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Introduction

Colony founding will be examined using insights from the adaptive value of cooperative behavior in colony founding behavior. Studies of colony founding behavior have shown that colonies derived from a single queen are more successful in the wild than those derived from multiple queens. These studies suggest that the number of queens is an important factor in determining the success of colony founding.

Abstract

By Steven W. Briseno, Robert A. Johnson

Geographic Variation in Metamorphosis
Colony Founding Behavior of Some Desert Ants:

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species displaying cooperative colony foundation has grown steadily (Rissing and Pollock 1988), the discovery and documentation of intraspecific geographical variation in pleometrosis is new and little explored (see Ryti 1988). In this paper we summarize recent observations on geographic variation in colony founding behavior for several species common in the deserts of the southwestern United States.

METHODS

Occurrence of haplometrosis and pleometrosis in the field

Nests of newly mated foundresses were excavated and censused in the field following mating flights, which are triggered by summer/fall rains for species discussed here except for *Messor pergandei* and *Pogonomyrmex californicus* which have asynchronous flights apparently triggered by photoperiod. In the field, starting colonies are identifiable by the characteristic coarse grain of soil excavated by foundresses.

Relatedness as a criterion for association formation

Queens were brought into the laboratory to determine whether foundress associations formed with respect to kinship, using the assay developed by Rissing and Pollock (1986). Associations (haplometrotic and pleometrotic) from a given locale were collected, the queens marked uniquely with paint and then permitted to form new associations in a plastic shoe box half-filled with moistened soil followed by excavation and identification of all queens in all associations 24 hours later. Similar manipulations revealed a major role for kinship in the formation of foundress associations in the wasp *Polistes fuscatus* (Noonan 1981) but not the ants *M. pergandei* (Rissing and Pollock 1986) and *Acromyrmex versicolor* (Rissing et al. 1986). The lack of close relatedness within foundress associations of these ants was later verified by allozyme electrophoresis (Hagen et al. 1988).

Geographic variation in colony founding behavior

The above assay demonstrated that *M. pergandei* queens collected after mating flights from locales that had pleometrotic and haplometrotic foundresses would start colonies pleometrotically when given the chance, even if they were originally collected as a haplometrotic foundress (Rissing and Pollock 1986). In fact, they prefer to join associations (Krebs and Rissing 1991). Ryti (1988), however, demonstrated that foundresses collected from a completely haplometrotic population at Deep Canyon, CA, would not form pleometrotic associations when given the chance and would often fight. We used Ryti’s (1988) assay on foundresses collected from newly discovered all-haplometrotic populations of species previously known to display pleometrosis in other locales [*Myrmecocystus mimicus* (Bartz and Hölldobler 1982), *A. versicolor* (Rissing et al. 1986) and *P. californicus* (see Table 1 for pleometrosis)].

RESULTS

Haplometrosis and pleometrosis in the field

Our field surveys have revealed the first known populations of *Pogonomyrmex californicus* and *Pheidole tucsonica* where pleometrosis occurs regularly (Table 1). We have also found populations of *Myrmecocystus mimicus* and *Acromyrmex versicolor*, species previously shown to be pleometrotic, where haplometrosis predominates, often exclusively (Table 1). In addition to the species in Table 1, RAJ has documented solitary colony foundation (haplometrosis) in *Pogonomyrmex apache* Wheeler (N = 22, Cochise Co., AZ), *Pogonomyrmex salinus* Olsen [N = 60 (Note: 3 additional colonies contained 2 foundresses), Clark Co., NV], *Dorymyrmex insanus* (Buckley) (N = 35, Pinal Co., AZ), and *Myrmecocystus flaviceps* Wheeler (N = 25, Pinal Co., AZ).

Foundress assortment

*Pogonomyrmex californicus*, *Pheidole tucsonica*, *Myrmecocystus mimicus*, and *Acromyrmex versicolor* all displayed the same patterns in our laboratory tests. Field-caught foundress associations do not retain their original composition when permitted to reform in the presence of other queens from the same population in the laboratory. New, usually larger associations develop in which queens from field-caught foundress associations mix freely. Likewise, haplometrotic (i.e. solitary) foundresses taken from populations in which pleometrosis occurs readily join pleometrotic groups in the laboratory without conflict. This does not occur in the populations where haplometrosis is the rule: queens fight rather than join groups.
Table 1. Foundress association size of some desert ants; numbers are percent of total. Voucher specimens with detailed locality information are deposited in the insect collection at Arizona State University.

<table>
<thead>
<tr>
<th>Species</th>
<th>County, State</th>
<th>Foundress Association Size</th>
<th>N</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acromyrmex versicolor</strong></td>
<td>Maricopa, AZ</td>
<td>44 25 9 11 5 3 2 2</td>
<td>64</td>
<td>Rissing et al. (1986)</td>
</tr>
<tr>
<td>(Pergande)</td>
<td>Mohave, AZ</td>
<td>100</td>
<td>70</td>
<td>This study</td>
</tr>
<tr>
<td><strong>Messor pergandei</strong></td>
<td>Maricopa, AZ</td>
<td>32 28 17 8 5 2 4 5</td>
<td>132</td>
<td>Pollock and Rissing (1985)</td>
</tr>
<tr>
<td>(Mayr)</td>
<td>Riverside, CA</td>
<td>100</td>
<td>181</td>
<td>Rytie (1988)</td>
</tr>
<tr>
<td><strong>Myrmecocystus minicus</strong></td>
<td>Cochise, AZ</td>
<td>10 18 29 17 13 7 2 1</td>
<td>164</td>
<td>Bartz and Hölldobler (1982: Fig. 1a)</td>
</tr>
<tr>
<td>Wheeler</td>
<td>Pinal, AZ</td>
<td>100</td>
<td>20</td>
<td>This study</td>
</tr>
<tr>
<td><strong>Pogonomyrmex californicus</strong></td>
<td>San Diego, CA</td>
<td>26 23 9 4 9 4 6 4</td>
<td>19</td>
<td>This study</td>
</tr>
<tr>
<td>(Buckley)</td>
<td>Maricopa, AZ</td>
<td>97 3</td>
<td>29</td>
<td>This study</td>
</tr>
<tr>
<td><strong>Pheidole tucsonica</strong></td>
<td>Maricopa, AZ</td>
<td>36 19 17 11 6 6 3 3</td>
<td>36</td>
<td>This study</td>
</tr>
<tr>
<td>Wheeler</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We add two new species (Pogonomyrmex californicus and Pheidole tucsonica) to the growing list of ants in which cooperative colony founding is known (see Rissing and Pollock 1989). Further, while Wheeler (1976; 1980) thought that such behavior occurred only under very exceptional circumstances (e.g., the wasp Polistes jacobita normally forms associations over several weeks, and only if conditions are very favorable), our data suggest that not all Pogonomyrmex colonies can afford the luxury of limiting their reproductive females. A female attempting to form a cooperative colony is found within a newly formed nest, where she is immediately attached by another worker. Activity continues immediately, even though her nestmate has just started. The colony expands at a constant rate, and nestmate production begins immediately. This is especially true of ants (e.g., Myrmecocystus, Pheidole tucsonica) and is a rare phenomenon in ants generally. The Table 1 associations are formed and nest expansion usually occurs immediately, with no apparent delay.