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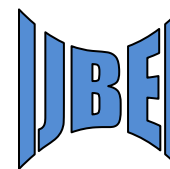
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Checklist of Aphidophagous Predatory Bugs (Heteroptera: Hemiptera: Insecta) in India

Singh Rajendra* and Srivastav Ajai K.

Department of Zoology, D.D.U. Gorakhpur University, Gorakhpur 273009, Uttar Pradesh, India

**Corresponding Author*

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Abstract: In this study, aphidophagous predatory bugs (Heteroptera: Hemiptera: Insecta) are catalogued along with their prey (aphid) species (Aphididae: Homoptera: Hemiptera) and host plants of the prey recorded in different states and union territories of India. Data reveal that a total of 29 species of Heteroptera are aphidophagous in India belonging to 6 families, Anthocoridae being the largest one comprising 17 species under 10 genera followed by Miridae and Reduviidae (4 species in each), and Geocoridae (2 species in 1 genus), Nabidae and Pentatomidae (one species each) preying on 45 species of aphids belonging to 21 genera associated with 37 species of plants belonging to 26 genera in 13 states/union territories of India; with 88 triplets (tritrophic association of predators, preys and host plants). A maximum of 39 triplets are recorded in Uttarakhand followed by 12 triplets in Ladakh and 9 and 6 triplets in Jammu and Kashmir and West Bengal. A maximum of 13 species of these predators were recorded from Uttarakhand preying on 21 species of aphids feeding on 20 plant species. No species of these predatory bugs is recorded from 17 states and 6 union territories of India. Indeed, no investigation was conducted in most of the states and union territories of India regarding the aphidophagy of predatory bugs and hence, it requires an extensive survey in these areas to record them particularly in the agroecosystems to establish their relationship with aphid preys on different crops.

Keywords: Anthocoridae, aphids, biocontrol, Geocoridae, India, Miridae, Pentatomidae, predatory bugs, Reduviidae, Nabidae

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Introduction

The aphids (Hemiptera: Aphididae) are soft-bodied sap-sucking insects. Almost 250 species of aphids are major pests of both agricultural and horticultural crops (Singh and Singh, 2016). They exhibit a number of unique features that

contribute to their success such as polyphagy, peculiar mode of reproduction, development, and polymorphism. According to the climatic conditions and availability of the food plants, they may reproduce either by parthenogenesis,

zygogenesis, or pedogenesis. They may either be oviparous or viviparous or both (Singh and Singh, 2022; Singh *et al.*, 2023).

Several families of Heteroptera (Hemiptera: Insecta) are predatory feeding on soft-bodied insects. Among them, 4 families, Anthocoridae, Geocoridae, Miridae and Nabidae are known to feed on aphids along with other soft-bodied insects, mites etc.

For the sustainable management and conservation of biodiversity of the animal species of any region of the world, their proper documentation is vital as it helps in monitoring their conservation (Fonseca *et al.*, 2017). The preparation of a checklist of species is an essential component of systematic documentation. Hence, because of the increasing intensity of anthropogenic threats to biodiversity, cataloguing and appropriate documentation of biodiversity is desirable (Singh R *et al.*, 2024). So far, no complete checklist of the aphidophagous fauna of Heteroptera along with their aphid preys, food plants and distribution is available, hence, this checklist is prepared.

The present checklist is based on the published literature on aphidophagous Anthocoridae, e.g. books, book chapters, journals, proceedings of conferences, Records and Fauna Series of the Zoological Survey of India, Kolkata, and a few authentic theses up to June 30, 2024. In most of the recent past literature, there are several errors in the scientific names of the insects both predatory as well as prey 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), aphids following Favret (2024), and the plants, following (WFO, 2024). For synonymy of valid species, above references may be consulted.

Table 1 demonstrates that a total of 29 identified species of Heteroptera are aphidophagous in India belonging to 6 families, Anthocoridae being the largest one comprising 17 species under 10 genera followed by Miridae and Reduviidae (4 species in each), and Geocoridae (2 species in 1 genus), Nabidae and Pentatomidae (one species each) preying on 45 species of aphids belonging to 21 genera associated with 37 species of plants belonging to 26 genera in 13 states/union territories of India. A maximum of 39 triplets (predator – prey – host plant) are recorded in Uttarakhand followed by 12 triplets in Ladakh and 9 and 6 triplets in Jammu and Kashmir and West Bengal (Fig. 1).

In India, the aphidophagous Heteroptera are distributed only in 13 states/union territories. A maximum of 13 species of these predators were recorded from Uttarakhand preying on 21 species of aphids feeding on 20 plant species. No species of these predatory bugs is recorded from 18 states and 6 union territories of India. Out of 29 species of aphidophagous bugs recorded from India, only *Orius* Wolff, 1811 is considerably widely distributed in 5 states/union territories followed by *Anthocoris* Fallén, 1814, 12 species of which are distributed in 3 states. Indeed, no investigation was conducted in most of the states and union territories of India regarding the aphidophagy of predatory bugs and hence, it requires an extensive survey in these areas to record them throughout the country particularly in the agroecosystems to establish their relationship with aphid preys on different crops. Most of the surveys were conducted only in Uttarakhand, Ladakh, Jammu and Kashmir, West Bengal and Karnataka.

Following is the detailed list of these predatory bugs along with their aphid preys and food plants recorded from different states/union territories of India.

A. Family: Anthocoridae

The Anthocoridae is a large and diverse family of the order Hemiptera and are globally distributed in all the zoogeographical regions. They are

Table 1: Number of species of predatory bugs belonging to different families preying on aphids infesting different number of host plants in different states/union territories of India

Families of predators	Number of predator species	Number of prey species	Number of host plant species	Number of predator – prey – host – plant associations	Number of states/union territories
1. Anthocoridae	17	30	27	64	8
2. Geocoridae	2	4	8	8	4
3. Miridae	4	6	6	7	1
4. Nabidae	1	1	1	1	1
5. Pentatomidae	1	1	2	2	2
6. Reduviidae	4	3	6	6	2
Total	29	45	37	88	13

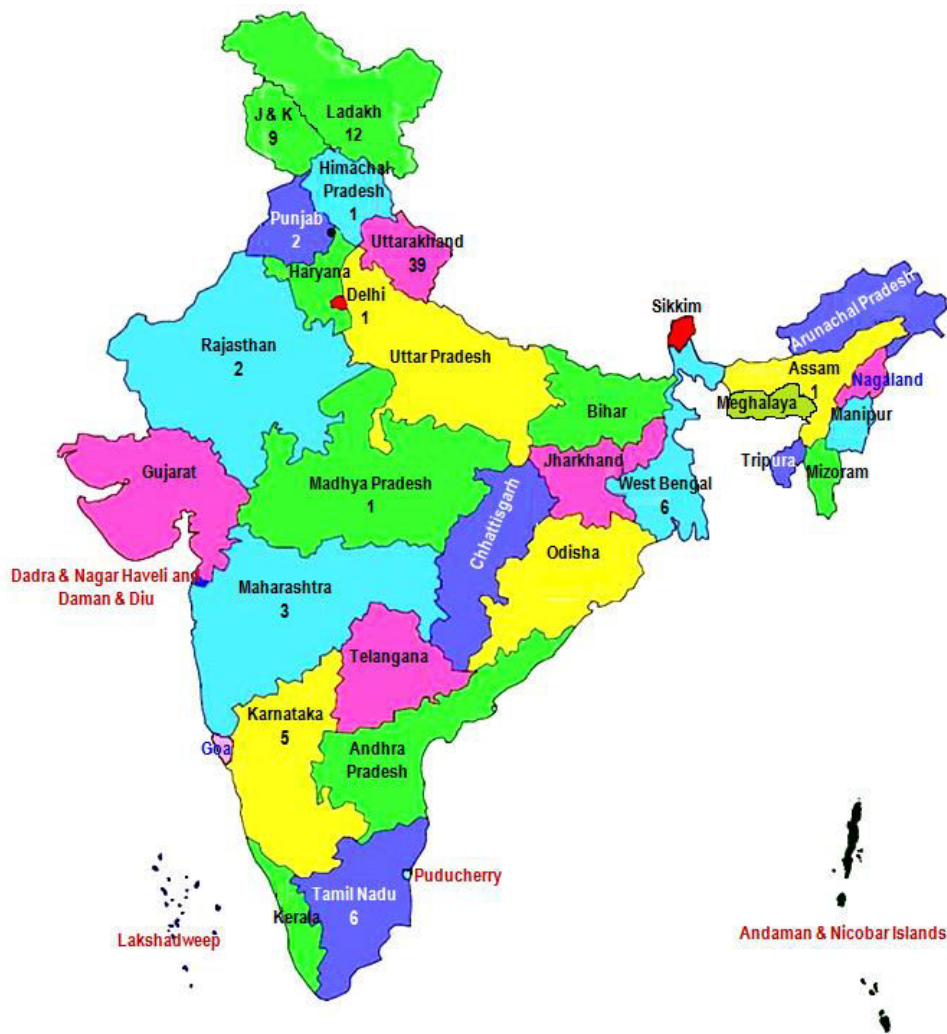


Fig. 1: Map showing the number of tritrophic association of aphidophagous heteropteran bugs preying on aphids in different states and union territories of India.

commonly known as minute pirate bugs or flower bugs. Few species are phytophagous but most of them are predaceous on soft-bodied arthropods (aphids, caterpillars, grubs, mites, psocids, thrips, etc.) both as nymphs and adults (Muraleedharan and Ananthakrishnan, 1978). The predatory anthocorids are acknowledged as potential biocontrol agents against several agricultural insect pests (Ballal and Yamada, 2016). In several European countries, many species of anthocorid predators are commercially available and are released in greenhouses and fields for the management of several insect pests. In India, researchers have mainly focused on identifying anthocorid species preying on different insects infesting several crops. Recently, the National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Bangalore, have generated a significant amount of information on the diversity of indigenous anthocorid predators; procedures for their mass culture and some potential species have been field evaluated (Ballal and Yamada, 2016).

A total of 17 identified species of Anthocoridae were recorded from India preying on 30 species of aphids infesting 27 plant species, mostly agricultural crops in 7 states: Assam, Himachal Pradesh, Karnataka, Punjab, Tamil Nadu, Uttarakhand and West Bengal and one union territory, Jammu and Kashmir as mentioned below:

1. *Anthocoris confusus* Reuter, 1884

- *Brachycaudus* (*Brachycaudus*) *helichrysi* (Kaltenbach, 1843)
- *Prunus amygdalus* Batsch - Himachal Pradesh (Bhardwaj, 1991); Uttarakhand (Ghosh *et al.*, 1986)
- *Eriosoma lanigerum* (Hausmann, 1802)
- *Malus domestica* (Suckow) Borkh. (syn. *Pyrus malus* L.) - Uttarakhand (Ghosh *et al.*, 1986)
- *Melanaphis arundinariae* (Takahashi, 1937)

- *Pyrus pashia* Buch.-Ham. ex D. Don - Uttarakhand (Ghosh *et al.*, 1986)
- *Myzus* (*Myzus*) *dycei* Carver, 1961
- *Urtica dioica* L. - Uttarakhand (Ghosh *et al.*, 1986)
- *Myzus* (*Myzus*) *sorbi* Bhattacharya and Chakrabarti, 1982
- *Sorbaria tomentosa* (Lindl.) Rehder - Uttarakhand (Ghosh *et al.*, 1986)
- *Pemphigus* (*Pemphigus*) *mordwilkoii* Chlodkovsky, 1912
- *Populus ciliata* Wall. ex Royle - Uttarakhand (Ghosh *et al.*, 1986)
- *Prociphilus* sp.
- *Lonicera quinquelocularis* Hardw. - Uttarakhand (Ghosh *et al.*, 1986)
- *Sappaphis* sp.
- *Cotoneaster bacillaris* Wall. ex Lindl. (syn. *Cotoneaster obtusus* Wall. ex Lindl.) - Uttarakhand (Ghosh *et al.*, 1986)

2. *Anthocoris minki pistaciae* Wagner, 1957

- *Brachycaudus* (*Brachycaudus*) *helichrysi* (Kaltenbach, 1843)
- *Prunus domestica* L. - Uttarakhand (Ghosh *et al.*, 1986)
- *Prunus persica* (L.) Batsch - Uttarakhand (Ghosh *et al.*, 1986)
- *Eumyzus pruni* Chakrabarti and Bhattacharya, 1985
- *Prunus cornuta* (Wall. ex Royle) Steud. - Uttarakhand (Ghosh *et al.*, 1986)
- *Myzus* (*Myzus*) *sorbi* Bhattacharya and Chakrabarti, 1982
- *Sorbaria tomentosa* (Lindl.) Rehder - Uttarakhand (Ghosh *et al.*, 1986)
- *Prociphilus* sp.

- *Lonicera quinquelocularis* Hardw. - Uttarakhand (Ghosh *et al.*, 1986)
- *Sappaphis* sp.
- *Cotoneaster bacillaris* Wall. ex Lindl. (syn. *Cotoneaster obtusus* Wall. ex Lindl.) - Uttarakhand (Ghosh *et al.*, 1986)
- *Tumoranuraphis indica* (Chakrabarti and Maity, 1984)
- *Prunus cornuta* (Wall. ex Royle) Steud. - Uttarakhand (Ghosh *et al.*, 1986)
- 3. *Anthocoris* nr. *pilosus* (Jakovlev, 1877) [syn. *Anthocoris* nr. *sibiricus* Reuter, 1875]
- *Brachycaudus* (*Brachycaudus*) *helichrysi* (Kaltenbach, 1843)
- *Prunus persica* (L.) Batsch - Uttarakhand (Ghosh *et al.*, 1986)
- 4. *Anthocoris* sp.
- *Aphis* (*Aphis*) *gossypii* Glover, 1877
- *Solanum melongena* L. – Jammu and Kashmir (Bhat, 2008)
- *Eriosoma lanigerum* (Hausmann, 1802)
- *Malus domestica* (Suckow) Borkh. (syn. *Pyrus malus* L.) – Uttarakhand (Maurya, 2011)
- *Hyalopterus gracilis* (Walker, 1852)
- *Prunus* sp. – Jammu and Kashmir (Bhagat and Masoodi, 1988)
- *Pemphigus* (*Pemphigus*) *immunis* Buckton, 1896
- *Populus ciliata* Wall. ex Royle - Jammu and Kashmir (Bhagat and Lone, 1984)
- 5. *Bilia castanea* (Carvalho, 1951)
- *Lipaphis* (*Lipaphis*) *erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. - West Bengal (Ghosh, 1983)
- *Brassica nigra* L. - West Bengal (Ghosh *et al.*, 1981)
- 6. *Bilia* sp.
- *Greenidea* (*Trichosiphum*) *psidii* van der Goot, 1917
- *Psidium guajava* L. - West Bengal (Raychaudhuri *et al.*, 1978; Debnath, 2020)
- 7. *Blaptostethus pallescens* Poppius, 1909
- *Aphis* (*Aphis*) *gossypii* Glover, 1877
- *Gossypium hirsutum* L. - Tamil Nadu (Nasreen *et al.*, 2022)
- *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. – Karnataka (Ballal *et al.*, 2009)
- 8. *Cardiastethus exiguus* Poppius, 1913
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (syn. *Camellia thea* Link) – Karnataka (Sahayaraj, 2004)
- 9. *Deraeocoris indicus* Poppius, 1915
- *Aphis* (*Aphis*) *gossypii* Glover, 1877
- Unknown host plant - Karnataka (Rao, 1969)
- *Myzus* (*Nectarosiphon*) *persicae* (Sulzer, 1776)
- unknown host plant - Karnataka (Rao, 1969)
- 10. *Ectemna* sp.
- *Epipemphigus imaicus* (Cholodkovsky, 1912)
- *Populus ciliata* Wall. ex Royle - Uttarakhand (Ghosh *et al.*, 1986)
- 11. *Orius albidipennis* (Reuter, 1884)
- *Lipaphis* (*Lipaphis*) *erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. - West Bengal (Ghosh, 1983)
- *Brassica nigra* L. - West Bengal (Ghosh *et al.*, 1981)
- 12. *Orius bifilarus* Ghauri, 1972
- *Eumyzus prunicolus* Medda and Chakrabarti, 1986
- *Prunus padus* L. – Uttarakhand (Debnath, 1991)

- *Taoia indica* (Ghosh and Raychaudhuri, 1982)
 - *Alnus nepalensis* D. Don – Uttarakhand (Debnath, 1991)
- 13. *Orius lindbergi* Wagner, 1952**
- *Aphis* (*Aphis*) *craccivora* Koch, 1854
 - *Medicago sativa* L. - Jammu and Kashmir (Bhagat and Lone, 1984)
 - *Brachycaudus* (*Scrophulaphis*) *persicae* (Passerini, 1860)
 - *Prunus amygdalus* Batsch - Jammu and Kashmir (Bhagat and Lone, 1984)
 - *Macrosiphoniella* (*Macrosiphoniella*) *artemisiae artemisiae* (Boyer de Fonscolombe, 1841)
 - *Artemisia* sp. - Jammu and Kashmir (Bhagat and Lone, 1984)
 - *Pemphigus* (*Pemphigus*) *mordvilkovii* Bozhko, 1979
 - *Populus alba* var. *caspica* Bornm. [syn. *Populus caspica* (Bornm.) Bornm.] - Jammu and Kashmir (Bhagat and Lone, 1984)
- 14. *Orius maxidentex* Ghauri, 1972**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonsc., 1841
 - *Camellia sinensis* (L.) Kuntze (syn. *Camellia thea* Link) – Assam (Hazarika et al., 2001)
- 15. *Orius minutus* (Linnaeus, 1758)**
- *Amphicercidus tuberculatus* David, Narayanan and Rajasingh, 1971
 - *Lonicera quinquelocularis* Hardw. - Jammu and Kashmir (Bhagat and Lone, 1984)
 - *Brachycaudus* (*Prunaphis*) *cardui* (Linnaeus, 1758)
 - *Carduus edelbergii* Rech.fil. - Jammu and Kashmir (Bhagat and Lone, 1984)
- 16. *Orius niger* (Wolff, 1811)**
- *Capitophorus formosartemisiae* (Takahashi, 1921)
 - *Artemisia vulgaris* L. – Uttarakhand (Debnath, 1991)
 - *Myzus* (*Myzus*) *dycei* Carver, 1961
 - *Urtica dioica* L. – Uttarakhand (Debnath, 1991)
 - *Pemphigus* (*Pemphigus*) *mordwilkoii* Cholodkovsky, 1912
 - *Populus ciliata* Wall. ex Royle – Uttarakhand (Debnath, 1991)
 - *Sappaphis* sp.
 - *Cotoneaster bacillaris* Wall. ex Lindl. (syn. *Cotoneaster obtusus* Wall. ex Lindl.) – Uttarakhand (Debnath, 1991)
- 17. *Orius tantillus* (Motschulsky, 1863) [syn. *Triphleps tantilus* (Motschulsky, 1863)]**
- *Aphis* (*Aphis*) *gossypii* Glover, 1877
 - *Gossypium hirsutum* L. - Punjab (Rahman, 1940)
- 18. *Orius* sp.**
- *Aphis* (*Aphis*) *gossypii* Glover, 1877
 - *Solanum melongena* L. - Punjab (Shankar and Tripathi, 2021)
 - *Brachycaudus* (*Brachycaudus*) *helichrysi* (Kaltenbach, 1843)
 - *Cirsium wallichii* DC. (syn. *Cnicus wallichii* Hook.f.) – Uttarakhand (Debnath, 1991)
 - *Hayhurstia atriplicis* (Linnaeus, 1761)
 - *Chenopodium album* L. – Uttarakhand (Debnath, 1991)
 - *Myzus* (*Myzus*) *dycei* Carver, 1961
 - *Urtica dioica* L. – Uttarakhand (Debnath, 1991)
 - *Sappaphis* sp.
 - *Cotoneaster bacillaris* Wall. ex Lindl. (syn. *Cotoneaster obtusus* Wall. ex Lindl.) – Uttarakhand (Debnath, 1991)

19. *Temnostethus paradoxus* (Hutchinson, 1934)

- *Amphicercidus tuberculatus* David, Narayanan and Rajasingh, 1971
- *Lonicera quinquelocularis* Hardw. - Ladakh (Bhagat, 2015)
- *Aphis* (*Aphis*) *craccivora* Koch, 1854
- *Medicago sativa* L. - Ladakh (Bhagat, 2015)
- *Brachycaudus* (*Prunaphis*) *cardui* (Linnaeus, 1758)
- *Carduus edelbergii* Rech.fil. - Ladakh (Bhagat, 2015)
- *Brachycaudus* (*Scrophulaphis*) *persicae* (Passerini, 1860)
- *Prunus amygdalus* Batsch - Ladakh (Bhagat, 2015)
- *Macrosiphoniella* (*Macrosiphoniella*) *artemisiae artemisiae* (Boyer de Fonscolombe, 1841)
- *Artemisia* sp. - Ladakh (Bhagat, 2015)
- *Pemphigus* (*Pemphigus*) *mordvilkovi* Bozhko, 1979
- *Populus alba* var. *caspica* Bornm. [syn. *Populus caspica* (Bornm.) Bornm.] - Ladakh (Bhagat, 2015)

20. *Xylocoris flavipes* (Reuter, 1875) [syn. *Anthocoris flavipes* Reuter, 1884]

- *Amphicercidus tuberculatus* David, Narayanan and Rajasingh, 1971
- *Lonicera quinquelocularis* Hardw. - Ladakh (Bhagat, 2015)
- *Aphis* (*Aphis*) *craccivora* Koch, 1854
- *Medicago sativa* L. - Ladakh (Bhagat, 2015)
- *Brachycaudus* (*Prunaphis*) *cardui* (Linnaeus, 1758)
- *Carduus edelbergii* Rech.fil. - Ladakh (Bhagat, 2015)

- *Brachycaudus* (*Scrophulaphis*) *persicae* (Passerini, 1860)
- *Prunus amygdalus* Batsch - Ladakh (Bhagat, 2015)
- *Macrosiphoniella* (*Macrosiphoniella*) *artemisiae artemisiae* (Boyer de Fonscolombe, 1841)
- *Artemisia* sp. - Ladakh (Bhagat, 2015)
- *Pemphigus* (*Pemphigus*) *dorocola* Matsumura, 1917
- *Populus ciliata* Wall. ex Royle - Uttarakhand (Ghosh *et al.*, 1986)
- *Pemphigus* (*Pemphigus*) *mordvilkovi* Bozhko, 1979
- *Populus alba* var. *caspica* Bornm. [syn. *Populus caspica* (Bornm.) Bornm.] - Ladakh (Bhagat, 2015)
- *Sappaphis* sp.
- *Cotoneaster bacillaris* Wall. ex Lindl. (syn. *Cotoneaster obtusus* Wall. ex Lindl.)- Uttarakhand (Ghosh *et al.*, 1986)

B. Family: Geocoridae

Geocoridae is a small family of Heteroptera, commonly called as big-eyed bugs. The members of its subfamily Geocorinae are generalist predators (Kóbor, 2020) while others are herbivorous, few of them are granivorous. Few species of the type genus *Geocoris* Fallen, 1814 have received attention as biocontrol agents in pest management researches (Kumar and Ananthakrishnan, 1985; Sweet, 2000). In India, two species were observed preying on 4 aphid species feeding on 8 host plants of agricultural importance recorded in West Bengal in tea orchard and another species was recorded in 4 states.

1. *Geocoris jucundus* (Fieber, 1861)

- *Aphis* (*Aphis*) *gossypii* Glover, 1877
- *Solanum melongena* L. - Rajasthan (Pal, 1974)

2. *Geocoris ochropterus* (Fieber, 1844)

- *Aphis* (*Aphis*) *gossypii* Glover, 1877
 - Unknown plant – India (Bal and Biswas, 2013)
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonsc., 1841
 - *Camellia sinensis* (L.) Kuntze - West Bengal (Mukhopadhyay and Sannigrahi, 1993; Das *et al.*, 2010)
- *Lipaphis* (*Lipaphis*) *erysimi* (Kaltenbach, 1843)
 - *Brassica oleracea* L. – Maharashtra (Shaikh *et al.*, 2020)
 - *Brassica rapa* L. [syn. *Brassica campestris*] – Maharashtra (Shaikh *et al.*, 2020)
 - *Raphanus sativus* L. – Maharashtra (Shaikh *et al.*, 2020)

3. *Geocoris* sp.

- *Aphis* (*Aphis*) *gossypii* Glover, 1877
 - *Abelmoschus esculentus* (L.) Moench [syn. *Hibiscus esculentus* L.] - Karnataka (Aravinda *et al.*, 2024)
- *Rhopalosiphum maidis* (Fitch, 1856)
 - *Zea mays* L. – Rajasthan (Swaminathan *et al.*, 2015)

C. Family: Miridae

The family Miridae is the largest family of Heteroptera. They are commonly known as plant bugs. They are either herbivore, predaceous, or a combination of both (zoophytophagous), and consequently are very important economically. Most mirids are generalist predators on soft-bodied arthropods (aphids, caterpillars, grubs, mites, psocids, thrips, etc.) both as nymphs and adults like anthocorids. Few species of mirids have been evaluated and released for aphid control in sweet pepper (Messelink *et al.*, 2015). In India, no biological study of mirids has been conducted regarding their use as biogents in controlling insect pests. Four species of mirids have been recorded on 6 aphid species only in Uttarakhand

as follows.

1. *Deraeocoris* sp.

- *Pemphigus* (*Pemphigus*) *mordwilkoii* Cholodkovsky, 1912
 - *Populus ciliata* Wall. ex Royle - Uttarakhand (Ghosh *et al.*, 1986)

2. *Lygus* sp.

- *Myzus* (*Myzus*) *sorbi* Bhattacharya and Chakrabarti, 1982
 - *Artemisia* sp. - Uttarakhand (Debnath, 1991)
 - *Sorbaria tomentosa* (Lindl.) Rehder - Uttarakhand (Ghosh *et al.*, 1986)

3. *Nesidiocoris caesar* (Ballard, 1927)

- *Aphis* (*Aphis*) *gossypii* Glover, 1877
 - *Lagenaria siceraria* (Molino) Standl. [syn. *Lagenaria vulgaris* Ser.] – Uttarakhand (Chakraborty and Chakrabarty, 1994)
- *Myzus* (*Nectarosiphon*) *persicae nicotianae* Blackman, 1987
 - *Nicotiana tabacum* L. – Uttarakhand (Chakraborty and Chakrabarty, 1994)

4. *Psallus* sp.

- *Brachycaudus* (*Brachycaudus*) *helichrysi* (Kaltenbach, 1843)
 - *Prunus persica* (L.) Batsch – Uttarakhand (Debnath, 1991)
- *Macrosiphoniella* (*Macrosiphoniella*) *pseudoartemisiae* Shinji, 1933
 - *Artemisia vulgaris* L. – Uttarakhand (Debnath, 1991)

D. Family: Nabidae

The Nabidae, commonly known as damsel bugs, is a small family of Heteroptera. They are polyphagous, either herbivore, predaceous, or a combination of both (zoophytophagous) like the plant bugs. They usually prey on leafhoppers in all stages, aphids of many different species of economic importance, etc. The polyphagous

feeding habits of the nabids make them less effective than species-specific predators against specific prey species (Lattin, 1989). Only a single species of this family is recorded as aphidophagous in India from Uttarakhand as follows.

1. *Nabis (Tropiconabis) capsiformis* Germar, 1838

- *Sitobion (Sitobion) miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. - Uttarakhand (Ghosh *et al.*, 1986)

E. Family: Pentatomidae

The Pentatomidae is a large family of comprising shield bugs or stink bugs. Most of them are severe pests on agricultural crops. However, some species are predatory. In India, a single species, *Eocanthecona furcellata* (Wolff, 1811) which is a generalist predator of several agricultural, horticultural and forest insect pests (Halder *et al.*, 2020), was recorded aphidophagous on a single aphid species as follows.

1. *Eocanthecona furcellata* (Wolff, 1811) [syn. *Cantheconidia urcellata* (Wolff, 1811)]

- *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
- *Tagetes erecta* L. - Madhya Pradesh (Singh *et al.*, 2024)

2. *Eocanthecona* sp.

- *Abelmoschus esculentus* Moench – Uttarakhand (Bhatt and Karnatak, 2018)

F. Family: Reduviidae

The Reduviidae is a wide spread family of Heteroptera commonly known as assassin bugs. Most of assassin bugs are terrestrial ambush and highly polyphagous predators of insects (Ambrose and Kumar, 2016). Their biocontrol potential has been investigated by Sahayaraj (2014). In India, 4 species are recorded as aphidophagous predators as follows.

1. *Brassivola hystrix* Distant, 1904

- *Lipaphis (Lipaphis) erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. - Delhi (Lakkhundi, 1989)

2. *Rhynocoris fuscipes* (Fabricius, 1787)

- *Aphis (Aphis) craccivora* Koch, 1854
- *Arachis hypogaea* L. – Tamil Nadu (Sahayaraj *et al.*, 2002)
- *Aphis (Aphis) gossypii* Glover, 1877
- *Gossypium hirsutum* L. - Tamil Nadu (Majesh *et al.*, 2011; Kalidas and Sahayaraj, 2012)
- *Capsicum frutescens* L. – Tamil Nadu (David and Natarajan, 1989)

3. *Rhynocoris kumarii* Ambrose and Livingstone, 1986

- *Aphis (Aphis) craccivora* Koch, 1854
- *Vigna unguiculata* (L.) Walp. – Tamil Nadu (Sahayaraj and Asha, 2010)

4. *Rhynocoris marginatus* (Fabricius, 1794)

- *Aphis (Aphis) craccivora* Koch, 1854
- *Vigna unguiculata* (L.) Walp. – Tamil Nadu (Sahayaraj, 2003)

References

- Ambrose DP and Kumar AG. (2016) Reduviid predators. In: Ecofriendly Pest Management for Food Security (ed.) Omkar, Academic Press, pp. 217-257.
- Aravinda H, Shruthi GT, Nandini SN, Shylesha AN, Shivalingaswamy TM and Paschapur AU. (2024) Benevolent battlers: Exploring the population dynamics of natural enemies in managing key sucking pests of okra. Intern J Adv Biochem Res SP-8(5): 99-108.
- Bal A and Biswas B. (2013) Handbook on Major Hemipteran Predators of India, Zoological Survey of India, Kolkata, pp. 44.
- Ballal CR and Yamada K. (2016) Anthocorid predators. In: Ecofriendly Pest Management for Food Security (ed.) Omkar, Academic Press, pp. 183-216.
- Ballal CR, Gupta T, Joshi S and Chandrashekhar K. (2009) Evaluation of an anthocorid predator *Blaptostethus pallens* against two-spotted spider mite *Tetranychus urticae*. In: Integrated Control in

- Protected Crops, (eds.) Castane C. and Perdakis D., IOBC/WPRS Bull. 49: 127-132.
- Bhagat RC. (2015) Diversity and updated systematic checklist of Cimicomorpha bugs (Heteroptera: Hemiptera) of Jammu, Kashmir and Ladakh Himalaya (India). Indian J Fund Appl Life Sci. 5(1): 275-279.
- Bhagat KC and Masoodi MA. (1988) Natural enemies of mealy plum aphid *Hyalopterus arundinis* Fabricius aphididae Homoptera in Kashmir, India. J Adv Zool. 9(2): 145-147.
- Bhagat RC and Lone MA. (1984) New records and host range of predators of aphids (Aphididae: Homoptera) in Kashmir valley India. Sci Culture 50: 364-366.
- Bhardwaj SP. (1991) Biological management of *Brachycaudus helichrysi* (Kalt.) infesting almond in dry temperate region of Himachal Pradesh. J Aphidol. 5(1-2): 26-31.
- Bhat DM. (2008) Studies on insect parasites and predators of some insect pests of vegetable crops of Kashmir Valley. Ph. D. thesis, P.G. Department of Zoology, University of Kashmir, Srinagar, Jammu & Kashmir (India), pp. 193.
- Bhatt B and Karnatak AK. (2018) Population dynamics of sucking pests and their predators on okra agroecosystem. J Ent Zool Stud. 6(2): 1289-1291.
- Chakrabarti S and Chakrabarti S. (1994) Parasitic behaviour of two aphidiid parasitoids on *Macrosiphum (Sitobion) miscanthi* in western Himalaya, India. J Aphidol. 8(1-2): 110-115.
- Das S, Roy S and Mukhopadhyay A. (2010) Diversity of arthropod natural enemies in the tea plantations of north Bengal with emphasis on their association with tea pests. Curr Sci. 99: 1457-1463.
- David PMM and Natarajan S. (1989) Bug that destroys chilli fruits. The Hindu (Indian National Daily), June 21, p. 24.
- Debnath M. (2020) Aphidophagous predator diversity in Kalimpong District, India. Int J Exp Res Rev. 22: 30-36.
- Debnath N. (1991). Studies on some aphidophagous insects in northwest and western Himalays. Ph.D. thesis, University of Kalyani, India.
- Favret C. (2024) Aphid Species. <https://Aphid.SpeciesFile.org>.
- Fonseca M, Lima E, Lemos F, Venzon M and Janssen A. (2017) Non-crop plant to attract and conserve an aphid predator (Coleoptera: Coccinellidae) in tomato. Biol Cont. 115: 129-134.
- GBIF (2024) The Global Biodiversity Information Facility. <https://www.gbif.org>.
- Ghosh AK and Raychaudhuri DN. (1982) Ecology of natural enemy complex of Aphidoidea (Homoptera) in some areas of eastern India. Proc Symp Ecol Anim Population Zool Surv India 3: 55-69.
- Ghosh D. (1983) Studies on mustard aphid *Lipaphis erysimi* (Kltb.) (Homoptera: Insecta) and its natural enemy complex in some parts of West Bengal. Ph. D. thesis, Calcutta University, Kolkata, West Bengal, India, pp. 207.
- Ghosh D, Debnath N and Chakrabarti S. (1986) Predators and parasites of aphids from northwest and western Himalaya. IV. Twelve species of heteropterans (Heteroptera: Insecta) from Garhwal and Kumaon ranges. Proc Zool Soc Calcutta 39: 15-19.
- Ghosh D, Poddar SC and Raychaudhuri DN. (1981) Natural enemy complex of *Aphis craccivora* Koch and *Lipaphis erysimi* (Kalt.) in and around Calcutta. Sci Culture 47: 58-60.
- Halder J, Kushwaha D and Rai AB. (2020) Biology and feeding potential of *Eocanthecona furcellata* (Wolff) on its lesser known prey, *Spilosoma obliqua* (Walker). J Biol Cont. 34(2): 109-112.
- Hazarika LK, Puzari KC and Wahab S. (2001) Biological control of tea pests. In: Biocontrol Potential and its Exploitation in Sustainable Agriculture, (eds.) Upadhyay R.K., Mukerji K.G. and Chamola B.P., Kluwer Academic/Plenum Publishers, New York, pp. 159-180.
- Kalidas S and Sahayaraj K. (2012) Comparative biology and life table traits of *Rhynocoris longifrons* Stal (Hemiptera: Reduviidae) on factitious host and four natural cotton pests. Proc Sci Technol Clean Green Environ. 27-28 July, 2012, pp. 142-149.
- Kóbor P. (2020) A review on biology and agricultural significance of big-eyed bugs (Heteroptera: Lygaeoidea: Geocoridae). Hung Agric Res. 2: 4-10.
- Kumar NS and Ananthakrishnan TN. (1985) *Geocoris ochropterus* Fabr. as a predator of some thrips. Proc Nat Acad Sci India Sec B: Biol Sci. 51: 185-193.
- Lakkundi NH. (1989) Assessment of reduviids for their predation and possibilities of their utilization in biological control, Ph D thesis, IARI, Division of Entomology, New Delhi.
- Lattin JD. (1989) Bionomics of the Nabidae. Annu Rev Ent. 34: 383-400.
- Majesh T, Kalidas S and Sahayaraj K. (2011) Bioefficacy of *Rhynocoris fuscipes* on three cotton hemipteran pests. National Seminar on Harmful/Beneficial Insects of Agricultural Importance, 17- 18 February 2011, St. Joseph's College, Devagiri, Calicut-673008, Kerala, pp. 92-98.

- Maurya RP. (2011) Natural enemies of apple woolly aphid, *Eriosoma lanigerum* Hausmann and their population dynamics in a mid hill apple orchard. Indian J Ent. 73(1): 15-18.
- Messelink GJ, Bloemhard CMJ, Hoogerbrugge H, Schelt J, Ingegno BL and Tavelle L. (2015) Evaluation of mirid predatory bugs and release strategy for aphid control in sweet pepper. J Appl Ent. 139(5): 333-341.
- Mukhopadhyay A and Sannigrahi S. (1993) Evaluation of predatory potentiality of *Geocoris ochropterus* (Hemiptera: Lygaeidae) on tea aphid *Toxoptera aurantii* (Hemiptera: Aphididae). Tea 14(1): 44-49.
- Muraleedharan N and Ananthakrishnan TN. (1978) Bioecology of four species of Anthocoridae (Hemiptera: Insecta) predaceous on thrips, with key to genera of anthocorids from India. Occ Pap, Rec Zool Surv India 11: 1-32.
- Nasreen A, Sridharan S, Muthukumar M and Ashok K. (2022) Feeding and oviposition preference of anthocorid predator, *Blaptostethus pallens* Poppius to different prey species. Pest Manag Hort Ecosyst. 28(1): 47-53.
- Pal S. (1974) *Geocoris jucundus* Fieb. (Lygaeidae: Hemiptera) as predator of lucerne and tomato aphids in the Indian desert. Curr Sci. 43(17): 564-564.
- Rahman KA. (1940) Important insect predators of India. Proc Indian Acad Sci. 12: 67-74.
- Rao VP. (1969) Survey of natural enemies of aphids in India. Rep Comm Inst Biol Cont. 480: 1-93.
- Raychaudhuri DN, Dutta S, Agarwala BK, Raychaudhuri D and Raha SK. (1978) Some parasites and predators of aphids from northeast India and Bhutan. Entomon 3: 91-94.
- Sahayaraj K. (2003) Biological control potential of aphidophagous reduviid predator *Rhynocoris marginatus*. Intern Arachis Newslett. 23: 29-30.
- Sahayaraj K. (2004) Indian Insect Predators in Biological Control. Daya Books, New Delhi, pp. 336.
- Sahayaraj K. (2014) Reduviids and their merits in biological control. In: Basic and Applied Aspects of Biopesticides, (ed.) Sahayaraj K., Springer, pp. 195-214.
- Sahayaraj K and Asha A. (2010) Biological control potential evaluation of *Rhynocoris kumarii* Ambrose and Livingstone (Hemiptera: Reduviidae) on *Aphis craccivora* (Koch.) (Hemiptera: Aphididae) (Koch.) (Hemiptera: Aphididae). Indian J Agric Res. 44(4): 281-287.
- Sahayaraj K, Selvaraj P and Nirmala K. (2002) Biological control potential of a reduviid predator, *Rhynocoris fuscipes* (Fab.) on three groundnut pests. Asian J Microbiol Biotech Env Sci. 4(4): 451-455.
- Shaikh M, Pawar M, Pandit S and Mitra S. (2020) Natural predators of the mustard aphid *Lipaphis erysimi* show differential predation preferences on the aphids feeding on different cole crops. Indian J Hill Farm. 33(2): 322-330.
- Shankar BK and Tripathi P. (2021) Bio-rational approaches for management of major brinjal pests: a review. Pharma Innov J. SP-10(5): 378-381.
- Singh LB, Bagri A, Sharma R, Kumar A and Pippal SS. (2024) Insect pests and its natural enemies of marigold. Plant Arch. 24(1): 1431-1435.
- Singh R and Singh G. (2016) Aphids and their biocontrol. In: Ecofriendly Pest Management for Food Security (ed.) Omkar, Academic Press, pp. 63-108.
- Singh R and Singh G. (2022) Reproductive strategies in aphids. In: Reproductive Strategies in Insects (eds.) Omkar and Mishra G., Taylor and Francis Group, LLC, pp. 259-282.
- Singh R, Tiwari AK and Tiwari KM. (2024) Checklist of aphidophagous Neuroptera (Insecta: Arthropoda) in India. Int J Biol Innov. 6(2): 99-127.
- Singh R, Verma AK and Singh G. (2023) Food Plant catalogue of Indian Aphids (Homoptera: Aphididae). Asian Biological Research Foundation, Prayagraj, India; Nature Light Publications, Pune, pp. 350.
- Swaminathan R, Meena A and Meena BM. (2015) Diversity and predation potential of major aphidophagous predators in maize. Appl Ecol Env Res. 13(4): 1069-1084.
- Sweet MH. (2000) Economic importance of predation by big-eyed bugs (Geocoridae). In: Heteroptera of Economic Importance, (eds.) Schaefer C.W. and Panizzi A.R., CRC Press, Boca Raton, pp. 713-724.
- WFO. (2024) The World Flora Online. <https://www.worldfloraonline.org>.