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A Comparison of Monogyne and Polygyne Populations of the Tropical Fire Ant, *Solenopsis geminata* (Hymenoptera: Formicidae), in Mexico

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ABSTRACT: We compared monogyne (single queen per nest) and polygyne (multiple functional queens per nest) populations of the tropical fire ant in Mexico. We collected up to 16 queens in nests of the polygyne population. Workers from polygyne nests were considerably smaller and lighter in color than workers from monogyne nests. Nest density was extremely high in the polygyne population (over 2500 occupied nests and over 6000 unoccupied nests per ha). These differences are similar to those found in the monogyne and polygyne populations of the imported fire ant, *Solenopsis invicta,* in the United States.

RESUMEN: Comparamos poblaciones monogénicas (una reina por nido) y poligénicas (más de una reina funcional por nido) de la hormiga *Solenopsis geminata* en México. Los nidos poligénicos contienen más de 16 reinas. Obreras de nidos poligénicos son más pequeñas y más claras en color que obreras de nidos monogénicos. La densidad de nidos poligénicos es muy alta. Estas diferencias son muy similares a las de las dos poblaciones de la hormiga importada de fuego (*Solenopsis invicta*) en los Estados Unidos.

Polygyny has been reported in many ant species (Bennett, 1987). Monogyne and polygyne forms (or sibling species pairs) are found in genera ranging from the army ants (*Neivamyrmex*), to the myrmicines (*Myrmica, Monomorium* and *Leptothorax*), the formicines (*Formica* and *Plagiolepis*) and the dolichoderines (*Iridomyrmex* and *Tapinoma*). Both forms are common in the fire ants, occurring in *S. invicta* (Greenberg et al., 1985), *S. xyloni* (Summerlin, 1976), *S. geminata* (Adams et al., 1976) and in the smaller *Solenopsis* (*Diplorhoptrum*) spp. (MacKay, pers. obs.).

The reasons ants form polygyne populations are not clear. Such populations are often found in disturbed, patchy habitats, where rapid growth and monopolization of resources are important. Polygyny often results in the reduction of species richness of a community, due to competition and predation by the polygyne species. Control of polygyne populations of pest species such as *S. invicta* may be more difficult due to the large numbers of queens which must be eliminated in order to destroy a nest (Mirenda and Vinson, 1982).

Our objective was to compare monogyne and polygyne populations of the tropical fire ant, *S. geminata,* and compare the characteristics of the two populations with similar populations of the red imported fire ant, *S. invicta.*

Materials and Methods

This study was done in an area located 6.5 km North of Tierra Blanca, state of Veracruz, Mexico on 28 May and 4 June 1988. The monogyne population was

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Table 1. Comparison of characteristics of monogyne and polygyne populations of *S. geminata*, and with similar forms of *S. invicta* (data from Greenberg et al., 1985; MacKay et al., 1989; Ross, 1989). Note that g: refers to *S. geminata*, i: refers to *S. invicta*.

Characteristic	Monogyne	Polygyne
Relative worker size	larger	smaller
Nest density	lower	higher
	g: <50 nests per ha	g: 2267–2667 nests per ha, + 5067–6133 unoccupied nests per ha
	i: 50–100 nests per ha	i: 400–1000 nests per ha
Worker color	dark	light
Impact on other ant species	small	g: apparently small i: great
Number of uninseminated gynes in nest	few or none	many g: 8% of gynes i: 10–30% of gynes, may change seasonally

located in a brushy area (*Acacia* spp. and *Prosopis* spp.). The polygyne population was found in a cleared, heavily grazed pasture. Both areas were heavily disturbed and were located about 1 km apart. We estimated the density of nests using two belt transects (1.5 m × 50 m) in areas with each of the populations. Nests were partially excavated to determine if they were active. Gynes were collected from the nests and were dissected later in the laboratory. Samples of workers were preserved from nests of each population and head widths were measured using the technique of Porter (1983).

Results

Nests in the polygyne population contained from 1 to 16 dealated gynes ($\bar{x}$ = 7.0 ± 2.5 SD). We did not completely excavate the nests and expect there were many more we did not collect. Most of the gynes were inseminated and contained functional ovaries (92.2% ± 2.5 SD), showing that the nests were actually polygynous. The 8% of unseminated gynes (Table 1) may be due to dealation in nests during periods of low levels of queen inhibitory pheromone (Vargo and Fletcher, 1986a), or females that have not found fertile males during a nuptial flight (Ross, 1989). All dissected gynes had histolized wing muscles.

The polygyne population did not seem to have a negative impact on the other ant fauna. We collected the genera *Odontomachus**, *Pachycondyla* (*harpax**), *Pseudomyrmex* (*gracilis* and *ferrugineus*), *Atta* (*mexicana*), *Crematogaster, Pheidole**, *Solenopsis* (*Diplorhoptrum** and *globularia*), *Conomyrma* sp. and *Forelius** (taxa indicated by asterisks were found in unoccupied *S. geminata* nests). We found *Gnamptogenys* (*tornata*), *Pachycondyla* (*harpax*), *Neivamyrmex, Pseudomyrmex* (*ferrugineus*), *Atta, Monomorium, Pheidole, Solenopsis* (*Diplorhoptrum*), *Tetramorium* (*spinosus*) and *Camponotus* in the area with the monogyne population. Nest density was much higher in the polygyne population (Table 1).

Workers in the polygyne population were much smaller than those from the monogyne population (Fig. 1). An allometric comparison of head width and pronotal width shows that polygyne workers were considerably less allometric (Fig. 2—polygyne: $\log y = 1.15x + 0.63$, $R = 0.995$; monogyne: $\log y = 1.37x +$

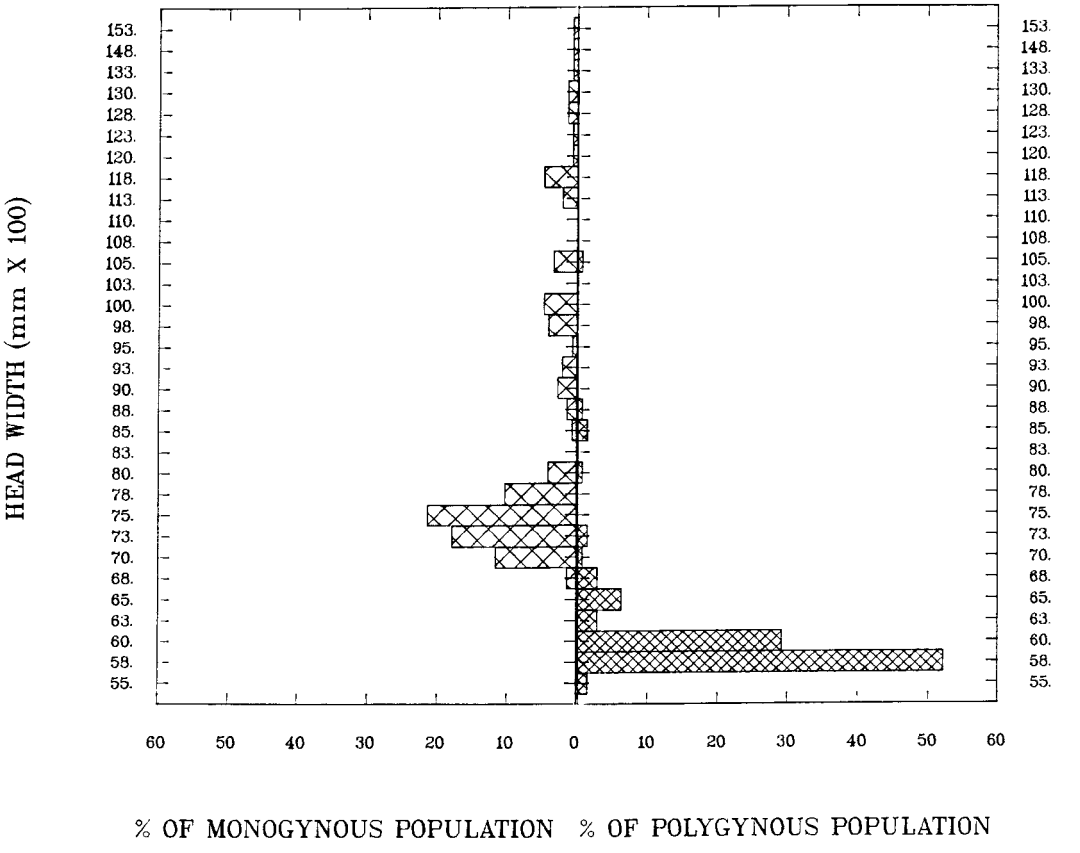

Fig. 1. A comparison of the sizes of workers (head width) in the monogyne and polygyne populations of the tropical fire ant, *Solenopsis geminata,* in the state of Veracruz, Mexico.

0.76, $R = 0.998$). It is unknown whether these differences in slope are primarily due to the presence of multiple queens or other genetic differences. By comparison, *S. invicta* has an allometric slope of 1.06 and *S. geminata* in Florida has a slope of 1.4 (Wheeler, pers. comm.). The gross differences in size and color were sufficient for simple field identification of the two populations of *S. geminata.*

Discussion

Populations of polygyne fire ants are common in North America. Such populations of *Solenopsis invicta* have been reported in Texas, Mississippi, Georgia and Florida (Green, 1952; Glancey et al., 1987; Hung et al., 1974; Fletcher, 1983; Mirenda and Vinson, 1982; Lofgren and Williams, 1984; Ross, 1988). Similar populations of *S. geminata* have been reported in Florida (Banks et al., 1973; Adams et al., 1976), Texas (Porter et al., 1988) and now in Mexico. Polygyny in *S. invicta* is spreading in Florida (Glancey et al., 1987) and in Texas (pers. obs.). We have no data which suggest that the polygyne population of *S. geminata* is increasing in Mexico, where it does not appear to be common.

Why does polygyny occur in *Solenopsis*? Although individual gynes of *S. invicta* from a polygyne nest are less productive than those from a monogyne nest ("reproductivity effect"—Ross, 1989), such nests are more productive due simply to the large population of gynes (Fletcher et al., 1980). Thus, many large, durable

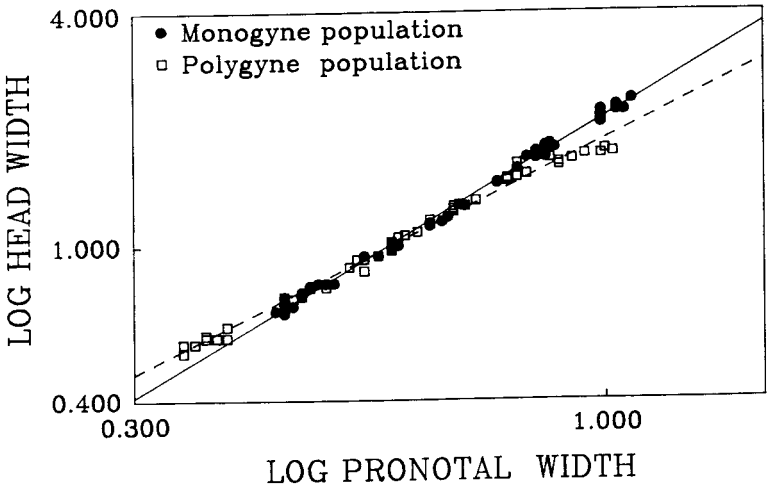

Fig. 2. Allometric comparison of head width and pronotal width of monogyne and polygyne populations of the tropical fire ant, *Solenopsis geminata*, in the state of Veracruz, Mexico.

nests are produced. This productivity is expressed only in terms of workers. Polygyne nests produce fewer sexuals (Vargo and Fletcher, 1986b, 1987; Porter et al., 1988). This is apparently due to the high levels of queen pheromones produced in the nests (which inhibit gyne production). Larger numbers of sterile males (primarily diploids) are produced in polygyne nests, possibly due to a bottleneck effect of the founder population (Vargo and Fletcher, 1987). In addition, the gynes from polygyne nests are less massive and are not as successful in founding nests (Porter et al., 1988).

There are some advantages to polygyny. Females are accepted into nests of *S. invicta* after the mating flight (Glancey and Lofgren, 1988), where the mortality rates would be much lower. Later polygyne mounds of *S. invicta* undergo "budding" in which one or more gynes, together with a group of workers, leave the nest to form another nest (Vargo and Porter, 1989). Mortality rates would again be low due to the protection offered by the workers. Ants in such populations may invade rapidly and saturate an area, eliminating most other species of ants by competition or aggression (Bennett, 1987; Porter et al., 1988).

It is difficult to explain how polygyne populations develop and are maintained, due to the high genetic load and the potential conflict of interest of members of the colony. This process presents many of the same theoretical challenges as do the origins of eusociality (Ross, 1989).

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