Chakrabarti et al., 2012)

3. ***Macrosiphoniella pseudoartemisiae*** **Shinji, 1933**

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1991)

4. ***Myzus persicae*** **(Sulzer, 1776)**

- *Solanum tuberosum* L. - Manipur (Shantibala & Singh, 1985)

5. ***Rhopalosiphoninus*** **sp.**

- *Elsholtzia fruticosa* (D.Don) Rehder - Uttarakhand (Ghosh et al., 1991)

6. ***Hyalopterus pruni*** **(Geoffroy, 1762)**

- *Prunus amygdalus* Batsch - Manipur (Devi & Singh, 1987)

- *Prunus persica* (L.) Stokes - Manipur (Devi & Singh, 1987)

7. ***Rhopalosiphum nymphaeae*** **(Linnaeus, 1761)**

- *Prunus amygdalus* Batsch - Manipur (Devi & Singh, 1987)

4. Conclusion

This study highlights the significant role of *Oenopia* species as important aphidophagous predators in India, demonstrating their wide prey range, diverse plant associations, and

distribution across multiple states. The dominance of species such as *Oenopia sauzeti*, *Oenopia kirbyi*, and *Oenopia sexareata* underscores their ecological importance in regulating aphid populations. However, the tri-trophic associations of these predators remain insufficiently documented in several regions, emphasizing the need for comprehensive surveys to fill these knowledge gaps. The resulting checklist will serve as a valuable tool for advancing taxonomy, research, conservation, and application of *Oenopia* species into sustainable biological control programs.

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Conflict of interests

The authors declare that they have no competing interests.

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