SUPERCOOLING POINTS OF RED IMPORTED FIRE ANTS, *SOLENOPSIS INVICTA* (HYMENOPTERA: FORMICIDAE) FROM LUBBOCK, TEXAS[1]

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ABSTRACT: Supercooling points were measured for multiple queen colonies of the red imported fire ant, *Solenopsis invicta,* from Lubbock, Texas. Ten minor workers from each of three marked field colonies and from one colony held at constant conditions in the laboratory were tested at two week intervals from 14 October 1985 to 17 February 1986. Supercooling abilities of field specimens differed markedly from those of laboratory specimens. Significant differences among mean supercooling temperatures of ants in the field were found among sampling periods, but not among colonies. The maximum difference over time among sample mean supercooling points was less than 2 C°, and the lowest mean supercooling point was slightly higher than -6°C.

We first became aware of the presence of red imported fire ants in Lubbock, Texas, during August 1985, when homeowners from a single subdivision reported colonies which apparently had been present for several years. This information was of immediate interest because Lubbock, at 33.5° N latitude, then represented the extreme northwestern record of *Solenopsis invicta* Buren. Furthermore, at 980 m elevation the Lubbock population is among the highest on record in the U.S.A.

Winter-kill has been cited as an important limiting factor in the northward spread of introduced fire ants (Moody et al. 1981). The ultimate distributional limits of the introduced fire ants in the U.S.A are thought to be linked to cold-hardiness (Francke and Cokendolpher 1986, Francke et al. 1986 and citations therein). One prediction of the ultimate range of this species in Texas excluded the Panhandle area north of the -18°C minimum temperature isotherm because of low winter temperatures in that area (Pimm and Bartell 1980 and citations therein). Lubbock County is located at the base of the Texas Panhandle, along the -18° C minimum temperature isotherm, and therefore is an ideal position for researchers to examine cold-hardiness of *S. invicta* and its ability to survive winter conditions.

Cold-hardiness in insects may be divided into three general categories: (1) cold-acclimation and acclimatization, (2) supercooling, and (3) freezing-tolerance (Salt 1961). Cold-acclimation/acclimatization require some tolerance or physiological preparation to avoid injury at

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temperatures too low for continued growth. We herein refer to short-term, physiological adjustments in the laboratory as acclimation and those occurring naturally in the field as acclimatization. The ability to supercool is an adaptation in which insects avoid injury by resisting the freezing process. If the organism is able to withstand bodily freezing, it is described as being freeze-tolerant.

Previous work with laboratory colonies of North American fire ant species revealed no significant differences among mean supercooling temperatures of *Solenopsis aurea* Wheeler, *S. richteri* Forel, and *S. xyloni* McCook within the minor caste (Francke et al. 1986). Neither was a significant difference found between *Solenopsis invicta* and *S. geminata* (Fabricius), but the two species were significantly different. From the same study the following generalizations were made: (1) worker ants have a slightly lower supercooling point than do reproductives, (2) within a given species, immature ants have lower supercooling points than do adults, and (3) pupae have lower supercooling temperatures than do larvae. The effects of acclimation on the freezing point of *S. invicta* were tested by maintaining major, medium, and minor workers at each of three temperatures: 12°, 22°, and 32°C. No significant differences were noted among treatments, nor in the interactions between castes and treatments, but significant differences were found among castes. However, nothing was previously known of the acclimatization abilities of *S. invicta.* Therefore, we investigated the supercooling abilities of red imported fire ants in a field situation during the fall and winter months.

MATERIALS AND METHODS

The same equipment and procedures reported by Francke et al. (1986) were used to measure supercooling points (lowest body temperature reached before spontaneous freezing). Following those procedures the temperature of the ants decreased by approximately 5C° per minute. At two week intervals, from 14 October 1985 until 17 February 1986, we collected 10 minor workers from each of three designated mounds and determined their supercooling points immediately upon returning to the laboratory. Experiments were concluded by March because the ants were poisoned in an effort to control their spread in Lubbock. Ten samples were taken during the 18 week period. The previous study (Francke et al. 1986), demonstrated that supercooling abilities differ among caste members. Therefore, we used minor workers in the present experiments because they were reported to have the lowest supercooling points among adults tested. Supercooling points of 10 minor workers, from a laboratory colony previously (September 1985) removed from the field locality, were determined at two week intervals until 3 February. The laboratory colony was maintained with the same food, light, and temperature regimens used

by Francke et al. (1986). Direct observations of the laboratory colony and numerous other colonies collected from the study site revealed the Lubbock population to be composed of multiple queen colonies.

RESULTS AND DISCUSSION

No significant differences were found among mean supercooling points from the three field colonies using a one-way analysis of variance [$F(2, 297) = 0.45$, $p > 0.05$]. Analysis of covariance confirmed this finding but revealed significant differences among samples taken throughout the season [$F(1,294 = 115.38$, $p < 0.05$]. The mean supercooling temperature $\pm$ standard error for each sampling period is shown in Fig. 1. The data seem to show oscillatory changes in the supercooling points over the 18 week period, and there does not appear to be monotonic acclimatization in minor workers of *S. invicta.* The maximum difference between mean supercooling temperatures is less than 2C°, and the minimum individual supercooling temperature recorded was -7.6°C.

The mean supercooling points $\pm$ standard errors for minor workers from a laboratory colony are shown in Fig. 2. The reasons for the large standard errors are not immediately apparent. Diet may be a factor; the laboratory colony was supplied with cockroaches, mealworms, and water. Temperature and photoperiod may also affect the supercooling point. The laboratory colony was kept in complete darkness at a constant 22°C, whereas the field colonies experienced normal photoperiods and fluctuating temperatures. These comparisons are interesting; but because the primary goal of this study was to observe changes of mean supercooling points in field colonies over time, no further investigation of the laboratory colony was pursued.

Like Francke and Cokendolpher (1986) and Francke et al. (1986), we noted no ants that survived freezing, and therefore, freeze-tolerance as a possible overwintering mechanism in *S. invicta* was excluded.

In summary, the following points are important: (1) differences among supercooling abilities of ants in the field were noted among samples over time, but not among colonies, (2) differences among sampling periods might not be due to acclimatization, (3) the mean supercooling points for field colonies varied less than 2°C from October through February, but never fell below -6°C, and (4) supercooling abilities of the red imported fire ant are altered in the laboratory.

Recent soil temperature measurements (Harlan Thorvilson et al., unpub. data) obtained in the immediate vicinity of the field colonies indicate that the temperature at a depth of 30 cm between 6 January and 20 February 1986 never fell below 4°C. If the supercooling temperature of *S. invicta* is the primary measure of cold-hardiness, such a soil temperature would cause little mortality.

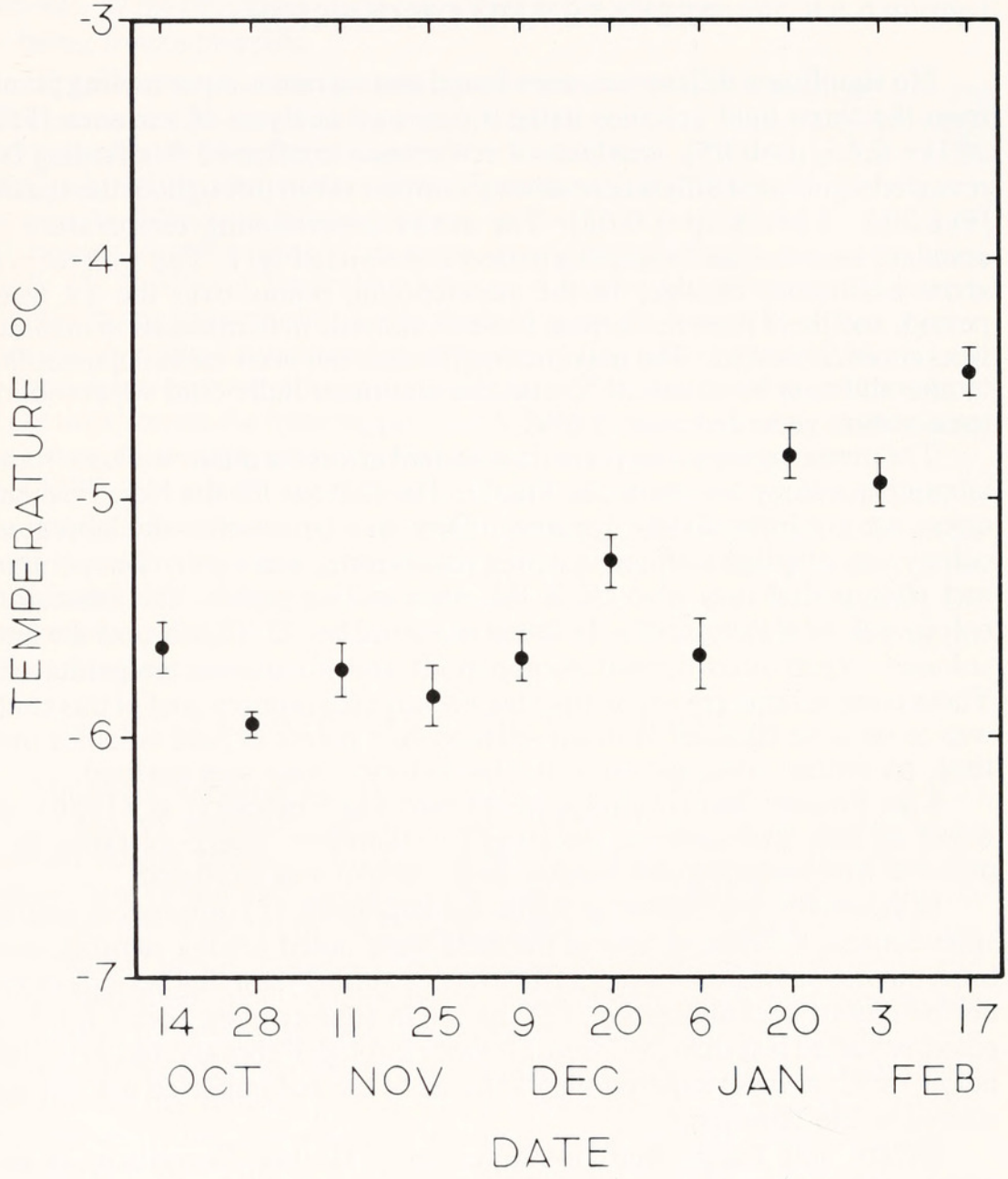

Fig. 1. Mean freezing points ± standard errors of minor workers of *Solenopsis invicta* in field samples from Lubbock, Texas.

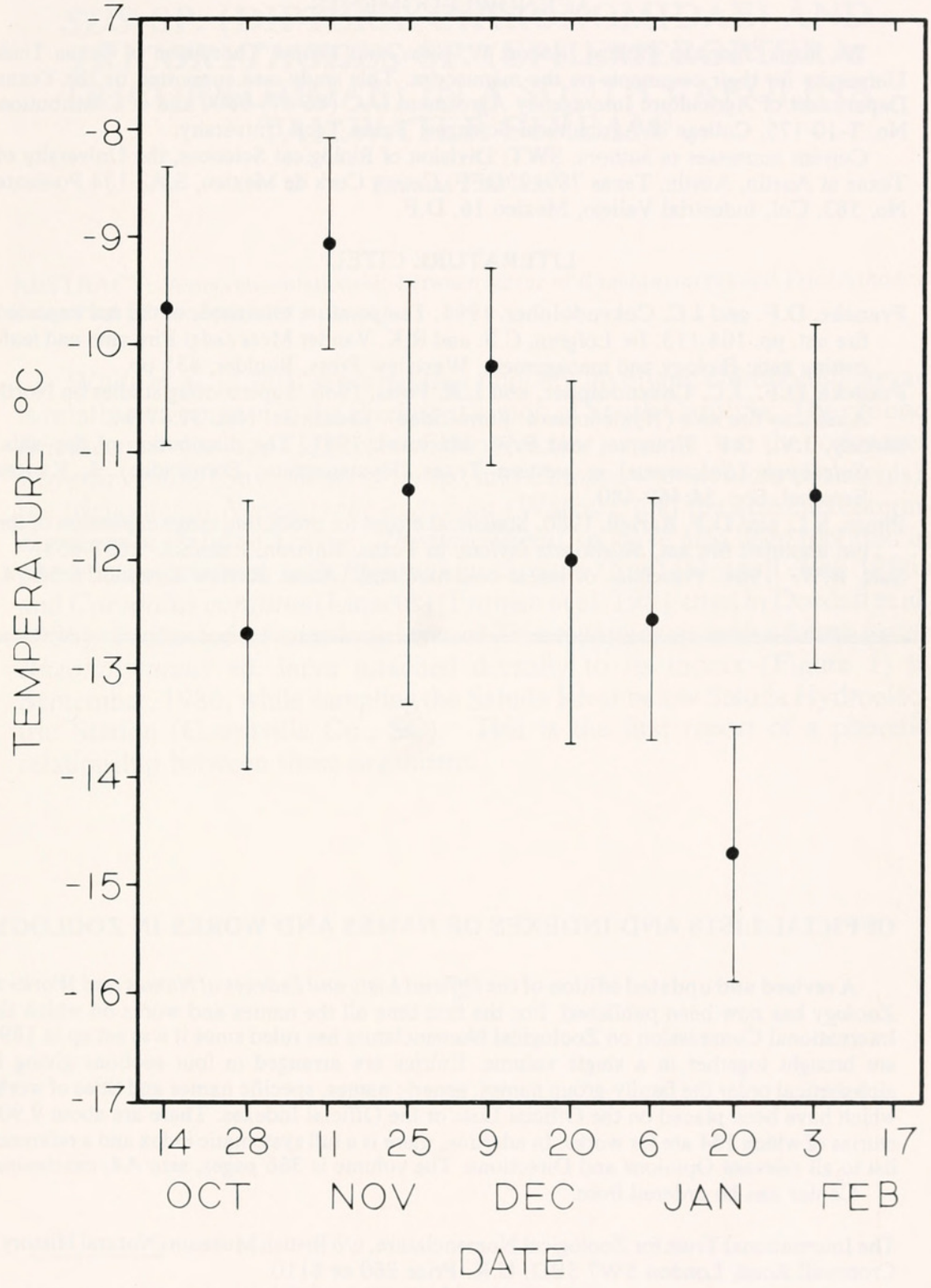

Fig. 2. Mean freezing points ± standard errors of minor workers of *Solenopsis invicta* from a laboratory maintained colony from Lubbock, Texas.

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