POLYGYNY IN THE TROPICAL FIRE ANT, *SOLENOPSIS GEMINATA*[1] WITH NOTES ON THE IMPORTED FIRE ANT, *SOLENOPSIS INVICTA*

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ABSTRACT

Thirty-one queens of the tropical fire ant, *Solenopsis geminata* (F.), were found in a single nest in the field. All produced worker ants in laboratory colonies indicating that all had been inseminated. The eggs and immature forms produced by 14 of the queens were tended mutually in a common nest by all 14 queens and their workers, an example of true polygyny. Oil soluble dyes of 7 colors were incorporated into the food of the ants of 14 individual colonies (2 colonies per color). The ants were permitted to feed ad lib for 7 days. Individual colors appeared in the eggs laid by queens feeding on their respective dyes. Colonies were recombined on the 17th day and the colors continued to appear in the eggs deposited in the large colony until trophallaxis blended the dyes to the point that they were indistinguishable, indicating a continued mutual contribution by each queen present in the composite colony.

Polygyny has been known for several years among the species of a number of genera of ants (Wilson 1971). The relatively common occurrence of polygyny in some *Solenopsis* species, however, is a fairly recent discovery. Wilson (1971) stated that M. S. Blum had reported the occasional coexistence of 2 queens in the red imported fire ant. Glancey et al. (1973) found 2 small nests of *S. invicta* Buren (estimated to be 6-8 months old) that contained 20 fertile females. On another occasion, they found 3 mounds that contained a total of 16 dealated females, all of which produced eggs in the laboratory. However, the eggs from only 3 of the females subsequently produced worker ants. Later, Glancey et al. (1975) reported that a group of 10 nests of *S. invicta* in southeastern Mississippi contained from 7 to 677 fertile queens per mound. Also, Summerlin (1976) found that 5 of 12 dealated females taken from a single nest in the southern fire ant, *Solenopsis xyloni* McCook, near College Station, TX, were fertile. Banks et al. (1973) reported that 2 physogastric females taken from a single nest of *Solenopsis geminata* (F.) were both fertile.

This paper reports observations of polygyny in the tropical fire ant, *S. geminata*.

METHODS AND MATERIALS

During our routine field studies, numerous mounds of *S. geminata* and of the red imported fire ant, *S. invicta*, are opened with a shovel, and observations are made of conditions of the colony or the presence of the various castes. Often, colonies and a portion of the mound are excavated and returned to the laboratory for study. These colonies are then separated from the soil of the mound by flotation, or the

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ants may be forced to move into the moist plaster of paris nests by spreading the soil in a shallow tray to dry.

One colony of *S. geminata,* excavated in northwest Gainesville, contained 31 dealated females. Tests were conducted to determine if all the females were fertile.

Fourteen of the 31 queens were established in individual 10 cm circular plexiglass ant nests with ca. 25 worker ants each. Each nest was placed in the center of a 22.5 × 30 cm plastic dishpan. The sides of the pan were dusted with inert talc to prevent the ants' escape.

The remaining 17 queens were placed together with several hundred workers and larvae in a single 19 cm circular plexiglass nest. The nest was placed in a 40 × 50 cm plastic tray, and the sides of the tray were dusted with talc. All the colonies were maintained at a temperature of 27±2°C. Laboratory-reared German cockroaches, *Blatella germanica* (L.), and an artificial medium (macerated insects, beef baby food, whole egg, multiple vitamins, water, and agar) were provided for food. After 21 days, 14 of the queens from the large nest (2 had died and 1 had been transferred to replace a queen that had died in a small individual nest) were each placed in separate 10-cm nests with 25-50 workers and a small quantity of larvae. Each colony was then permitted to feed ad lib for 7 days on peanut butter containing, oil-soluble orange, red, blue, green, yellow, bronze or black dye (2 colonies per color). The colonies were then returned to the regular diet. Daily observations were made and the egg production of each colony was noted. On the 17th day after removal of the dyed food, the queens and workers from these 14 colonies were recombined in a large nest, and observations of egg production were continued.

Results and Discussion

From observations of colonies of *S. geminata* in the field or from studies of colonies brought into the laboratory, we know that most mounds of *S. geminata* contained only 1 queen but some mounds contained as many as 31 queens. At a site in northwest Gainesville, 8 of 11 nests of *S. geminata* examined contained multiple queens. Two of the nests contained 2 queens, 3 other nests contained 7, 10, and 31 queens, respectively; the number of queens in the other 3 nests was not determined except to note that more than 1 was present. In the laboratory studies with the 31 queens taken from the 1 nest, all 14 females established in individual nests began producing eggs within 24-48 hr. By 7 days, each nest contained numerous larvae that were recognizable as sexual larvae. After 16 days, worker larvae were present in all 14 nests, and by the 25th day, callow workers were present. This production of worker ants indicated that all the queens were fertile since by Dzierzon's rule, virgin queens produce only males (Wilson 1971). Six of the 14 queens died between the 20th and 50th days after establishment so their colonies were destroyed once all the immatures had completed development. The other 8 colonies continued to increase through 120 days, when the study was ended.

The 17 queens placed together in the large nest also began to produce eggs within 24-48 hr. No counts were made of the number of

eggs laid. From the size of the egg clutches, it would appear that most, if not all, of the queens were contributing as the egg clutches were several-fold greater than the number produced by any single queen in an individual nest. All the eggs and the resulting larvae were maintained in a common cluster and were tended mutually by all the queens and workers, an example of true polygyny as defined by Wilson (1974). After these queens were placed in the individual nests, and their colonies were allowed to feed on the peanut butter containing dye, the eggs produced by the queens contained the dye. When the queens were recombined in the large nest, all 7 dyes were seen in the eggs laid during the first 2 days, thus indicating that all of the queens continued to lay in the presence of other queens. By the 3rd day, intermixing of the dyes from the trophallaxis made the individual colors indistinguishable. There did not appear to be any dominance exhibited by any queen or any inhibition of egg laying by a queen due to the presence of other functional queens since all dyes were present in the eggs laid and the relative quantity of eggs of each color was about equal.

Colony founding by groups of queens may be a prominent factor in the survival of new colonies of *Solenopsis*. Markin et al. (1972) found that when colonies were started by 3 queens nearly one-third more of the colonies survived than when colonies were founded by a single queen. Also, Wilson (1966) showed that queens starting nests cooperatively survived longer and produced more workers per queen in the first brood than those founding colonies singly.

Markin et al. (1972, 1973) found that 1-5 queens of *S. invicta* may cooperate in founding a colony and that at least 5% of the nests that were 2 or more years old contained more than 1 queen. Glancey et al. (1973, 1975) and our own unpublished data, confirm these observations for colonies as young as 6-8 months of age.

Several *Solenopsis* queens may therefore found a colony cooperatively and live together in a common nest throughout the life of the colony. This arrangement could seem a waste of reproductive potential unless each queen can lay a normal complement of eggs and produce the expected number of ants. Coexistence may have an adaptive advantage for colony survival, however, as Wilson (1974) has hypothesized for *Leptothorax curvispinosus* Mayr. He proposed that any disadvantages imposed on a given queen in a polygynous colony may be outweighed by the fact that multiple queens provide sufficiently greater potential for survival of the colony so as to make mutual tolerance by the queens adaptive.

Our observations suggest that some mature colonies of *Solenopsis* may adopt newly-mated queens after nuptial flights. We recently found workers of *S. invicta* apparently caring for newly-mated queens under debris in the vicinity of established nests. This evidence is in direct contrast to the reports of numerous researchers (Arant et al. 1958, Hays 1959, Green 1967, Markin et al. 1971, Whitcomb et al. 1973) who have seen workers of established colonies quickly kill many newly-mated queens as they alight on the soil surface after the nuptial flight. Why worker ants sometimes kill the newly-mated queens, and apparently sometimes do not, is uncertain. It could reflect the re-

lationship of the newly-mated queens to the ants in the mounds: sister queens arising from those same mounds or adjacent related mounds would more likely to be accepted; queens from unrelated mounds would be killed.

There is also the possibility that the multiple queens within single mounds may result from mating within the nest. Our studies suggest that this is not the case, however. Since 1969 we have maintained many large queenless colonies of both *S. geminata* and *S. invicta* in the laboratory. Although many of these colonies have contained both male and female sexuals within the same nest, we have seen no attempt on the part of the ants to mate within the nest, and we have never had any of these colonies begin production of worker larvae or adult worker ants which would indicate that a female has been inseminated within the nest.

Although the discovery of polygyny in *Solenopsis* occurred recently, present evidence indicates that it is rather common in the genus. Further studies will be necessary to determine what effects polygyny may have on the survival and success of the fire ants.

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MATING SPECIFICITY IN *SPODOPTERA* SPP.— (*Note*). Laster (1972, Environ. Ent. 1: 682-7) discovered that in the laboratory the progeny of *Heliothis virescens* (F.) that mated with *H. subflexa* (Guenée), a closely related species, were sterile. He therefore proposed that native *H. virescens* populations might be controlled by releases of these sterile hybrids. In various trapping experiments, I have observed cross sex attraction among several *Spodoptera* species. For example, traps baited with *Spodoptera exigua* (Hubner) often attract males of *S. eridania* (Cramer), and female *S. eridania* attract male *S. exigua* though female *S. frugiperda* (J. E. Smith) attract only conspecific males.

I report here the results of experiments designed to determine the degree of cross mating, if any, among several species of *Spodoptera* (Guenée).

All insects used in the experiments were reared from larvae maintained on artificial diet (Burton, R. L., 1970, J. Econ. Ent. 63: 1969-70). The insects were sexed in the pupal stage and held separately until they were tested. All possible male-female combinations were made among *S. exigua, S. eridania, S. frugiperda,* and *S. ornithogalli.* The moths (5 females and 10 males) of each combination were confined in 3.8-liter paper cartons with screened ends, and they were held in a temperature-controlled cabinet maintained at ca. 27°C and 65% RH under a 14:10 light:dark cycle. The moths remained together until all insects in each cage died. Then they were collected and preserved in 70% alcohol. Later the insects were sexed, and the females were dissected for evidence of mating (the presence of a spermatophore in the bursa copulatrix). Each treatment (male:female combination) was replicated 2-3 times. Controls (5 females and 10 males of each species) were maintained to confirm conspecific mating in the test conditions.

Mating among conspecific males and females was: *S. exigua,* 67%; *S. eridania,* 63%; *S. frugiperda,* 84%; *S. ornithogalli,* 57%. There was no evidence of cross mating between any of the *Spodoptera* spp. Therefore, the possibility of obtaining hybrid sterility among 2 or more species in this particular group of *Spodoptera* in the laboratory or in nature appears remote despite the evidence of cross sex attraction in the field.—E. R. Mitchell, Insect Attractants, Behavior, and Basic Biology Research Laboratory, Agr. Res. Serv., USDA, Gainesville FL 32604. I gratefully acknowledge the following personnel of this laboratory for their assistance in insect rearing—C. Green, I. Rodgers, and R. Hines.