

Research article

Effects of colony-level attributes on larval feeding in the fire ant, *Solenopsis invicta*

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Summary. Do colony attributes modulate individual behavior? The effects of colony size and worker:brood ratio on the rate of worker-to-larva trophallaxis in the fire ant, *Solenopsis invicta*, were investigated. Neither colony size ranging from 100 to 10,000 nor worker:brood ratio ranging from 1:1 to 16:1 affected the density of workers on the brood pile, nor the rate or duration of worker-to-larva trophallaxis. The demands of hungry larvae were met even in groups as small as 100 workers in worker:brood ratios as small as 1. Only when the worker:brood ratio was less than 1, were larvae tended or fed at reduced rates. Under natural conditions, this occurs only in incipient colonies. Otherwise, in post-incipient colonies, the flow of food to larvae was unmodified by colony attributes. The implications of this finding are two-fold: First, it reinforces previous research demonstrating that social feeding in the fire ant emerges from localized interactions rather than mass communication. Second, it highlights the resiliency of this weedy species. Hypothetically, colonies drastically reduced by catastrophic events such as flooding should still be able to produce sexuals.

Key words: Worker:larva ratio, colony size, trophallaxis.

Introduction

For holometabolous insects, adult body size is second only to adult nutrition in determining adult fecundity (Chapman, 1982, p. 94). In social Hymenoptera, colony size is the equivalent of adult body size for predicting survival (Kaspari and Vargo, 1995) and reproductive output. Species that produce larger colonies produce more sexuals (*Myrmica*, Elmes and Wardlaw, 1982). Within species, larger colonies produce more sexuals (Hölldobler and Wilson, 1990, pp.159; *Solenopsis invicta*, Tschinkel, 1993a; *Harpagoxenus sublaevis*, Bourke et al., 1988; *Tetramorium caespitum*, Brian et al., 1967).

But is large colony size the trigger for sexual production? After all, a number of colony attributes change with colony size. For example, colony size is positively associated with elaborate communication systems (Hölldobler and Wilson, 1990, pp. 160); complex caste structure (reviewed in Michener, 1964; Tschinkel, 1993a); territory size and boundary disputes (Adams, 1990); colony survival after founding (Markin et al., 1973; Tschinkel, 1993b); and complex nest construction (Markin et al., 1973; Tschinkel et al., 1995). Colony size is associated with individual-level attributes such as the production of larger-bodied workers (*Atta cephalotes*, Wilson, 1983; *Solenopsis invicta*, Porter and Tschinkel, 1985; Tschinkel, 1988a), more sexuals (Tschinkel, 1988b, 1993a) and heavier queens (Tschinkel and Howard, 1978). Because of the complexity of associations among colony-level attributes, the extent to which colony size itself actively shapes other attributes is difficult to determine.

Nevertheless, several researchers have separated the effects of colony size from other correlated variables. In *Myrmica rubra* (Brian, 1953, 1956), nest complexity and worker:brood ratio rather than colony size, produced larger larvae. When the size of nurses and worker:brood ratio of the fire ant were analyzed as covariates (Porter and Tschinkel, 1985), the effect of colony size on pupal size was no longer significant.

Recently, we characterized the individual attributes of larvae and of workers during social feeding and found that workers regulate the flow of food from the environment into the nest (Cassill and Tschinkel, 1999a) whereas larvae regulate its distribution within the nest (Cassill and Tschinkel, 1995, 1996, 1999b; Cassill et al., 1999). In this paper, we report on the capacity of two colony attributes, colony size and worker:brood ratio to affect the distribution of food among larvae.

