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1974 PROGRESS REPORT

[FINAL]

WATER LOSS IN CHIHUAHUAN DESERT ANTS

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This Research Memorandum is one of two manuscripts prepared for publication from the Desert Biome project entitled "Demography and role of herbivorous ants in a desert ecosystem as functions of vegetation, soil and climate variables" — W. G. Whitford, project leader. The other manuscript appears as Research Memorandum 75-28. The two Memoranda constitute the final report on the project.

ABSTRACT

During the first eight hours of exposure, all species of seed harvesters had similar dessication rates, and *Formica perpilosa*, a plant exudate feeder, had a higher dessication rate and lower dessication resistance. Dessication rate and dessication resistance were not correlated with foraging behavior in *Pogonomyrmex* sp. and *Novomessor cockerelli*, but were similar to ants from the Saharan Desert. There was no relationship between body size and dessication rate and resistance, but female sexuals of *N. cockerelli* had lower rates and greater resistance than did workers and male sexuals of the same species.

INTRODUCTION

Little is known about the physiological relationships of ants which inhabit desert regions (Cloudsley-Thompson 1975). Ettershank and Whitford (1973) and Kay and Whitford (1975) have studied the influence of temperature and humidity on respiration in Chihuahuan Desert ants. Schumacher and Whitford (1974) presented data on critical maximum and minimum temperatures in two species of desert ants. The only comprehensive study of the physiology of desert ants was that of Dlye (1969) in which he compared rates of water loss and lethal temperatures for Saharan Desert ants with congeners from southern France.

Our studies (Whitford and Ettershank, in press; Schumacher and Whitford 1974) suggested that differences in rates of water loss might be important in understanding the foraging ecology of Chihuahuan Desert ant species. With respect to foraging habits, these ants can be grouped into two "guilds," 1) seed harvesters or 2) plant or insect exudate feeders. We selected five species of seed harvesters and one exudate feeder for our studies because we had data on the foraging ecology of those species and they were of sufficiently large size for our experiments.

This study was designed to evaluate differences in dessication rates in six species of Chihuahuan Desert ants as related to size, foraging behavior and geographical distribution.

METHODS

The ants used in this study were collected at the New Mexico State University Experimental Ranch and Aguirre Springs, ca. 40 km NNE and ca. 30 km E, respectively, of Las Cruces, Dona Ana County, New Mexico, between May and July 1974. Ants were collected by aspiration and transferred to plastic boxes lined with moist paper toweling for transport to the laboratory.

In the laboratory, the ants were held for approximately 12 hr in constant-temperature chambers at 25 C in the paper-lined boxes, then transferred to plastic vials which had

wire screening on both ends to allow air to flow through the vial. The vials containing the freshly collected ants were weighed on a Mettler Balance (Model H20) and then placed in a Plexiglas box (32 cm x 18 cm x 10 cm) in which the vials were mounted in holes in the cover. Air was pumped through the box at a rate adjusted to replace the volume of air in the vials every minute. The experiments and weighings were made inside a walk-in environmental room maintained at 35 C and 0% RH. Weighings were made at 1.5, 3.0, 4.5, 6.0, 9.5, 12.0 and 24.0 hr after the start of an experiment. At each interval the number of dead ants in each vial was recorded. Each vial contained eight ants and between four and eight replicates were measured for each species.

The critical thermal maximum for *Pogonomyrmex barbatus* was measured by the methods described in Schumacher and Whitford (1974).

RESULTS

The conditions at which the ants were held prior to the experiments had no apparent effect on them. There was no mortality in the ants held in the laboratory and they exhibited the same activity as freshly captured ants.

Workers of *Formica perpilosa*, a species which feeds primarily on plant exudates, had the highest dessication rate and *Novomessor cockerelli*, a species which is primarily nocturnal, the lowest dessication rate (Fig. 1). The maximum deviation of any replicate was 9%, but more commonly in the range of 1-3%. The dessication rate in all *Pogonomyrmex* species was similar, resulting in a loss of 56-57% of the initial body weight in 24 hr (Fig. 1). All of the seed harvesters had similar dessication rates for the first 8 hr of exposure. Only *F. perpilosa* had a significantly higher rate of water loss during the first 8 hr of exposure (Fig. 1). All of the *F. perpilosa* died within 12 hr. Individuals of all of the other species survived a 24-hr exposure, but *P. desertorum*, *P. rugosus* and *P. californicus* had over 85% mortality (Fig. 2).

When dessication rates of male sexuals, female sexuals and workers of *N. cockerelli* were compared, male sexuals and

workers were nearly identical (approximately 50% body weight loss in 24 hr) but the female sexuals lost only 23% of their body weight in 24 hr (Fig. 3). Mortality in *N. cockerelli* showed a similar pattern with about 50% of the male sexuals and workers dead in 24 hr, while only 20% of the female sexuals died (Fig. 4).

The mean critical thermal maximum of *P. barbatus* was 51.7°C. The mean live weights of the species studied were: *F. perpilosa* -- 560 mg; *N. cockerelli* workers -- 742 mg, male sexuals -- 179 mg, female sexuals -- 1030 mg; *P. barbatus* -- 647 mg; *P. californicus* -- 550 mg; *P. desertorum* -- 680 mg; and *P. rugosus* -- 754 mg.

DISCUSSION

Comparison of dessication rates in the first 4 to 8 hr of exposure is the most meaningful ecologically since this represents the maximum time an individual forager making repeated foraging trips would be exposed to a dessicating environment. Comparisons of dessication rates and resistance

for periods greater than 8 hr have ecological implications only if workers are unable to completely rehydrate at night in the nest environment. Since we know of no data on rehydration in ants, we can assume either complete or incomplete rehydration in interpreting these data. The lack of difference in dessication rates in the "harvester guild" during the first 8 hr, although there are differences in the physical environments encountered during surface activity by these species, is surprising. The only result consistent with the relationship between foraging behavior, environment stress and dessication is the lower death rate in *P. californicus* during the first 8 hr. *P. californicus* forages during midday at the highest soil surface temperatures and saturation deficits measured (Whitford and Ettershank, in press).

The critical thermal maxima of all the species were similar (Whitford and Ettershank, in press; Schumacher and Whitford 1974), except for *F. perpilosa*, which had the highest dessication and mortality of the six species studied. The critical thermal maxima and dessication rate during the first 8 hr show the same pattern.

Figure 1. Mean water loss in six species of Chihuahuan Desert ants expressed as percent body weight. FOR = *Formica perpilosa*; RUG = *Pogonomyrmex rugosus*; BAR = *Pogonomyrmex barbatus*; DES = *Pogonomyrmex desertorum*; CAL = *Pogonomyrmex californicus*; NOV = *Novomessor cockerelli*.

Figure 2. Mortality resulting from water loss in six species of Chihuahuan Desert ants. Symbols are the same as in Figure 1.

There was no clear relationship between desiccation rates, desiccation resistance and the foraging ecology of most of the species studied. *N. cockerelli*, which had the lowest desiccation rate, is subject to little desiccation stress since it forages primarily at night during the summer months (Whitford and Ettershank, in press). *P. barbatus*, which with *N. cockerelli* had the greatest resistance to desiccation stress, forages at environmental conditions nearly identical to its congener *P. rugosus* (Johnson, Ramirez and Whitford, unpubl. data). Also, *P. barbatus* does not inhabit areas as arid as those inhabited by *P. californicus* (Cole 1968), a species which forages at soil surface temperatures and saturation deficits higher than the other *Pogonomyrmex* studied (Whitford and Ettershank, in press), but which has lower resistance to desiccation than *P. barbatus*. This lack of correlation between desiccation and foraging ecology in *Novomessor* and *Pogonomyrmex* suggests that factors other than environmental conditions experienced by foragers were responsible for evolution of resistance to desiccation and structure of the cuticle which affects rates of water loss.

In closely related species such as *P. californicus*, *P. desertorum* and *P. rugosus*, it has been suggested niche division consisted mainly of seasonal division of peak foraging

time (Schumacher and Whitford 1974). Other studies have suggested that differences in desiccation resistance between the species involved might be an important factor in such seasonal division of peak foraging time (Kay and Whitford 1975). The data of this study show this is not a significant factor affecting seasonal differences in peak foraging activity.

The desiccation rate and resistance of *F. perpilosa* were correlated with its foraging ecology. *F. perpilosa* forages mainly on plant exudates and spends most of the time it is above ground in plant canopies where ambient temperatures rarely exceed 35 C (Schumacher and Whitford 1974).

Since body surface areas vary with body weight as KW^b where b is a fractional exponent (van Bertalanffy 1957), it is assumed that water loss per unit weight should be lower in large animals. However, there was no direct relationship between body size and the desiccation rate in the species studied. The *N. cockerelli* workers and male sexuals differ in body weight by 563 mg, yet exhibited almost identical desiccation rates. The four *Pogonomyrmex* species with similar desiccation rates differed in body weight by as much as 204 mg.

Figure 3. Comparison of mean water loss in female sexuals (A), workers (B) and male sexuals (C) of *Novomessor cockerelli*.

Figure 4. Mortality resulting from water loss in female sexuals (A), workers (B) and male sexuals (C) of *Novomessor cockerelli*.

The resistance to dessication in female sexuals of *N. cockerelli* appears to be an important adaptation contributing to the assurance of reproductive success. After mating, female sexuals are subjected to both heat and dessication stress while searching for a suitable place to establish a colony and dig a nest. Search for a nest site may occupy two to three days following the nuptial flight (pers. obs.). The larger body size and more favorable surface to mass ratio may also contribute to the dessication resistance of female sexuals but does not appear to be of great importance since workers and male sexuals have nearly identical dessication resistance. Male sexuals would not require the dessication tolerance of workers or female sexuals since nuptial swarming usually occurs at night, during or immediately following rains.

There was a relationship between feeding "guild" and dessication resistance. The seed harvesters, *Pogonomyrmex* and *Novomessor*, which are exposed to high temperatures and dessication stress while searching for seeds on the soil surface, had rates of water loss and critical thermal maxima similar to Saharan ants (Dlye 1969). The exudate feeder, *F. perpilosa*, exhibited water loss at rates comparable to ants from more mesic environments. The collection of liquid food would allow greater water loss without physiological detriment than would be possible in species dependent on dry seeds as their primary food source.

LITERATURE CITED

- CLOUDSLEY-THOMPSON, J. L. 1975. Adaptations of arthropoda to arid environments. *Ann. Rev. Entomol.* 20:261-283.
- COLE, A. C. 1968. *Pogonomyrmex* harvester ants. Univ. of Tennessee Press, Knoxville.
- DLYE, G. 1969. Recherches sur l'cologie, la physiologie et l'thologie des fourmis du Sahara. Thses: Universit d'Aix-Marseille. 155 pp.
- ETTERSHANK, G., and W. G. WHITFORD. 1973. Oxygen consumption of two species of *Pogonomyrmex* harvester ants (Hymenoptera:Formicidae). *Comp. Biochem. Physiol.* 46A:605-611.
- KAY, C. A., and W. G. WHITFORD. 1975. Influences of temperature and humidity on oxygen consumption of five Chihuahuan Desert ants. *Comp. Biochem. Physiol.* 50A: 281-286.
- SCHUMACHER, A. M., and W. G. WHITFORD. 1974. The foraging ecology of two species of Chihuahuan Desert ants: *Formica perpilosa* and *Trachymyrmex smithi neomexicanus* (Hymenoptera:Formicidae). *Insectes Sociaux* 21:317-334.
- VAN BERTALLANFFY, L. 1957. Quantitative laws in metabolism and growth. *Quart. Rev. Biol.* 32:217-231.
- WHITFORD, W. G., and G. ETTERSHANK. Factors affecting foraging activity in Chihuahuan Desert harvester ants. *Environ. Entomol.* (In press)