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Research Note

Influence of weaver ant, *Oecophylla smaragdina* Fabricius (Hymenoptera: Formicidae) on mealybug parasitism by encyrtids (Chalcidoidea: Encyrtidae)

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ABSTRACT: The influence of *Oecophylla smaragdina* Fabricius on parasitism of *Phenacoccus solenopsis* Tinsley and *Ferrisia virgata* Cockerell by *Aenasius arizonensis* (Girault) (= *Aenasius bambawalei* Hayat) and *A. advena* Compere were studied under laboratory conditions. The number of surviving *A. arizonensis* and *A. advena* was 3.40 and 5.20 at 20th minute, and 1.0 and 0.8 at 60th minute, respectively. Per cent parasitism was 13.60 and 10.00 in treatment with *O. smaragdina* for *A. arizonensis* and *A. advena*, respectively. Per cent mortality due to *O. smaragdina* attack was 93.33 and 94.67 for *A. arizonensis* and *A. advena*, respectively.

KEY WORDS: *Aenasius arizonensis*, *Aenasius advena, Oecophylla smaragdina*, parasitism

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Mealybugs once considered as minor pests have assumed the major pest status due to their polyphagous nature coupled with high reproductive capacity with short life cycle which is more favoured due to prolonged drought and quick dispersal through wind, seeds and planting materials. During 2004-05, there was a severe incidence of *Phenacoccus solenopsis* Tinsely on cotton in Haryana and subsequently in Punjab, Gujarat, Maharashtra and Karnataka. In Tamil Nadu the incidence was quite severe only during 2006-07 season attacking cotton, sunflower, many vegetable crops and weed hosts resulting in heavy yield loss (Suresh *et al.*, 2010). *Phenacoccus solenopsis* was found to be the predominant mealybug species, comprising 95% of the samples examined. This mealybug now appears to be widespread on cotton in almost all cotton-growing states of the country (Dhawan *et al*., 2008). Earlier, two tailed mealybug, *Ferrisia virgata* (Cockerell) and pink mealybug, *Maconellicoccus hirsutus* (Green) were considered as major polyphagous coccid pests in India. In addition, citrus mealybug, *Planococcus citri*, (Risso) and long tailed mealybug, *Pseudococcus longispinus* (Tag-Tazz.) were also recorded on few fruit crops and on coconut (Suresh and Kavitha, 2007). Therefore, as alien invasive pest species in India, *P. solenopsis* and *F. virgata* are obvious target for classical biological control.

The importance of the Encyrtidae in mealybug management is not surprising since almost all the members of the family are primary parasitoids of mealybugs; with the vast majority of these species belonging to the subfamily Tetracneminae (Noyes, 2000). *Aenasius arizonensis* and *A. advena* are recovered most frequently from *P. solenopsis* and *F. virgata* (Nalini and Manickavasagam, 2011). Several studies have shown that ants tend on honeydew-producing hemipteran insects such as mealybugs to access a renewable and defensible source of carbohydrates energy-rich food (Carroll *et al.*, 1973). In return, the ants render protection against parasitoids, predators and even their competitors (Hölldobler and Wilson, 1990; Jiggins *et al.*, 1993), as well as sanitation (Buckley, 1987). The relative effectiveness of the weaver ant *Oecophylla smaragdina*, a dominant canopy ant in India in reducing the incidence of predation and parasitization in different hemipteran has rarely been examined. By providing protection to the mealybugs from natural enemies, the presence of certain ant species can be detrimental to the impact of biological control (Tanga, 2012; Wimp and Whitham, 2001; Martinez-Ferrer, 2003). So, with this background, the present study was focused on the influence of *O. smaragdina* on encyrtids.

Culturing of *Phenacoccus solenopsis* and *Ferrisia virgata*

The cultures of *P. solenopsis* and *F. virgata* were

established in the laboratory from individuals collected from the fields. Both mealybug species cultures were maintained separately in two incubators at 32 ± 2°C, 65 ± 5 per cent RH and L10:D14 on potato sprouts kept in plastic tubs (10cm high and 33cm dia.), with fine sand of 5cm depth. Six to twelve potato sprouts were placed (depending upon size of potatoes) per tub and moistened regularly. Two adult females of *P. solenopsis* and *F. virgata* were released per potato separately. After one to two weeks (*P. solenopsis*) and two to three weeks (*F. virgata*) of inoculation, the potato sprouts developed into second and third instar stages. This inoculation was repeated on fresh potato sprouts every three weeks to get a continuous supply of mealybugs.

Culturing of *Aenasius arizonensis* and *A. advena*

The cultures of *A. arizonensis* Hayat and *A. advena* Compere were established in the laboratory from the mummies of the respective mealybugs collected from the fields. The parasitoids emerged were identified and cultured on *P. solenopsis* and *F. virgata*, respectively. Adult parasitoids (five pairs) were released in to a glass container (15cm long and 10cm dia) covered with khadda cloth containing 1-2 potato sprouts supporting second and third instars of *P. solenopsis* and *F. virgata* and removed after 48h of oviposition. A streak of 100 per cent honey was placed on the inside wall of glass container. Ten to fifteen days after parasitization adults started emerging out from the mealybug mummies. Both parasitoid cultures were kept separately in two incubators and maintained at 32 ± 2°C, 65 ± 5 per cent RH and L10: D14.

Experimental procedure

Fifty third instar *P. solenopsis* were placed on a potato sprouts in an open Petri plate (10 cm dia) from the culture maintained in the laboratory. Weaver ant, *Oecophylla smaragdina* nest was collected from the orchard of Faculty of Agriculture, Annamalai University and placed inside a plastic container (22.5cm long and 11cm dia) secured with a lid and transferred to the laboratory. A set up was arranged to mimic the natural condition as far as possible. A transparent cage (30cmx31cmx51.5cm) with one round vent on one of its sides and with a top lid was used to conduct the experiment. Through the top lid the parasitoids were introduced, secured with khadda cloth to prevent escape of parasitoids, after keeping the Petri plate containing potato sprouts with mealybugs. The round vent on one of its sides was fitted with the container having the weaver ant nest. Ants were allowed to forage freely for the honey dew for 48h prior to the experiment. A streak of 100 per cent honey was placed on the side wall of the cage. Fifteen mated females of *A. arizonensis* were introduced with a single tube aspirator through the top lid by gently blowing through the tube. Observations were made 10 min after the release of parasitoids. The number of ants and parasitoids inside the cage was recorded during one min period at every 10 min interval for 1h. Parasitoids were left in the cage for 24h after which they were removed and the number of surviving, dead and/or missing if any, were recorded.

Hand lens (15X) was used to search the missing parasitoids in the ant nest as well as on mealybug colony. After 24h, mealybugs on the potato sprouts in the cage were transferred to a glass container covered with khadda cloth containing two potato sprouts. After mummification, hosts were transferred individually into 5ml glass vials and observed daily for the emergence of parasitoid offsprings from 10th day after oviposition. Control (ant-free treatment) was also maintained. With this single set up, the test was repeated five times at five different dates and considered as replications. Per cent parasitism and per cent mortality were calculated.

$$\text{Percent mortality of the parasitoids} = \frac{\text{The number of dead + missing parasitoids}}{\text{Total number of parasitoids}} \times 100$$

(Mgocheki and Addison, 2009)

Per cent parasitism was calculated. The same protocol was followed for *A. advena* except that third instar *F. virgata* was used instead of *P. solenopsis*.

When *Aenasius arizonensis* was introduced inside the setup containing *Phenacoccus solenopsis* and *Oecophylla smaragdina*, the population of *O. smaragdina* was 33.60 at 0 min of release, 75.60 at 10th min, 77.60 at 20th min and finally it was 50.20 at the end of 1h study period. The number of surviving *A. arizonensis* was 15.00 at 0 min, 8.20 at 10th min, 3.40 at 20th min and finally one at the end of the study period (Fig. 1). Both *A. arizonensis* and *A. advena* were prevented by the presence of *O. smaragdina* in accessing *P. solenopsis* and *F. virgata. Oecophylla smaragdina* was more aggressive towards both the species which is evident from reduction of their population at the end of 1h study period. This coincides with the statement of Buckley and Gullan (1991) who stated that low parasitism rates of coccids was observed in the presence of the more aggressive *Oecophylla* and *Solenopsis* species.

When *A. advena* was released inside the cage with *F. virgata* and *O. smaragdina*, the population of *O. smaragdina* was 42.20 at 0 min of release, 54.00 at 10th min, 79.20 at 20th min and finally it was 72.00 at the end of 1h study period. The number of surviving *A. advena* was 15.00 at 0 min, 5.40 at 10th min, 5.20 at 20th min and finally 0.8 at the end of the study period (Fig. 2).

After 30 minutes *O. smaragdina* population increased in

cages where *A. advena* was released (Fig. 2) but reverse was true in cages where *A. arizonensis* was released (Fig. 1). So, it can be assumed that *A. arizonensis* tackled *O. smaragdina* better than *A. advena* which was also evident by high per cent parasitism. This is supported by Martinez–Ferrer *et al*. (2003) who reported that some parasitoids have developed escape strategies from ants to improve their efficiency, others are so ant sensitive that after an encounter with ants, they are deterred not only by ants, but by any moving object including other parasitoids or the host itself, thereby greatly reducing their potential as biological control agents.

Per cent parasitism was 74.40 and 62.40 in control for *A. arizonensis* and *A. advena*, respectively; it was 13.60 and 10.00 in treatment with *O. smaragdina* for *A. arizonensis* and *A. advena*, respectively (Fig. 3). The per cent mortality recorded due to *O. smaragdina* attack was 93.33 and 94.67 for *A. arizonensis* and *A. advena*, respectively at the end of 1h study period (Fig. 4). *Oecophylla smaragdina* not only affected per cent parasitism of both parasitoid species (Fig. 3) but also caused direct mortality (Fig. 4) which reduced parasitoid population considerably. This was earlier confirmed by Daane *et al*., (2007) who noticed that complete absence of parasitoids in vineyards infected with *Pseudococcus maritimus* attended by *Linepithema humile*. This is further supported by several other studies, which pointed out that the activities of natural enemies of mealybugs are often disrupted by some species of tending ants, compromising the parasitization potential of mealybugs' natural enemies and inducing further outbreaks of these economically important pests (Daane *et al*., 2007; Mgocheki *et al*., 2009; Tollerup *et al*., 2007). The mutualistic relationship between some ants and mealybug species is linked to the mealybugs' honeydew, which constitutes an important food resource for ants, implying that the latter are capable of employing strong territorial defences and aggressive tendencies that might end up disrupting or killing parasitoids and/or predators just to protect the mealybugs (Tanga, 2012; Mansour *et al*., 2012). Similarly, Tanga *et al*. (2016) also reported that *Anagyrus pseudococci* also suffered significantly high direct mortality due to encounters with *Oecophylla longinoda* workers, which led to a quick decline in parasitoid populations over time. Thus, field studies are needed to validate the present findings. Future field releases of parasitoids to control invasive mealybugs must be done with caution taking into account the biotic interference between natural enemies.

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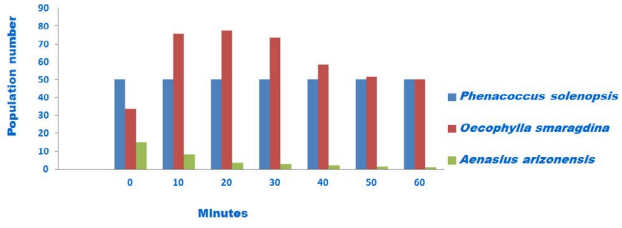

Fig. 1. Influence of *Oecophylla smaragdina* on number of *Phenacoccus solenopsis* and *Aenasius arizonensis.*

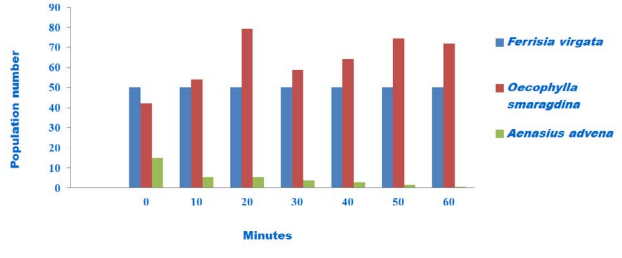

Fig. 2. Influence of *Oecophylla smaragdina* on number of *Ferrisia virgata* and *Aenasius advena.*

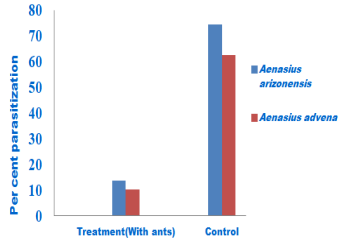

Fig. 3. Influence of *Oecophylla smaragdina* on per cent parasitization by *Aenasius arizonensis* and *A. advena.*

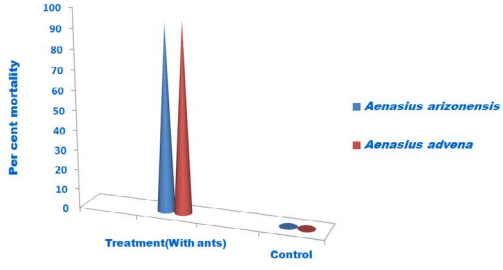

Fig. 4. Influence of *Oecophylla smaragdina* on per cent mortality of *Aenasius arizonensis* and *A. advena.*

Kolkatta for the identification of ants.

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