JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY
78(3), 2005, pp. 290–292

SHORT COMMUNICATION

Production of Minima Workers by Gynes of *Atta colombica* Guérin-Ménéville (Hymenoptera: Formicidae: Attini) that Lack a Fungal Pellet

HERMÓGENES FERNÁNDEZ-MARÍN[1] AND WILLIAM T. WCISLO[2]

SUMMARY: Early studies of *Atta* nest founding showed that gynes exhibit claustral nest foundation, cultivate fungal gardens with fecal secretions, and nourish their larvae with eggs. These studies also showed that gynes sometimes lose their fungal pellets, or the fungal garden fails before workers emerge, apparently dooming the incipient colony. Here we report that *Atta colombica* foundresses maintained in the laboratory can produce workers even though they lack fungal pellets to initiate gardens. If such behavior occurs in nature, it raises the possibility that workers might re-acquire a fungal symbiont after nest establishment, and potentially rescue failing colonies.

SPANISH ABSTRACT: Estudios sobre la fundación de nidos por hormigas del género *Atta*, muestran que hembras conducen una fundación claustral, cultivan los jardines de hongo con sus secreciones fecales y nutren las larvas con huevos tróficos. Estos estudios también muestran que las hembras algunas veces pierden sus sepas de hongos, o los jardines de hongos, antes de la aparición de las obreras, aparentemente condenando las incipientes colonias. Aquí reportamos que fundadoras de *Atta colombica* mantenidas en laboratorio pueden producir obreras en la ausencia de sus sepas de hongo simbionte para iniciar los jardines y colonias. Si este comportamiento ocurre en la naturaleza, esto sugiere la posibilidad que obreras pueden re-adquirir un hongo simbionte después del establecimiento del nido, y potencialmente rescatar la colonia de la muerte.

KEY WORDS: Fungal acquisition, foundresses, fungus growing ants

The leaf-cutter ant genus *Atta* (Hymenoptera: Formicidae) is phylogenetically the most derived taxon among the fungus-growing ants (Attini) (Schultz and Meier, 1995). Mature colonies contain up to 5 million polymorphic workers (Weber, 1972) and have a complex fungiculture system (Weber, 1972; Currie, 2001; Wirth *et al*., 2003). *Atta* colonies are generally initiated by a single foundress in a claustral foundation (Weber, 1972; Fernández-Marín *et al.,* 2004). Following the nuptial flight, each *Atta* gyne sheds her wings, digs a primary chamber between 5 and 25 cm deep, and closes the entrance and tunnel of the nest using soil from the primary chamber (Huber, 1907 and Autouri, 1942 on *Atta sexdens rubropilosa* Forel; Mariconi, 1974 on *A. capiguara* Gonçalves; Mintzer, 1987 on *Atta texana* Buckley; and Weber, 1972 and 1982 on several *Atta* species). Following this nest excavation, an *Atta* foundress expels a fungal pellet collected from her natal nest, which she transported in the infrabuccal pocket. A foundress then lays eggs on the fungus garden as soon as it starts to grow; she nourishes the larvae with trophic eggs; and applies fecal secretions to the fungus garden. Upon emergence, workers open the claustral chamber and start to forage for leaf material to use as substrate to support the continued growth of the fungus garden.

Among attines, *Atta* foundresses are unique in conducting claustral foundation (Fernández-Marín *et al.,* 2004). It is not known if *Atta* or other attine foundresses that lack a fungal pellet to establish fungus gardens can produce workers. Autouri (1941), Mariconi (1974) and Weber (1972) reported that some *Atta* foundresses started nests and laid eggs even though they lacked a fungal pellet; however, these incipient nests did not survive more than one month and did not produce any adults or even larvae. Here we describe results from laboratory foundress colonies of *Atta colombica* Guérin-Ménéville, showing that foundresses that lacked fungal pellets nevertheless produced small numbers of minima workers.

[1]Department of Biology, University of Puerto Rico, P.O. Box 23360, San Juan, Puerto Rico 00931-3360. e-mail: ic972735@rrpac.upr.clu.edu

[2]Smithsonian Tropical Research Institute, Apartado 2072, Balboa, Ancón, República de Panamá. Address for mail: Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002-0948, USA. e-mail: WcisloW@si.edu

Accepted 20 May 2004; Revised 8 October 2004

Materials and Methods

Following a nuptial flight on June 8, 2003 in central Panamá (Soberanía National Park, Pipeline Road, km 2.2), *A. colombica* gynes were collected either when they were digging the nest tunnel or primary chamber, or had just closed the primary chamber. We used twenty-eight foundress nests that lacked a fungal symbionts (pellet or small fungus garden in the primary chamber). The gynes from these nests were transported to the laboratory in individual transparent plastic boxes ($5.2 \times 5.2 \times 5.4$ cm) with non-sterile moist soil on the floors. The nests were maintained from June 8 to August 25, 2003, at 24° C in the dark, and were exposed to light only when observations were made. On July 23 and August 25 we recorded whether a fungal pellet or garden was present, as well as the percentage of nests that contained eggs (E), larvae (L), pupae (P), and workers (W), or whether the colony died.

Results

Forty-five days after establishment of the artificial nests in *Atta colombica*, 18 of 28 nests (64.3%) were alive, containing P, L, or E; no fungal pellet or garden was observed in any of these nests. The remaining nests (10/28; 35.7%) died. Of the 18 nests that were alive, 12 had P, L, and E; 2 nests had L and E; and 4 nests only had E. Seventy-eight days after nest establishment, 16 nests were alive, including 10 nests with minima workers (W), as well as P, L and E; 3 nests had P, L and E; and 3 nests had L and E. No fungi were observed in these 16 nests. The range of minima workers produced in nests without fungi was 1 to 12 ($X = 4.8$; $SD = 4.07$; $N = 10$).

Discussion

Atta colombica foundresses without a fungus garden produced and maintained workers for up to 78 days. Prior research has shown that *Atta* foundresses can rear minima workers using their eggs as a food source, in the presence of a fungal garden (Huber, 1907; Autouri, 1942; Weber, 1972). This study shows that some foundresses can successfully rear brood even in the absence of the garden, at least in the laboratory. *Atta colombica*, *A. sexdens* L., and *A. cephalotes* L., foundresses form their incipient fungus gardens in a soup-bowl shape, with the developing brood placed in the bowl (HFM and WTW, unpubl. data), similar to that described for *A. sexdens rubropilosa* (Autouri, 1942). If *A. colombica* foundresses can produce workers in the absence of a fungus symbiont in nature, then this raises the possibility that minima workers could secondarily acquire a fungus symbiont from a neighboring nest or, in principle, from a nearby garbage dump, essentially pulling the colony back from the brink of failure. Such a possibility may be unlikely because of the difficulties a worker would face in entering an alien nest and robbing fungi, or the difficulties the untended symbiont would face in the highly competitive microbial environment of the garbage dump. In the laboratory, some other attines can use fungi from other nests to restart their own garden (Adams *et al.,* 2000) but there are no data for *Atta* showing that workers search for a fungal symbiont away from their natal nests.

The relevance of our findings to natural populations is presently uncertain. It will likely be impossible to document whether natural colonies that lack the fungal symbiont are nonetheless able to produce workers and reacquire a symbiont, because of the difficulties in manipulating underground nests. We also lack data documenting how the size or quality of a fungus garden affects the rate of worker production during claustral foundation. An indirect test involves observing marked foragers from incipient nests in nature, to ascertain whether they even enter other nearby nests to obtain fungi, or scavenge for fungi from external garbage dumps (Weber, 1972). Nevertheless, our laboratory results raise an intriguing possibility that warrants further attention.

Acknowledgments

Thanks to Juan Torres for comments on the manuscript, to the Smithsonian Tropical Research Institute (STRI) for facilities, and financial support from a Predoctoral Fellowship to HF-M and general research funds to WTW; we thank the Autoridad Nacional del Ambiente de la República de Panamá for a collecting permit.

Literature Cited

Adams, R. M. M., U. G. Mueller, A. K. Holloway, A. M. Green, and J. Narozniak. 2000. Garden sharing and garden stealing in fungus-growing ants. Naturwissenschaften 87:491–493.

Autuori, M. 1942. Contribuição para o conhecimento da Saúva (*Atta* spp.-Hymenoptera-Formicidae). (II) O saúverio inicial (*Atta sexdens rubropilosa* Forel, 1908). Arquivos Instituto Biologico, Sao Pãulo 13:67–86.

Currie, C. R., 2001. A community of ants, fungi, and bacteria: a multilateral approach to studying symbiosis. Annual Review of Microbiology 55:357–380.

Fernández-Marín, H., J. K. Zimmerman, and W. T. Wcislo. 2004. Ecological traits and evolutionary sequence of nest establishment in fungus-growing ants (Hymenoptera, Formicidae, Attini). Biological Journal of the Linnean Society 81:39–48.

Huber, J. 1907. The founding of colonies by *Atta sexdens* L. Annual Report of the Smithsonian Institution 1906:355–372.

Mariconi, F. A. M. 1974. Contribuição para o conhecimento do sauverio initial da "saúva parda" *Atta capiguara* Gonçalves 1944 (Hymenoptera, Formicidae). Anais da Sociedade Entomologica do Brasil 3:5–13.

Mintzer, A. C. 1987. Primary polygyny in the ant *Atta texana*: number and weight of females and colony foundation success in the laboratory. Insectes Sociaux 34:108–117.

Schultz, T. R., and R. Meier. 1995. A phylogenetic analysis of the fungus-growing ants (Hymenoptera: Formicidae: Attini) based on morphological characters of the larvae. Systematic Entomology 20:337–370.

Weber, N. A. 1972. Gardening ants, The attines. The American Philosophical Society. xvii + 146.

Weber, N. A. 1982. Fungus ants. *In* H. R. Hermann, (ed.), Social Insects, pp: 255–363. Vol. IV. Academic Press New York, New York. xii + 385 pp.

Wirth, R., H. Herz, R. J. Ryel, W. Beyschlag, and B. Hölldobler. 2003. Herbivory of leaf-cutting ants: a case study on *Atta colombica* in the tropical rainforest of Panama. Ecological Studies 164:1–230.