

SYMPATRY OF FIRE ANT POLYGYNE AND MONOGYNE SOCIAL FORMS

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Abstract. The polygyne form of the red imported fire ant, *Solenopsis invicta*, had been thought to occur primarily in discrete and homogeneous populations within areas composed of monogyne colonies. Polygyne queens are inseminated primarily by monogyne-derived males. Therefore, opportunities for female alate insemination might be minimal at the centers of large polygyne populations. We tested the homogeneity of a large polygyne population in North central Florida by examining colonies at six sites located along an East-West transect through this polygyne population. The social form of each colony sampled was determined by an aggression test of workers to the introduction of non-nestmates and by the dissection of males for sterility. Both social forms of *S. invicta* were present at all collection sites. About 30% of all colonies sampled (N = 333) were determined to be monogyne. The polygyne region in North central Florida is more accurately described as an area where relatively high frequencies of polygyne colonies are interdispersed with single queen colonies.

Introduction. Patches of polygyne fire ant colonies have been reported in many areas of the Southeast, including Louisiana, Florida, Arkansas, Alabama, Oklahoma, and Texas (Fletcher et al. 1980, Miranda & Vinson 1982, Lofgren & Williams 1984, Ross & Flethcer 1985a, Glancey et al. 1987, Glancey et al. 1989). Studies on the densities and distribution of polygyne colonies in the Southeast have implied that certain areas are exclusively inhabited by polygyne colonies (e.g. Porter et al. 1991). The manner in which these regions became polygyne is not clear.

A region of North Florida has one of the largest polygyne patches of fire ants in the United States (Porter 1992), encompassing approximately 2900 km². Porter (1992) sampled 113 different locations in this particular polygyne patch in 1991 and re-sampled 103 of these sites in 1992 (Porter 1993). The distribution map of both social forms indicates that single queen colonies are absent from most areas where polygyne colonies have been collected (Porter 1992, 1993). A similar exclusion of monogyne colonies from polygyne areas has been noted in Texas (Porter et al. 1991). However, Ross (1992) reported that over 80% of polygyne queens mate with single queen males, thus requiring the participation of both social forms in the same mating flights. The purpose of this study was to determine whether the large polygyne region of Florida was exclusively polygyne, as previously indicated, or had low frequencies of monogyne colonies as well. We examined the distribution of both social forms along an East-West transect through the center of the polygyne patch in North central Florida.

Materials and Methods. Six collection sites were established along an East-West transect in north central Florida (Figure 1). The western-most end of transect started in Levy County and continued eastward to the easternmost edge of Marion County (Figure 1, B-G). Up to 51 separate colonies of *S. invicta* were sampled at each collection site. The distance between mounds was at least 10m. The top portion of a colony was removed and several hundred workers plus nest soil were collected from each colony. When males were found they were collected and later dissected for the presence of spermatozoa. All colony samples were transported to a laboratory facility for behavioral assays.

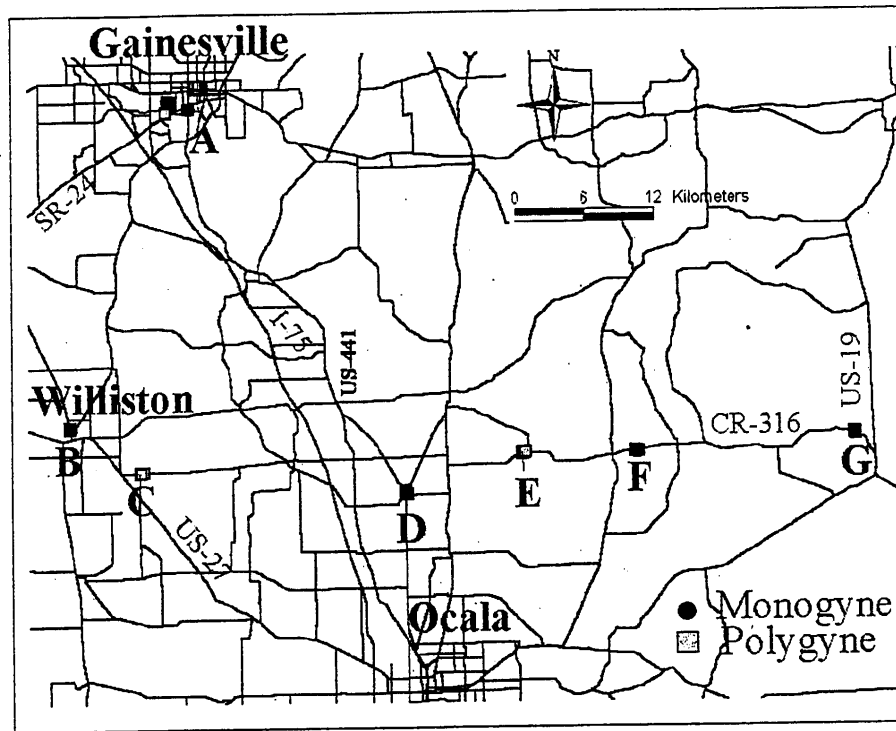


Figure 1. Location of seven collection sites of *S. invicta* in north central Florida; East-West transect bisects the center of the polygyne population (sites B-G). The three collection locations and identity (polygyne or monogyne) of colonies from site A are shown at the right.

Two methods were used to establish the social form of colonies. One method was an assay quantifying the aggressive behavior of workers towards non-nestmate intruders (Morel et al. 1990). The second method was dissection of males for gonadal development, since only polygyne colonies are expected to produce sterile males (Ross & Fletcher 1985b, 1986; and see Hung et al. 1974, for the method).

Results. The distribution of initial aggression scores was bimodal (Figure 2), corresponding to the two social forms (monogyne aggressive and polygyne non-aggressive, Morel et al. 1990). Twenty-two colonies initially scored between the monogyne criteria (≥ 7) and the polygyne criteria (≤ 4). When these colonies were re-tested, four scored in the monogyne range and the remaining 18 scored in the polygyne range. The combined results were used to designate colonies as either monogyne or polygyne.

The determination of the sterility of males collected from 20 colonies and six sites was consistent with the determination of social form by the behavioral bioassay. From one to eight males were collected from 20 colonies in six of the collection sites. Nine of these colonies were determined to be of single queens based on the aggression test and all but one of the males ($n = 35$) from these colonies was fertile. Seven of the 11 colonies scored as polygyne by the aggression test had one or more sterile males (12 of 25 sterile).

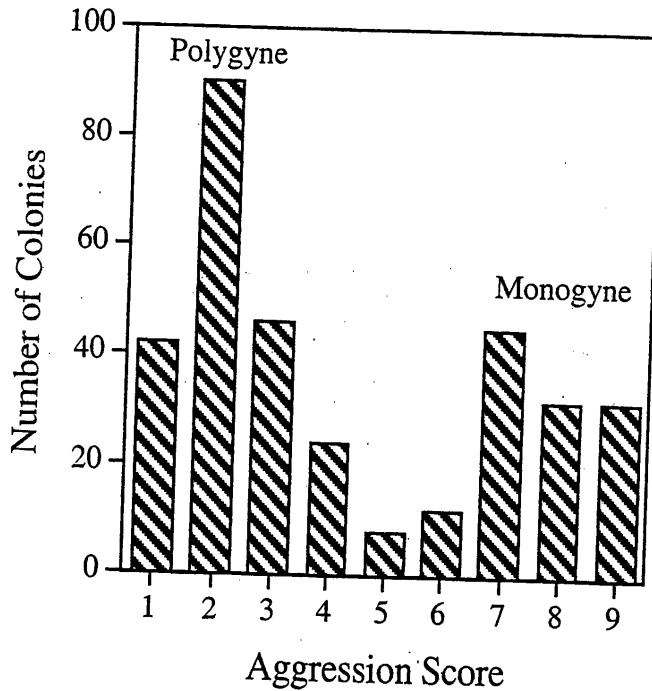


Figure 2. Frequency histogram of the aggression score for colonies of *S. invicta* sampled in North central Florida. Scores equal to or greater than 7 indicate a monogyne and scores equal to or less than 4 indicate polygyny.

Discussion. Polygyne colonies produce significantly fewer sexuals per unit time than those with single queens (Vargo & Fletcher 1987). In addition, polygyne colonies primarily produce sterile males (Ross & Fletcher 1985b). Polygyne-derived female alates appear to depend primarily on monogyne colony-derived males for successful mating, since males from monogyne colonies account for approximately 80% of polygyne queen inseminations (Ross 1997). Therefore, polygyne colonies must participate in monogyne mating flights and polygyne colonies that are far removed from sources of monogyne males may have difficulty maintaining numbers of fertile queens by queen adoption or difficulty expanding their territory through budding. Such large tracts of polygyne colonies have been reported for both Texas (Porter et al. 1991) and Florida (Porter 1992, 1993).

Our data demonstrate that the North Florida transect bisects an area that is primarily polygyne, as expected from previous surveys (Porter 1992, 1993). However, the number of monogyne colonies found at each site was unexpected. Monogyne colonies were found at every site along the transect and comprised approximately 25% or more of the colonies encountered at 5 of the 6 sites. Polygyny, therefore, does not inevitably lead to the complete displacement of monogyne colonies in a particular region. Most likely, though, monogyne colonies persist in polygyne areas by foundress queens originating from local monogyne colonies or from those in adjacent areas. Newly mated queens from polygyne colonies have relatively small fat reserves and are not expected to be successful at independent colony foundation (Porter et al. 1988, Keller & Ross 1993, 1995). Polygyne colonies are thought to spread primarily by budding (Vargo & Porter 1989). Although the literature on *S. invicta* implies that the polygyne form has a negative effect on the presence and density of the monogyne form, the proximate reasons for such an effect are not known and the relationship remains speculative. If there is a

competitive interaction between both social forms in Florida, the vagility of single queen forms probably helps maintain their presence in available habitat.

We have demonstrated that monogyne colonies can be found in close association with polygyne *S. invicta* populations, which probably maintains the reproductive and genetic dynamics between both social forms as reported by Ross (1997, Ross & Fletcher 1985a, Ross et al. 1996). While our data is for a Florida population our conclusions are logically extended across the fire ant range in the United States.

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