Article

The parasitoids of *Myzus* spp. (Aphididae: Hemiptera) and their distribution in India

Rajendra Singh
Department of Zoology, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, U.P., India
E-mail: rsinghgpu@gmail.com

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Abstract
In this study, the parasitoids of 12 species of *Myzus* Passerini, 1860 (Aphididae: Hemiptera) are enlisted along with their host aphids and host plants distributed in different states and union territories of India. The study demonstrated that 48 species of parasitoids (6 species belonging to Aphelinidae; one species belonging to Encyrtidae and 41 species of Aphidiinae (Braconidae) parasitising 12 species of aphids belonging to the genus *Myzus* Passerini, 1860 infesting 82 plant species in 21 states/union territories of India. Most of the host plants are highly economically important agricultural crops. A total of 261 tritrophic associations were recorded. Aphelinidae is represented by a single genus, *Aphelinus* with 6 species while Aphidiinae (Braconidae) comprises 40 species belonging to 10 genera, among which *Aphidius matricariae* Haliday, 1834 is a polyphagous and diversified parasitising 6 species of aphids infesting 29 plant species in 11 states/union territories of India.

Keywords aphids; Aphelinidae; Aphidiinae; biological control; India; *Myzus*; parasitoids.

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1 Introduction

The genus *Myzus* Passerini (1860) is a big genus and comprises 80 valid species under 4 subgenera, *Galiobium* Börner 1933, *Myzus* Passerini, 1860, *Nectarosiphon* Schouteden 1901 and *Sciamyzus* Stroyan 1954 which are distributed throughout the world (Favret, 2024). Of which, several species are notorious pests of economically important agricultural as well as horticultural crops throughout the world (Blackman and Eastop, 2000). In India, 24 species including 2 subspecies of *Myzus* are reported under 3 subgenera: *Myzus*, *Nectarosiphon* and *Sciamyzus* (Singh et al., 2015, 2023). Among them, only few species are highly destructive to the crops, e.g. the green peach aphid, *Myzus (Nectarosiphon) persicae* (Sulzer, 1776) (Singh et al., 2015) which alone infests around 300 species of plants belonging to 64 families, particularly of Brassicaceae and Solanaceae; the tobacco aphid, *Myzus (Nectarosiphon) persicae nicotianae* Blackman, 1987 feeding and destroying tobacco crops; and

Myzus (Myzus) ornatus (Laing, 1932), pestiferous on several cherry crops throughout the world. Other species of *Myzus* are also pestiferous on orchard plantations and several field crops (Singh and Singh, 2017).

Like other aphids, *Myzus* spp. directly damage crops by sucking their nutrients which causes lack of vigour in the plants and indirectly by excreting high amount of honeydew that covers the stomatal openings of the leaves, hindering their normal physiology like photosynthesis, transpiration and respiration (Singh and Singh, 2021; Singh and Singh, 2022). They also damage the crops by transmitting several plant viruses (Chan et al., 1991; Singh et al., 2015).

There are several natural enemies of *Myzus* spp. that includes aphidophagous predators, parasiotoids and pathogenic diseases. Predatory aphidophagous arthropods of *Myzus* spp. in India are recently compiled by Singh (2024a). Among the aphid parasitoids braconid wasps (Aphidiinae: Braconidae: Hymenoptera) stand first due to their species diversity and having high foraging and parasitising efficiencies (Starý, 1988; Singh and Agarwala, 1992; Singh and Singh, 2016) followed by aphelinid chalcid wasps (Aphilinini: Aphelininae: Aphelinidae: Hymenoptera) (Hayat, 1998). Among these parasitoids, several species are known to efficiently regulate the aphid population and check their severe outbreaks (Hagvar and Hofsvang, 1991; Singh and Singh, 2016; Das and Chakrabarti, 2023a, b). Because of this, several aphelinid and aphidiine species are widely used as biocontrol agents (Boivin et al., 2012) and therefore, their conservation values are advocated (Rakhshani and Starý, 2021; Das and Chakrabarti, 2023b). For successful biocontrol programmes, the parasitoids that act as biocontrol/natural control agents against insect pests must be documented and emphasis should be given to their conservation (Pons et al., 2018). The extensive and explanatory surveys should be conducted in unexplored geographical regions and in-depth research should go into their taxonomy and ecological aspects (Singh, 2024b). In this regard, the present article compiles the available information regarding the records of parasitoids of *Myzus* species, and its distribution in different states and union territories of India. This will definitely facilitate to comprehend the latest situation of parasitoids parasitising only *Myzus* spp. in India as it will ultimately be helpful to appraise their usefulness as their biocontrol agents against them. Accordingly, based on the available literature, an up-to-date aphelinid and aphidiine species, parasitising *Myzus* spp. with their associated plants along with their distribution in different states of India are presented.

2 Material and Methods

The present study is based on the primary data of published literature on aphid 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 August 31, 2024. In most of the recent-past literature, there are several errors in the scientific names of both parasitoids and their aphid hosts 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 present study, attempts have been made to provide the valid scientific names of the parasitoids following GBIF (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

In India, the natural parasitoids are reported to parasitize only 12 species of *Myzus* out of 23 species recorded in India (Singh et al., 2023) grouped into 2 subgenera as: *Myzus (Myzus) cerasi* (Fabricius, 1775); *Myzus (Myzus) cornutus* Medda and Chakrabarti, 1986; *Myzus (Myzus) dycei* Carver, 1961; *Myzus (Myzus) mumecola* (Matsumura, 1917); *Myzus (Myzus) obtusirostris* David, Narayanan and Rajasingh, 1972; *Myzus (Myzus) ornatus* (Laing, 1932); *Myzus (Myzus) siegesbeckicola* Strand, 1929; *Myzus (Myzus) sorbi* Bhattacharya and

Chakrabarti, 1982; *Myzus (Myzus) varians* Davidson, 1912; *Myzus (Nectarosiphon) persicae* (Sulzer, 1776) and its subspecies *Myzus (Nectarosiphon) persicae nicotianae* Blackman, 1987. These parasitoids belong to three families of Hymenoptera: Aphelinidae (only subfamily Aphelininae, tribe: Aphelinini), Encyrtidae and Braconidae (only subfamily Aphidiinae). Among them, only the members of Aphelininae and Aphidiinae include members that parasitise exclusively aphids. The Aphelininae include only two genera *Aphelinus* Dalman, 1820 and *Protaphelinus* Mackauer, 1972 which exclusively parasitise aphids (Hayat, 1998). Manickavasagam and Menakadevi (2014) listed 16 species of *Aphelinus* and their distribution in India without giving their host records. The Aphidiinae comprise 157 species under 23 genera parasitising several aphid species in India (Das and Chakrabarti, 2023a). However, in this study and others, the tritrophic associations (parasitoid - aphid host - host plant, triplets) along with their distribution are not clearly mentioned for each triplet. In addition, the taxonomic status of some species of parasitoids, aphids and host plant have also been modified and need correction.

A total of 48 species of parasitoids belonging to three families, 6 of Aphelinidae, one from Encyrtidae and 41 of Braconidae were observed to parasitise 12 species of the genus *Myzus* on 86 food plant species distributed in 21 states/union territories of India. A total of 261 tritrophic associations (parasitoid - aphid host - host, triplets) were observed in India. Maximum number of triplets was recorded with *Myzus persicae* (202 triplets; 18 with aphelinine, one with encyrtid and 183 with aphidiine parasitoids in India. Aphelinidae is represented by a single genus, *Aphelinus* while Aphidiinae (Braconidae) comprises 41 species belonging to 10 genera, among which *Aphidius matricariae* is a polyphagous and diversified species and parasitise 6 species of aphids infesting 29 plant species in 11 states/union territories of India.

The foloowing are aphid parasitoids along with their prey aphid species infesting food plants in different states of India.

3.1 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). In spite of this, the family is a major source of biocontrol agents of economically important insect pest species such as coccoids, aphids and aleyrodids (Homoptera). The members of the subfamily Aphelininae, tribe Aphelinini are exclusively aphid parasitoids (Viggiani, 1984; Starý, 1988).

A total of 16 species of *Aphelinus* and a single species of *Protaphelinus* are recorded to parasitise aphids in India (Hayat, 1998). However, only 6 species of *Aphelinus* are recorded to parasitise a single species, *Myzus persicae* infesting 18 species of host plants in only 8 states of India. Among them, *Aphelinus gossypii* parasitises *Myzus pericae* infesting 12 species of plants recorded only in 2 states. Next to this species, *Aphelinus albipodus* parasitises *Myzus persicae* which infest 6 host plant species distributed in 3 states (Table 1).

Table 1 The aphelinid parasitoid species parasitising *Myzus persicae* on different number of plant species, tritrophic associations (triplets) and their distribution in India.

Parasioid species	Number of host plant species	Number of tritrophic associations	Number of states/union territories
Aphelinus abdominalis	1	1	1
Aphelinus albipodus	6	6	3
Aphelinus asychis	4	4	5
Aphelinus gossypii	12	12	2
Aphelinus kurdjumovi	3	3	1

Parasioid species	Number of host plant species	Number of tritrophic associations	Number of states/union territories
Aphelinus mali	1	1	1
Aphelinus sp.	1	1	1
Total	**18**	**18**	**8**

Following list displays species of aphelinid parasitoids recorded/described parasiting the aphid genus *Myzus* infesting several host plants and their distribution in different states/union territories of India.

3.1.1 *Aphelinus abdominalis* (Dalman, 1820)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Solanum tuberosum L. - Himachal Pradesh (Thakur and Chandla, 2013)

3.1.2 *Aphelinus albipodus* Hayat and Fatima, 1992

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Beta vulgaris L. - Bihar (Parween et al., 2023)

Brassica oleracea L. - Bihar (Parween et al., 2023)

Raphanus sativus L. - Bihar (Parween et al., 2023)

Solanum tuberosum L. - Bihar (Parween et al., 2023)

Sorghum bicolor (L.) Moench – Unknown place (Hayat, 1998)

Zea mays L. - Punjab (Hayat, 1998)

3.1.3 *Aphelinus asychis* Walker, 1839

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Brassica oleracea L. - Meghalaya (Hayat, 1998); Tamil Nadu (Hayat, 1998); Uttar Pradesh (Hayat, 1998)

Brassica spp. - Assam (Hayat, 1998)

Capsicum annuum L. - Himachal Pradesh (Gavkare and Kumar, 2012; Gavkare et al., 2014)

Solanum tuberosum L. - Assam (Hayat, 1998); Meghalaya (Hayat, 1998); Tamil Nadu (Hayat, 1998); Uttar Pradesh (Hayat, 1998)

3.1.4 *Aphelinus gossypii* Timberlake, 1924 [syn. *Aphelinus kashmiriensis* Hayat, 1972]

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Brassica oleracea L. - Bihar (Kumar, 2013)

Brassica rapa L. - Bihar (Parween et al., 2023)

Calendulla sp. - Bihar (Kumar, 2013)

Capsicum frutescens L. - Bihar (Parween et al., 2023)

Delphinium sp. - Uttar Pradesh (Ahmad and Singh, 1992; Ahmad and Singh, 1993)

Helianthus sp. - Bihar (Ahmad and Singh, 1996)

Hemigraphis sp. - Uttar Pradesh (Ahmad and Singh, 1993; Singh et al., 1999)

Rumex sp. – Bihar (Kumar, 2013)

Solanum lycopersicum L. - Bihar (Parween et al., 2023)

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

Solanum tuberosum L. - Bihar (Ahmad and Singh, 2007; Parween et al., 2023); Uttar Pradesh (Tripathi and Singh, 1997; Chaudhary and Singh, 2007)

Vicia faba L. - Uttar Pradesh (Tiwari et al., 2024)

3.1.5 *Aphelinus kurdjumovi* Mercet, 1930
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica sp. - Tamil Nadu (Nagalingam, 1988)
Capsicum frutescens L. - Tamil Nadu (Nagalingam, 1988)
Solanum melongena L. - Tamil Nadu (Nagalingam, 1988)
3.1.6 *Aphelinus mali* (Haldeman, 1851)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Capsicum frutescens L. - Tamil Nadu (Rajagopal and Kareem, 1983)
3.1.7 *Aphelinus* sp.
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Capsicum annuum L. - Karnataka (Mani and Krishnamoorthy, 1994)

3.2 Family: Encyrtidae, subfamily: Encyrtinae

The Encyrtidae are a large group of Chalcidoidea (Hymenoptera), containing over 450 genera and more than 3700 species, mostly parasitising insects belonging to different taxa, particularly, soft scales, bugs, ticks, caterpillars etc. (Prinsloo, 1997). Only one species, *Syrphophagus aphidivorus* (Mayr, 1876) was observed to parasitise *Myzus (Nectarosiphon) persicae nicotianae* Blackman, 1987 infesting tobacco crop (*Nicotiana tabacum* L. in Andhra Pradesh (Rao et al., 2007).

3.3 Family: Braconidae, subfamily: Aphidiinae

The main contributions regarding the Indian aphidiine species go to primarily Starý and Ghosh (1983), Raychaudhuri et al. (1990), Dey and Akhtar (2007), Akhtar et al. (2011a), Das and Chakrabarti (2023a) who compiled these species. Das and Chakrabarti (2023a) listed 157 aphidiine species parasitising several aphid species in India. Out of these, 40 species are described/recorded from India parasitising 12 species of the genus *Myzus* infesting 82 species of host plants distributed in 21 states/union territories of India (Table 2). Maximum number of parasitoids is known to parasitise *Myzus persicae* (34 species of parasitoids) feeding on 81 plant species followed by *Myzus ornatus* (12 species of parasitoids) infesting 16 species of food plants, of which several species are economically important crops. A total of 242 tritrophic associations (parasitoid - aphid host - host, triplets) were observed in India. It indicates that India has rich fauna and biodiversity of aphidiine parasitoids parasitising several species of aphids of economic importance, despite no information from several states like Goa, Gujarat, Haryana, Jharkhand, Kerala, Maharashtra, Odisha, Telangana, Tripura and union territories like Andaman and Nicobar Islands, Dadra and Nagar Haveli and Daman and Diu, Ladakh, Lakshadweep and Puducherry (Fig. 1). It accounts for about one-third of the area of India. Even big states, like Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Madhya Pradesh, Punjab and Rajasthan, only 1 - 6 tritrophic associations are known. It demonstrates that survey programmes should be conducted regarding the biodiversity of aphid parasitoids in those areas.

Among the parasitoids, *Aphidius matricariae* is a polyphagous species and parasitses 6 aphid species on 29 food plant species forming 39 tritrophic associations in 11 states/union territories of India (Table 3). However, it prefers mostly *Myzus persicae* infesting mostly brassica and solanaceous crops (Tazerouni et al., 2016). *Aphidius matricariae* is an effective biological control agent against aphid populations especially in greenhouse crops and is produced by a number of commercial companies around the world (Singh, 2001; Singh and Singh, 2016). The parasitoid, *Diaeretiella rapae* is also a polyphagous parsitoid parasitising about 98 species of the aphids infesting more than 180 plant species belonging to 43 plant families distributed in 87 countries throughout the world (Singh and Singh, 2015). It was found heavily parasitising Russian wheat aphid, *Diuraphis noxia* in Europian, American and to some extent to African countries (Elliott et al., 1995). However,

it parasitises only 3 species of *Myzus* infesting 15 species of plants in India.

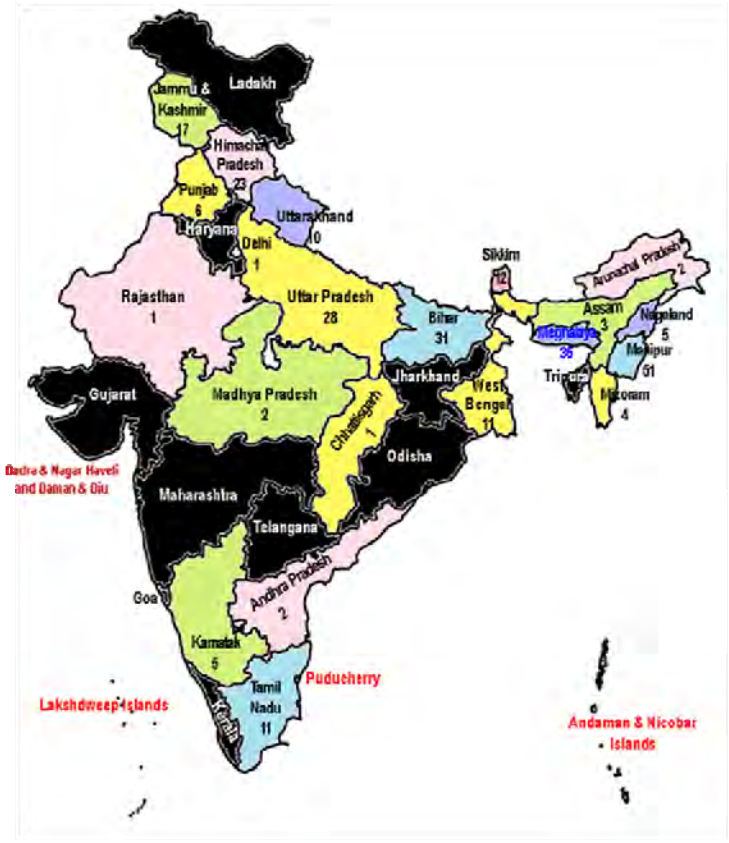

Fig. 1 Map showing the number of tritrophic assocations of parasitoids of *Myzus* spp. in different states/union territories of India. No parasitoid species was record in black shaded states/union territory of India.

Table 2 Number of species of aphidiine parasitoids parasitising the number of host aphids (*Aphis* spp.), host plants infested, number of tritrophic associations and their distribution in India.

Aphid species	Number of parasitoid species	Number of host plants	Number of triplets	Distribution in states/union territories
1. *Myzus boehmeriae*	2	2	2	1
2. *Myzus cerasi*	2	3	3	3
3. *Myzus cornutus*	1	1	1	1
4. *Myzus dycei*	7	5	10	7
5. *Myzus mumecola*	4	4	5	2
6. *Myzus obtusirostris*	2	2	2	1
7. *Myzus ornatus*	12	16	20	6
8. *Myzus persicae*	34	81	183	19
9. *Myzus persicae nicotianae*	3	1	4	3
10. *Myzus siegesbeckicola*	1	1	1	1
11. *Myzus sorbi*	4	1	4	2
12. *Myzus varians*	1	1	1	1
13. *Myzus* sp.	4	5	6	2
Total	**40**	**82**	**242**	**21**

Table 3 Number of parasitoid species belonging to different species parasitising the number of host aphid species infesting many plant species, tritrophic associations and their distribution in India.

Parasioid species	Number of host species	Number of host plant species	Number of tritrophic associations	Number of states/union territories
Aphidius asteris	1	3	3	1
Aphidius avenae	1	4	4	2
Aphidius colemani	2	15	16	7
Aphidius eglanteriae	3	1	3	2
Aphidius ervi	1	2	2	2
Aphidius gifuensis	1	3	3	1
Aphidius hortensis	2	1	2	1
Aphidius macrosiphoniella	1	1	1	1
Aphidius matricariae	6	29	39	11
Aphidius platensis	1	2	2	1
Aphidius pleotrichophori	1	1	1	1
Aphidius qadrii	2	6	6	5
Aphidius rhopalosiphi	1	1	1	1
Aphidius sp.	5	9	9	7
Aphidius similis	1	4	4	2
Aphidius staryi	1	1	1	1
Aphidius urticae	2	2	2	1
Aphidius uzbekistanicus	2	2	2	1
Binodoxys basicurvus	1	1	1	1
Binodoxys brevicornis	1	3	3	2
Binodoxys indicus	3	16	16	7
Binodoxys struma	1	1	1	1
Binodoxys tomentosae	1	1	1	1
Diaeretiella rapae	3	15	16	12
Ephedrus brevis	1	1	1	1
Ephedrus lacertosus	1	1	1	1
Ephedrus niger	1	1	1	1
Ephedrus persicae	2	5	5	5
Ephedrus sp.	2	6	6	2
Ephedrus plagiator	2	21	21	4
Ephedrus srinagarensis	2	4	4	4
Ephedrus trichosiphoniellae	1	1	1	1
Ephedrus urticae	1	1	1	1
Kashmiria aphidis	1	1	1	1
Lipolexis oregmae	1	8	8	2
Lysiphlebus confusus	1	1	1	1
Neoephedrus kalimpongensis	1	1	1	1
Praon volucre	2	10	10	4

Parasioid species	Number of host species	Number of host plant species	Number of tritrophic associations	Number of states/union territories
Praon sp.	2	3	3	1
Toxares deltiger	4	6	6	1
Toxares macrosiphophagum	4	5	5	1
Toxares shigai	1	1	1	1
Toxares zakai	1	2	2	1
Total	**12**	**82**	**242**	**21**

Following list displays species of aphidiine parasitoids recorded/described parasiting the aphid genus *Myzus* infesting several host plants and their distribution in different states/union territories of India.

3.3.1 *Aphidius asteris* Haliday, 1834 [syn. *Aphidius absinthii* Marshall, 1896; *Aphidius commodus* Gahan, 1926]

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica sp. - Tamil Nadu (Nagalingam, 1988)
Capsicum frutescens L. - Tamil Nadu (Nagalingam, 1988)
Solanum melongena L. - Tamil Nadu (Nagalingam, 1988)

3.3.2 *Aphidius avenae* Haliday, 1834 [syn. *Aphidius picipes* (Nees, 1811)]

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica oleracea L. - Mizoram (Sarkar, 1991)
Carica papaya L. - Manipur (Subhrani et al., 2010)
Solanum melongena L. - Manipur (Subhrani et al., 2010)
Urtica dioica L. - Manipur (Singh, 1987)

3.3.3 *Aphidius colemani* Viereck, 1912

Myzus (Myzus) varians Davidson, 1912
Prunus domestica L. - Manipur (Subhrani et al., 2006)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Ageratum conyzoides L. - Bihar (Ahmad and Singh, 1996)
Brassica juncea (L.) Czern - Himachal Pradesh (Dey and Akhtar, 2007; Akhtar, 2009)
Brassica nigra (L.) K. Koch - Manipur (Singh, 1987)
Brassica oleracea L. - Uttar Pradesh (Ahmad and Singh, 1993; Chaudhary and Singh, 2007)
Brassica oleracea L. *botrytis* - Manipur (Bijaya et al., 2001a)
Brassica oleracea L. *capitata* - Manipur (Devi et al., 1999; Bijaya et al., 2001a)
Brassica oleracea L. *gongylodes* - Manipur (Bijaya et al., 2001a)
Brassica rapa L. - Manipur (Bijaya et al., 2001b); Uttar Pradesh (Tiwari et al., 2024)
Calendulla sp. - Bihar (Kumar, 2013)
Duranta erecta L. - Manipur (Singh and Singh, 1986a)
Lantana camara L. - West Bengal (Tamili, 1988)
Rumex sp. - Bihar (Kumar, 2013)
Solanum lycopersicum L. - Uttar Pradesh - (Rafi et al., 2010; Tiwari et al., 2024)

Solanum melongena L. - Manipur (Subhrani et al., 2010)
Solanum nigrum L. - Uttar Pradesh (Rafi et al., 2010)
Solanum tuberosum L. - Bihar (Kumar, 2013); Himachal Pradesh - (Trivedi and Rajagopal, 1988); Jammu and Kashmir - (Khan and Shah, 2017); Manipur (Singh and Singh, 1986a; Subhrani et al., 2006)
Unknown plant - Meghalaya (Starý and Ghosh, 1983)

3.3.4 *Aphidius eglanteriae* Haliday, 1834

Myzus (Myzus) ornatus Laing, 1932
Unknown plant - Meghalaya (Samanta and Raychaudhuri, 1984)

Myzus (Myzus) sorbi Bhattacharya and Chakrabarti, 1982
Sorbaria tomentosa (Lindl.) Rehder - Uttarakhand (Das and Chakrabarti, 1990; Sarkar, 2022)

Myzus (Myzus) sorbi Bhattacharya and Chakrabarti, 1982
Sorbaria tomentosa (Lindl.) Rehder - Uttarakhand (Das and Chakrabarti, 2018)

3.3.5 *Aphidius ervi* Haliday, 1834

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Beta vulgaris L. - Sikkim (Tamili, 1988)
Capsicum annuum L. - Himachal Pradesh (Gavkare et al., 2014; Kumar et al., 2020)

3.3.6 *Aphidius gifuensis* Ashmead, 1906

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica oleracea L. - Manipur (Subhrani et al., 2010)
Cardamine debilis Banks ex DC. - Manipur (Singh, 1987)
Gynura bicolor DC. - Manipur (Singh, 1987)

3.3.7 *Aphidius hortensis* Marshall, 1896

Myzus (Myzus) dycei Carver, 1961
Brassica oleracea L. - Manipur (Singh, 1987)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica oleracea L. *capitata* - Manipur (Subhrani et al., 2006)

3.3.8 *Aphidius macrosiphoniella* (Tamili and Raychaudhuri, 1984)

Myzus (Myzus) cerasi (Fabricius, 1775)
Artemisia sp. - Manipur (Singh, 1987)

3.3.9 *Aphidius matricariae* Haliday, 1834

Myzus (Myzus) cerasi (Fabricius, 1775)
Phlox drummondii Hook. - Jammu and Kashmir (Bhagat and Ahmad, 1991)

Myzus (Myzus) cerasi umefoliae (Shinji, 1924)
Rubia cordifolia L. - India (Das and Chakrabarti, 2023a)

Myzus (Myzus) dycei Carver, 1961
Persicaria capitata (Buch. - Ham. ex D. Don) H. Gross - Sikkim (Tamili, 1988)
Urtica dioica L. - Uttarakhand (Das and Chakrabarti, 1988; Das and Chakrabarti, 1990)
Urtica sp. - Himachal Pradesh (Saha et al., 1982); Jammu and Kashmir (Chakrabarti and Debnath, 2009)

Unknown plant - Meghalaya (Starý and Ghosh, 1975; Raychaudhuri et al., 1982)

Myzus (Myzus) ornatus (Laing, 1932)

Biden pilosa L. - Arunachal Pradesh (Samanta, 1986)

Chromolaena odorata (L.) R.M.King and H.Rob. - Sikkim (Tamili, 1988)

Duranta erecta L. - Manipur (Singh, 1987)

Gynura bicolor DC. - Manipur (Singh, 1987)

Sonchus sp. - Himachal Pradesh (Saha et al., 1982)

Myzus (Myzus) siegesbeckicola Strand, 1929

Boehmeria sp. - Manipur (Singh, 1987)

Bougainvillea spectabilis Willd. - Manipur (Singh, 1987)

Brassica napus L. - Sikkim (Agarwala et al., 1980; Raychaudhuri et al., 1982)

Brassica oleracea L. - Bihar (Prakash and Rani, 2015)

Brassica oleracea L. *capitata* - Manipur (Devjani and Singh, 1998; Subhrani et al., 2006)

Brassica rapa L. - Manipur (Bijaya et al., 2001a)

Urtica dioica L. - Uttarakhand (Das and Chakrabarti, 1988; Das and Chakrabarti, 1990)

Unknown plant - Manipur (Nonita et al., 2002); Meghalaya (Starý and Ghosh, 1975)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Brassica oleracea L. *botrytis* - Manipur (Bijaya et al., 2001a)

Brassica oleracea L. *capitata* - Manipur (Bijaya et al., 2001a)

Brassica oleracea L. *gongylodes* - Manipur (Bijaya et al., 2001a)

Brassica rapa L. - Manipur (Bijaya et al., 2001b)

Capsicum annuum L. - Himachal Pradesh (Gavkare et al., 2014)

Cardamine debilis Banks ex DC. - Manipur (Singh, 1987)

Carica papaya L. - Manipur (Subhrani et al., 2010)

Descurainia sophia (L.) Webb ex Prantl - Jammu and Kashmir (Takada and Rishi, 1980)

Gynura sp. - Manipur (Singh, 1987)

Hibiscus rosasinensis L. - Delhi (Dey and Akhtar, 2007; Akhtar, 2009); Manipur (Singh, 1987)

Lablab purpureus (L.) Sweet ssp. *purpureus* - Uttarakhand (Das and Chakrabarti, 1988; Das and Chakrabarti, 1990)

Momordica charantia L. - Bihar (Ahmad and Singh, 1997)

Pisum sativum L. - Manipur (Subhrani et al., 2010)

Raphanus sativus L. - Uttar Pradesh (Tiwari et al., 2024)

Solanum lycopersicum L. - Bihar (Ahmad and Singh, 1996); Uttar Pradesh (Ahmad and Singh, 1993; Singh et al., 1999)

Solanum melongena L. - Manipur (Subhrani et al., 2010)

Solanum sp. - Nagaland (Singh et al., 1991)

Solanum tuberosum L. - Manipur (Subhrani et al., 2006)

Sonchus sp. - Himachal Pradesh (Chakrabarti and Debnath, 2009)

Triticsum aestivum L. - Uttar Pradesh (Singh et al., 1999)

Unknown plant - Meghalaya (Starý and Ghosh, 1975)

Myzus sp.

Indet Rubiaceae - Meghalaya (Starý and Ghosh, 1978)

3.3.10 *Aphidius platensis* Brethes, 1913

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Capsicum frutescens L. - Tamil Nadu (Rajagopal and Kareem, 1979)
Solanum melongena L. - Tamil Nadu (Easwaramoorthy et al., 1976)

3.3.11 *Aphidius pleotrichophori* (Takada, 1966) [syn. *Lysaphidus pleotrichophori* Takada, 1966]

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Persicaria chinensis (L.) H.Gross - Manipur (Singh, 1987)

3.3.12 *Aphidius qadrii* (Shuja - Uddin, 1977) [syn. *Lysaphidus qadrii* Shuja - Uddin, 1976]

Myzus (Myzus) ornatus (Laing, 1932)
Capsicum sp. - Arunachal Pradesh (Samanta, 1986)
Thysanolaena latifolia (Roxb. ex Hornem.) Honda (- Nagaland (Singh et al., 1991)
Unknown plant - Himachal Pradesh (Das and Raychaudhuri, 1983; Starý and Ghosh, 1983); Uttarakhand (Das and Chakrabarti, 1991)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Carica papaya L. - Uttar Pradesh (Rafi et al., 2010)
Solanum lycopersicum L. - Uttar Pradesh (Rafi et al., 2010)

3.3.13 *Aphidius rhopalosiphi* de Stefani - Perez, 1902 [syn. *Aphidius equiseticola* Stary, 1963]

Myzus (Myzus) mumecola (Matsumura, 1917)
Prunus amygdalus Batsch - Manipur (Subhrani et al., 2006)

3.3.14 *Aphidius similis* Stary and Carver, 1980

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica napus L. - Sikkim (Agarwala et al., 1980)
Gynura bicolor DC. - Sikkim (Raychaudhuri et al., 1982)
Solanum lycopersicum L. - Manipur (Subhrani et al., 2006)
Solanum tuberosum L. - Sikkim (Agarwala et al., 1980)

3.3.15 *Aphidius* sp.

Myzus (Myzus) ornatus Laing, 1932
Duranta sp. - (Starý and Ghosh, 1983)

Myzus (Myzus) sorbi Bhattacharya and Chakrabarti, 1982
Sorbaria tomentosa (Lindl.) Rehder - Jammu and Kashmir (Chakrabarti and Debnath, 2009)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica juncea (L.) Czern - Karnataka (Chinnu et al., 2023)
Capsicum annuum L. - Karnataka (Mani and Krishnamoorthy, 1994)
Eruca vesicaria (L.) Cav. - Punjab (Bakhetia and Sharma, 1979)
Solanum betaceum Cav. - West Bengal (Starý and Ghosh, 1983)
Solanum tuberosum L. - Himachal Pradesh (Thakur and Chandla, 2013)

Myzus (Nectarosiphon) persicae nicotianae Blackman, 1987
Nicotiana tabacum L. - Andhra Pradesh (Rao et al., 1984; Rao et al., 2007)

Myzus (Myzus) dycei Carver, 1961
Urtica dioica L. - Manipur (Singh, 1987)

3.3.16 *Aphidius staryi* Das and Chakrabarti, 1990

Myzus (Myzus) cornutus Medda and Chakrabarti, 1986
Prunus cornuta (Wall. ex Royle) Steud. - Uttarakhand (Das and Chakrabarti, 1990; Sarkar, 2022)

3.3.17 *Aphidius urticae* Haliday, 1834 [syn. *Aphidius aulacorthi* Stary, 1963]

Myzus (Myzus) dycei Carver, 1961
Urtica dioica L. - Manipur (Singh, 1987)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Solanum melongena L. - Manipur (Subhrani et al., 2010)

3.3.18 *Aphidius uzbekistanicus* Luzhetzki, 1960

Myzus (Myzus) mumecola (Matsumura, 1917)
Prunus amygdalus Batsch - Manipur (Singh, 1987)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Solanum melongena L. - Nagaland (Singh et al., 1991)

3.3.19 *Binodoxys basicurvus* (Shuja - Uddin, 1973)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Cardamine debilis Banks ex DC. - Nagaland (Singh et al., 1991)

3.3.20 *Binodoxys brevicornis* (Haliday, 1833)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Artemisia sp. - Meghalaya (Samanta, 1986)
Prunus persica (L.) Stokes - Himachal Pradesh (Chakrabarti and Debnath, 2009)
Unknown plant - Himachal Pradesh (Sharma and Subba Rao, 1964)

3.3.21 *Binodoxys indicus* (Subba Rao and Sharma, 1958) [syn. *Trioxys indicus* Subba Rao and Sharma, 1958]

Myzus (Myzus) dycei Carver, 1961
Urtica sp. - Meghalaya (Samanta, 1986)
Myzus (Myzus) ornatus Laing, 1932
Mentha sp. - Meghalaya (Samanta, 1986)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassica oleracea L. - Mizoram (Sarkar, 1991)
Cajanus cajan (L.) Millsp. - Uttar Pradesh (Ahmad and Singh, 1993)
Calendulla sp. - Bihar (Kumar, 2013)
Calotropis procera (Aiton) Dryand. - Uttar Pradesh - (Ahmad and Singh, 1993)
Capsicum frutescens L. - Uttar Pradesh (Singh and Tripathi, 1988a)
Datura stramonium L. - Bihar (Kumar, 2013)
Hibiscus sabdariffa L. - Bihar (Parween et al., 2023)
Raphanus sativus L. - Bihar (Kumar, 2013)
Sechium edule (Jacq.) Sw. - Sikkim (Agarwala et al., 1980)
Solanum lycopersicum L. - Bihar (Parween et al., 2023); Uttar Pradesh (Singh and Tripathi, 1988a)
Solanum melongena L. - Bihar (Ahmad and Singh, 2007); Uttar Pradesh (Singh et al., 1999; Chaudhary and Singh, 2007)
Solanum tuberosum L. - Bihar (Ahmad and Singh, 2007); Uttar Pradesh (Singh and Tripathi, 1988a; Singh et al., 1999)
Unknown plants - Karnataka (Rao et al., 1969); Manipur (Nonita et al., 2002); Meghalaya (Starý and Ghosh, 1975)

3.3.22 *Binodoxys struma* (Gahan, 1926)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Unknown plant - Meghalaya (Samanta and Raychaudhuri, 1984)

3.3.23 *Binodoxys tomentosae* (Das and Chakrabarti, 1990)

Myzus (Myzus) sorbi Bhattacharya and Chakrabarti, 1982
Sorbaria tomentosa (Lindl.) Rehder - Uttarakhand (Das and Chakrabarti, 1990)

3.3.24 *Diaeretiella rapae* (McIntosh, 1855)

Myzus (Myzus) mumecola (Matsumura, °1917)
Brassica napus L. - Manipur (Singh, 1987)
Cardamine debilis Banks ex DC. - Manipur (Singh, 1987)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Brassia oleracea L. - Bihar (Prakash and Rani, 2015); Himachal Pradesh (Sharma et al., 2020); Madhya Pradesh (Veda et al., 1994); Manipur (Devjani and Singh, 1998; Devi et al., 1999)
Brassica juncea L. - Himachal Pradesh (Soni et al., 2021)
Brassica oleracea L. var. *botrytis* – Manipur (Bijaya et al., 2001a); Rajasthan (Chandra and Kushwaha, 1987); Uttar Pradesh (Halder et al., 2014)
Brassica oleracea L. var. *capitata* - Chhattisgarh (Gauraha, 2021); Manipur (Singh and Singh, 1986b; Bijaya et al., 2001a); - Rajasthan (Chandra and Kushwaha, 1987); Uttar Pradesh (Halder et al., 2014)
Brassica oleracea L. var. *gongylodes* – Manipur (Bijaya et al., 2001a)
Brassica rapa L. - Bihar (Parween et al., 2023); Manipur (Bijaya et al., 2001b)
Brassica sp. - Assam (Sethumadhavan and Dharmadhikari, 1969); Himachal Pradesh (Raj and Lakhanpal, 1998); Karnataka (Sethumadhavan and Dharmadhikari, 1969); Punjab (Atwal et al., 1969); Uttar Pradesh (Akhtar et al., 2011b); West Bengal (Rao et al., 1970)
Capsicum annuum L. - Himachal Pradesh (Kumar et al., 2020; Soni et al., 2022)
Cardamine debilis Banks ex DC. - Jammu and Kashmir (Rao et al., 1969; Sethumadhavan and Dharmadhikari, 1969); Manipur (Singh and Singh, 1986a); Punjab (Atwal et al., 1969)
Descurainia sophia (L.) Webb ex Prantl (syn. *Descorina sofia* auct. n.) - Jammu and Kashmir (Takada and Rishi, 1980)
Mirabilis jalapa L. - Himachal Pradesh (Saha et al., 1982)
Papaver somniferum L. - Madhya Pradesh (Veda et al., 1994)
Raphanus sativa L. - Himachal Pradesh (Saha et al., 1982)
Solanum betaceum Cav. - Jammu and Kashmir (Rao et al., 1969; Sethumadhavan and Dharmadhikari, 1969); Punjab - (Atwal et al., 1969)

Myzus (Nectarosiphon) persicae nicotianae Blackman, 1987
Nicotiana tabacum L. - Punjab (Sethumadhavan and Dharmadhikari, 1969)

3.3.25 *Ephedrus brevis* Stelfox, 1941

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Duranta erecta L. - Manipur (Singh et al., 2011)

3.3.26 *Ephedrus lacertosus* (Haliday, 1833)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Unknown plant - Himachal Pradesh (Chakrabarti and Debnath, 2009); Jammu and Kashmir (Chakrabarti and Debnath, 2009)

3.3.27 *Ephedrus niger* Gautier, Bonnamour and Gaumont, 1929 [syn. *Ephedrus campestris* Stary, 1962]

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Unknown plant - Meghalaya (Samanta and Raychaudhuri, 1984)

3.3.28 *Ephedrus persicae* Froggatt, 1904

Myzus (Myzus) sorbi Bhattacharya and Chakrabarti, 1982

Sorbaria tomentosa (Lindl.) Rehder - Uttarakhand (Das and Chakrabarti, 1990; Sarkar, 2022)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Beta vulgaris L. - Mizoram (Sarkar, 1991)

Hibiscus rosasinensis L. - West Bengal (Tamili, 1988)

Unknown plants - Jammu and Kashmir (Chakrabarti and Debnath, 2009); Meghalaya (Starý and Ghosh, 1983)

3.3.29 *Ephedrus plagiator* (Nees, 1811)

Myzus (Myzus) ornatus (Laing, 1932)

Duranta sp. - India (Ghosh and Agarwala, 1982)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Ageratina riparia (Regel) R.M.King and H.Rob. (syn. *Eupatorium riparium* - Rigel.) - India (Ghosh and Agarwala, 1982)

Ageratum conyzoides L. - West Bengal (Tamili, 1988)

Antirrhinum majus L. - Meghalaya (Starý and Ghosh, 1978)

Artemisia vulgaris L. - India (Ghosh and Agarwala, 1982)

Brassica oleracea L. - Sikkim (Raychaudhuri et al., 1979)

Brassica oleracea L. *botryitis* – Manipur (Bijaya et al., 2001a)

Brassica oleracea L. *capitata* - Manipur (Bijaya et al., 1996; Devi et al., 1999)

Brassica oleracea L. *gongylodes* – Manipur (Bijaya et al., 2001a)

Brassica rapa L. - Manipur (Bijaya et al., 2001b)

Capsicum annuum L. - India (Ghosh and Agarwala, 1982)

Chenopodium album L. - India (Ghosh and Agarwala, 1982)

Impatiens balsamina L. - India (Ghosh and Agarwala, 1982)

Lantana camara L. - India (Ghosh and Agarwala, 1982)

Pisum sativum L. - India (Ghosh and Agarwala, 1982)

Polygonum sp. - India (Ghosh and Agarwala, 1982)

Prunus dulcis (Mill.) D.A. Webb. (syn. *Prunus communis* (L.) Arcang.) - India (Ghosh and Agarwala, 1982)

Psidium guajava L. - India (Ghosh and Agarwala, 1982)

Rubus rosifolius Sm. - India (Ghosh and Agarwala, 1982)

Solanum betaceum Cav. - India (Ghosh and Agarwala, 1982)

Solanum nigrum L. - West Bengal (Agarwala, 1983)

Solanum tuberosum L. - Sikkim (Agarwala et al., 1980)

Sonchus arvensis L. - India (Ghosh and Agarwala, 1982)

3.3.30 *Ephedrus* sp.

Myzus (Myzus) dycei Carver, 1961
Urtica sp. ? - Meghalaya (Starý and Ghosh, 1975)
Urticaceae - Meghalaya (Starý and Ghosh, 1983)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Coriander sp. - Manipur (Singh, 1987; Singh et al., 2011)
Solanum sp. - Manipur (Singh, 1987; Singh et al., 2011)

3.3.31 *Ephedrus srinagarensis* Starý and Bhagat, 1978

Myzus (Myzus) mumecola (Matsumura, 1917)
Rubia cordifolia L. - Jammu and Kashmir (Khan and Shah, 2017)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Ageratum conyzoides L. - Meghalaya (Samanta, 1986); Sikkim (Tamili, 1988)
Solanum nigrum L. - Manipur (Singh et al., 2011)
Myzus sp.
Lonicera quinquelocularis Hardw. - Jammu and Kashmir (Starý and Bhagat, 1978)

3.3.32 *Ephedrus trichosiphoniellae* Takada, 1968

Myzus (Myzus) ornatus Laing, 1932
Unknown plant - Meghalaya (Samanta and Raychaudhuri, 1984)

3.3.33 *Ephedrus urticae* Bhagat, 1982

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Solanum nigrum L. - Nagaland (Pramanik, 1986)

3.3.34 *Kashmiria aphidis* Starý and Bhagat, 1978

Myzus sp.
Lonicera quinquelocularis Hardw. - Jammu and Kashmir (Starý and Bhagat, 1978)

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

Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Capsicum frutescens L. - Uttar Pradesh (Singh and Tripathi, 1988b; Chaudhary and Singh, 2007)
Chenopodium album L. – Uttar Pradesh (Tiwari et al., 2024)
Coriandrum sativum L. – Uttar Pradesh (Tiwari et al., 2024)
Gnaphalium sp. - Bihar (Kumar, 2013)
Solanum lycopersicum L.- Uttar Pradesh (Singh and Tripathi, 1988a)
Solanum melongena L. - Bihar (Ahmad and Singh, 2007; Kumar, 2013); Uttar Pradesh (Singh and Tripathi, 1988a; Singh et al., 1999)
Solanum tuberosum L. - Uttar Pradesh (Rafi et al., 2010)
Withania sp. - Bihar (Kumar, 2013)

3.3.36 *Lysiphlebus confusus* Tremblay and Eady, 1978

Myzus (Myzus) dycei Carver, 1961
Urtica sp. - Himachal Pradesh (Saha et al., 1982)

3.3.37 *Neoephedrus kalimpongensis* Samanta, Tamili, Saha and Raychaudhuri, 1983

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Foeniculum vulgare Mill. - West Bengal (Samanta et al., 1983)

3.3.38 *Praon volucre* (Haliday, 1833) [syn. *Praon myzophagum* Mackauer, 1959]

Myzus (Myzus) ornatus (Laing, 1932)
Duranta sp. - India (Ghosh and Agarwala, 1982)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Argemone mexicana L. - West Bengal (Dharmadhikari and Ramaseshiah, 1970)
Brassica oleracea L. - Himachal Pradesh (Chakrabarti and Debnath, 2009)
Hibiscus rosasinensis L. - Sikkim (Tamili, 1988)
Nicotiana tabacum L. - West Bengal (Dharmadhikari and Ramaseshiah, 1970)
Polygonum perfoliatum L. - India (Ghosh and Agarwala, 1982)
Raphanus sativus L. - India (Ghosh and Agarwala, 1982)
Solanum tuberosum L. - Himachal Pradesh (Ghosh and Agarwala, 1982)
Myzus sp.
Brassica sp. - Jammu and Kashmir (Starý and Bhagat, 1978)
Prunus domestica L. - Jammu and Kashmir (Chakrabarti and Debnath, 2009)

3.3.39 *Praon* sp.

Myzus (Myzus) ornatus Laing, 1932
Chromolaena odorata (L.) R.M.King and H.Rob. - Meghalaya (Starý and Ghosh, 1983)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Antirrhinum majus L. - Meghalaya (Starý and Ghosh, 1978)
Myzus sp.
Rubiaceae - Meghalaya (Starý and Ghosh, 1978)

3.3.40 *Syrphophagus aphidivorus (*Mayr, 1876) [syn. *Aphidencyrtus aphidivorus* (Mayr, 1876)]

Myzus (Nectarosiphon) persicae nicotianae Blackman, 1987
Nicotiana tabacum L. - Andhra Pradesh (Rao et al., 2007)

3.3.41 *Toxares deltiger* (Haliday, 1833)

Myzus (Myzus) obtusirostris David, Narayanan and Rajasingh, 1972
Unknown plant - Meghalaya (Starý and Ghosh, 1978)
Myzus (Myzus) ornatus Laing, 1932
Unknown plant - Meghalaya (Starý and Ghosh, 1978)
Myzus (Nectarosiphon) persicae (Sulzer, 1776)
Crassocephalum crepidioides (Benth.) S.Moore - Meghalaya (Starý and Ghosh, 1978)
Dianthus sp. - Meghalaya (Starý and Bhagat, 1978)
Solanum aculeatissimum Jack. - Meghalaya (Starý and Ghosh, 1978)
Myzus (Myzus) boehmeriae Takahashi, 1923
Unknown plant - Meghalaya (Starý and Ghosh, 1978)

3.3.42 *Toxares macrosiphophagum* Shuja-Uddin, 1974

Myzus (Myzus) obtusirostris David, Narayanan and Rajasingh, 1972
Unknown plant - Meghalaya (Starý and Ghosh, 1983)
Myzus (Myzus) ornatus (Laing, 1932)
Capsicum sp. - West Bengal (Tamili, 1988)
Chrysanthemum sp. - Mizoram (Sarkar, 1991)

Unknown plant - Meghalaya (Starý and Ghosh, 1983)

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Unknown plant - Meghalaya (Starý and Ghosh, 1983); West Bengal (Tamili, 1988)

Myzus (Myzus) boehmeriae Takahashi, 1923

Unknown plant - Meghalaya (Starý and Ghosh, 1983)

3.3.43 *Toxares shigai* Takada, 1965

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Unknown plant - Meghalaya (Starý and Ghosh, 1975)

3.3.44 *Toxares zakai* Shuja-Uddin, 1974

Myzus (Nectarosiphon) persicae (Sulzer, 1776)

Solanum nigrum L. - Jammu and Kashmir (Shuja-Uddin, 1974; Dey and Akhtar, 2007)

Solanum tuberosum L. - Jammu and Kashmir (Khan and Shah, 2017)

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