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Activity Patterns of the Red Harvester Ant in a Mexican Tropical Desert

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Abstract

Red harvester ant (*Pogonomyrmex barbatus)* inhabits deserts of USA and Mexico. Its activity patterns are well known in temperate deserts, but they have not been studied in tropical ones. We studied these patterns in the Tehucan Valley, a tropical desert in central Mexico. It had bimodal activity patterns in spring, summer, and fall while unimodal patterns in winter. These patterns differ from those reported for this species in temperate deserts where activity stopped in winter. Our results suggest that *P. barbatus* extends its activity periods and remains active all year round in the Tehuacan Valley.

Introduction

Red harvester ant **(***Pogonomyrmex barbatus* Smith) is one of the most common and abundant species in deserts of USA and Mexico (Johnson, 2000). This ant harvests high proportions of seeds from annual and perennial plants, affecting their abundance and distribution. Activity patterns determine periods in which ants forage seeds, therefore it is essential to document them and how they change along year in sites located at different latitudes.

Activity patterns of several *Pogonomyrmex* species, including *P. barbatus*, have been studied in North American temperate deserts. Diurnal ants are active in the morning and late afternoon with a period of decline around midday when temperatures reach maximum values, showing a bimodal pattern of activity most of the year (Whitford, 1978; MacKay & MacKay, 1989; Pol & Lopez de Casenave, 2004). Ants diminish activity during winter changing to inactivity or to a unimodal pattern by being active during the hottest hours of the day (Whitford & Ettershank 1975; Hölldobler & Wilson, 1990; Crist & MacMahon, 1991). Although these activity patterns are known in temperate deserts, they have not been studied in tropical ones. *Pogonomyrmex barbatus* is distributed in North American temperate and tropical deserts; however, no reports exist about its activity in the tropics. We study activity patterns of this ant species in the Tehuacan Valley, a tropical desert in central Mexico. This study represents the southernmost site where activity has been studied until now (Figure 1).

Because seasonal and daily temperature variation is lower in tropical than in temperate regions (MacKay & MacKay, 1989), we expect *P. barbatus* will be active all year round at the Tehucan Valley compared to northern locations. This paper reports the number of ants returning to the nest and soil surface temperature for all seasons of the year. Although activity patterns depend on environmental factors such as seed availability, daily and seasonal temperatures, we only measured soil surface temperature because it is considered the most important factor regulating ant activity in deserts (Whitford, 1999).

Material and methods

This study was conducted at San Rafael Coxcatlán (18° 12' - 18° 14' N, 97° 07'- 97° 09' W; 1000m a. s. l.; Fig 1) in the Tehuacán Valley, central Mexico. The mean annual temperature is 25°C and the mean annual rainfall is 394.5 mm (Valiente, 1991). The main vegetation type is tropical deciduous forest dominated by *Fouquieria formosa*, *Bursera aptera*, and *Ceiba parvifolia* (Ríos-Casanova et al., 2006).

We selected 8 nests separated by at least 10 m each, to count the number of ants returning to nest during 5-min periods. Counts were conducted from 0700–1900 h during one day in fall (September 2010), winter (December 2010), spring (March 2011), and summer (July 2011) for a total of 384 observation periods. Nocturnal activity was not recorded. Soil surface temperature was recorded every hour (0700–1900 h) by placing one thermometer at 30 cm from nest entrance and burying the mercury containing bulb at 1 cm depth.

Results

Ants showed a bimodal activity pattern during fall, spring, and summer (Fig. 2). Foraging activity started when surface temperature rose to 21°C. The first activity peak (60-71 ants/5 min) occurred between 11-13 h, when soil surface temperature was 36-42ºC. The second peak (10-40 ants/5 min) occurred in the afternoon (16-17 h), when temperature was 39-47ºC. Foragers stopped activity between peaks in spring when maximum temperature was ca. 50ºC while they were always active between peaks in summer and fall. The maximum temperature in these seasons was 45-47ºC.

Ants only showed one activity peak in winter (20 ants/5 min), which occurred during midday when temperature was 40°C, which was the highest temperature recorded in the season (Fig. 2).

Discussion

Our results showed that *P. barbatus* has bimodal activity patterns in spring, summer, and fall, and unimodal activity patterns in winter. Activity peaks in bimodal patterns occurred when soil surface temperature was 36-47ºC. Activity stopped when temperature rose to 50ºC. Activity peak in unimodal patterns occurred when temperature was 40ºC.

The activity pattern found in our study differs from that reported for *P. barbatus* in a temperate desert (García-Pérez et al., 1994), where bimodal activity patterns occurred in spring and summer, and unimodal patterns ocurred in fall. This ant species was not active in winter (Garcia-Perez et al., 1994). Our findings therefore suggest that *P. barbatus* inhabiting a tropical desert extends its activity periods and remains active all year round, according to our predictions.

Despite differences in activity patterns, it seems that soil surface temperature is one of the main environmental fac-

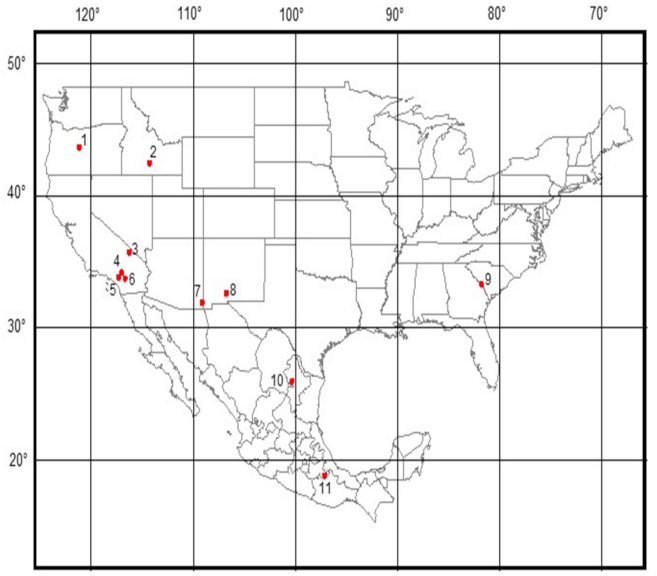

Fig 1. Localities where *Pogonomyrmex* activity has been studied. 1 = *P. owyheei*, 2 = *P. occidentalis* (Bernstein, 1979), 3 = *P. californicus*, *P. rugosus*, (Bernstein, 1974), 4 = *P. montanus*, 5 = *P. rugosus*, 6 = *P. subnitidus* (MacKay & MacKay, 1989), 7 = *P. barbatus* (Gordon, 1983), 8 = *P. rugosus* (Whitford & Ettershank, 1975, 9 = *P. badius* (Golley & Gentry, 1964), 10 = *P. barbatus* (García-Pérez, et al., 1994), 11 = *P. barbatus* (this study).

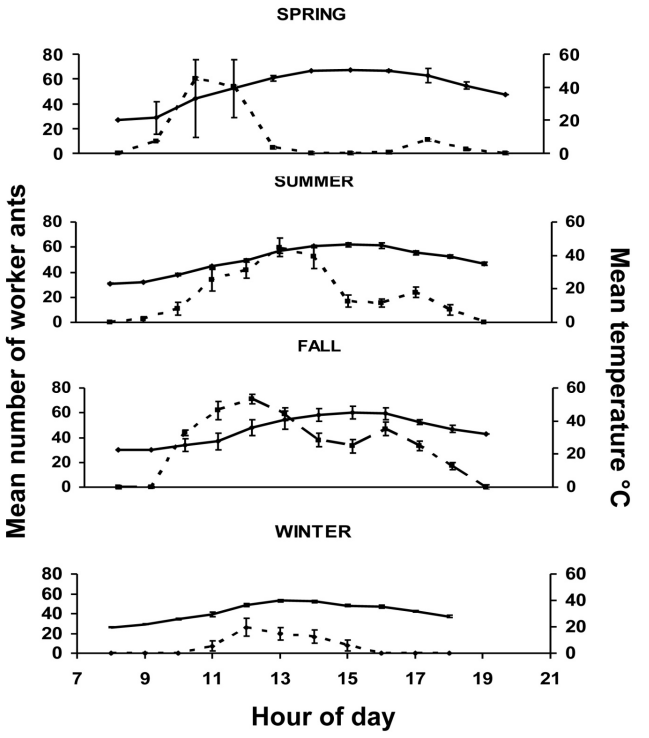

Fig 2. Mean soil surface temperature ± 1 standard error (solid line) and average number of active ants (*P. barbatus*) outside the nest ± 1 standard error (dashed line) hourly and four seasons of the year in San Rafael Coxcatlán, Puebla, Mexico.

tors regulating activity of this ant species in temperate and tropical deserts. Johnson (2000) in analyzing physiological thermal tolerance of *P. barbatus* from the Chihuahuan Desert found that ant foragers stopped their activity at 47°C because they were unable to survive at higher temperatures. Our data on soil surface temperature indicate that ant activity stopped at 50°C. Other *Pogonomyrmex* species such as *P. montanus*, *P. subnitidus*, *P. apache*, and *P. rugosus* from temperate North American deserts also reduce or stopped their activity when surface temperature was > 50°C (MacKay & MacKay, 1989; Hölldobler & Wilson, 1990; Whitford, 1999). These findings suggest that activity patterns of *Pogonomyrmex* species are regulated by soil surface temperature. This may be interpreted as an adaptation of these ants to high desert temperature, independently of latitude, which may be a phylogenetically conserved trait (MacMahon et al., 2000). Our results however should be interpreted cautiously because they assume that soil surface temperature is the only factor regulating ant activity. Other factors such as seed availability, presence of other harvester ants, predation, and plant relationships which also regulate activity were not measured in this study (Wilby & Shachak, 2000; Pol & López de Casenave, 2004). These factors should be considered in future studies to determine their relative importance on ant foraging activity.

In short, *P. barbatus* extends its activity period and remains active all year round in the Tehuacan Valley. Evaluation of activity patterns throughout its distribution is essential to understand seed foraging impact on plant abundance and distribution.

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