Colony Movement of the Black Imported Fire Ant (Hymenoptera: Formicidae) in Argentina

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ABSTRACT We studied the movement of colonies of the black imported fire ant, *Solenopsis richteri* Forel, in its native land, Buenos Aires province, Argentina. We established 6 field plots and monthly monitored the number of abandoned and new mounds for 2 yr. We compared the movement of all colonies with the movement of colonies infected with the microsporidium *Thelohania solenopsae* Knell, Allen & Hazard. We estimated the distance of colony movement and recorded the duration of the colonies remaining in the same place. *S. richteri* colonies moved their mounds very often. The mean percentage of abandoned and new mounds per monitoring date was 36 and 30% of all active mounds, respectively. The pathogen *T. solenopsae* did not have any effect on colony movement. The mean estimated distance of displacement was 3.7 m and the mean duration of the colonies in the same place was 3.1 mo. Rainfall stimulated colony movement in Argentina.

KEY WORDS *Solenopsis richteri, Thelohania solenopsae,* microsporidia, colony movement

SINCE THEIR ACCIDENTAL introduction into the United States from South America >60 yr ago, the imported fire ants *Solenopsis richteri* Forel and *S. invicta* Buren have become important economic pests (Lofgren 1986). Consequently, more research has been conducted on their basic biology, behavior, ecology, and control than on any other group of ants except, perhaps, the leafcutting ants.

Movement of colonies of the red imported fire ant, *S. invicta,* was reported by Green (1952), Horton (1973), Lofgren et al. (1975), and Hays et al. (1982) for the United States and by Wojcik (1986) for South America, but it has never been quantified. Information on colony movement of the black imported fire ant, *S. richteri,* in North and South America was lacking.

The native fire ant populations in South America are associated with many pathogens, predators, and parasites (Williams et al. 1973; Williams and Whitcomb 1974; Avery et al. 1977; Jouvenaz 1983; Nickle and Jouvenaz 1987; Williams and Banks 1987; Wojcik et al. 1987, 1991; Johnson 1988; Jouvenaz 1990; Wojcik 1990). Among them, the microsporidium *Thelohania solenopsae* Knell, Allen & Hazard (Microsporida: Thelohaniidae) was the most common microorganism in Buenos Aires province, Argentina, and showed a detrimental effect on populations of *S. richteri* (Briano 1993, Briano et al. 1995).

We speculated that the effect (either negative or positive) of the infection with this microsporidium on colony movement would be detrimental for the fire ant colonies. If infection decreased colony movement, the capacity of the fire ants to change their nest location under a stress factor would be diminished. However, if infection increased colony movement, more of the energy of the workers would be refocused on building the new nest and eventually, this could decrease the normal foraging activity, brood care, and queen protection. In both cases the potential of *T. solenopsae* as a biocontrol agent of the imported fire ants in the United States should be favored.

The main objective of this work was to quantify the movement of colonies of the black imported fire ant *S. richteri* in Argentina and to see whether the infection with *T. solenopsae* affects colony movement.

Materials and Methods

Study Area. We conducted the study in the area of Saladillo, Buenos Aires province (180 km SW of Buenos Aires). The area is topographically flat and often has standing water for short periods in the low spots because of poor drainage. The land is used mainly for livestock grazing in natural and improved pastures. In October 1988 we established 6 circular 0.125-ha plots 2–4 km north of Saladillo. Because of changes in agricultural practices, we lost 2 plots and replaced them in May 1989. The fire ant species present within the plots was identified as *S. richteri,* based on cuticular hydrocarbon studies conducted at the USDA–ARS

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Frequency of Colony Movement. Once the plots were established, we monitored them every 30–50 d until July 1990. We determined the frequency of movement by counting and labeling every colony within the plots and recording whether it was original, abandoned, or new. To determine the effect, if any, of *T. solenopsae* on colony movement, we compared the percentage of infection found within the plots every monitoring date with the percentage of infection of the colonies that moved. If *T. solenopsae* did not have any incidence on colony movement, these percentages should be similar.

Because we suspected that the water content of the soil was one possible stimuli for colony movement and activity, we compared the percentage of new mounds per monitoring date with the percentage of abandoned mounds and with the rainfall between monitoring dates. Records of rainfall were obtained from the Sociedad Rural of Saladillo, located 1 km from the plots.

Infection with *T. solenopsae*. To determine the percentage of infection, we sampled 1,000–2,000 workers on every monitoring date from each active colony by inserting a 7-ml vial into the mounds. The inner walls of the vials were dusted with talc to prevent the ants from escaping. During sampling, we disturbed the mounds as little as possible to minimally affect the ant colonies. Once we removed and capped the vials, we kept them on ice in a cooler for transportation to the laboratory. We prepared the ants for examination by freezing and grinding them in a tissue grinder with 2–4 ml of water; and then we examined 1 drop of the aqueous extract with phase-contrast microscopy (400×) for the presence of spores of the pathogen. The number of infected colonies was recorded.

Distance and Duration. Because no successful marking technique was available, we estimated the displacement of colonies by measuring the distance between the location of a new mound and the location of the nearest abandoned mound; we examined a total of 163 colonies.

We determined the duration of the colonies in the same location by recording the date on which we found a mound in a new location and the date on which we found that same mound abandoned. We examined a total of 298 colonies.

Statistical Analysis. We did the statistical tests with Minitab Statistical Software (1991). We analyzed the frequencies of colony movement with 2-sample *t*-test, and the percentages of abandoned and new mounds were converted with the arcsine transformation. We analyzed the relationships between the percentages of abandoned and new mounds and between the percentage of new mounds and rainfall with the linear regression model. Means are reported with ±1 SD.

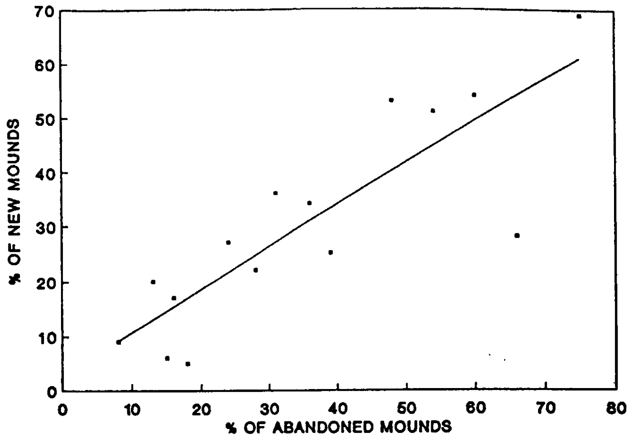

Fig. 1. Relationship between the percentages of abandoned and new mounds of *S. richteri* within the field plots.

Results and Discussion

Frequency of Colony Movement. The colonies of *S. richteri* moved their mounds very often. The mean percentage of abandoned mounds found per monitoring date was 36 ± 20% (range, 8–75%), 27 ± 15% (range, 3–55%) belonged to healthy colonies, and 9 ± 6% (range, 0–20%) belonged to colonies infected with *T. solenopsae*. Wojcik (1986) observed similar abundance of abandoned mounds for *S. invicta* in Mato Grosso, Brazil. He reported 33% of the fire ant mounds abandoned in several surveys made along roadsides. Horton (1973), in a field population study of *S. invicta* in South Carolina, reported that 42% of the observed mounds were abandoned.

The mean percentage of new mounds found per monitoring date was 30 ± 19% (range, 5–69%), 24 ± 14% (range, 4–53%) belonged to healthy colonies, and 6 ± 5% (range, 0–16%) belonged to infected colonies. We found a highly positive association between the percentage of new mounds and the percentage of abandoned mounds (Fig. 1; $y = 3.01 + 0.77x$; $r^2 = 0.72$; $F = 33.64$; df = 1, 13; $P < 0.0001$).

The explanation for this high level of *S. richteri* colony movement remains unclear. Hays et al. (1982) suggested the lack of food supply as the most reasonable explanation for the movement activity of *S. invicta* in the United States. They also suggested that the colonies produce satellite nests and may expand and constrict the colony by activation and deactivation of mounds. If this is the case, *S. richteri* deserves further investigation.

We found that rainfall partially influenced colony movement. The abundance of new mounds was positively associated with the rainfall between monitoring dates (Fig. 2; $y = 7.64 + 0.23x$; $r^2 = 0.44$; $F = 9.99$; df = 1, 13; $P = 0.008$). This means that rainfall explained 44% of the fire ant colony movements. Rainfall produced peaks of movement activity; the heavier the rain, the longer the period with high water content in the soil and the longer

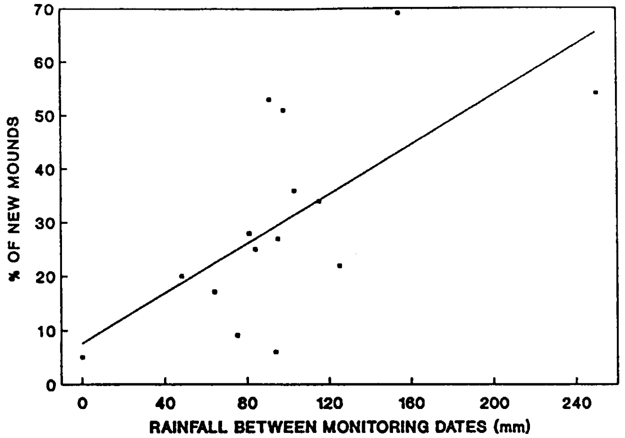

Fig. 2. Relationship between the percentage of new mounds of *S. richteri* within the field plots and rainfall between monitoring dates.

and higher the movement activity. After a heavy rainfall between December 1989 and February 1990 (250 mm), there were high percentages of abandoned and new mounds from February to May 1990 (>50% to almost 80% of abandoned and new mounds). We observed the lowest percentage of new mounds (5%) after a period with no rainfall (March to May 1989).

The abundance of abandoned and new mounds was cyclic but unrelated to temperature. We observed peaks of movement activity during almost all seasons, for example, January 1989 (summer), June 1989 (winter), and March 1990 (fall). This agrees with Hays et al. (1982) who reported the lack of consistency in the trends of *S. invicta* colony movement during a 3-yr period.

We did not find enough evidence to show that the microsporidium *T. solenopsae* affects the frequency of colony movement. The mean percentage of infection within the plots was 21%, and the mean percentage of infection within the colonies that moved was 19% ($t = 0.72$, df = 28, $P = 0.48$).

Distance and Duration. The mean estimated distance of colony movement was 3.7 ± 2.3 m (range, 1–13 m). We made no distinction between healthy and infected colonies because *T. solenopsae* did not affect colony movement.

The methodology we used here probably underestimated the distance of displacements. Because it was impossible to keep track of all individual colonies and no reliable marking technique was available, the exact distance that a colony is capable of moving remains unknown. Range of distances reported by Lofgren et al. (1975) for the red imported fire ant, *S. invicta*, in the United States was 1–30 m, but they also were not sure of the origin of each new colony.

The mean (weighted) duration of the colonies in the same place was 3.1 mo, but 48.7% of the colonies remained in the same location for only 1.4 mo, 20.8% for 2.8 mo, 10.1% for 4.2 mo, 8.1% for 5.6 mo, 7.4% for 7 mo, and the remaining 5% for 8.4–12.6 mo. This is consistent with Hays et al. (1982) who reported that, in their 3-yr study in South Carolina, most colonies of *S. invicta* occupied their mounds for <1 yr and only a few remained in the same location during the complete study period.

We conclude that, in their native land, colonies of *S. richteri* move the mounds very frequently and the microsporidium *T. solenopsae* has no major influence on colony movement. Rainfall is one of the stimuli of colony movement.

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