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Biodiversity of predators and parasitoids of greenideine aphids (Insecta: Hemiptera: Aphididae: Greenideinae) and their host plant associations in India

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Abstract

The present article lists the predators and parasitoids of the Greenideinae aphids (Insecta: Hemiptera: Aphididae: Greenideinae) infesting different food plants and their distribution in various states and union territories of India. Predators belong to one order of class Arachnida, the order Araneae (spiders) (2 families) and five orders of class Insecta: Coleoptera (family Coccinellidae), Dermaptera (family Forficulidae), Diptera (family Syrphidae), Hemiptera (family Anthocoridae) and Neuroptera (families Chrysopidae, Hemerobiidae). A total of 43 species of predators from various taxa were recorded to feed 15 species of the greenideine aphids on 12 food plant species in 14 states of India. The highest number of predators belonged to the families Coccinellidae (28 species) and Syrphidae (5 species). Most of the tritrophic associations (triplets, predators-preys-host plants) of these predators were reported in Manipur (41 triplets), Uttarakhand (22 triplets), West Bengal (10 triplets) and in other states with fewer than 10 triplets. All the parasitoids of greedineine aphids belong to a single subfamily Aphelininae (Aphelinidae: Hymenoptera) and Aphidiinae (Braconidae: Hymenoptera) in India. A total of 23 species of parasitoids were observed parasitising these aphids infesting on 19 host plants in 12 states of India. Most of the tritrophic associations (triplets, parasitoids-hosts-host plants) of these parasitoids were reported from Meghalaya (15 triplets), followed by West Bengal (9 triplets), Manipur (8 triplets), and in other states with fewer than 8 triplets. Indeed, minimal attempts have been made to record the natural enemies of these aphids in India, and an intensive and extensive survey plan is warranted to record them in unexplored areas.

Key words: Aphids, Aphidiinae, Greenideinae, biocontrol, Chrysopidae, Coccinellidae, Neuroptera, predators, Syrphidae, parasitoids, Braconidae.

1. Introduction

Aphids (Hemiptera: Aphididae) are among the most injurious insect pests in agroecosystem causing severe damages by sucking the plant nutrients and also by virus transmission (Singh & Singh, 2022). They belong to a single family Aphididae Latreille, 1802 (Aphidoidea: Hemiptera: Insecta) which comprises 24 subfamilies comprising about 5,683 species kept in 629 genera (Favret, 2024). The Greenideinae Baker, 1920 is one of the subfamily and most of its members are Oriental in distribution except for a few from the eastern Palaearctic, Ethiopian, Australian and Neotropical regions. It includes 189 valid species belonging to 18 genera kept in 3 tribes: Cervaphidini van der Goot, 1917; Greenideini Baker, 1920 and Schoutedeniini Nieto Nafría, Mier Durante & Pérez Hidalgo, 2011 (Favret, 2024). Most of them are distributed in Oriental region and few from the eastern Palaearctic, Ethiopian, Australian and Neotropical regions (Ghosh & Agarwala, 1993). India represents 9 genera and 93 valid species, i.e. Indian Greenideinae consists of almost half of the world fauna of the subfamily. Among them, 19 species belonging to 6 genera are monoecious holocyclic, i.e. the parthenogenetic and sexual aphids feed on a single host-plant species throughout the year (Singh & Ghosh, 2012). Out of 93 species of Greenideinae recorded in India, 46 species are monophagous feeding on only one species of plants; 32 species are oligophagous infesting 2 to 5 plant species; and 11 species are moderately polyphagous infesting 6 to 10 plant species while only 4 species are highly polyphagous reported on 15 to 25 plant species and about three-fourth of the species reported from India are endemic (Singh & Singh, 2017; Singh et al., 2023). The group is mainly distributed from east to west Himalayas. The biology and brief history of taxonomy of these aphids are summarized by Ghosh & Agarwala (1993). They feed the sap of the leaves and shoots of dicotyledonous trees and shrubs mostly belonging to the families Betulaceae (birches), Fagaceae (beeches), Juglandaceae (walnuts), Moraceae (figs), Myrtaceae (myrtles), Phyllanthaceae, Rosaceae (pears), etc. (Singh et al., 2023). The species, *Cervaphis rappardi indica* Basu, 1961 is pestiferous in Manipur, a northeast state of India on pigeonpea, *Cajanus cajan* (L.) Millsp., a pulse crop cultivated in tropical and semitropical regions of the world. Shantibala et al. (1997) studied the impact of several predators on its population. Another aphid, *Greenidea (Trichosiphum) psidii* van der Goot have been recorded as potential pests of guava in west Bangal, India (Maji et al., 2023a).

In the recent years, due to ecological disorder caused by pesticides, biological control is considered as the most promising practice for sustainable agriculture. Aphid predators and parasitoids play an important role in the natural/biological control of aphids (Singh, 2001; Singh & Singh, 2016). Records of natural enemies of these aphids begin with Raychaudhuri et al. (1978) who recorded an anthocorid bug, *Bilia* sp. to prey *Greenidea (Trichosiphum) psidii* van der Goot, 1917 on guava (*Psidium guajava* L.) from West Bengal. After two years, Agarwala et al. (1980) recorded a ladybird beetle, *Verania* sp. feeding on *Eutrichosiphum khasyanum* (Ghosh & Raychaudhuri, 1962) on jolcham oak, *Quercus serrata* Murray from Manipur. Similarly, Dharmadhikari & Ramaseshiah (1970) were the first to record *Lipolexis oregmae* (Gahan, 1932) parasitising these aphids on guava from Karnataka. Later on, Starý & Ghosh (1975) described/recorded *Binodoxys eutrichosiphi* (Starý, 1975) on these aphids from Meghalaya. Thereafter, a considerable number of predators and parasitoids were recorded from several states/union territories of India on the greenideine aphids on several host plants of economic importance. As the natural enemies of aphids play a major function in the terrestrial food webs, the study of multitrophic intraction of these webs will provide an important ground to improve their effectiveness against the herbivore populations (Singh, 2003; Bayram & Özdemir, 2021; Singh & Singh, 2021a). Presently, the worldwide trend in

biological controls is the conservation strategies, based on existing natural enemies of that area, which need information on the aphid-parasitoid species status of a particular area that make the backbone of such a strategy (Pons et al., 2018). By conservation of these available biocontrol agents (predators/parasitoids) of aphids in the fields, we can enhance their action in order to control the population of their aphid hosts (conservation biological control). This can be performed by providing flowering plants (they attract and retain natural enemies), using pheromone lures (to attract parasitoids back into the crops) and technology can be developed to mass rear them and to release them in the fields (Singh & Singh, 2016). For this reason, the study of tritrophic associations (parasitoid-aphid-plant) is necessary. However, such informations are sporadic records of species, isolated studies in the life cycles of individual species, and discrete information on the biology and ecology of a few species across the country. The basic purpose of this article is to enlist the natural enemies of greenideine aphids along with their host plants in different states/union territories of India as such checklist provides an invaluable reference for taxonomists, researchers, academicians, conservation managers, and policymakers to their proper use in natural/biological control programmes against these aphid pests.

2. Materials and methods

No survey was conducted by the author for these records. The methodologies of collection of aphids and their natural enemies and their identification are described in detail by Starý & Ghosh (1983) for parasitoids and Tiwari et al. (2024) for predators. The present checklist is based only on the primary data of published literature on predators and parasitoids, e.g. books, book chapters, journals, proceedings of conferences, and a few authentic theses available on Shodhganga (https://shodhganga.inflibnet.ac.in) up to 15 November, 2024. The predators, parasitoids, aphids and host plants identified at generic level are considered species. In most of the recent-past literature, there are several errors in the scientific names of the predators, parasitoids, aphids and their food plants because of their modified status and other nomenclatural decisions and clarification. The names of aphids, as well as plants that were misspelt in the original records have been corrected where we logically ascertain the intended species. In the present checklist, attempts have been made to provide the valid scientific names of the predators following GBIF (2024), WSC (2024), aphids following Favret (2024), and of the plants, following (WFO, 2024). For detailed synonymy of the valid species, the above references should be consulted.

3. Results and Discussion

Family Greenideinae

The members of the Greenideinae possess usually elongated and densely hairy cornicles, if short and truncate then without any hair but with a pair of dorsal processi arising from the 7th abdominal tergite. Adult Greenideinae viviparae may be alate (winged) or apterous. The subfamily includes 189 species under 18 genera kept in 3 tribes: kept in 3 tribes: Cervaphidini van der Goot, 1917; Greenideini Baker, 1920 and Schoutedeniini Nieto Nafría, Mier Durante & Pérez Hidalgo, 2011. Cervaphidini are characterised by having paired tubercles or processi present on anterior tergites of abdomen with cauda never with a median stylus (Figure 1) while these structures are present only on 7th or on the 7th and 8th tergites of abdomen and cauda rounded or with a median stylus in Schoutedeni (Figure 2). In Greenideini, the body in apterae and alatae viviparae never with any processi but siphunculi are elongated with many long hairs (Figure 3). In India, 93 species belonging to 9 genera are known to feed on

130 species of plants (Singh et al., 2023). Out of them, only 15 species are recorded serving as preys/hosts of 43 species of predators and 23 species of parasitoids as described below.

Figure 1-3. Photographs of apterae aphids belonging to tribes Cervaphidini (1), Schoutedini (2) and Greenideini (3). Courtsey, InfluentialPoints.com.

Predators of greenideine aphids

The data displayed in Table 1 demonstrated that a total of 54 species of predators are recorded to prey on 16 species of greenideine aphids out of 93 species recorded (Singh & Singh, 2017). Totally, they constitute 100 tritrophic associations (triplets) in 14 states/union territories of India. Predators of these species belong to one order of the class Arachnida, the order Araneae (spiders) (2 families) and five orders of the class Insecta: Coleoptera (family Coccinellidae), Dermaptera (family Forficulidae), Diptera (family Syrphidae), Hemiptera (family Anthocoridae) and Neuroptera (families Chrysopidae, Hemerobiidae). The total number of these predator species distributed only in 14 states/union territories of India as shown in Table 2 which demonstrates that these are recorded mostly in northwestern and east western Himalayas. The maximum number of predator species are recorded in Manipur (27 species, 41 triplets) followed by Uttarakhand (18 species, 22 triplets), Uttar Pradesh (14 species, 18 triplets), Sikkim (9 species, 9 triplets), West Bengal (8 species, 10 triplets), and 1-5 species in rest 11 states of India. Most of the predators are found to prey *Cervaphis rappardi indica* Basu on pulse crop, pigeonpea (*Cajanus cajan* (L.) Millsp.) and *Greenidea (Trichosiphum) psidii* van der Goot on gthe guava trees (*Psidium guajava* L.) (Table 3). Some of the records of predators may represent erroneous records or misuse of valid taxonomic names (Agarwala & Ghosh, 1988).

Food plants of Greenideinae associated with predators/parasitoids

Table 4 shows that 15 species of food plants belonging to 9 families (including unknown species which may includes multiple species) are associated with greenideine aphids which serve as prey for 54 species of predators distributed in 14 states/union territories of India. Most of the host plants are infested by single species of aphids except *Alnus nepalensis* D. Don which is fed by 4 species of aphids. Among the host plants, two plants are agricultural pulse crops (*Cajanus cajan* (L.) Millsp., *Pisum sativum* L.) of high economic importance and are grown widely. These plants are infested mostly by aphids belonging to the subfamily Aphidinae (Singh et al., 2016), but strangely, one of the greenideine aphid, *Cervaphis rappardi indica* Basu, 1961 is pestiferous in Manipur, a northeast state of India, on *Cajanus cajan* and Shantibala et al. (1997) studied the impact of predators on its population. *Psidium guajava*, the guava, is a delicious fruit crop of India and abroad and guava aphid, *Greenidea*

(Trichosiphum) psidii van der Gootis pestiferous on it (Culik et al., 2016). Several workers have studied the occurrence of 18 predators of this aphid species (Table 3) particularly in Bihar, Manipur, Uttarakhand and West Bengal (Ghosh & Raychaudhuri, 1982; Devi & Singh, 1987; Debnath et al., 1988; Ahmad et al., 2012). Eighteen species of parasitoids are recorded on guava on two species of aphids in Arunachal Pradesh, Karnataka, Meghalaya, Mizoram, Uttar Pradesh and West Bengal (Dharmadhikari & Ramaseshiah, 1970; Samanta et al., 1983b; Samanta, 1986; Raychaudhuri et al., 1990; Sarkar, 1991; Ahmad & Singh, 1993; Tiwari et al., 2024). *Syzygium cumini*, the black plum, is a medicinal plant and its fruits are eaten fresh, or processed into jams, jellies, fruit drinks, wine, vinegar, and more. The wood is water resistant and is used for railway sleepers, well motors, and cheap furnitures. None of the aphid species is pestiferous on it. *Alnus nepalensis* (the alder tree) and *Quercus serrata* (the oak tree) both are infested with greenideine aphids and sometimes cause heavy damage to their plantation in Sikkim (Phaloura & Singh, 1991). Several authors reported several species of predators in Manipur, Nagaland, Sikkim, Uttarakhand and West Bengal (Phaloura & Singh, 1991; Chakrabarti et al., 2012; Debnath, 2020). Both trees are economically important for its use in making wooden boxes and light constructions, and making charcoal. Another fruit tree, *Phyllanthus emblica*, the Indian gooseberry, is sometimes heavily infested with Indian gooseberry aphid, *Schoutedenia emblica* (Patel & Kulkarni, 1952) in Gujarat, Karnataka, Tamil Nadu and Uttar Pradesh (Bharpoda et al., 2009; Singh & Singh, 2012; Singh et al., 2018; Haldhar et al., 2022; Chinnu et al., 2023; Poorani & Thanigairaj, 2023).

Table 1. Number of species of predators belonging to different taxa preying on number of species of greenideine aphids infesting different number of species of host plants and number of predator-aphid-plant associations (triplets) distributed in different states/union territories of India.

Class	Orders	Families of predators	Number of species				States/ union territories
			Predators	Preys	Host plants	Triplets	
Arachnida	Araneae	Salticidae	2	1	1	2	1
		Thomisidae	1	1	1	1	1
		Sub total	3	2	2	3	2
Insecta	Coleoptera	Coccinellidae	37	14	14	77	13
	Dermaptera	Forficulidae	1	1	1	1	1
	Diptera	Syrphidae	6	4	4	9	4
	Hemiptera	Anthocoridae	1	1	1	1	1
	Neuroptera	Chrysopidae	5	5	5	7	2
		Hemerobiidae	1	2	2	2	1
		Sub total	6	5	5	7	2
Total			**54**	**16**	**15**	**100**	**14**

Table 2. Number of species of predators preying on number of species of greenideine aphids infesting number of species of host plants and triplets in different states/union territories of India.

Indian States	Number of predator species	Number of aphid species	Number of host plant species	Number of Triplets
1. Bihar	3	1	2	3
2. Gujarat	2	1	1	2
3. Himachal Pradesh	1	1	1	1
4. Karnataka	1	1	1	1
5. Manipur	27	8	10	41
6. Meghalaya	1	1	1	1
7. Mizoram	1	1	1	1
8. Nagaland	5	4	3	8
9. Sikkim	9	3	3	9
10. Tamil Nadu	1	1	1	1
11. Tripura	4	2	2	5
12. Uttar Pradesh	14	3	3	18
13. Uttarakhand	18	6	4	22
14. West Bengal	8	4	4	10
15. Unknown place	1	2	2	2
Total	**54**	**16**	**15**	**100**

Table 3. Number of species of coccinellid predators preying on different species of greenideine aphids feeding on different number of host plant species and triplets (predator-prey-host plant associations) and their distribution in India.

Aphid species	Nymber of			
	Predator species	Host plant species	Triplets	States/union territories
1. *Cervaphis quercus*	9	2	15	3
2. *Cervaphis rappardi indica*	18	2	20	2
3. *Cervaphis schouteniae*	2	2	2	2
4. *Eutrichosiphum dubium*	1	1	1	2
5. *Eutrichosiphum khasyanum*	4	1	4	2
6. *Eutrichosiphum raychaudhurii*	2	2	2	2
7. *Eutrichosiphum* spp.	2	2	2	2
8. *Greenidea parthenocissi*	1	1	1	1
9. *Greenidea ficicola*	3	1	1	1
10. *Greenidea psidii*	18	4	22	7
11. *Greenideoida ceyloniae*	5	5	5	2
12. *Mollitrichosiphum montanum*	10	2	11	5
13. *Mollitrichosiphum nandii*	1	1	1	1
14. *Mollitrichosiphum* spp.	11	1	11	1
15. *Schoutedenia emblica*	5	1	6	4
16. *Sumatraphis celti*	1	1	1	1
Total	**54**	**15**	**100**	**14**

Table 4. Number of species of greenideine aphids infesting different food plants, number of species of their predators of different taxa, number of triplets (tritrophic associations) and their distribution in different number of states/union territories of India.

Family and species of host plants	Order of predators	Family of predators	Number of species of aphids	Number of species of predators	Number of triplets	Number of states/union territories
1. Betulaceae: *Alnus nepalensis*						
	Araneae	Salticidae	1	2	2	1
	Coleoptera	Coccinellidae	4	12	15	5
	Dermaptera	Forficulidae	1	1	1	1
	Diptera	Syrphidae	1	1	1	1
	Neuroptera	Chrysopidae	1	1	1	1
		Subtotal	**4**	**17**	**20**	**5**
2. Betulaceae: *Alnus* sp.						
	Coleoptera	Coccinellidae	1	1	1	1
	Neuroptera	Chrysopidae	1	1	1	1
		Subtotal	**2**	**2**	**2**	**2**
3. Cannabaceae: *Cannabis sativa*						
	Coleoptera	Coccinellidae	1	1	1	1
4. Cannabaceae: *Celtis tetrandra*						
	Coleoptera	Coccinellidae	1	1	1	1
5. Fabaceae: *Cajanus cajan*						
	Coleoptera	Coccinellidae	1	12	12	2
	Diptera	Syrphidae	1	4	4	1
	Neuroptera	Hemerobiidae	1	1	1	1
		Subtotal	**1**	**17**	**17**	**2**
6. Fabaceae: *Pisum sativum*						
	Coleoptera	Coccinellidae	1	1	1	3
7. Fagaceae: *Lithocarpus dealbatus*						
	Coleoptera	Coccinellidae	1	2	2	2
8. Fagaceae: *Quercus serrata*						
	Coleoptera	Coccinellidae	2	10	10	3
	Neuroptera	Hemerobiidae	1	1	1	1
		Subtotal	**2**	**11**	**11**	**3**
9. Fagaceae: *Quercus* sp.						
	Araneae	Thomisidae	1	1	1	1
	Coleoptera	Coccinellidae	2	2	2	2
		Subtotal	**3**	**3**	**3**	**3**
10. Myrtaceae: *Psidium guajava*						
	Coleoptera	Coccinellidae	2	15	18	5
	Hemiptera	Anthocoridae	1	1	1	1
	Neuroptera	Chrysopidae	1	2	2	1

Family and species of host plants	Order of predators	Family of predators	Number of species of aphids	Number of species of predators	Number of triplets	Number of states/union territories
		Subtotal	**2**	**18**	**21**	**7**
11. Myrtaceae: *Syzygium cumini*						
	Coleoptera	Coccinellidae	1	3	3	2
12. Phyllanthace:ae: *Phyllanthus emblica*						
	Coleoptera	Coccinellidae	1	3	3	4
	Diptera	Syrphidae	1	1	1	1
	Neuroptera	Chrysopidae	1	1	1	1
		Subtotal	**1**	***5***	***5***	**4**
13. Rosaceae: *Rosa* sp.						
	Coleoptera	Coccinellidae	1	1	1	1
14. Vitaceae: *Parthenocissus semicordata*						
	Coleoptera	Coccinellidae	1	1	1	1
15. Unknown plant species						
	Coleoptera	Coccinellidae	2	2	2	1
	Diptera	Syrphidae	1	3	3	1
		Subtotal	2	4	5	2
		Total	**16**	***54***	**100**	**14**

Checklist of predators of greenideine aphids and their food plants in different states/union territories of India

A. Class : Arachnida
1. Order: Araneae

The order Araneae contains spiders which are an enormously valuable element of the earth's ecosystem as they feed mostly insects and keeping their population under control (Nyffeler & Birkhofer, 2017). But, unlike insect predators, their potential as biocontrol agents is not exploited to its fullest. Recently, Singh et al. (2024a) reported 79 species of aphidophagous spiders in India preying on 53 species of aphids infesting 59 species of plants. Table 1 reveals that only 3 species of spiders belonging to 2 families are known to prey on two species of Greenideinae only in Uttarakhand state of India as mentioned below. Indeed, nominal attempts have been made to record these aphidophagous spiders in India, and an intensive and extensive survey plan is necessary to record them in unexplored areas.

1. Family: Salticidae: Salticidae comprises jumping spiders and is the largest family of the order Araneae. In general, they are master hunters, with the ability to jump vast distances feeding a large variety of preys (Singh et al., 2021). At present, only two species of Salticidae are known from India to feed greenideine aphids infesting alder in Uttarakhand as mentioned below.

1. ***Marpissa* sp.**
   Mollitrichosiphum sp.
   Alnus nepalensis D. Don – Uttarakhand (Debnath, 1991)

2. ***Zygoballus* sp.**
   Mollitrichosiphum sp.
   Alnus nepalensis D. Don – Uttarakhand (Debnath, 1991)

2. Family: Thomisidae: Thomisidae includes the crab spiders, flower spiders or flower crab spiders and do not build web, rather capture the prey by ambushing and sometimes by active persuit. They are not active hunters but are sit–and–wait predators that hunt in flowers, foliage, or leaf litter (Singh & Singh, 2021b).

1. ***Xysticus*** **sp.**
   Eutrichosiphum khasyanum (Ghosh & Raychaudhuri, 1962)
      Quercus sp. – Himachal Pradesh (Das & Raychaudhuri, 1983)

B. Class 2: Insecta

1. Order: Coleoptera

a. Family: Coccinellidae: Among the Coleoptera, the aphidophagous ladybird beetles (Coccinellidae) are widely distributed throughout the world. Though several species of this family are major agricultural pests, more than 260 species are insectivorous preying on soft insects like aphids, mealy bugs, scale insects, whiteflies etc. in India (Omkar & Pervez, 2004) and have been utilised as bioagents in classical and applied biocontrol of aphids and other soft insects (Kumar & Omkar, 2023). Table 1 displays that 28 species of Coccinellidae prey on 11 species of these aphids infesting 11 species of host plants distributed only in 13 states/union territories of India with 64 predator-prey-food plant associations (triplets). Most of the species of these ladybird beetles are reported from Manipur (22 species) followed by Uttarakhand (12 species). Among these aphids, *Cervaphis rappardi indica* Basu serves as food for 13 species of coccinellids. Detail predator-prey-host plant records are given below.

1. ***Adalia tetraspilota*** **(Hope, 1831)**
   Mollitrichosiphum sp.
      Alnus nepalensis D. Don – Uttarakhand (Ghosh et al., 1991)

2. ***Alloneda dodecaspilota*** **(Hope, 1831) [syn.** ***Aiolocaria dodecaspilota*** **(Hope, 1831)]**
   Cervaphis quercus Takahashi, 1918
      Alnus nepalensis D. Don – Manipur (Chakrabarti et al., 2012)
      Quercus serrata Murray – Manipur (Shantibala, 1989); Nagaland (Shantibala, 1989)
   Eutrichosiphum dubium (van der Goot, 1917)
      Lithocarpus dealbatus (Hook.f. & Thomson ex Miq.) – Manipur (Shantibala, 1989); Nagaland (Shantibala, 1989)
   Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)
      Alnus nepalensis D. Don – Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

3. ***Anegleis cardoni*** **(Weise, 1892) [syn.** ***Micraspis cardoni*** **(Weise, 1892)]**
   Greenidea (Trichosiphum) psidii van der Goot, 1917
      Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

4. ***Calvia albida*** **Bielawski, 1972**
   Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)
      Alnus nepalensis D. Don – Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

5. ***Calvia shiva*** **Kapur, 1963 [syn.** ***Calvia durgae*** **Kapur, 1963]**
   Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)
      Alnus nepalensis D. Don – Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

6. *Calvia* sp.
   Mollitrichosiphum sp.
      Alnus nepalensis D. Don – Uttarakhand (Ghosh et al., 1991)
      Syzygium cumini (L.) Skeels – West Bengal (Chakrabarti et al., 2012)

7. *Cheilomenes sexmaculata* (Fabricius, 1781) [syn. *Menochilus sexmaculatus* (Fabricius, 1781)]
   Cervaphis rappardi indica Basu, 1961
      Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997); West Bengal (Maji et al., 2023b)
      Cannabis sativa L. – Manipur (Shantibala, 1989)
   Cervaphis schouteniae van der Goot, 1917
      Unknown plant – Tripura (Agarwala et al., 1987)
   Greenidea (Trichosiphum) psidii van der Goot, 1917
      Psidium guajava L. – Bihar (Ahmad et al., 2012); Manipur (Devi & Singh, 1987); Uttar Pradesh (Tiwari et al., 2024); West Bengal (Ghosh & Raychaudhuri, 1982; Chakrabarti et al., 2012)
      Syzygium cumini (L.) Skeels – Manipur (Devi & Singh, 1987)
   Greenideoida (Greenideoida) ceyloniae van der Goot, 1917
      Unknown plant – Tripura (Agarwala et al., 1987)
   Schoutedenia emblica (Patel & Kulkarni, 1952)
      Phyllanthus emblica L. – Gujarat (Bharpoda et al., 2009); Karnataka (Chinnu et al., 2023); Uttar Pradesh (Singh et al., 2018)

8. *Coccinella septempunctata* Linnaeus, 1758
   Cervaphis rappardi indica Basu, 1961
      Cajanus cajan (L.) Millsp. – Manipur (Shantibala, 1989; Shantibala et al., 1997)
   Eutrichosiphum sp.
      Quercus sp. – Uttarakhand (Ghosh et al., 1991)
   Greenidea (Greenidea) ficicola Takahashi, 1921
      Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024);
   Greenidea (Trichosiphum) psidii van der Goot, 1917
      Pisum sativum L. – Bihar (Ahmad et al., 2012); Sikkim (Ghosh & Raychaudhuri, 1982); Uttar Pradesh (Chaudhary & Singh, 2012)
      Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024); West Bengal (Ghosh & Raychaudhuri, 1982; Chakrabarti et al., 2012)
   Schoutedenia emblica (Patel & Kulkarni, 1952)
      Phyllanthus emblica L. – Gujarat (Bharpoda et al., 2009); Uttar Pradesh (Singh et al., 2018)

9. *Coccinella transversalis* Fabricus, 1781
   Cervaphis quercus Takahashi, 1918
      Quercus serrata Murray – Manipur (Shantibala, 1989)
   Cervaphis rappardi indica Basu, 1961
      Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997)
   Greenidea (Greenidea) ficicola Takahashi, 1921
      Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)
   Greenidea (Trichosiphum) psidii van der Goot, 1917
      Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

10. *Coccinella undecimpunctata* Linnaeus, 1758
   Greenidea (Greenidea) ficicola Takahashi, 1921

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

11. ***Coelophora bissellata*** **Mulsant, 1850 [syn. *Lemnia bissellata* (Mulsant, 1850)]**

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Shantibala, 1989); Meghalaya (Shantibala, 1989)

Cervaphis rappardi indica Basu, 1961

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

12. ***Coelophora saucia*** **(Mulsant, 1850) [syn. *Lemnia saucia* Mulsant, 1850]**

Cervaphis rappardi indica Basu, 1961

Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997)

13. ***Cryptogonus quadriguttatus*** **(Weise, 1895)**

Cervaphis quercus Takahashi, 1918

Quercus sp. – Manipur (Chakrabarti et al., 2012)

14. ***Halyzia sanscrita*** **Mulsant, 1853**

Mollitrichosiphum sp.

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

15. ***Harmonia dimidiata*** **(Fabricius, 1781)**

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Shantibala, 1989; Sharmila et al., 2009)

Cervaphis rappardi indica Basu, 1961

Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997)

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

Alnus nepalensis D. Don – Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

16. ***Harmonia eucharis*** **(Mulsant, 1853)**

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Sharmila et al., 2006); Nagaland (Shantibala, 1989)

Cervaphis rappardi indica Basu, 1961

Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997)

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

Alnus nepalensis D. Don – Manipur (Chakrabarti et al., 2012); Nagaland (Shantibala, 1989); Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

17. ***Harmonia sedecimnotata*** **(Fabricius, 1801) [syn. *Callineda sedecimnotata* (Fabricius, 1801)]**

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

Alnus nepalensis D. Don – Sikkim (Phaloura & Singh, 1991); Uttarakhand (Phaloura & Singh, 1991)

Mollitrichosiphum sp.

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

18. ***Hippodamia variegata*** **(Goeze, 1777) [syn. *Adonia variegata* (Goeze, 1777)]**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

19. ***Megalocaria dilatata*** **(Fabricius, 1775) [syn. *Anisolemnia dilatata* (Fabricius, 1775)]**

Cervaphis schouteniae van der Goot, 1917

Unknown plant – Manipur (Chakrabarti et al., 2012)

Greenideoida (Greenideoida) ceyloniae van der Goot, 1917

Unknown plant – Manipur (Chakrabarti et al., 2012)

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

Alnus nepalensis D. Don – Manipur (Shantibala, 1989)

20. ***Megalocaria*** **sp.**

Eutrichosiphumr khasyanum (Ghosh & Raychaudhuri, 1962)

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

21. ***Micraspis discolor*** **(Fabricius, 1798) [syn. *Verania discolor* (Fabricius, 1798)]**

Cervaphis rappardi indica Basu, 1961

Cajanus cajan (L.) Millsp. – West Bengal (Maji et al., 2023b)

22. ***Micraspis vincta*** **(Gorham, 1895) [syn. *Verania vincta* Gorham, 1895]**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

23. ***Micraspis*** **sp.**

Eutrichosiphumr khasyanum (Ghosh & Raychaudhuri, 1962)

Quercus serrata Murray – Manipur (Shantibala, 1989)

24. ***Oenopia kirbyi*** **Mulsant, 1850**

Cervaphis rappardi indica Basu, 1961

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

Eutrichosiphumr raychaudhurii (Ghosh, 1969)

Alnus nepalensis D. Don – Nagaland (Shantibala, 1989)

Mollitrichosiphum sp.

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

25. ***Oenopia manipurensis*** **Devi, Singh & Singh, 1991**

Cervaphis rappardi indica Basu, 1961

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

26. ***Oenopia quadripunctata*** **Kapur, 1963**

Cervaphis rappardi indica Basu, 1961

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

Sumatraphis celti Takahashi, 1935

Celtis tetrandra Roxb. – Manipur (Shantibala, 1989)

27. ***Oenopia sauzeti*** **Mulsant, 1866**

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Shantibala, 1989; Chakrabarti et al., 2012); Nagaland (Shantibala, 1989)

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

Alnus nepalensis D. Don – Manipur (Shantibala, 1989); Nagaland (Shantibala, 1989; Chakrabarti et al., 2012)

Mollitrichosiphum sp.

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

28. ***Oenopia sexareata*** **(Mulsant, 1853) [syn. *Coelophora sexarcata* Mulsant, 1853)]**

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Shantibala, 1989; Chakrabarti et al., 2012); Nagaland (Shantibala, 1989)

Eutrichosiphumr raychaudhurii (Ghosh, 1969)

Alnus sp. – Sikkim (Joshi & Sangma, 2015)

Eutrichosiphumr sp.

Lithocarpus dealbatus (Hook.f. & Thomson ex Miq.) Rehder – Manipur (Shantibala, 1989)

Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)

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

Rosa sp. – Manipur (Chakrabarti et al., 2012)

29. ***Platynaspis variegata*** **Crotch, 1874 [syn. *Platynaspidius bimaculata* Pang & Mao, 1979; *Platynaspis kapuri* Chakraborty & Biswas, 2000]**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – West Bengal (Chakrabarti et al., 2012)

Syzygium cumini (L.) Skeels – Manipur (Shantibala, 1989)

30. ***Platynaspis*** **sp.**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – West Bengal (Chakrabarti et al., 2012)

31. ***Propylea dissecta*** **(Mulsant, 1850)**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Uttar Pradesh (Tiwari et al., 2024)

32. ***Scymnus (Neopullus) fuscatus Bohe*****man, 1859 [syn. *Scymnus picescens* Gorham, 1894]**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Manipur (Chakrabarti et al., 2012); Mizoram (Singh & Singh, 1991); Uttar Pradesh (Tiwari et al., 2024)

33. ***Scymnus (Pullus) hilaris*** **Motschulsky, 1858**

Cervaphis rappardi indica Basu, 1961

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

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Sikkim (Chakrabarti et al., 2012); Uttar Pradesh (Tiwari et al., 2024)

34. ***Scymnus (Pullus) pyrocheilus*** **Mulsant, 1853**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Bihar (Ahmad et al., 2012)

35. ***Scymnus (Scymnus) hodeki*** **Poorani & Thanigairaj, 2023**
Schoutedenia emblica (Patel & Kulkarni, 1952)
Phyllanthus emblica L. – Tamil Nadu (Poorani & Thanigairaj, 2023)

36. ***Synonycha grandis*** **(Thunberg, 1781)**
Cervaphis rappardi indica Basu, 1961
Cajanus cajan (L.) Millsp. – Manipur (Shantibala, 1989)

37. ***Verania*** **sp.**
Eutrichosiphum khasyanum (Ghosh & Raychaudhuri, 1962)
Quercus serrata Murray – Manipur (Agarwala et al., 1980)

2. Order: Dermaptera

a. Family: Forficulidae: Forficulidae, a family of earwigs, are omnivorous and aphids seem to be a preferred prey (Hagen et al., 1999). In India, only a single species is known to feed on a single species of greenideine aphids in Uttarakhand as mentioned below.

1. ***Forficula beelzebub*** **(Burr, 1900)**
Mollitrichosiphum sp.
Alnus nepalensis D. Don – Uttarakhand (Debnath, 1991)

3. Order : Diptera

a. Family : Syrphidae: Among the Diptera, the family Syrphidae, commonly known as the hover flies, are the most common aphid predators. Most of them offer twofold service in nature, as an adult they assist in crop pollination (Joshi et al., 2023) and as larvae, they feed several soft-bodied insects such as aphids, mealy bugs, scale insects, whiteflies, thrips etc.; and thus form an integral part of natural control of these insects (Kumar & Omkar, 2023). Table 1 shows that only 5 species of hover flies feed on 4 species of these aphids infesting only 3 species of host plants distributed only in 4 states/union territories of India with 9 predator-prey-food plant associations (triplets). Detail predator-prey-host plant records are given below.

1. ***Allograpta javana*** **(Wiedemann, 1824) [syn.** ***Sphaerophoria javana*** **Wiedemann, 1824;** ***Syrphus javana*** **Wiedemann, 1824]**
Cervaphis rappardi indica Basu, 1961
Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1997)
Greenideoida (Greenideoida) ceyloniae van der Goot, 1917
Unknown plant – Tripura (Agarwala et al., 1987)

2. ***Episyrphus balteatus*** **(De Geer, 1776) [syn.** ***Syrphus balteatus*** **De Geer, 1776]**
Cervaphis rappardi indica Basu, 1961
Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1994a; Shantibala et al., 1997)

3. ***Episyrphus*** **sp.**
Schoutedenia emblica (Patel & Kulkarni, 1952)
Phyllanthus emblica L. – Uttar Pradesh (Singh et al., 2018)

4. ***Eupeodes confrater*** **(Wiedemann, 1830) [syn.** ***Metasyrphus confrater*** **(Wiedemann, 1930)]**
Cervaphis rappardi indica Basu, 1961
Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1997)
Greenideoida (Greenideoida) ceyloniae van der Goot, 1917
Unknown plant – Tripura (Agarwala et al., 1987)

5. ***Ischiodon scutellaris*** **(Fabricius, 1805) [syn.** ***Xanthogramma scutellare*** **(Fabricius, 1805)]**

Cervaphis rappardi indica Basu, 1961
Cajanus cajan (L.) Millsp. – Manipur (Shantibala et al., 1997)
Greenideoida (Greenideoida) ceyloniae van der Goot, 1917
Unknown plant – Tripura (Agarwala et al., 1987)

6. ***Sphaerophoria scripta*** **(Linnaeus, 1758)**
Mollitrichosiphum (Metatrichosiphon) nandii Basu, 1964
Alnus nepalensis D. Don – West Bengal (Agarwala et al., 1982; Agarwala et al., 1984)

4. Order : Hemiptera

a. Family: Anthocoridae: The order Hemiptera includes almost 7 families of predatory bugs preying on soft-bodied insects like aphids, scale insects, mealybugs, bugs, leaf hoppers, thrips, mites, caterpillars etc. (Chellappan & Ranjith, 2023). In India, members of a single family, Anthocoridae (single species) is recorded as predators of a single species of greenideine aphids in West Bengal as mentioned below.

1. ***Bilia*** **sp.**
Greenidea (Trichosiphum) psidii van der Goot, 1917
Psidium guajava L. – West Bengal (Raychaudhuri et al., 1978; Debnath, 2020)

5. Order: Neuroptera

Neuroptera comprises lacewings, mantisflies, antlions and their relatives and both adults and larvae are entomophagous. They are generalist predators of soft-bodied insects. Recently, Singh *et al.* (2024b) enlisted 32 species of aphidophagous neuropterans from India belonging to 4 families. In India, its 2 families, Chrysopidae (green lacewings) and Hemerobiidae (brown lacewings) are recorded to prey on greenideine aphids in India. Among the chrysopids, 3 species prey on 3 species of these aphids feeding on 3 species of food plants distributed mostly in Uttarakhand state as mentioned below.

a. Family: Chrysopidae

1. ***Chrysoperla zastrowi sillemi*** **(Esben-Petersen, 1935)**
*Schoutedenia emblica (*Patel & Kulkarni, 1952)
Phyllanthus emblica L. – Uttar Pradesh (Singh & Singh, 2012)

2. ***Cunctochrysa jubingensis*** **(Hölzel, 1973) [syn.** ***Retipenna jubingensis*** **(Hölzel, 1973)]**
Greenidea (Trichosiphum) psidii van der Goot, 1917
Psidium guajava L. – Uttarakhand (Debnath et al., 1988; Dey, 2015)
Mollitrichosiphum sp.
Alnus nepalensis D. Don – Uttarakhand (Debnath et al., 1988; Dey, 2015)
Alnus sp. - Uttarakhand (Chakrabarti et al., 1991)

3. ***Italochrysa aequalis*** **(Walker, 1853)**
Greenidea (Paragreenidea) parthenocissi Saha & Chakrabarti, 1988
Parthenocissus semicordata Planch – Uttarakhand (Debnath et al., 1988; Dey, 2015)
Greenidea sp.
Parthenocissus semicordata Planch – Uttarakhand (Debnath, 1991)

4. ***Mallada desjardinsi*** **(Navás, 1911) [syn.** ***Anisochrysa boninensis*** **(Okamoto, 1914);** ***Mallada boninensis*** **(Okamoto, 1914)]**
Greenidea (Trichosiphum) psidii van der Goot, 1917
Psidium guajava L. – Uttarakhand (Debnath et al., 1988; Dey, 2015)

b. Family: Hemerobiidae

1. *Micromus timidus* Hagen, 1853

Cervaphis quercus Takahashi, 1918

Quercus serrata Murray – Manipur (Shantibala et al., 1994b)

Cervaphis rappardi indica Basu, 1961

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

B. Parasitoids of greenideine aphids

Three families of the order Hymenoptera are known to parasitise aphids: Aphelinidae, Encyrtidae and Braconidae (only subfamily Aphidiinae). Among them, only the members of Aphidiinae include members that parasitise only aphids. Among them, several species of parasitoids are known to efficiently contain the aphid population and check their severe outbreaks (Hagvar & Hofsvang, 1991; Singh & Singh, 2016; Das & Chakrabarti, 2023a, b). Because of this, several aphidiine species are widely used as biocontrol agents and as a result, their conservation values are advocated (Rakhshani & Starý, 2021; Das & Chakrabarti, 2023b).

The parasitoids of the greenideine aphids belong to two families of the order Hymenoptera: Aphelinidae (only subfamily Aphelininae, tribe Aphelinini) and Braconidae (only subfamily Aphidiinae). Aphidiinae species are the most abundant and active ones in regulating of the aphid populations (Singh & Singh, 2016). Starý et al. (2010) presented a review and illustrated key of the world aphidiine parasitoids of Greenideinae aphids including their distribution without mentioning their host plants. A total of 23 species of parasitoids belonging to two subfamilies (Aphelinidae, Aphidiinae: Hymenoptera) were observed to parasitise 18 species of these aphids on 17 food plant species distributed in 12 states of India (Table 5), mostly in Meghalaya (15 species), West Bengal (9 species) and Manipur (8 species) (Table 6) constituting 46 tritrophic associations (triplets). The maximum number of parasitoids was recorded parasitising *Greenidea ficicola* Takahashi, 1921 (11 species of aphidiine parasitoids) in India (Table 7).

Food plants of Greenideinae associated with parasitoids

Table 8 shows that 19 species of food plants belonging to 12 families of plants (including unknown species which may includes multiple species) are associated with 24 species of parasitoids in 12 states/union territories of India. Most of the host plants are infested by single species of aphids except *Alnus nepalensis* D. Don, *Castanopsis* sp., *Lithocarpus dealbatus* (Hook.f. & Thomson ex Miq.), *Listea* sp., *Psidium guajava* L. and *Quercus* sp. fed by 3, 2, 2, 2, 5 and 4 species of aphids, respectively. Among the host plants, the guava, *Psidium guajava*, is a delicious fruit crop of India and abroad and the guava aphid, *Greenidea (Trichosiphum) psidii* van der Goot, 1917 is pestiferous on it. Eight species of parasitoids are recorded on 5 species of aphids in Arunachal Pradesh, Karnataka, Meghalaya, Mizoram, Uttar Pradesh and West Bengal (Dharmadhikari & Ramaseshiah, 1970; Samanta et al., 1983b; Samanta, 1986; Raychaudhuri et al., 1990; Sarkar, 1991; Ahmad & Singh, 1993). *Syzygium cumini*, the black plum, is a medicinal plant and its fruits are eaten fresh, or processed into jams, jellies, fruit drinks, wine, vinegar, and more. The wood is water resistant and is used for railway sleepers, well motors, and cheap furnitures. None of the aphid species is pestiferous on it. *Alnus nepalensis* (the alder tree) are infested with 3 species of greenideine aphid which sometimes cause heavy damage to their plantation in Sikkim (Phaloura & Singh, 1991).

Table 5. Number of parasitoid species belonging to different species parasitising the number of species of greenideine aphids infesting different number of plant species, tritrophic associations and their distribution in number of states/union territories of India.

Parasitoid species	Number of			
	Host species	Host plant species	Tritrophic associations	States/union territories
Family: Aphelinidae, subfamily: Aphelininae				
1. *Aphelinus ancer*	1	1	1	1
Family: Braconidae, subfamily: Aphidiinae				
2. *Archaphidus greenideae*	4	6	9	3
3. *Binodoxys acalephae*	1	1	1	1
4. *Binodoxys angelicae sikkimensis*	1	1	1	1
5. *Binodoxys equatus*	1	1	1	2
6. *Binodoxys eutrichosiphi*	4	5	7	4
7. *Binodoxys indicus*	1	1	1	1
8. *Binodoxys kumaonensis*	1	1	1	1
9. *Binodoxys nunghaensis*	1	1	1	1
10. *Binodoxys shillongensis*	2	2	2	4
11. *Binodoxys sikkimensis*	1	1	1	4
12. *Binodoxys trichosiphae*	1	1	1	1
13. *Cristicaudus nepalensis*	1	2	2	2
14. *Eoaphidius longicaudatus*	1	1	1	1
15. *Ephedrus* sp.	1	1	1	1
16. *Fissicaudus androensis*	1	1	1	1
17. *Fissicaudus areolatus*	1	2	2	2
18. *Indaphidius curvicaudatus*	4	2	5	4
19. *Indoephedrus neoficicola*	1	1	1	1
20. *Indoephedrus reticulatus*	1	1	1	1
21. *Lipolexis oregmae*	2	1	2	3
22. *Praon mollitrichosiphi*	1	1	1	1
23. *Trioxys peniculatus*	1	1	1	1
24. *Trioxys* sp.	1	1	1	1
Total	**18**	**17**	**46**	**12**

Table 6. Number of species of parasitoids parasitising number of species of greenideine aphids feeding on different number of host plants species in different in different states of India.

States of India	Number of parasitoid species	Number of host species	Number of host plant species	Number of tritrophic associations
1. Arunachal Pradesh	1	1	1	1
2. Himachal Pradesh	1	1	1	1
3. Karnataka	2	2	2	2
4. Manipur	8	4	6	8
5. Meghalaya	15	9	8	15
6. Mizoram	4	3	4	4
7. Nagaland	2	2	1	2
8. Sikkim	7	4	4	7
9. Tripura	1	1	1	1
10. Uttar Pradesh	5	4	1	5
11. Uttarakhand	1	1	1	1
12. West Bengal	9	4	3	9
Total	**24**	**18**	**17**	**46**

Table 7. Number of parasitoid species parasitising different species of greenideine aphids infesting different number of host plant species and triplets and their distribution in India.

Aphid species	Number of parasitoid species	Number of host plant species	Number of triplets	Number of states
1. *Cervaphis schouteniae*	1	1	1	1
2. *Eutrichosiphum dubium*	1	1	1	1
3. *Eutrichosiphum flavum*	1	1	1	1
4. *Eutrichosiphum makii*	1	2	2	1
5. *Eutrichosiphum pseudopasaniae*	1	1	1	1
6. *Eutrichosiphum pyri*	1	1	1	2
7. *Eutrichosiphum quercifoliae*	1	1	1	1
8. *Eutrichosiphum raychaudhurii*	2	2	2	2
9. *Eutrichosiphum* sp.	2	4	5	3
10. *Greenidea artocarpi*	1	1	1	1
11. *Greenidea ficicola*	11	4	11	6
12. *Greenidea kumaoni*	1	1	1	1
13. *Greenidea psidii*	4	3	5	6
14. *Greenidia* sp.	6	5	7	2
15. *Mollitrichosiphum nandii*	1	1	1	2
16. *Mollitrichosiphum tenuicorpus*	2	2	2	2
17. *Mollitrichosiphum montanum*	1	1	1	1
18. *Mollitrichosiphum* sp.	1	2	2	2
Total	**24**	**17**	**46**	**12**

Table 8. Number of species of greenideine aphids infesting different food plants, number of species of their parasitoids, number of triplets (tritrophic associations) and their distribution in different number of states/union territories of India.

Species of host plants	Family of host plants	Number of			
		Species of aphids	Species of parasitoids	Triplets	States/union territory
1. *Alnus nepalensis*	Betulaceae	3	1	3	2
2. *Artemisia* sp.	Asteraceae	1	1	1	1
3. *Artocarpus heterophyllus*	Moraceae	1	1	1	1
4. *Berberis* sp.	Berberidaceae	1	1	1	1
5. *Betula* sp.	Betulaceae	1	1	1	2
6. *Calophyllum inophyllum*	Calophyllaceae	1	1	1	1
7. *Castanopsis* sp.	Fagaceae	2	1	2	1
8. *Eugenia* sp.	Myrtaceae	1	1	1	1
9. *Ficus* sp.	Moraceae	1	5	5	5
10. *Justicia adhatoda*	Acanthaceae	1	1	1	1
11. *Lithocarpus dealbatus*	Fagaceae	2	1	2	1
12. *Litsea* sp.	Lauraceae	2	1	2	1
13. *Microcos poniculata*	Malvaceae	1	1	1	1
14. *Psidium guajava*	Myrtaceae	5	8	10	6
15. *Pyrus communis*	Rosaceae	1	1	1	2
16. *Quercus* sp.	Fagaceae	4	5	5	6
17. *Syzygium cumini*	Myrtaceae	1	1	1	1
18. *Viburnum* sp.	Viburnaceae	1	2	2	1
19. Unknown species		3	3	3	3
	Total	**19**	**23**	**46**	**12**

The checklist of aphid parasitoids along with their prey infesting various food plants in different states/union territories of India

1. Family: Aphelinidae, subfamily: Aphelininae: The Aphelinidae are a small group of Chalcidoidea (Hymenoptera) containing 32 genera and a little over a thousand species (Hayat, 1998) and is a major source of biocontrol agents of economically important insect pest species such as coccoids, aphids and aleyrodids (Homoptera). Aphelinidae is represented by a single species in Karnataka as mentioned below.

1. ***Aphelinus ancer*** **Hayat, 1990**

Greenidea (Greenidea) artocarpi (Westwood, 1890)

Artocarpus heterophyllus Lam. – Karnataka (Hayat, 1998)

2. Family: Braconidae, subfamily: Aphidiinae: Das & Chakrabarti (2023) listed 157 aphidiine species parasitising several aphid species in India. Out of these, only 22 species are described/recorded from India parasitising 16 species of the greenideine aphids infesting 16 species of host plants distributed only in 12 states of India. All these parasitoids parasitise 1-4 aphid species (Table 4). It indicates that India has very limited fauna and biodiversity of these parasitoids parasitising only few species of greenideine aphids of economic importance. It demonstrates that survey programmes should be conducted regarding the biodiversity of aphid parasitoids in unexplored areas. Following checklist displays the species of aphidiine parasitoids recorded parasitising the greenideine aphids in India.

1. ***Archaphidus greenideae*** **Starý & Schlinger, 1967**

Eutrichosiphum dubium (van der Goot, 1917)

Lithocarpus dealbatus (Hook.f. & Thomson ex Miq.) Rehder – Manipur (Singh & Singh, 1986a)

Eutrichosiphum pseudopasaniae Szelegiewicz, 1968

Lithocarpus dealbatus (Hook.f. & Thomson ex Miq.) Rehder – Manipur (Singh & Singh, 1986a)

Greenidea (Greenidea) ficicola Takahashi, 1921

Psidium guajava L. – Uttar Pradesh (Ahmad & Singh, 1993, 1995)

Greenidea (Trichosiphum) psidii van der Goot, 1917

Eugenia sp. – Manipur (Singh, 1987)

Psidium guajava L. – Uttar Pradesh (Singh et al., 1999)

Greenidea sp.

Justicia adhatoda L. – Manipur (Singh, 1987)

Calophyllum inophyllum L. – Manipur (Singh & Singh, 1986a)

Viburnum sp. – Manipur (Singh & Singh, 1986a)

Eutrichosiphum sp.

Quercus sp. – Uttarakhand (Chakrabarti & Debnath, 2009)

2. ***Binodoxys acalephae*** **(Marshall, 1896) [syn. *Binodoxys rietscheli* (Mackauer, 1959); *Trioxys acalephae* (Marshall, 1896)]**

Greenidea (Greenidea) ficicola Takahashi, 1921

Quercus sp. – Sikkim (Tamili, 1988)

3. ***Binodoxys angelicae sikkimensis*** **(Raychaudhuri, Samanta, Pramanik, Tamili & Sarkar, 1990)**

Greenidea (Greenidea) ficicola Takahashi, 1921

Ficus sp. – Sikkim (Raychaudhuri et al., 1990)

4. ***Binodoxys equatus*** **(Samanta, Tamili & Raychaudhuri, 1985) [syn. *Trioxys (Binodoxys) equatus* Samanta, Tamili & Raychaudhuri, 1985]**

Eutrichosiphum raychaudhurii (Ghosh, 1969)

Betula sp. – Sikkim (Das & Chakrabarti, 2023a); West Bengal (Das & Chakrabarti, 2023a)

5. ***Binodoxys eutrichosiphi*** **(Starý, 1975) [syn. *Trioxys (Binodoxys) eutrichosiphi* Starý, 1975]**

Eutrichosiphum makii Raychaudhuri & Chatterjee, 1974

Castanopsis sp. – Meghalaya (Ghosh & Raychaudhuri, 1982; Starý & Ghosh, 1975)

Litsea sp. – Meghalaya (Ghosh & Raychaudhuri, 1982; Starý & Ghosh, 1975)

Eutrichosiphum pyri Chakrabarti, Ghosh & Raychaudhuri, 1972

Pyrus communis L. – Meghalaya (Samanta, 1986); Sikkim (Tamili, 1988)

Eutrichosiphum sp.

Castanopsis sp. – Meghalaya (Starý & Ghosh, 1975)

Litsea sp. – Meghalaya (Starý & Ghosh, 1975)

Psidium guajava L. – Arunachal Pradesh (Samanta, 1986); Meghalaya (Samanta, 1986)

Greenidea (Greenidea) ficicola Takahashi, 1921

Ficus sp. – Mizoram (Sarkar, 1991)

6. ***Binodoxys indicus*** **(Subba Rao & Sharma, 1958) [syn. *Trioxys indicus* Subba Rao & Sharma, 1958]**

Greenidea sp.

Psidium guajava L. – Uttar Pradesh (Rakhshani et al., 2012)

7. ***Binodoxys kumaonensis*** **(Starý & Raychaudhuri, 1982)**

Greenidea (Trichosiphum) kumaoni Chakrabarti & Raychaudhuri, 1978

Berberis sp. – Himachal Pradesh (Starý & Raychaudhuri, 1982)

8. ***Binodoxys nungbaensis*** **(Paonam & Singh, 1986)**

Greenidea sp.

Viburnum sp. – Manipur (Singh & Singh, 1986b)

9. ***Binodoxys shillongensis*** **(Starý, 1978)**
Eutrichosiphum quercifoliae Raychaudhuri *et al.*, 1973
Quercus sp. – Mizoram (Sarkar, 1991); Nagaland (Pramanik, 1986)
Eutrichosiphum raychaudhurii (Ghosh, 1969)
Betula sp. – Meghalaya (Samanta, 1986; Raychaudhuri et al., 1990); West Bengal (Tamili, 1988)

10. ***Binodoxys sikkimensis*** **Raychaudhuri, 1990 [syn. *Binodoxys acalephae sikkimensis* Raychaudhuri, 1990]**
Greenidea ficicola Takahashi, 1921
Quercus sp. – Meghalaya (Das & Chakrabarti, 2023a); Nagaland (Das & Chakrabarti, 2023a); Sikkim (Das & Chakrabarti, 2023a); West Bengal (Raychaudhuri et al., 1990; Starý et al., 2010)

11. ***Binodoxys trichosiphae*** **(Samanta & Raychaudhuri, 1990)**
Greenidea (Trichosiphum) psidii van der Goot, 1917
Psidium guajava L. – Meghalaya (Samanta, 1986; Das & Chakrabarti, 2023a)

12. ***Cristicaudus nepalensis*** **(Takada, 1970)**
Greenidea (Trichosiphum) psidii van der Goot, 1917
Psidium guajava L. – West Bengal (Raychaudhuri et al., 1990)
Syzygium cumini (L.) Skeels – Mizoram (Sarkar, 1991)

13. ***Eoaphidius longicaudatus*** **Samanta & Raychaudhuri, 1990**
Greenidea (Greenidea) ficicola Takahashi, 1921
Ficus sp. – Meghalaya (Samanta, 1986; Das & Chakrabarti, 2023a)

14. ***Ephedrus*** **sp.**
Eutrichosiphum flavum (Takahashi, 1941)
Unknown plant – Meghalaya (Starý & Ghosh, 1983)

15. ***Fissicaudus androensis*** **Singh & Singh, 1988**
Greenidea sp.
Ficus sp. – Manipur (Singh & Singh, 1988)

16. ***Fissicaudus areolatus*** **(Samanta, Tamili & Raychaudhuri, 1985) [syn. *Trioxys* (*Fissicaudus*) *areolatus* Samanta, Tamili & Raychaudhuri, 1985]**
Greenidea (Greenidea) ficicola Takahashi, 1921
Artemisia sp. – West Bengal (Samanta et al., 1985)
Ficus sp. – Meghalaya (Samanta et al., 1985); West Bengal (Tamili, 1988)

17. ***Indaphidius curvicaudatus*** **Starý, 1979**
Greenidea (Greenidea) ficicola Takahashi, 1921
Psidium guajava L. – Meghalaya (Samanta, 1986)
Mollitrichosiphum (Metatrichosiphon) montanum (van der Goot, 1917)
Alnus nepalensis D. Don – West Bengal (Agarwala, 1983; Akhtar et al., 2011)
Mollitrichosiphum (Metatrichosiphon) nandii Basu, 1964
Alnus nepalensis D. Don – Sikkim (Agarwala, 1979; Raychaudhuri et al., 1979); West Bengal (Raychaudhuri et al., 1979)
Mollitrichosiphum sp.
Alnus nepalensis D. Don – West Bengal (Starý, 1979)
Psidium guajava L. – Uttar Pradesh (Rakhshani et al., 2012)

18. ***Indoephedrus neoficicola*** **Samanta, Pramanik & Raychaudhuri, 1983**
Greenidea (Greenidea) ficicola Takahashi, 1921

Psidium guajava L. – Meghalaya (Samanta et al., 1983)

19. ***Indoephedrus reticulatus*** **Samanta, Pramanik & Raychaudhuri, 1983**

Greenidea (Greenidea) ficicola Takahashi, 1921

Psidium guajava L. – Meghalaya (Samanta et al., 1983)

20. ***Lipolexis oregmae*** **(Gahan, 1932) [syn.** ***Lipolexis pseudoscutellaris*** **Pramanik & Raychaudhuri, 1984;** ***Lipolexis scutellaris*** **Mackauer, 1962]**

Greenidea (Trichosiphum) psidii van der Goot, 1917

Psidium guajava L. – Karnataka (Dharmadhikari & Ramaseshiah, 1970); Mizoram (Sarkar, 1991)

Greenidea sp.

Psidium guajava L. – Uttar Pradesh (Rakhshani et al., 2012)

21. ***Praon mollitrichosiphi*** **Agarwala, Saha & Mahapatra, 1987**

Mollitrichosiphum (Mollitrichosiphum) tenuicorpus (Okajima, 1908)

Quercus sp. – Sikkim (Agarwala et al., 1987)

22. ***Trioxys peniculatus*** **Agarwala, Saha & Mahapatra, 1985**

Cervaphis schouteniae van der Goot, 1917

Microcos poniculata L. – Tripura (Agarwala et al., 1985)

23. ***Trioxys*** **sp.**

Mollitrichosiphum (Mollitrichosiphum) tenuicorpus (Okajima, 1908)

Fagaceae – Meghalaya (Starý & Ghosh, 1978)

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Conflict of interests

The authors declare that they have no competing interests.

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