SUPERCOOLING STUDIES ON THE IMPORTED FIRE ANTS: *SOLENOPSIS INVICTA* AND *SOLENOPSIS RICHTERI* (HYMENOPTERA: FORMICIDAE) AND THEIR HYBRID

Stan K. Diffie and D. Craig Sheppard
Department of Entomology
University of Georgia
Coastal Plain Experiment Station
Tifton, GA 31793
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ABSTRACT

The discovery of hybrid fire ants, *Solenopsis invicta* × *S. richteri,* in northwest Georgia at a more northern latitude than *S. invicta* led to an investigation into the hybrid's ability to withstand cold temperatures. This study was undertaken to determine if the hybrid would supercool at a lower temperature than either parental species. Major workers, male alates, and female alates of the three ant types were collected, and supercooling points were determined. Of the three castes tested, only male alates of the hybrid and *S. richteri* had lower supercooling points than did *S. invicta.* The inhabitance of north Georgia by the hybrid fire ant and not *S. invicta* does not seem to be determined by supercooling.

Key Words: *Solenopsis invicta, Solenopsis richteri,* hybrid, supercooling.

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INTRODUCTION

The ability of insects to survive freezing temperatures can be attributed to one or two phenomena: favorable microclimates and/or cold-hardiness. Supercooling, cold acclimation, and freeze tolerance are the three components of cold-hardiness (Danks 1978). Supercooling is the ability to avoid freezing at temperatures below the melting point. The supercooling temperature of an insect is determined by measuring the temperature at which the insect freezes.

Imported fire ants were first reported in Floyd County of northwest Georgia in 1984 and represented the northern-most infestation of imported fire ants in Georgia. Because these ants were found 130 to 160 km north of previous fire ant infestations, a positive identification was sought. Major workers collected on a subsequent trip to the area were sent to the Insects Affecting Man and Animals Laboratory in Gainesville, FL. Gas chromatographic traces of the cuticular hydrocarbons and venom analyses identified the ants as hybrids of *Solenopsis invicta* Buren × *S. richteri* Forel (Diffie et al. 1988). The discovery of this "hybrid" fire ant in this geographical area prompted several questions concerning the extension of the imported fire ant's range. Monitoring winter-kill of *S. invicta* in north and south Georgia and the hybrid in north Georgia has revealed no appreciable amount of mortality during the past three years (unpublished data). Soil temperatures during this time period (National Weather Service - Auburn, AL) showed only four days of below 0°C at the 10 cm depth. These freezing temperatures occurred only in North Georgia in areas infested with *S. invicta.* We determined

supercooling temperatures of *S. invicta, S. richteri,* and their hybrid to define the role of supercooling ability in the northern extension of the range of these ants.

MATERIALS AND METHODS

Colonies of *S. richteri* were collected on 18 February, 1986, in Tishomingo County, MS. *Solenopsis invicta* and the hybrid were collected on 19 February 1986, in Georgia from Tift and Floyd Counties, respectively. Colonies were collected by shoveling the active mounds into ten-gallon plastic garbage cans. The upper inside edges of these cans had been treated with Fluon® to prevent the ants from escaping. The ants were then transported to the laboratory in Tifton and maintained in a greenhouse. Foraging ramps were established in each colony. Diet (Williams 1980) and water were provided regularly to the distal end of the ramps. This technique allowed for the collection of foragers and not other age classes which minimized the variation in age of ants collected (Vinson 1983).

Fifty major workers collected from each ant type were placed in petri dishes. The method used to determine the supercooling temperatures was adapted from the method described by Francke et al. (1986). Supercooling temperatures of ants were individually measured using a Bailey Instruments MT-29/1 microprobe. Vasoline® petroleum jelly held the ant's abdomen to the microprobe. A Bailey Instruments digital thermometer BAT-12 displayed the readings to 0.1°C resolution. The ant and microprobe were then lowered into an ice chest containing dry ice. At the point when the abdomen froze, exothermic heat was given off causing the temperature to increase briefly, indicating the supercooling temperature. The lowest temperature prior to the heat exchange was recorded as the supercooling temperature.

Supercooling temperatures of alates were determined at the original collecting sites on 10 and 11 October 1987. Male and female alates were collected from active mounds. They were then carried to a field laboratory and tested within two hours. The same procedure was used as described earlier.

The results were grouped according to caste. The three types of ants were then compared within castes using Duncan's Multiple Range Test ($P < 0.05$).

RESULTS AND DISCUSSION

The hybrid major workers had a significantly higher supercooling temperature ($p < .05$) than majors of the two other ant types (Table 1). The hybrid is found at a similar latitude as *S. richteri* and at a higher but somewhat overlapping latitude than *S. invicta. Solenopsis richteri* and *S. invicta* major workers did not differ significantly in their supercooling temperatures. The higher supercooling temperature means the hybrid major workers freeze sooner than the major workers of the two other ant types and in itself contradicts their geographical distribution.

Statistical differences were not found among the supercooling temperatures of the female alates of three ants. The two parental lines afforded almost identical results. Differences here could most convincingly have explained the northerly range extension.

The male alates did show a correlation between geographical range and supercooling temperature. *Solenopsis richteri* and the hybrid had significantly lower supercooling points than male alates of *S. invicta*. The former two did not differ significantly.

Table 1. Supercooling temperatures of male alates, female alates, and major workers °C.

	Male Alates			Female Alates			Major Workers		
	n	$\bar{x}$	Standard Deviation	n	$\bar{x}$	Standard Deviation	n	$\bar{x}$	Standard Deviation
Solenopsis invicta	42	−5.33 b*	(± 1.75)	55	−6.18 a	(± 2.08)	49	−6.57 a	(± 1.19)
Hybrid	19	−6.55 a	(± 1.99)	18	−5.96 a	(± 1.48)	49	−5.90 b	(± 0.80)
Solenopsis richteri	23	−5.84 a	(± 2.43)	41	−6.17 a	(± 1.74)	49	−7.01 a	(± 1.62)

* Mean temperatures within a column followed by the same letter are not significantly different ($P < 0.05$).

The range of supercooling temperatures we measured for the ant types tested was ca. −5.3° to −7.0°C. This is higher than the values Taber et al. (1987) gave for minor workers of *S. invicta* held in the lab (ca −9° to −15°C) and most values given by Francke et al (1986) for *S. invicta* adults (−6.8° to −11.2°C). Supercooling temperatures measured in this study are most comparable to values given by Taber et al (1987) for *S. invicta* workers collected in the field (ca −4.5° to ca 6.0°C). Our supercooling values for alates were measured immediately after field collection. Workers were held in colonies in a greenhouse for testing in light conditions approximating those in the field. Most ants held for testing by Taber et al. (1987) and all those by Francke et al. (1986) were held in complete darkness. This may have caused a lowering of supercooling points in their tests. Taber et al. (1987) speculated that photoperiod may have been responsible for the large difference in supercooling temperatures seen in *S. invicta* minors collected directly from field colonies versus those held in their lab.

Of the three castes studied, only the male alates showed a correlation between the geographical distribution of the ants and the temperatures at which their abdomen froze. Although the male alates are obviously vital in the continuation and expansion of the species, the northward spread of fire ants is not determined by this caste alone. If lower supercooling temperatures of hybrid female alates had been found then this would explain better survival of queens in newly founded colonies, and could be an explanation for their distribution. In the absence of this data it appears that a lower supercooling point is not a factor in the more northerly range of the hybrid. Some behavioral factor such as mound construction or foraging ability may be responsible.

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