Insect. Soc. 50 (2003) 403–404
0020-1812/03/040403-02
DOI 10.1007/s00040-003-0702-4

Insectes Sociaux

Short communication

Apparent facilitation of an invasive mealybug by an invasive ant

K. R. Helms [1,2,3] and S. B. Vinson [2]

[1] *Institute of Ecology, IE-ZEA, University of Lausanne, 1015 Lausanne, Switzerland*
[2] *Department of Entomology, Entomology Research Laboratory, Texas A&M University, College Station, TX 77843-2475, USA, e-mail: bvinson@neo.tamu.edu*
[3] *Current address: Department of Entomology, Entomology Research Laboratory, Texas A&M University, College Station, TX 77843-2475, USA, e-mail: khelms@neo.tamu.edu*

Received 17 April 2003; revised 2 July 2003; accepted 24 July 2003.

Summary. In the southeast United States, the invasive ant *Solenopsis invicta* is known to derive important carbohydrate (honeydew) resources from mealybugs utilizing grasses. Most important appears to be an invasive mealybug, *Antonina graminis*. We studied whether this mealybug and a similar native species also benefit from association with *S. invicta*. We found that mealybug occurrence increases significantly with increasing proximity to *S. invicta* mounds, suggesting that mealybugs benefit as well. Mutual benefits derived by *S. invicta* and *A. graminis* are consistent with a hypothesis proposing that associations among invasive species can be important in their success at introduced locations.

Key words: Ants, mealybugs, invasive species, *Solenopsis invicta*, *Antonina graminis.*

Dominance in ant assemblages can be associated with extensive use of honeydew from Hemiptera (e.g. aphids, scales, mealybugs) and plant exudates. Abundant carbohydrates allow for extensive activity, which allows for the discovery and acquisition of additional resources (e.g. Davidson, 1998). Consistent with this hypothesis, extensive use of honeydew appears characteristic of invasive ants, which can reach tremendous population densities (Helms and Vinson, 2002; Holway et al., 2002). In the southeast United States, the invasive red imported fire ant, *Solenopsis invicta*, constructs shelters for and tends a wide variety of honeydew-producing Hemiptera; however, the 'legless' mealybugs *Antonina graminis* and *Antoninoides* spp. appear exceptionally important (Helms and Vinson, 2002). These mealybugs occur largely below ground level on the crowns, root nodes, and under leaf sheaths of grasses. At sites in Texas, Helms and Vinson (2002) estimated that these mealybugs comprise 89% of the Hemiptera biomass housed in shelters, with 71% of that being *A. graminis* biomass. *Antonina graminis* honeydew was estimated to supply from 16 to 48% of the energetic requirements of an average *S. invicta* colony. While it appears clear that *S. invicta* benefits from association with these mealybugs, whether the mealybugs in turn benefit from association with *S. invicta* is unknown. To investigate this possibility, we tested whether the abundance of *A. graminis,* and *Antoninoides* are associated with their proximity to *S. invicta* colonies.

The study was conducted at three sites in eastern Texas during a three-week period in late October and early November 2001. Two sites were located in Brazos County and the other in Washington County. Mealybugs were identified as either *A. graminis* or *Antoninoides* sp. as described by Helms and Vinson (2002). Three *Antoninoides* occur in Texas, *A. parrotti*, *A. boutelouae*, and *A. nortoni* (Helms and Vinson, 2000); however, we did not distinguish between them in this study. We determined the presence or absence of either *A. graminis* or *Antoninoides* sp. on grasses within mounds and at 5 cm intervals from the edge of mounds to a distance of 3 m from the mounds. The direction of transects was selected such that the grass species of interest occurred at approximately equal density along the entire length and did not pass within 3 m of an adjacent mound. At each 5 cm interval along transects, we selected the nearest root node of bermudagrass (*Cynodon dactylon*), or the nearest plant of oldfield threeawn (*Aristida oligantha*), unearthed the node or plant, and examined the basal area just above the roots for mealybugs. When the grass occurred within a mound, we selected a single node or plant for examination. Twenty-two mounds were utilized; 11 for bermudagrass (numbers per site: 5, 6, 0) and 11 for oldfield threeawn (numbers per site: 3, 5, 3). Presence/absence data according to distance from *S. invicta* mounds was analyzed with binary logistic regression using Minitab 13.20 (Minitab Inc.). Sites and samples were pooled within each grass species for statistical analyses.

Only *A. graminis* occurred on bermudagrass, while both *A. graminis* and *Antoninoides* occurred on the threeawn. On the threeawn, approximately 90% of mealybugs were *Antoninoides* and the remainder *A. graminis*. In both grasses, the presence of mealybugs was associated significantly with distance from *S. invicta* mounds; mealybugs were most common on grasses in mounds and their frequency of occurrence decreased significantly with increasing distance from mounds (Fig. 1). In an earlier study, these mealybugs frequently occurred in shelters constructed by *S. invicta* (Helms and Vinson, 2002); however, in this study, shelters were relatively rare. Of all plants with mealybugs, only 13% (32 of 247) occurred in shelters. Why the frequency of shelters varies is unknown; however, it seems clear that shelter absence does not indicate that significant interactions are not occurring (Fig. 1).

Our results are consistent with the facilitation of *A. graminis* and *Antoninoides* by *S. invicta*. The precise nature of that facilitation is unclear; however, there are a number of possible explanations. *Solenopsis invicta* may protect the mealybugs from predators and parasites, and honeydew removal may aid in disease prevention (e.g. Way, 1963; Hölldobler and Wilson, 1990). The fire ant might also actively transport mealybugs during the first instar (crawler) stage (e.g. Vinson and Scarborough, 1991).

Very few ant species are considered invasive; however, they often have profound impacts on the native biota at introduced locations (reviewed by Holway et al., 2002). Tending honeydew-producing Hemiptera appears important in the ecology of invasive ants (Helms and Vinson, 2002; Holway et al., 2002), and most are frequently reported to tend introduced and invasive species (Helms and Vinson, 2002). Like *S. invicta*, *A. graminis* is an important invasive species (Helms and Vinson, 2002). A recent hypothesis proposed that associations between invasive species can be important in their success (Simberloff and Von Holle, 1999). Because *S. invicta* benefits from association with *A. graminis*, and it appears that *A. graminis* benefits from association with *S. invicta*, association between these species may lend important support for this hypothesis. Our study does not, however, test whether *A. graminis* benefits from association with *S. invicta* to a greater degree than it would from the native ant fauna if *S. invicta* were absent. However, because *S. invicta* tend Homoptera extensively, while achieving densities greater than the native ants they replace (e.g. Porter and Savignano, 1990), it is likely that *A. graminis* populations in the southeast United States are larger when associated *S. invicta* than with only native ants. It is also important to note that the native range of *S. invicta* occurs in South America while *A. graminis* appears to have originated in Asia (Helms and Vinson, 2002). While both species may benefit from their association, it is fortuitous and not the result of long-term coevolution between species.

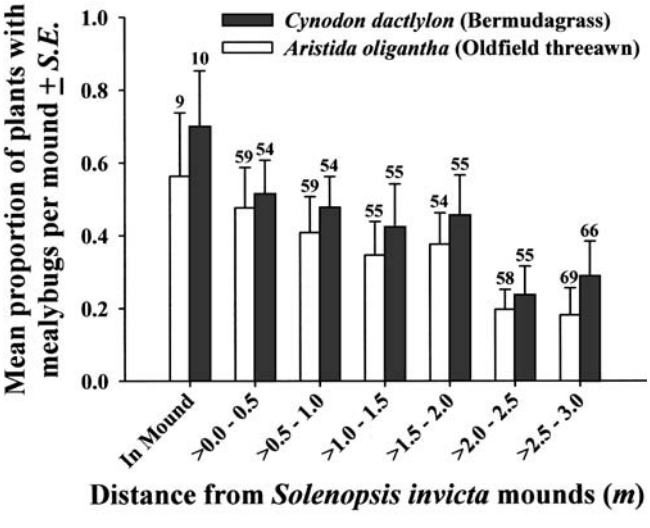

Figure 1. Occurrence of the mealybugs *Antonina graminis* and *Antoninoides* on grasses decreases with increasing plant distance from *Solenopsis invicta* mounds (Logistic Regressions: *Aristida oligantha*: $G = 22.45$, $P < 0.001$, *Cynodon dactylon*: $G = 14.89$, $P < 0.001$). Statistical analyses were conducted using actual rather than categorical distances. Numbers above bars are the number of plants assessed within each category

Acknowledgements

We thank Jim Martin for field assistance and anonymous reviewers for comments on the manuscript. Ken Helms also thanks Laurent Keller and the Swiss National Science Foundation for support during the fieldwork.

References

Davidson, D.W., 1998. Resource discovery versus resource domination in ants: a functional mechanism for breaking the trade-off. *Ecol. Entomol. 23*: 484–490.

Helms, K.R. and S.B. Vinson, 2000. New host records for the 'legless' mealybugs of Texas (Homoptera: Pseudococcidae: *Antonina, Antoninoides*). *Southwest. Entomol. 25*: 229–231.

Helms, K.R. and S.B. Vinson, 2002. Widespread association of the invasive ant *Solenopsis invicta* with an invasive mealybug. *Ecology 83*: 2425–2438.

Hölldobler, B. and E.O. Wilson, 1990. *The Ants*. Belknap Press, Harvard University, Cambridge, Mass. 732 pp.

Holway, D.A., L. Lach, A.V. Suarez, N.D. Tsutsui and T.J. Case, 2002. The causes and consequences of ant invasions. *Ann. Rev. Ecol. System. 33*: 181–233.

Porter, S.D. and D.A. Savignano, 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. *Ecology 71*: 2095–2106.

Simberloff, D. and B. Von Holle, 1999. Positive interactions of nonindigenous species: invasional meltdown? *Biol. Invasions 1*: 21–32.

Vinson, S.B., and T.A. Scarborough, 1991. Interactions between *Solenopsis invicta* (Hymenoptera: Formicidae), *Phopalosiphum maidis* (Homoptera: Aphididae), and the parasitoid *Lysiphlebus testaceipes* Cresson (Hymenoptera: Aphidiidae). *Ann. Entomol. Soc. Amer. 84*: 158–164.

Way, M.J., 1963. Mutualism between ants and honeydew-producing Homoptera. *Ann. Rev. Entomol. 8*: 307–344.