Research article

The comparative biology of two sympatric paper wasps in Michigan, the native Polistes fuscatus and the invasive Polistes dominulus (Hymenoptera, Vespidae)

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Summary. The biology of the invasive Polistes dominulus and the native P. fuscatus was compared at a field site in Rochester, Michigan over a two-year period. Colonies nesting semi-naturally in plywood nestboxes were studied using videography, extensive surveys, and colony-specific marking of gynes.

Both single- and multiple-foundress colonies of P. dominulus were significantly more productive than comparable colonies of P. fuscatus. The disparity in productivity was significantly more pronounced in single-foundress colonies than in multiple-foundress colonies. P. dominulus had significantly shorter larval and pupal development times than P. fuscatus, which allowed P. dominulus to produce its first workers about a week earlier than P. fuscatus. P. dominulus had a number of additional advantages over P. fuscatus that contributed to its productivity including (1) significantly less parasitism by Strepsiptera, (2) significantly greater probability of renesting after predation by raccoons, (3) significantly lower usurpation pressures, and (4) possibly longer foraging days. The recovery of colony-marked foundresses indicated that gynes of P. dominulus suffered significantly greater mortality than gynes of P. fuscatus during winter diapause and that foundresses of both species were equally, strongly philopatric.

P. dominulus is likely replacing P. fuscatus in many areas of southeastern Michigan via indirect or exploitative competition. The two species may be competing for nest sites.

Key words: Polistes, paper wasps, invasive species.

Introduction

The old world paper wasp, Polistes dominulus (Christ), was apparently introduced accidentally into the United States near Boston, Massachusetts in the late 1970’s (Eickwort, 1978). P. dominulus spread rapidly westward, and in 1995 was discovered in Michigan (Judd and Carpenter, 1996). In at least some areas of Michigan, P. dominulus has replaced the only native species of paper wasp, P. fuscatus (F.) (Gamboa et al., 2002). According to Cervo et al. (2000) and Pickett and Wenzel (2000), P. dominulus has recently been found in California.

Pickett and Wenzel (2000) first examined the rapid spread and success of P. dominulus in the United States. They reported that in Ohio, single-foundress laboratory and field colonies of P. dominulus were significantly more productive than comparable colonies of the native P. metricus. Furthermore, P. dominulus produced its workers earlier than P. metricus in the laboratory. Pickett and Wenzel (2000) collected P. dominulus and the native P. fuscatus from New York state and found that only P. fuscatus was parasitized by Strepsipteran parasites.

Gamboa et al. (2002) compared the biology of single-foundress, field colonies of P. dominulus and P. fuscatus in Michigan. They studied semi-naturally nesting colonies housed in plywood nestboxes and found that P. dominulus had 4–5 times the number adults and cells as the average P. fuscatus colony at the end of the colony cycle. P. dominulus also produced its workers significantly earlier than P. fuscatus despite initiating its colonies at about the same time as P. fuscatus. Gamboa et al. (2002) reported that P. dominulus had other advantages over P. fuscatus including significantly higher queen and worker per capita foraging rates and significantly higher queen survivorship. Gamboa et al. (2002) found no evidence that P. dominulus was negatively impacting P. fuscatus through direct, agonistic encounters and concluded that P. dominulus was not replacing P. fuscatus through interference competition.

In our study we examined other factors that might explain the success and rapid spread of the invasive P. dominulus. We compared P. dominulus and P. fuscatus with respect to (1) productivity of multiple-foundress colonies, (2) renesting frequencies after natural predation by raccoons, (3) egg, lar-
val, and pupal development times, (4) time of day for first foraging departures, (5) weights and headwidths of females, (6) winter survivorship of gynes, and (7) dispersal distances of spring foundresses. We also examined usurpation pressures and the frequency of parasitism by Strepsiptera, which Gamboa et al. (2002) were unable to compare statistically because of small sample sizes.

Methods

Field studies were conducted in 2001 and 2002 at the Oakland University Preserve. In mid-May, all foundresses nesting in plywood nestboxes were marked for individual identification with Testors enamel. Adults emerging later in the colony cycle, i.e., workers, gynes and males, were not marked. For a more complete description of the field site and nestboxes see Judd (1998).

Surveys of colonies were conducted in early morning (~06.00 h) when temperatures were cool (< 20°C) and wasps had not yet left the nest to forage. We recorded the presence of marked foundresses, unmarked adults, and numbers of eggs, larvae, pupae, and cells in each comb. In 2002 surveys, we noted evidence of parasitism by Strepsiptera. During most of the preworker phase of the colony cycle, surveys were conducted daily in order to document the dates of nest initiation, first larva, first pupa, and first workers for each colony. During July, August and September, we reduced the frequency of surveys to weekly or biweekly.

To compare usurpation behavior between the two species, we videotaped matched, preworker colonies of Polistes dominulus and P. fuscatus with Sony Hi 8 camcorders. Each matched pair of colonies consisted of a colony of P. dominulus and a spatially proximate colony of P. fuscatus with the same number of foundresses. Matched colonies were suspended from the same wood crossbar ~1 m apart. Matched colonies were videotaped simultaneously; thus colonies were matched for number of foundresses, spatial proximity, date and time of day. In 2001, we videotaped each colony for 2 h about 3 and 7 weeks after nest initiation (7 matched, single-foundress colonies; 56 h of videography). In 2002, we videotaped each colony for 2 h about 3, 5 and 7 weeks after nest initiation (7 matched multiple-foundress colonies; 84 h of videography).

We viewed videotapes in the laboratory and recorded intrusions into colonies by non-nestmate Polistes. An intrusion was considered to be a usurpation attempt if the resident queen became agitated, assumed a defensive posture, and/or physically repelled the intruder. To minimize observer bias, each matched set of videotapes was observed by the same person.

To compare the weights and sizes of females, we collected 9 foundresses of P. fuscatus (7 colonies) and 10 foundresses of P. dominulus (6 colonies) on 6 June 2001 prior to the emergence of workers. On 19 July 2001, we collected 7 workers of P. fuscatus (7 colonies) and 7 workers of P. dominulus (7 colonies). Foundresses and workers were placed in a freezer and subsequently weighed (Denver Instrument Model M-220 balance) and measured for maximum headwidth at 10x with a dissecting microscope fitted with an ocular micrometer.

From 26 August to 19 September 2002, we collected 20 colonies of P. dominulus and 17 colonies of P. fuscatus at ~07.00 h when temperatures were ~20°C. We transported these colonies housed in nestboxes to a coldroom maintained at 4°C to mark females (presumably gynes) with Testors enamel on the dorsum of the thorax. All gynes from a given colony were marked the same combination of colors so that each gynae possessed a colony-specific mark. We marked 1374 gynes of P. dominulus and 497 gynes of P. fuscatus. Marked gynes were returned to the field in their nestboxes to their previous location on the same day that they were collected. The following spring (2003), we surveyed colonies three weeks after nest initiation to determine how far colony-marked foundresses had dispersed from their natal nest.

Matched comparisons involved sets of colonies (P. fuscatus and P. dominulus) matched for spatial proximity and foundress number. We utilized matched comparisons whenever we had a sufficient number of matched colonies for a meaningful statistical comparison. If we lacked a sufficient number of matched comparisons, we compared two independent samples. Matched comparisons tests are Wilcoxon Matched-Pairs tests while two independent sample tests are Mann-Whitney tests. Correlations are Spearman Rank Correlation tests and one sample tests are Chi-Square tests. The sample size (n) is the number of colonies analyzed or, in the case of matched comparisons and correlations, the number of matched pairs of colonies. Means are followed by the standard deviation (S.D.). All statistical tests are two-tailed.

Results

In 2001, 25 colonies of P. dominulus (16 single and 9 multiple foundress) and 36 colonies of P. fuscatus (13 single and 23 multiple foundress) were initiated in nestboxes at our field site. In 2002, 33 colonies of P. dominulus (27 single and 6 multiple foundress) and 31 colonies of P. fuscatus (18 single and 13 multiple foundress) were initiated in nestboxes at our field site.

Productivity

In 2001, we calculated productivity from a survey completed shortly before raccoon predation. P. dominulus multiple-foundress colonies were significantly more productive, in numbers of adults (p = 0.0006) and cells (p = 0.005), than P. fuscatus multiple-foundress colonies (Table 1).

In 2002, we based productivity on matched comparisons of numbers of cells (and numbers of cells with meconia) at the end of the colony cycle. Multiple-foundress colonies of P. dominulus had significantly more cells (p = 0.027) and significantly more cells with meconia (p = 0.027) than did multiple-foundress colonies of P. fuscatus. Single-foundress colonies of P. dominulus had significantly more cells (p = 0.0001) and significantly more cells with meconia (p = 0.0001) than did single-foundress colonies of P. fuscatus (Table 2).

Table 1. Comparisons of productivity of multiple-foundress colonies of P. fuscatus and P. dominulus in 2001. Values for 2001 include all multiple-foundress colonies at the field site and are based on the last survey completed (18 July) before raccoon predation. The sample sizes are 22 and 9 colonies for P. fuscatus and P. dominulus, respectively

<table>
<thead>
<tr>
<th>Number of Adults (x ± SD)</th>
<th>Number of Cells (x ± SD)</th>
</tr>
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<tbody>
<tr>
<td><em>P. fuscatus</em></td>
<td><em>P. dominulus</em></td>
</tr>
<tr>
<td>9 ± 4</td>
<td>33 ± 19</td>
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* Two-tailed Mann-Whitney tests.