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Short Communication

Impact of Two Attending Ants, *Crematogaster subnuda* and *Camponotus compressus* (Hymenoptera: Formicidae), on the Parasitism of Sugarcane Aphid *Melanaphis sacchari* (Zehnt.)

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ZA and SH conceived the idea of the project. ZA and SH carried out the sampling, analysed the data and wrote the manuscript. KAK contributed in final preparation of the manuscript. HAG, KAK and FK provided suggestions and corrections.

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Behavior, Ants, Parasitoids, Aphids, *Melanaphis sacchari*

ABSTRACT

The mutualistic relation between ants and aphids is considered as one of the best examples of inter-specific mutualism between species that produces net benefits for the participants. In this paper, the interaction between aphid *M. sacchari* and their attending ants on sugarcane (*Saccharum officinerum*) was studied. The presence of ants, especially, *Crematogaster subnuda* Mayr. and *Camponotus compressus* adversely affects the parasitoid effectiveness of *Lysiphlebia mirzai* and *Aphelinus desantesi*. The aphids got 31% and 26.3% parasitism when attended by *C. compressus* and *C. subnuda* Mayr., respectively. Further in the presence of these two dominant species the other ants viz., *Paratrechina longicornis* (Latr) and *Tapinoma melanocephalum* (F.) are unable to make contact with the aphids and even chased away on their mere appearance in the vicinity of aphid colony. The vague stimuli via the host in *C. subnuda* Mayr. causes a phenomenal warning to the other members for searching the invader.

Aphids and ants are the two abundant and highly successful insect groups, which usually share the same habitat and interact with one another, which is one of the classic examples of a mutualistic relationship (Darwin, 1859; Stadler and Dixon, 2005). The interaction of ants and aphids is of economic importance because of their effects on the host plants. The ants get honeydew from the aphids and in return give manifold protection to them (Way, 1963; Völkl *et al*., 1999; Flatt and Weisser, 2000; Stadler and Dixon, 2005, 2008; Muller *et al*., 2016). Firstly, they feed upon the honeydew and provide a check on the growth of saprophytic moulds (Way, 1963). The accumulation of honeydew is harmful to the aphids, but its removal indirectly helping the parasitoids too, since the excess of it along with mould retard oviposition (Nielsen *et al*, 2010; Henry *et al*., 2015). Secondly, the attending ants regulate the aphid population, protecting sufficient individuals and chaperone them from parasites and predators (Buckley, 1987; Vinson and Scarborough, 1991; Volkl, 1992, 1997; Stechmann *et al*., 1996; Novgorodova and Ryabinin, 2017). However, ants do not always benefit aphids and their association can be antagonistic (Stadler and Dixon, 1998; Yao *et al*., 2000). Hence, it is a prerequisite to study and evaluate the economic significance of the specific ant against the parasitoid of its tended aphid species, before an establishment of the parasitoid is made to combat such pests. Notwithstanding of its great economic importance, the detailed studies on the behavior of any specific ant

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for the parasitoid of its attended aphids are not available except some fragmentary observations mainly focused on one or few pairs of aphid-ant species (Völkl, 1997; Bronstein and Barbosa, 2002; Stadler and Dixon, 2005; Renault *et al*, 2004; Sadeghi-Namaghi and Amiri-Jami, 2018; Saha *et al*., 2018; Siddiqui *et al*., 2019). However, there is a lack of the knowledge of aphid-ant interaction data from Indian subcontinent except for a few scattered studies (Kurl and Misra, 1980; Kataria and Kumar, 2013). The present work includes detailed observations on the behaviour of *Crematogaster subnuda* Mayr. and *Camponotus compressus* Fabr. towards the parasitoids and ants of other genera associated with *Melanaphis sacchari* (Zehnt.) on *Saccharum officinarum* L.

Materials and methods

The survey of sugarcane fields was conducted every year from July to April (1998-2003) for five years to record the number of different species of ants and their parasitoids associated with aphid *M. sacchari* in Western Uttar Pradesh. The behaviour of *Crematogaster subnuda* Mayr. and *Camponotus compressus* against *Paratrechina longicornis* (Latr.) and *Tapinoma melanocephalum* (Fabr.) and parasitoids *Lysiphlebia mirzai* Shujauddin, and *Aphelinus desantesi* Hayat was studied in the field. The presence of ants especially *Crematogaster subnuda* Mayr. and *Camponotus compressus* and their role on the effectiveness of parasitoids had been established by selecting three plants with healthy aphid populations for parasitoids activity (i) in the presence of *Crematogaster subnuda* Mayr. (ii) *Camponotus compressus* and (iii) in the absence of ants. Ten mated females of *L. mirzai* were released on each plant and after five days 100 aphids were randomly dissected for evaluating % of parasitism in each case and the experiment were repeated three times. The whole experiments were conducted in a screened glasshouse under controlled condition (22 ± 3℃ Tem. 70%-80% R.H.) described by Kennedy and Booth (1954) and El-Ziady (1960). Statistical analyses and significance tests (P <0.05) were performed using STATISTIX, 1998, and the difference among the percentage parasitism of the aphids attended by ants were tested using chi-square test.

Results and discussion

The sugarcane aphid *M. saccchri* is attended by four species of ants, viz. *Crematogaster subnuda* Mayr., *Camponotus compressus*, *Paratrechina longicornis* (Latr.) and *Tapinoma melanocephalum* (F.). The first two species are found in abundance (66-30%).Throughout, winter *Crematogaster subnuda* Mayr. is conspicuously in greater number than *Camponotus compresus* Fabr. With the result that the former does not permit an easy stay of the later in an aphid colony.These two dominant ants do not permit the other two species *Paratrechina longicornis* (Latr.) and *Tapinoma melanecephalum* (F.) to develop contact with the aphids so much so that they are chased away on their mere appearance in the vicinity. The ants dislike the parasitoids and markedly decrease their efficiency is supported from the field observations, where % of parasitism of the aphids attended by *Crematogaster subnuda* Mayr. had been found very low (20%) than unattended as well as the aphids attended by other ants. Similar results were obtained under controlled condition. The aphids in the absence of ants show highest % of parasitism 68.6% (Table I) and the tendency of dispersion might be due to excess of parasitoids activity. These attended by *C. compressus* got 31% (Table I) parasitism. However, those attended by the *Crematogaster subnuda* Mayr. are parasitized in the smaller number (26.3%) (Table I).

When *Crematogaster subnuda* Mayr. is in abundance and predominantly attending the aphids, it may provide heavy protection by building a cover over the rapidly declining populations. Even, at times it is practically impossible to see the aphids under such covers. It had been found that slight disturbance of aphids by foreign invaders or even by artificial means unquiet the attending ants. The members immediately retaliate assuming an aggressive posture by raising their abdomens vertically upwards. The quick and simultaneous alerting of all the members under such circumstances might be due to the release of pheromones by some ants. Similar, behavior has been noticed for an approaching predator or other wasps attracted to the honeydew, although, neither aphids are disturbed nor there is any possibility of simultaneous perception by all of them. However, if an approaching parasitoid or another kind of ant is noticed, it is chased by the single aggressive ant without alerting other members. It indicates that pheromones are only released in the presence of vague stimuli received via host for searching the invaders or concentrating other members to combat with bigger enemies. The disquiet members start a vigorous search for such invaders and if perceived chase and drive them out for quite long distances. Even at times, they directly attack them by their mandibles and may cause fatal injuries.

The parasitoids are also afraid of the ants which are apparent by frequent interruptions in oviposition under the pressure of aggressive ants and they were seen running away from the hosts before completing a succession and generally taking shelter on the reverse side of the leaf. Even sometimes they have left the host after macro contact before stinging though other condition remains quite favorable. On the other hand, under similar conditions, some female parasitoids behave quite differently. They camouflage

Table I. Overall percentage parasitism of the aphids attended by ants.

Species of attending ants	No. of aphids dissected	No. of aphids with parasitism	% Parasitism	X2 Difference
Crematogaster subnuda	1000	263	26.3*	Between A & B = 5.63 (p>0.05)
Camponotus compressus	1000	310	31.0*	Between A, B, C= 319.93 (p>0.05)
Absence of ants	600	412	68.6	

themselves among disturbed aphids by sitting quiet, though, frequently overrun or even occasionally palpated by the disquiet ants. Immediately, after normalization of timid aphids, consequently, settling the aggressive ants, they again resume normal oviposition till other conditions remain favorable. It is quite interesting that a female parasitoid even during its course of oviposition if palpated by the ant is not recognized as intruder unless it gets frightened. The conclusions of Banks (1962), Pontin (1960) and Wichmann (1955) that "ants disregarded the parasites; parasites were not noticed," a possible explanation for this unique behavior of ants against parasitoids is might be chemical mimicry in which chemical cues on the cuticular surface of some wasps prevent them from being recognized and attacked by mutualistic ants (Völkl, 1992; Völkl and Mackauer, 1993).

The present observations confirm the findings of El-Zaidy and Kennedy (1956), El-Ziady (1960), Völkl and Mackauer (1993), Stechmann *et al*. (1996), Stadler and Dixon (1999) and Kaneko (2003) that (i) the ants dislike even the nonspecific species, (ii) any foreign invader disturbing the normal life of their attended aphids and (iii) may directly attack them causing fatal injuries with their mandibles are new additions. Some studies on interactions between ants and aphid parasitoids have reported opposing results. Where several studies showed that ant attendance enhanced primary parasitism by some species of aphid parasitoids (Völkl, 1992; Völkl and Stechmann, 1998). A possible reason for this parasitoid preference is that ant tending protects the parasitoid's offspring against hyperparasitoids and predators (Teegelar *et al*., 2012; Tegelaar, 2015). Furthermore, wasps developing in ant-attended colonies may benefit from reduced predation, since many predators are attacked and repelled from the aphid colony by tending ants (Banks, 1962; Teegelar *et al*., 2012; Tegelaar, 2015).

Conclusions

The present writers based on field and laboratory studies on the behavior of aforesaid ants conclude that ants dislike any source which disturbs the normal life of their tended aphids and is an important factor controlling the parasitoid effectiveness.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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