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

T. NALINI* and S. MANICKAVASAGAM
Department of Entomology, Faculty of Agriculture, Annamalai University, Chidambaram - 608002, Tamil Nadu, India
*Corresponding author E-mail: nalini_jk@yahoo.com

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

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 Tinsley 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, 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
Influence of weaver ant, *Oecophylla smaragdina* on mealybug parasitism by encyrtids

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 lid and transferred to the laboratory. A set up was arranged to mimic the natural condition as far as possible. A transparent 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 lid and transferred to the laboratory. A set up was arranged to mimic the natural condition as far as possible. A transparent
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 percent 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.

**ACKNOWLEDGEMENT**

Our special thanks to Dr. S. Suresh, Tamil Nadu Agricultural University, Coimbatore for the identification of the mealybugs and to Ms. Sheela, Zoological Survey of India,
Influence of weaver ant, *Oecophylla smaragdina* on mealybug parasitism by encyrtids

Kolkatta for the identification of ants.

**REFERENCES**

Buckley RC. 1987. Interactions involving plants, Homoptera, and ants. *Ann Ecol Syst.* **18**: 111–135. https://doi.org/10.1146/annurev.es.18.110187.000551

Buckley R, Gullan P. 1991. More aggressive ant species (Hymenoptera: Formicidae) provide better protection for soft scales and mealybugs (Homoptera: Coccidae, Pseudococcidae). *Biotropica* **23**: 282-286. https://doi.org/10.2307/2388205

Carroll CR, Janzen DH. 1973. Ecology of foraging by ants. *Annu Rev Ecol Evol Syst.* **4**: 231–257. https://doi.org/10.1146/annurev.es.04.110173.001311

Daane KM, Sime KR, Fallon J, Cooper ML. 2007. Impacts of Argentine ants on mealybugs and their natural enemies in California’s coastal vineyards. *Ecol Entomol.* **32**: 583-596. https://doi.org/10.1111/j.1365-2311.2007.00910.x

Dhawan AK, Saini S, Singh K, Bharathi M. 2008. Toxicity of some new insecticides against *Phenacoccus solenopsis* (Tinsley) [Hemiptera: Pseudococcidae] on cotton. *J Insect Sci.* **21**: 103–105.

Hölldobler B, Wilson EO. 1990. The *Ants*. The Belknap Press of Harvard University Press: Cambridge, MA, USA. p. 732. https://doi.org/10.1007/978-3-662-10306-7

Jiggins C, Majerus MEN, Gough U. 1993. Ant defence of colonies of *Aphis fabae*. *Br J Entomol Nat Hist.* **6**: 129–137.

Mansour R, Gaetana M, Alessandra LP, Kaouthar GL, Agatino RA. 2012. Survey of scale insects (Hemiptera: Coccoidea) and tending ants in Tunisian vineyards. *J Plant Prot Res.* **51**: 197–203.

Martinez-Ferrer MT, Grafton-Cardwell EE, Shorey HH. 2003. Disruption of parasitism of the California red scale (Homoptera: Diaspididae) by three ant species (Hymenoptera: Formicidae). *Biol Control* **26**: 279-286. https://doi.org/10.1016/S1049-9644(02)00158-5

Mgocheki N, Addison P. 2009. Interference of ants (Hymenoptera: Formicidae) with biological control of the vine mealybug *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae). *Biol Control* **49**: 108-185. https://doi.org/10.1016/j.biocontrol.2009.02.001

Nalini T, Manickavasagam S. 2011. Records of Encyrtidae (Hymenoptera: Chalcidoidea) parasitoids on mealybugs (Hemiptera: Pseudococcidae) from Tamil Nadu, India. *Check List* **7**: 510-515. https://doi.org/10.15560/7.4.510

Noves JS. 2000. Encyrtidae of Costa Rica (Hymenoptera: Chalcidoidea), 1. The subfamily Tetracneminae, parasitoids of mealybugs (Homoptera: Pseudococcidae). *Mem Am Entomol Inst.* **62**: pp. 355.

Suresh S, Jothimani R, Sivasubramanian P, Karuppuchamy P, Samiyappan R, Jonathan El. 2010. Invasive mealybugs of Tamil Nadu and their management. *Karnataka J Agric Sci.* **23**: 6-9.

Tanga MC. 2012. *Bio-Ecology of the Mango Mealybug, Rastrococcus iceryoides Green (Hemiptera: Pseudococcidae) and its Associated Natural Enemies in Kenya and Tanzania*. Ph.D. Thesis, University of Pretoria, Pretoria, South Africa.

Tanga CM, Ekesi S, Govender P, Nderitu PW, Mohamed SA. 2016. Antagonistic Interactions between the African Weaver Ant *Oecophylla longinoda* and the Parasitoid *Anagyrus pseudococci* Potentially Limits Suppression of the Invasive Mealybug *Rastrococcus iceryoides*. *Insects* **7**: 1-17. https://doi.org/10.3390/insects7010001 PMid:26703741 PMCid:PMC4808781

Tollerup K, Rust MK, Klotz JH. 2007. *Formica perpilosa*, an emerging pest in vineyards. *J Agric Urban Entomol.* **24**: 147–158. https://doi.org/10.3954/1523-5475-24.3.147

Wimp GM, Whitham TG. 2001. Biodiversity consequences of predation and host plant hybridization on an aphid-ant mutualism. *Ecology* **82**: 440–452. https://doi.org/10.2307/2679871