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Exploration of natural enemy fauna of aphids and associated ant species from eastern dry zone of Karnataka, India

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ABSTRACT: Purposive surveys were conducted at regular intervals in different districts of eastern dry zone of Karnataka (Zone 5) during the year 2021-22, to document the natural enemy fauna and the ant species associated with aphids. Out of 34 aphid species recorded, 16 species of aphids were preyed on by 14 species of predators belonging to Coccinellidae, Syrphidae, Hemerobiidae and Chamaemyiidae and seven species of aphids were found parasitized by eight species of parasitoids belonging to Braconidae. Predators belonging to Coccinellidae and Syrphidae were recorded more abundantly with six species in each family, preying on 12 and 10 aphid species, respectively. Among the aphid parasitoids, *Aphidius* spp. was the more abundant taxa. Eleven species of ants belonging to Formicinae, Myrmicinae and Dolichoderinae were found associated with 17 aphid species. Ants belonging to the genus *Camponotus* were found to be more abundant and associated with 10 species of aphids. A comprehensive list of predators, parasitoids and ants associated with different aphid species was put together during this study.

KEY WORDS: Purposive surveys, abundance, predators, parasitoids, aphidocolous ants

INTRODUCTION

Aphids (Hemiptera, Aphididae) are small soft bodied sap sucking insects. More than 450 species of aphids are found to be associated with different crop plants (Blackman and Eastop, 2000) of which about 100 species are of economic importance. Chemical insecticides have been used regularly for the management of aphid pests but not without risk of resurgence, destruction of natural enemies, development of resistance, phytotoxic effects, environmental pollution and residual toxicity. Changing scenario of modern sustainable agriculture emphasizes the need for biological control for effective management of aphids. Aphids are good candidates for biological control (Joshi *et al*., 2010) as they serve as a consistent and abundant food source for many natural enemies (Singh and Singh, 2016). Aphids have a mutualistic relationship with the ants which is by way of the aphids providing rich supply of food for ants in the form of honey dew and in return receiving

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protection from their natural enemies. The risk to aphids of death caused by predators can be decreased through recruiting more ants by producing more attractive honeydew (Stadler and Dixon, 2005). Presence of ants also accelerates growth of aphids and establishment of aphid colony (Saha *et al*., 2018). Ants that attend aphids belong largely to the most evolved subfamilies Myrmicinae, Formicinae and Dolichoderinae (Tizado *et al*., 1993). Noteworthy contributions on the natural enemies of aphids in India were made by Rao (1969), Raychaudhuri (1978), Ghorpade (1981), Ghosh and Raychaudhuri (1982), Stary and Ghosh (1983), Agarwala and Ghosh (1988), Singh *et al*. (1999), Joshi (2005), Dey and Akthar (2007), Akthar *et al*. (2011), Chaudhary and Singh (2012), Joshi and Sangma (2015), Bhat and Bhagat (2017), Khan *et al*. (2017), Bhat *et al*. (2020), Kale *et al*. (2020) and Maji *et al*. (2023). In India, aphid-ant association has been mainly dealt with Gadiyappanavar (1970), Roy and Behura (1980), Kurl and Misra (1980), Datta *et al*. (1982, 1983), Devi and Singh (1986), Verghese and Tandon (1987), Devi *et al*. (1987), Devi *et al*. (2001), Bisht *et al*. (2002), Joshi (2005), Kataria and Kumar (2013) and Rakshan and Ahmad (2015). The present investigation was carried out with an aim to record the natural enemies and ant species associated with aphids from eastern dry zone of Karnataka (Zone 5).

MATERIALS AND METHODS

In order to record the various natural enemies associated with different species of aphids, purposive surveys were conducted at regular intervals (15 days) in six districts of eastern dry zone of Karnataka *viz*., Bengaluru Urban (13.0801° N; 77.5406° E), Bengaluru Rural (13.3535° N; 77.5406° E), Kolar (13.1320°N; 78.1783° E), Chikkaballapura (13.3354°N; 78.0824°E), Tumkur (13.2818° N; 77.1860°E) and Ramanagara (12.9576°N; 77.2261°E) during 2021-22. Field collection of aphid infested plant parts and associated aphid predators was carried out. The aphids collected were preserved in small plastic vials containing ethyl alcohol (70%), properly furnished with labels and the slides were prepared in accordance with the method suggested by Eastop and van Emden (1972). Identification of aphids up to species level was carried out using the keys available from Aphids on the world's plants: an online identification and information guide and on confirmation of the identity with the specialist. Immature stages of predators associated with aphids were collected in small plastic containers and brought to the laboratory. These were reared to adult stages in rearing containers, providing respective host aphids as food (Joshi *et al*., 1997). To record the parasitoid species associated with aphids, a part of the collection of aphid infested plant material and also colony with mummified aphids were brought to the laboratory (Joshi, 2005). Emerging adult parasitoids and predators were collected and processed for study. Identification of the predators and parasitoids were carried out with the help of specialists in the respective fields. Ants associated with different species of aphids were collected directly from the field and preserved in small vials containing alcohol (70%) for identification.

RESULTS AND DISCUSSION

During the course of investigation, out of 34 aphid species recorded, 16 species of aphids were preyed on by 14 species of predators belonging to four families and seven species of aphids were found parasitized by eight species of parasitoids belonging to Braconidae. The aphidophagous predators belonged to Coccinellidae, Syrphidae, Hemerobiidae and Chamaemyiidae. Six species each of aphidophagous coccinellid beetles and syrphids were recorded preying on 12 and 10 aphid species, respectively. Members of Hemerobiidae were recorded feeding on six aphid species and *Leucopis* sp. belonging to Chamaemyiidae was recorded preying on three aphid species (Table 1). Out of the eight aphid parasitoids, *Aphidius* spp. was recorded parasitizing five aphid species. Other parasitoids recorded include *Binodoxys* sp., *Lysiphlebus* sp. and *Trioxys* sp. which were recorded feeding on single aphid species each (Table 2). Out of 34 species of aphids reported, 17 species of aphids were found associated with 11 species of ants (Table 3). Three subfamilies of Formicidae were reported. Subfamily Formicinae was found more abundant with five species,

Table 1. Predatory species associated with different species of aphids in eastern dry zone of Karnataka during 2021-22

Predator	Aphid	Host plants
Cheilomenes sexmaculata (F.) Coccinellidae	*Aphis craccivora* Koch	*Cajanus cajan* (L.); *Cyamopsis tetragonoloba* (L.); *Dolichos lablab* L.; *Vigna unguiculata* (L.)
	A. odinae (van der Goot)	*Anacardium occidentale* L.
	Brevicoryne brassicae (Linnaeus)	*Brassica oleraceae* L. var. *capitata*
	Hysteroneura setariae (Thomas)	*Melinis repens* (Willd.) Zizka
	Hyadaphis coriandri Das	*Anethum graveolens* L.
	Macrosiphum rosae (Linnaeus)	*Rosa* sp.
	Myzus persicae (Sulzer)	*Br. juncea* L.
	Rhopalosiphum maidis (Fitch)	*Zea mays* L.
	Schoutedenia emblica (Patel and Kulkarni)	*Phyllanthus emblica* L.
Coccinella transversalis Fabricius Coccinellidae	*A. craccivora*	*Arachis hypogea* Willd
	Br. brassicae	*Br. oleraceae* L. var. *capitata*
	M. persicae	*Br. juncea*
	R. maidis	*Z. mays*
Propylea dissecta (Mulsant) Coccinellidae	*A. craccivora*	*Arachis hypogea C. cajan*
Pseudaspidimerus sp. Coccinellidae	*A. citricida* (Kirkaldy)	*Artocarpus heterophyllus* Lamk.
	A. odinae	*Garcinia indica* Choisy
Scymnus nubilus Mulsant Coccinellidae	*R. maidis*	*Z. mays*
S. latemaculatus Motschulsky Coccinellidae	*A. craccivora*	*Gliricidia maculate* (Jacq.)
	A. gossypii Glover	*Hibiscus rosa sinensis* L.
	A. nerii Boyer de Fonscolombe	*Calotropis gigantea* (L.)
Asarkina belli Ghorpade Syrphidae	*A. gossypii*	*H. rosa sinensis*.
Betasyrphus sp. Syrphidae	*A. craccivora*	*C. cajan*
	A. nerii	*C. gigantea*
	Lipaphis pseudobrassicae (Davis)	*Br. juncea*
	M. persicae	*Br. juncea*
Dideopsis aegrota (F.) Syrphidae	*A. odinae*	*Anacardium occidentale* L.
Episyrphus viridaureus (Wiedemann); Syrphidae	*Macrosiphum rosae* (Linnaeus)	*Rosa* sp.
Ischiodon scutellaris (Fabricius) Syrphidae	*A. craccivora*	*C. cajan*
	A. gossypii	*Cucumis sativa* L.; *Chromolaena odorata* (L.)
	A. citricida	*Citrus* sp.
	Hyperomyzus carduellinus (Kirkaldy)	*Sonchus* sp.

Serratoparagus serratus (Fabricius) Syrphidae	*A. craccivora*	*C. cajan*; *Cyamopsis tetragonoloba* (L.); *G. maculata*
	A. citricida	*Citrus* sp.
	R. maidis	*Z. mays*
Unidentified Hemerobiidae	*A. craccivora*	*Vigna unguiculata* (L.)
	A. odinae	*Aralia* sp.
	A. gossypii	*Lantana camara* L.
	Macrosiphum euphorbiae (Thomas)	*Rosa* sp.
	R. maidis	*Zea mays* L.
	Uroleucon compositae (Theobald)	*Phyllocephalum scabridum* (DC.)
Leucopis sp. Chamaemyiidae	*A. gossypii*	*H. rosachinensis*
	Hysteroneura setariae (Thomas)	*Melinis repens* (Willd.) Zizka
	R. maidis	*Z. mays*

Table 2. Parasitoid species [Braconidae, Aphidiinae] associated with different species of aphids in the eastern dry zone of Karnataka during 2021-22

Parasitoid	Host aphid	Host plants
Aphidius matricariae Haliday	*Aulacorthum solani* (Kaltenbach)	*Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.)
Aphidius sp.	*Macrosiphum rosae* (Linnaeus)	*Rosa* sp.
Aphidius sp.	*Myzus persicae* (Sulzer)	*Brassica juncea* L.
Aphidius sp.	*Macrosiphoniella sanborni* (Gillette)	*Chrysanthemum indicum* L.
Aphidius sp.	*Lipaphis pseudobrassicae* (Davis)	*Brassica oleraceae* L. var *capitate*
Binodoxys sp.	*A. gossypii* Glover	*Duranta* sp.
Lysiphlebus sp.	*A. craccivora* Koch	*Arachis hypogea* Willd.
Trioxys sp.	*A. craccivora*	*Cyamopsis tetragonoloba* (L.)

followed by Myrmicinae and Dolichoderinae with three species each.

Among the coccinellid predators, more common was *Cheilomenes sexmaculata* (Fabricius), which was found preying on nine species of aphids followed by *Coccinella transversalis* Fabricius which preyed on four aphid species. Pervez (2004) provided a catalogue of predaceous coccinellids of India and its prey, which also gives an account of *Ch. sexmaculata* and *Co. transversalis* as predators. In the study conducted by Megha *et al.* (2015) on coccinellids in different crops at Dharwad region of Karnataka, *Ch. sexmaculata* was the dominant species, consistent with the present findings. The catalogue of predaceous coccinellids of India gives the account of *Propylea dissecta* (Mulsant) feeding on *Aphis craccivora* Koch (Pervez, 2004). Agarwala and Ghosh (1988) provided prey records of aphidophagous coccinellids in India, which gives an early record of *Pseudaspidimerus* sp. preying on the *Aphis citricida* (Kirkaldy) and *A. odinae* (van der Goot). Megha *et al.* (2015) recorded *Scymnus nubilus* Mulsant feeding on *Rhopalosiphum maidis* (Fitch) from Dharwad region of Karnataka and the record of *S. latemaculatus* Motschulsky preying on *A. craccivora*, *A. gossypii* Glover and *A. nerii* Boyer

Table 3. List of aphidocolous ant species recorded from eastern dry zone of Karnataka during 2021-22

Ant species	Associated aphid species	Host plants
Subfamily - Formicinae		
Anoplolepis gracilipes (Smith)	*Aphis gossypii* Glover	*Gardenia resinifera* Roth
	A. nerii	*Calotropis gigantea* (L.)
	A. odinae	*Mussaenda erythrophylla* Lam.
	Pseudoregma bambucicola (Takahashp)	*Bambusa vulgaris* Schrad. ex J. C. Wendl.
	Rhopalosiphum maidis	*Zea mays* L.
Camponotus sp.	*A. craccivora*	*Cajanus cajan* (L.) *Cyamopsis tetragonoloba* (L.) *Gliricidia maculate* (Jacq.)
	A. fabae	*Solanum nigrum* L.
	A. gossypii	*Ruellia britonniana* Leonard *Catharanthus rosea* (L.)
	A. spiraecola Patch	*Bidens Pilosa* L.
	A. citricida (Kirkaldy)	*Artocarpus heterophyllus* Lamk. *Citrus aurantifolia* Christm., *Citrus* sp.
	A. odinae (van der Goot)	*Hamelia patens* Jacq. *Mussaenda erythrophylla* Lam.
	Cinara tujafilina (del Guercio)	*Thuja chinensis* Borders and Gausen
	Hysteroneura setariae (Thomas)	*Eleusine corocana* (L.) *Melinis repens* (Willd.) Zizka
	Rhopalosiphum maidis (Fitch)	*Zea mays* L.
	Schoutdenia emblica (Patel "and Kulkarni)	*Phyllanthus emblica* L.
Crematogaster sp.	*A. craccivora*	*Solanum torvum* Sw.
	A. gossypii	*Hibiscus rosa sinensis* L. *Lantana camara* L.
Oecophylla smaragdina Smith	*A. gossypii*	*Chromolaena odorata* (L.)
	A. citricida (Kirkaldy)	*Citrus* sp.
	A. odinae (van der Goot)	*Anacardium occidentale* L.
	Schoutdenia emblica (Patel and Kulkarni)	*Phyllanthus emblica* L.
Paratrechina sp.	*A. gossypii*	*Ocimum sanctum* L.
Subfamily - Myrmicinae		
Lophomyrmex sp.	*A. gossypii*	*Chromolaena odorata* (L.)
Myrmicaria brunnea (Saunders)	*A. craccivora*	*Cyamopsis tetragonoloba* (L.) *Dolichos lablab* L. *Moringa oleifera* Lam.
	A. gossypii	*Parthenium hysterophorus* L. *Tecoma stans* (L.)
	A. odinae	*Mussaenda erythrophylla* Lam. *Tagetes erecta* L.
	H. setariae	*Melinis repens* (Willd.) Zizka

Solenopsis sp.	*A. craccivora*	*Arachis hypogea* *Vigna radiata* (L.)
	A. gossypii	*Abelmoschus esculentus* Moench
	A.odinae	*Anacardium occidentale*
	H. setariae	*Eleusine indica* (L.)
	Uroleucon compositae (Theobald)	*Guizotia abyssnicia* (L.f.) Cass.
Subfamily - Dolichoderinae		
Tapinoma melanocephalum (F)	*Aphis spiraecola* Patch	*Chromolaena odorata* (L.)
Technomyrmex albipes (Smith)	*A. odinae*	*Pentas* sp.
Technomyrmex sp.	*A. craccivora*	*Arachis hypogea Cordyline* sp.
	A. odinae	*Aralia* sp.
	Cerataphis brasiliensis (Hempel)	*Areca catechu* L.
	Pentalonia caladii Boyer de Fonscolombe	*Alpinia zerumbet* (Pers.)
	Pentalonia nigronervosa Coquerel	*Musa* sp.
	Melanaphis sacchari (Zehntner)	*Saccharum officinarum* L.
	Schoutdenia emblica (Patel and Kulkarni)	*Phyllanthus emblica* L.

de Fonscolombe have also been made earlier (Chaudhary and Singh, 2012), similar to the findings of this study.

Among the syrphids recorded during the present study, *Ischiodon scutellaris* (Fabricius) and *Betasyrphus* sp. were found in abundance preying on four aphid species each. The syrphid, *Serratoparagus serratus* (Fabricius) was recorded feeding on three species of aphids. *Asarkina belli* Ghorpade, *Dideopsis aegrota* (Fabricius) and *Episyrphus viridaureus* (Wiedemann) were also recorded, each feeding on a single species. Similar reports of these aphid-syrphid associations were also given by Ghorpade (1981). Hemerobiidae are major biocontrol agents that are used against aphids in several parts of the world. Members of Chamaemyiidae such as *Leucopis glyphinivora* Tanas. are potential biocontrol agents against aphids (Singh and Singh, 2016).

During the investigation, eight aphid parasitoid species belonging to Braconidae were recorded. Joshi (2005) reported *Aphidius* spp. and *Binodoxys* sp. parasitizing the aphids analogous to the records made during the present study. Similarly, the catalogue of aphid, parasitoids (Braconidae, Aphidiinae) from India also provides an account of *Aphidius* sp., *Lysiphlebus* sp. and *Trioxys* sp. parasitizing the aphids (Akthar *et al*., 2011).

In the present study the *Camponotus* ants were more abundant, associated with ten species of aphids. Seven species of aphids were attended by *Technomyrmex* sp., *Anoplolepis gracilipes* (Smith) and *Solenopsis* sp. were found associated with five species of aphids. *Oecophylla smaragdina* Smith and *Myrmicaria brunnea* (Saunders) attended four species of aphids. *Crematogaster* sp. was found associated with two species of aphids. *Paratrechina* sp., *Lophomyrmex* sp., *Tapinoma melanocephalum* (Fabricius) and *Technomyrmex albipes* (Smith) attended one species of aphids each. Rohini (2017) also recorded 26 aphid species from Chikkamagaluru district and reported 11 species of ants associated with 12 species of aphids, where the genus *Camponotus* was encountered more commonly tending six species of aphids, *Solenopsis* sp. attended three species of aphids and *Anoplolepis gracilipes*, *Crematogaster* sp., *Myrmicaria* sp., *Oecophylla smaragdina*, *Technamyrmex albipes* and *Tapinoma* sp. attended one aphid species each. Similarly, Joshi (2005) recorded 66 species of aphids of which 23 species of aphids were attended by eleven species

of ants. *Camponotus compressus* (F.) was found most abundant, associated with 15 aphid species. A total of 22 species of aphid natural enemies which is constituted by 14 species of predators and eight species of parasitoids were found associated with 16 and seven aphid species, respectively in the eastern dry zone of Karnataka.

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