STUDY OF MUTUALISTIC ANTS ASSOCIATED WITH *APHIS CRACCIVORA* (HEMIPTERA: APHIDIDAE) ON VARIOUS HOST PLANTS OF FAMILY FABACEAE IN NORTHEAST BIHAR (INDIA)

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Abstract

Aphids are the soft bodied homopteran bugs infesting almost all types of agricultural and horticultural plants and cause considerable loss because of their polymorphism, parthenogenetic development, host alternating behaviour and ability of transmission of viral diseases. Aphids and ants have great mutualistic relationship where both partners may derived benefits from this association and has strong interaction with various host plants. The association of *Aphis craccivora* with ants was studied on six plants of family Fabaceae (*Cajanus cajan, Lablab purpureus, Phaseolus sinensis, Vicia faba, Vigna mungo* and *Vigna radiata*). Eleven species of aphidocolous ants viz., *Camponotus compressus* (Fab.), *Camponotus invidus* Forel, *Camponotus* sp., *Lepisiota frauenfeldi* (Mayr), *Meranoplus bicolor* (Guérin-Méneville), *Monomorium latinode* Mayr, *Monomorium pharaonis* (Linn.), *Paratrecina longicornis* (Latreille), *Pheidole* sp., *Polyrhachis hauxwelli* (Bingham) and *Tetraponera rufonigra* (Jerdon) belong to 3 subfamilies (Formicinae, Myrmicinae and Pseudomyrmicinae) were recorded from northeast Bihar for the first time. The maximum association of ants was observed on *L. purpureus* and *P. sinensis* followed by *V. faba* and *V. radiata*. The association of *C. compressus* and *M. bicolor* was greater on all host plants with *A. craccivora* than other aphids. However, *P. longicornis* and *T. rufonigra* were recorded on only one host plant with low extent.

Keywords : Aphids, Ants, Mutualism, Host plants

Introduction

Aphids (Homoptera: Aphididae) are small soft bodied, polyphagic, polymorphic, sap sucking insects whose reproductive potential is immense due to parthenogenesis, viviparity and fast development (Dixon, 1985; Ghosh & Singh, 2002). In favourable climatic condition, their numbers rapidly rise above economic threshold levels. They attack all types of agricultural and horticultural plants and damage the crop directly by drawing sap of plants which cause general devitalisation of plants. The subaerial infestation by aphids also cause yellowing of foliages, stunt growth and deform and discolor leaves and fruits. Furthermore, aphids are responsible for transmission of several plant viruses (Ghosh, 1974). *Myzus persicae* (Sulzer) alone transmits more than 100 different viruses (Verma, 1999). In spite of direct effects, aphids also excrete 'honeydew' which is responsible for development of sooty mould and restricting the photosynthesis. On the other hand, honeydew also attracts ants, flies and other insects.

Aphids and ants associationship is based upon mutualism which is beneficial to both of them but not necessarily involve either being completely dependent on either (Stadler & Dixon, 2005; Shiran et al., 2013). The mutualism here is based on the ants obtaining the rich food supply from the aphids in the form of honeydew and the aphid colonies get the protection from their natural enemies (predators and parasitoids) by the presence of ants. Presence of ants also stimulates the aphids to grow and mature more rapidly (Hölldobler & Wilson, 1990). The mutualistic relationship between ants and aphids has been the subject of many studies. Stadler & Dixon (2005) reviewed the whole range of interactions between ants and aphids. In spite of mutual relation of ants with aphids, the ant may antagonist in relation. They may occasionally or even mostly eat rather tend aphids (Stadler & Dixon, 1999; Delabie, 2001).

The protection from ants may also be mediated by ecological factors such a host plant quality, size of homopteran aggregation and abundance of predators (Cushman & Beattie, 1991; Yao, 2014). In India, several workers have reported aphidocolous ants and their association with the several species of aphids (Roy & Behura, 1980; Kurl & Chauhan, 1986; Devi & Singh, 1987; Devi et al., 2010, Sarkar et al., 2010; Kataria & Kumar, 2013). Kataria & Kumar (2013) reported that *Camponotus* sp. usually acted as one of the main cause of spread of aphids from one plant to other.

Thus, aphid–ant association has strong interaction with various host plants. *Aphis craccivora* Koch is one of the major pests of agricultural plants in the target area and mostly recorded on the plants belonging to family Fabaceae. The present study deals with the association of different species of ants with *A. craccivora* on various plants of Fabaceae.

Materials and Methods

The extensive survey was made in different localities of northeast Bihar (India) during 2011 to 2013 to study the associations between ants and aphid colonies. Aphids and ants were collected directly from different parts of plant and placed in plastic bags tightened with rubber bands and transported to the laboratory within 24 hours. Ants association with aphids was confirmed by observing ant antennation for stimulating aphids to secrete honeydew droplets and honeydew collection by ants. The aphids were preserved in 70% ethanol and glycerin (5:1) for taxonomical study in the laboratory by observing various taxonomical characters following Blackman & Eastop (2000) and Raychaudhari (1980) and the collected specimens of ants were also preserved in 70% ethanol for further taxonomical study.

Results and Discussion

During the extensive survey of different districts of northeast Bihar, 41 species of aphids on more than 122 plants species were recorded in the target area (Ahmad et al., 2012a). Among these, *A. craccivora* was recorded as most common polyphagous species in the target area and found abundantly in most of the localities (Ahmad & Singh, 1997; Ahmad et al., 2012b). It was recorded on 34 food plants (Ahmad & Kumar, 2007). Out of these, 16 plants belong to family Fabaceae. During the study of association of *A. craccivora* with ants in different seasons, twelve species of aphidocolous ants viz., *Camponotus compressus* (Fab.), (Plate-1), *Camponotus invidus* For., (Plate-2), *Camponotus* sp., (Plate-3), *Lepisiota frauenfeldi* (Mayr) (Plate-4), *Meranoplus bicolor* (Guer.), (Plate-5), *Monomorium latinode* Mayr, (Plate-6), *Monomorium pharaonis* (Linn.), (Plate-7,8), *Paratrecina longicornis* (Latreille), (Plate-9,10), *Pheidole* sp., *Polyrhachis hauxwelli* (Bingham), (Plate-11) and *Tetraponera rufonigra* (Jerdon), (Plate-12) belonging to 3 subfamilies (Formicinae, Myrmicinae, Pseudomyrmicinae) were first time recorded in target area on six host plants of family Fabaceae (*Cajanus cajan, Lablab purpureus, Phaseolus sinensis, Vicia faba, Vigna mungo* and *Vigna radiata*).

The appearance of *A. craccivora* started in the month of September and continued till up to April. Maximum population of aphids was observed in the month of November to March. Maximum degree of infestation of *A. craccivora* was observed on *L. purpureus, P. sinensis* and *V. faba* (Table-1). Herewith, all ant species are reported in details with their association with food plants in different seasons.

Camponotus compressus (Fabricius)

It measures about 10 mm in length. Entire body is black in colour, antennae 12- segmented, eye large and placed above middle of head; thorax

anteriorly broad, posteriorly more or less compressed; gaster broad, massive and oval. It is very common ant in the target area and it associationship was observed on all host plants. Its maximum association was observed on *C. cajan*, *P. sinensis* and *L. purpureus* followed by *V. faba*, *V. mungo* and *V. radiata* (Table-1). Its maximum association was observed during February. Associationship of *C. compressus* was observed very high during maximum infestation of *A. craccivora* however, low association was observed during low infestation of aphids.

Plate-1: *Camponotus compressus*

Camponotus invidus Forel

It measures about 8 mm in length. Its whole body is yellowish brown in colour. Antennae 12-segmented; eyes are well developed and black in colour. It was recorded on only *P. sinensis*. Seasonal study revealed that it is found in the month of December and January (Table-1). Its degree of association was observed high on *A. craccivora* during moderate to high degree of infestation.

Camponotus sp.

It measures about 10 mm in length. Its entire body is black in colour. Antennae 7- segmented; eyes are dark black in colour. Thorax elongated and somewhat compressed. It was associated with *A. craccivora* on *P. sinensis*. Its moderate association was observed during October on even low degree of infestation of *A. craccivora*.

Plate-2: *Camponotus invidus* Forel

Plate-3: *Camponotus* sp.

Lepisiota frauenfeldi (Mayr)

It measures about 3 mm in length. Shinning black in colour. Antennae 11-segmented and filliform; eyes well developed, ocelli present but may be reduced; mandibles with the apical margin oblique and dentate, over hung by clypeus; petiole usually with sharp prominences or spines. It was recorded during November to March and their population flourished during December. Its association was observed with *A. craccivora* on *L. purpureus, P. sinensis* and *V. radiata*. Moderate to very high degree of association was observed during very high degree of infestation of *A. craccivora* on *L. purpureus* and *P. sinensis.* However, its low association was observed on *V. radiata.*

Meranoplus bicolor (Guerin-Meneville)

It measures about 4-5 mm in length. Head, thorax, legs and pedicel are reddish brown and gaster oval black. Whole body is covered with long abundant hairs. Mesonotum is armed posteriorly with 2 long acute spines. It was also a very common ants associated with *A. craccivora* recorded on six host plants. Its seasonal study revealed that it is found in October to February and its population flourished during November and December. The maximum association was observed on *L. purpureus, P. sinensis* and *V. faba* during very high infestation of *A. craccivora* (Table-1). However, low to moderate degree of association was observed during low to moderate degree of infestation with *A. craccivora* on *V. mungo* and *V. radiata* (Table-1).

Plate-4: *L. frauenfeldi* on *P. sinensis.*

Plate-5: *M. bicolor* on *V. mungo*

Monomorium latinode Mayr

It measures about 2.5-3 mm in length. Head oval, vertex weakly convex, frons shining and smooth, eyes moderate set below midpoint of head capsule, 12 segmented antennae, antennal club three-segmented. Mesosoma and appendages brownish-yellow and gaster brown in colour. Petiole and post petiole shining and smooth. Its association was observed on *L. purpureus, P. sinensis* and *V. radiata*. The seasonal study revealed that it started to appear from October to March. Moderate to high degree of association was observed during high degree of infestation of *A. craccivora*

on *L. purpureus. and P. sinensis.* However, very low association was observed even on high degree of infestation of *A. craccivora* on *V. radiata.*

Monomorium pharaonis (Linnaeus)

It measures about 2- 2.5 mm in length. They are light yellow to reddish brown in color with a darker abdomen. Head rectangular, longer than broad, eyes prominent placed laterally at about the middle of the sides of the head, 12-segmented antennae with a three-jointed club; thorax narrower than head; petiole has two nodes; legs moderately long and body devoid of pubescence and hairs. Its association was observed on only *L. purpureus* and *V. radiata*. The seasonal study revealed that it started to appear from November and continued up to March. Its association was observed very high on maximum infestation of *A. craccivora* during December on *L. purpureus* while its low association was observed during March. However, it moderate association was observed on *V. radiata*.

Plate-6: M. latinode

Plate-7: M. pharaonis

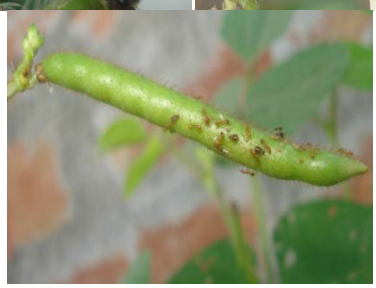

Plate-8: M. pharaonis.

Paratrecina longicornis (Latreille)

It measures about 2.3-3 mm in length. They are dark brown to black in colour; head elongate, eyes large; antennae slender and 12 segmented without a club, antennae and legs extraordinarily long. Its association was recorded on *L. purpureus, P. sinensis* and *V. faba.* The seasonal study revealed that it started to appear from December. Its association was observed little to moderate on very high infestation of *A. craccivora* on *L. purpureus, P. sinensis* and *V. faba.*

Plate-9: *P. longicornis* on *P. sinensis*.

Plate-10*: P. longicornis* on fruits of *P. sinensis.*

Pheidole sp.

It measures about 2 mm in length. It is brownish in colour. Head is small with 12- segmented long antennae, 3 segmented club, eyes moderate to small; legs moderately long and strong, claw simple; pedical 2-jointed with node; gaster more or less broadly oval. Its association was observed on only *L. purpureus*, It appeared first time in November and continued up to February. Its association was very high with maximum degree of infestation of *A. craccivora* during December. However, moderate association was observed on high infestation of *A. craccivora* on *L. purpureus* during February.

Polyrhachis hauxwelli (Bingham)

It measures about 7 mm in length. Body jet-black; head oval, convex above in the posterior region and wider behind, eyes prominent protruding; pronotum wide, convex above and round and on each side is provided with along and acute spine lamelliform at its base. Pro-mesonotal and meso-metanotal sutures distinct, mesonotum broader than long and unarmed with either spines or teeth. The node of the pedicel trapeziform, two very small teeth at the base of these spines on the outerwards. It association was observed with *A. craccivora* only on two host plants viz., *P. sinensis* and *V. faba*. It was recorded during December to March. Its degree of association was recorded high on large colonies and little on small colonies of *A. craccivora* on *V. faba.* However, a low association of *P. hauxwelli* was observed on large colonies of *A. craccivora* on *P. sinensis.* Hence, *P. hauxwelli* prefer *V. faba.*

***Tetraponera rufonigra* (Jerdon)**

This is a large species and about 12 mm in length. Body usually bicoloured, head and gaster black, rest orange-red, Antennae12-segmented. This species can be easily distinguished from other species by its large size. It was recorded on single host plant *L. purpureus*. Its association was observed with *A. craccivora* in December with very low association.

Plate-11: ***Polyrhachis hauxwelli***

Plate-12: ***Tetraponera rufonigra***

Thus, in the present study, the maximum association of ants was observed on *L. purpureus, P. sinensis, V. faba* followed by *V. radiata* and *V. mungo* (Table 1). *C. compressus, L. frauenfeldi, M. bicolor* and *M. pharaonis* are very common ants associated with *A. craccivora* in the target area. The association of these ants was observed high on several host plants during the heavy infestation of *A. craccivora* in the month of December. Thus, the degree of association of ants increases with increase of aphid infestation Stadler & Dixon (1999) have reported that ants are occasionally eat aphid but such activities has not been observed in the present study. Contrary to Kataria & Kumar, (2013) ants are not responsible to spread aphids from one plant to another. It was also observed that mostly at a time, only one species of ant is associated with aphids. It is probably due to avoiding interspecific competition on a host plant. In rare cases, two different species of ants were recorded on one host plant only with weak association.

Table-1 : Association of ants with *A. craccivora* on various host plants

Host plants	**Ant species/ Subfamily**	**Degree of infestation of aphid**	**Degree of association of ants**	**Month and year of collection**
Cajanus cajan	*Camponotus compressus* (Formicinae)	+ + + + + + +	+ + + + + +	Feb., 2012 Dec., 2013
	Meranoplus bicolor (Formicinae)	+ + + +	+ + +	Dec., 2013
Lablab purpureus	*Camponotus compressus* (Formicinae)	+ + + + + + +	+ + + + + +	Feb., 2011 Mar., 2012 Feb., 2013
	Lepisiota frauenfeldi (Myrmicinae)	+ + + + + + + + +	+ + + + + + + + +	Nov., 2011 Jan., 2012 Mar., 2013
	Meranoplus bicolor (Formicinae)	+ + + + + + + + + + + +	+ + + + + + + + + +	Dec., 2011 Nov., 2012 Nov., 2013 Dec., 2013
	Monomorium latinode (Myrmicinae)	+ + + + + + + + + + +	+ + + + + + + +	Feb., 2012 Nov., 2012 Jan., 2013

	Monomorium pharaonis (Myrmicinae)	+ + + + + + + + + + + + + +	+ + + + + + + + + + + + +	Dec., 2011 Dec., 2012 Mar., 2013 Dec., 2013
	Paratrecina longicornis (Formicinae)	+ + + +	+	Dec., 2013
	Pheidole sp. (Myrmicinae)	+ + + + + + + + + + +	+ + + + + + + +	Dec., 2011 Dec., 2012 Feb., 2012
	Tetraponera rufonigra (Formicinae)	+ + + +	+ +	Feb., 2013
Phaseolus sinensis	*Camponotus compressus* (Formicinae)	+ + + + + + + + + + +	+ + + + + + + + +	Feb., 2011 Feb., 2012 Feb., 2013
	Camponotus invidus (Pseudomyrmecinae)	+ + + + + + + +	+ + + + +	Dec., 2012 Jan., 2012
	Camponotus sp. (Myrmicinae)	+	+ +	Oct., 2012
	Lepisiota frauenfeldi (Myrmicinae)	+ + + + + +	+ + + + + +	Mar., 2011 Dec., 2012
	Meranoplus bicolor (Formicinae)	+ + + +	+ + +	Dec., 2013
	Monomorium latinode (Myrmicinae)	+ + + +	+ + + +	Dec., 2013
	Paratrecina longicornis (Formicinae)	+ + + +	+ +	Dec., 2013
	Polyrhachis hauxwelli (Formicinae)	+ + + +	+ +	Dec., 2012
Vicia faba	*Camponotus compressus* (Formicinae)	+ + + + + +	+ + + + +	Dec., 2012 Feb., 2013
	Meranoplus bicolor (Formicinae)	+ + + + + + + +	+ + + + + + +	Mar., 2011 Dec., 2012 Nov., 2013
	Polyrhachis hauxwelli (Formicinae)	+ + + + + + + + +	+ + + + + + + +	Dec., 2012 Feb., 2012 Mar., 2012
	Paratrecina longicornis (Formicinae)	+ + + +	+ + +	Feb., 2012 Mar., 2012
Vigna mungo	*Camponotus compressus* (Formicinae)	+ + + + +	+ + + + + +	Mar., 2011 Feb., 2013 Dec., 2013
	Meranoplus bicolor (Formicinae)	+ + + + + + + +	+ + + + + + + +	Oct., 2012 Nov., 2012 Nov., 2013 Dec., 2013
Vigna radiata	*Camponotus compressus* (Formicinae)	+ + + +	+ + + + +	Mar., 2012 Dec., 2013
	Lepisiota frauenfeldi (Myrmicinae)	+ + +	+	Nov., 2013
	Meranoplus bicolor (Formicinae)	+ + + + + + + +	+ + + + + +	Oct., 2012 Feb., 2012 Nov., 2013

	Monomorium latinode (Myrmicinae)	+ + + + + + + + + + +	+ + + + + + + + + +	Oct., 2011 Jan., 2012 Nov., 2013
	Monomorium pharaonis (Myrmicinae)	+ + + + + +	+ + + + +	Jan., 2012 Nov., 2013

Degree of infestation/ association :

+ = Low + + = Moderate + + + = High ++++ = Very high

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