Origins of New Queens in Polygyne Red Imported Fire Ant Colonies (Hymenoptera: Formicidae)[1]

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ABSTRACT Polygyne colonies of the red imported fire ant, *Solenopsis invicta*, accepted newly mated queens both from their own colony and unrelated colonies. Only a small fraction of the marked winged queens and newly mated queens were successful in joining test colonies in the field. None of the founding queens were accepted into test colonies. One marked colony queen switched colonies.

KEY WORDS *Solenopsis invicta*, multiple queens, polygyny.

Polygyne colonies of the red imported fire ant, *Solenopsis invicta*, Buren accept newly mated queens into their colonies following mating flights (Glancey and Lofgren 1988), a habit that allows proliferation by budding (Vargo and Porter 1989). The origin of these queens is somewhat a mystery. The low relatedness of polygyne queens (Ross and Fletcher 1985) indicates that intra-nest mating is not the primary source of new queens. On the other hand, the acceptance of newly mated queens from other colonies is usually very low (Glancey and Lofgren 1988).

The objective of this study was to investigate several possible origins of new queens in polygyne colonies. In particular, I tested the acceptance of five types of queens: 1) newly mated queens, 2) recently mated queens, 3) post-claustral queens with their incipient colonies, 4) winged queens marked and released with their mother colonies, and 5) functioning colony queens that were scattered across the test site.

Materials and Methods

The study site at Brackenridge Field Laboratory in Austin, TX was cleared of most fire ant mounds by an application of Amdro® in March 1989. Six polygyne colonies with large numbers of winged queens were collected 18 May 1989 from three locations one-half kilometer or more from the study site. Ants were separated from the soil using the drip-flotation method (Banks et al. 1981). Each colony was weighed and all sexuals were segregated from workers and brood with a No. 14 sieve.

All colony queens and unmated winged queens (Table 1) were immobilized on ice and distinctively marked on the thorax with one of 12 colors of Texpen®

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Table 1. Number and types of red imported fire ant queens marked and recovered 5-6 months later in polygyne colonies at study site. Percent recovery is shown in parentheses.

Type of Queens	Number Released with Test Colonies	Number Scattered across Site	Number Recovered
Colony Queens	313	-	49 (16%)
	-	265	5 (1.9%)
Winged Queens (unmated)	2470	-	4* (0.2%)
Newly Mated Queens	-	312	4 (1.3%)
Recently Mated Queens	-	96	0
Post claustral Founding Queens	-	95	0

* Three were inseminated.

ink (Mark-Tex Corp., Englewood, NJ 07631) dispensed from a blunted syringe. Both types of sexuals were returned to their colonies 12 hours after marking. Mark retention after two days in the lab was 100% for colony queens and about 97% for winged females. Forty-two colony queens were double marked with wire rings; all 21 that were recovered with rings also retained their paint mark after 6 months in the field.

Several days after marking, colonies were placed in 5 gallon plastic buckets half-filled with dirt (May 26) and allowed to dig in for three days. The buckets were then partially buried about 10 m apart (Fig. 1) at the study site. Colonies escaped into the field through three long slits in each bucket. Supplemental food was provided at the introduction site for 10 days.

In order to investigate other sources of new queens, the following were marked with different colors and scattered across the study site (Table 1): 312 newly mated queens collected at least 10 km from the study site on the afternoon of June 16 and released 12 hours later, 96 recently mated queens released 2-5 days after their mating flight on June 6, and 265 functioning colony queens which were retained from colony F and released June 27. Ninety-five post-claustral queens together with their incipient colonies, were also buried around the site (10 cm deep) in their rearing tubes, half on June 10 and half on June 22. Larger numbers of marked queens would have been used for all groups except that newly mated queens were very difficult to collect in polygyne areas because of reduced sexual production (Porter et al. 1988).

All 39 mounds in the study site plus an additional six just outside were excavated and weighed between November 24-30, 1990. Dealate queens in these colonies were inspected for marks and dissected to determine if they had mated.

Results

I was able to recover 49 of the marked colony queens from four of the original six colonies (Table 1, Fig. 1). Three of these colonies (D, E, and F) had divided into 5, 4 and 5 mounds respectively and grown 300% (to 296 g), 30% (to 85 g) and 110% (to 131 g). The number of unmarked queens that had joined these colonies was 198, 10, and 2, respectively. Clearly, adoption of new queens was very uneven

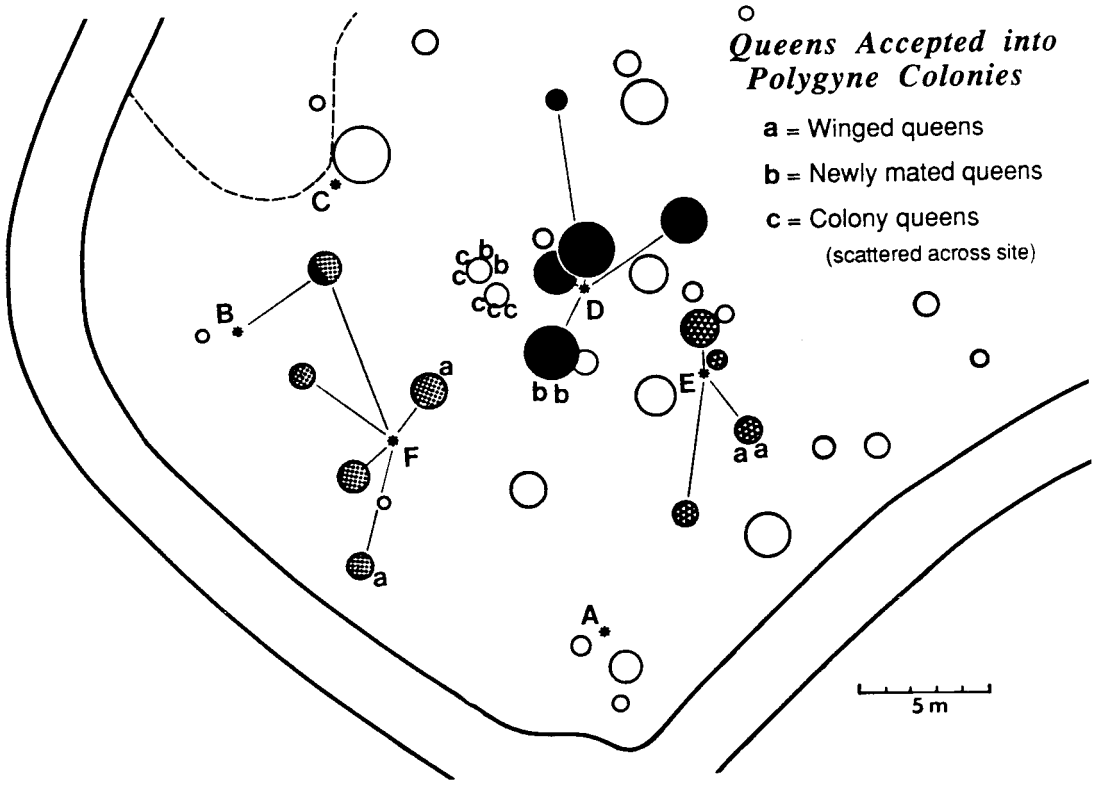

Fig. 1. Distribution of marked red imported fire ant queens in polygyne mounds 5-6 months after release. Small letters show locations of queens accepted into polygyne colonies. Asterisks show release points of test colonies (A-F). Shaded circles show mounds containing recaptured colony queens; the lines indicate origins of these queens. Areas of circles are porportional to the total weight of workers and brood in colonies at the end of the study.

from one colony to the next. Colony B was represented by a single queen found with five marked queens from colony F. Colonies B and F were originally collected from the same area about 50 m apart. Marked queens from colonies A and C disappeared entirely; therefore, I was unable to determine if several nearby mounds (Fig. 1) originated from these test colonies or not. At least some of the mounds without marked queens probably migrated in from the periphery of the study site.

The insemination frequency of queens recaptured in colonies D, E, and F was respectively 92%, 63%, and 79% compared to 100%, 60% and 79% for prerelease samples. Twenty-three of 39 colonies at the study site did not contain marked queens. A total of 124 dealate queens were found in these colonies, 79% of which were inseminated.

Of the 2470 winged queens that were originally marked, four were recovered (Table 1). All four were found with marked queens from their mother colonies (Fig. 1). They all lacked wings and had degenerate wing muscles. Three were inseminated. The probability of these three queens flying, mating, and returning only to their

mother colonies by chance is <0.04 assuming only three colonies were present ($(1/3)^3$); however, the actual chance was probably musch less considering other colonies were almost certainly present in and around the study site. The one unmated queen was from a colony E mound (Fig. 1). This queen may have simply lost her wings and remained in the mother colony or she may have flown and returned unmated. Porter et al. (1988) reported that about 60% of polygyne queens fail to mate during their mating flight.

Four of the 312 queens that had been marked and released immediately after their mating flight wree recovered (Table 1). None of the post-claustral or 2-5 day old queens were recovered. Five of the 265 functioning queens that were scattered around the site were recovered in two nearby colonies of undetermined origin (Fig. 1); the acceptance rate of these queens was about the same as for newly mated queens (Table 1).

Discussion

This study demonstrates that polygyne colonies do accept new queens from their own colony (Fig. 1). Recaptured winged queens showed a clear tendency to return to (or remain in) their mother colonies after mating. Polygyne colonies also accepted 4 of 312 newly mated queens that were collected from distant sites (>10 km) and were therefore presumably unrelated. Extremely low recapture rates (Table 1) make it difficult to determine whether new queens generally originate from related or unrelated colonies. It does seem clear, however, that only a small fraction of newly mated queens successfully join established polygyne colonies (Glancey and Lofgren 1988).

Post-claustral queens were not accepted into the polygyne colonies. The number of post-claustral queens tested was rather small (n = 95), but considering the low flight weight of polygyne alates (Porter et al. 1988) and the high mortality of founding colonies, it does not seem likely that post-claustral queens would be a major source of new queens unless they were unusually susceptible to adoption.

As expected, the polygyne test colonies grew by budding (Fig. 1 and Vargo and Porter 1989). Colony queens appeared to disperse between colonies in conjunction with budding, but one marked queen did join together with marked queens from a different source colony. Also, several mounds accepted functioning colony queens removed from one of the test colonies.

After six months, I recovered only 16% of the marked colony queens (Table 1) even though excavation procedures were sufficient to have collected at least 90% of the ants at the study site (personal estimate). Vargo and Porter (1989) recovered 48% of marked queens after 4-5 months. Low recovery rates may be a result of introduction stresses, but they may also reflect high natural mortality among polygyne queens. The insemination status of queens apparently did not affect their survival.

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