



Short communication

The functional significance of cemented nest caps of the harvester ant, *Pogonomyrmex maricopa*

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Harvester ants, *Pogonomyrmex maricopa*, construct cemented caps on the sand mound nests in a fine sand dune area. The caps are approximately 60% calcium carbonate that is transported from the underlying calcium carbonate layers. The caps protect the nest structure from being eroded away during high-wind periods. Partial erosion of the cemented caps adds calcium carbonate to the sand dune soils.

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Ants are ubiquitous in deserts and are present even in hyperarid environments (Holldobler & Wilson, 1990). Ants build structures that allow colonies to survive in environments that would be lethal without the structures. For example, high mounds of *Camponotus punctulatus* (average 70 cm) in the periodically inundated Chaco region in South America allow the colonies to escape the flood waters (Pire *et al.*, 1991). Sparsely vegetated sand dune environments present a challenge to long-lived colonies of social insects such as ants. Here, I report on ant-built structures that allow colonies to survive in a mobile sand environment.

Mobile sand in dune fields is a hazardous environment for animals that live in burrows or subterranean nests (Halverson *et al.*, 1976). In areas where dunes are stabilized by vegetation, most burrows and subterranean nests are constructed within the vegetation. Most sand dunes are relatively recent features of the Jornada Basin in southern New Mexico (Buffington & Herbel, 1965). These dunes develop around multi-stemmed mesquite (*Prosopis glandulosa*) and eventually are stabilized by a coppice of mesquite stems. The ant communities within the mesquite coppice dunes are essentially the same as in adjacent desert grasslands (Wisdom & Whitford, 1981; Whitford *et al.*, 1999).

Geologically older sand dunes occur in small patches and support an indigo bush-broom dalea, *Psoralea scoparia* that partially stabilizes the sand. In surveys of ant communities of the Jornada Basin, we found colonies of a large seed-harvesting ant, *Pogonomyrmex maricopa*, on the flanks of dunes and in the interdune spaces of the *P. scoparia* dune fields. These studies were conducted on a *P. scoparia*

dune field located approximately 10 km north of Jornada Range Headquarters and approximately 70 km north north-east of Las Cruces, N.M. Nests of other ant species, primarily *Forelius* spp. and *Conomyrma* spp., were located within the partially buried canopies of the *P. scoparia*. *Pogonomyrmex maricopa* is a harvester ant that occupies areas of fine sands and fine sandy loam soils (Cole, 1968). The *P. maricopa* colonies were capped with a light gray concrete in the shape of a dome. The cemented domes covered between 50% and 75% of the nest mound. Because this habitat and the ant community were different from that of the mesquite coppice dune environments, the vegetation cover and composition, *P. maricopa* colony densities, and structural and chemical characteristics of the domed colonies were measured. Seasonal changes in structure of the *P. maricopa* nests were also recorded.

Vegetation cover and composition were measured by line intercept (Canfield, 1941) on ten, 100 m lines oriented east-west. The origin of the line intercepts was determined by random numbers between 0 and 20 that were taken from the odometer readings on the 2 mile (3.1 k) road at the edge of the dune field. Each line was established 20 m from the road. The average vegetation cover in the dune field was 16.8%. The *P. scoparia* cover was 11.9%, *Yucca elata* cover was 2.9%, *Atriplex canescens* cover was 0.4% and drop-seed grasses, *Sporobolus* spp. accounted for 1.3%. Capped nests were located on the flanks of dunes that formed around the *P. scoparius* plants. Most of the ant colonies were on the southern and western aspect of the *P. scoparia* dunes where the nests were exposed to the prevailing winds from the southwest. The deep sand environment provides habitat for spring-winter and summer annuals. The most abundant annuals in this community were *Eriogonum abertianum*, *E. annuum*, *Helianthus annuus*, *Verbesina encelioides*, and *Pectis* spp. The annuals provided an abundance of seeds that supported the harvester ants.

Densities of colonies of *P. maricopa* were estimated from five 10 m \times 150 belt transects. The belt-transect locations were established 20 m from the edge of the road at randomly drawn odometer readings. The average density \pm standard deviation of *P. maricopa* colonies was $37.4 \pm 12.7 \text{ ha}^{-1}$. The average diameter of the nest mounds encountered within the 10 m belt transects was $1.2 \pm 0.34 \text{ m}$. Five nest caps and paired reference soils were taken at random (number encountered in the belt transect) were collected for chemical analysis. The cemented nest cap material and reference soil cores 5 m from the nest were collected by 15 cm deep cores with a diameter of 8 cm. Calcium carbonate content was estimated by treating approximately 100 g of nest cap or reference soil with an excess of dilute hydrochloric acid. The nest cap material was estimated to be approximately $60 \pm 5\%$ calcium carbonate and the reference soil was approximately $4 \pm 0.5\%$ calcium carbonate. Concentrations of cations in the samples were obtained from the New Mexico State University Soil and Water Testing Laboratory. Data are reported as mean \pm standard deviation. The nest caps had significantly higher concentrations of calcium ($p < 0.05$, $t > 6.0$) ($1080 \pm 725 \text{ mg kg}^{-1}$ soil) and manganese ($3.5 \pm 0.7 \text{ mg kg}^{-1}$ soil) than the reference soils ($60 \pm 22 \text{ mg kg}^{-1}$ soil and $1.3 \pm 0.1 \text{ mg kg}^{-1}$ soil for calcium and manganese, respectively). There were no significant differences in concentrations of the other cations that were measured, i.e. zinc, magnesium, iron, sodium, and potassium. The *P. scoparia* sand dune area is underlain by a caliche (cemented calcium carbonate) layer varying in depth between 1 and 3 m. The source of manganese and calcium that was concentrated in the nest caps is the caliche layer.

The five mounds, from which soil cores were removed, were excavated by splitting a dome through the center and removing half of the dome. A trench was excavated below the removed dome to provide access to the intact half of the nest. The dome and upper chambers to a depth of 30 cm were cemented with the calcium carbonate-sand mixture. The nest soil at the 30–60 cm depth was moist sand with a high concentration of particles that were finer than sand. The material was deposited in a laminar structure to the 30 cm depth. There were numerous chambers and tunnels in

the laminar material of the dome or mound. The cemented caps made up most of the top surface sand mounds that were similar to the more typical sand mounds of *P. maricopa* described by Cole (1968). The ants had deposited an accumulation of debris consisting of materials such as *P. scoparia* stem fragments, grass stem fragments, bird and lizard fecal material. Cole (1968) described *P. maricopa* nest domes as having a gravel or rock cover. It is likely that the deposition of stem fragments and debris on the nests of these ants was a substitute behavior for the deposition of rock fragments. Cole (1968) in his description of the large domes of sand nests of *P. maricopa* in the Rio Grande valley region of west Texas and Mexico stated 'I could not help noting how efficiently the gravel cover inhibited the blowout of the sand mound during the windy collecting period.' In the *P. scoparia* sand dunes, gravel and stones are not present in the soil profile. In this environment, *P. maricopa* has used the calcium carbonate to build cemented caps on the nests. These caps protect the upper chambers of the nests from being eroded away during the intense wind storms that are characteristic in this desert from January through April. Considering the low solubility of calcium carbonate in water, it is probable that *P. maricopa* uses secretions to dissolve the calcium carbonate to form the cement of the nest caps. Wheeler & Rissing (1975) found that secretions of *Messor* (= *Vermessor*) *pergandei* were used to cement the sand around the nest entrances.

After the spring wind season, the nest caps of *P. maricopa* exhibited erosion on side of the dome facing the prevailing winds. The eroded portion exposed some of the laminar structure. This destruction of the cemented cap structure was the result of sand grain impact from wind-initiated saltation (Rice *et al.*, 1996). However, at the end of the activity season, in November, the damaged caps had been repaired. Wind erosion is not the only force that damages the cemented caps. The estimated portion of the nest cap eroded by wind was 20,000 cm³ per nest cap. This is equivalent to approximately 800,000 cm³ ha⁻¹ or the addition of approximately 620 kg of CaCO₃ ha⁻¹ to the soil. *Pogonomyrmex maricopa* thus contributes to the chemical composition of the sand dune soils and may provide a necessary feedback for the maintenance of the vegetation in the *P. scoparia* dunes.

In March, 1991, several of the nest caps were excavated by pronghorn antelope, *Antilocapra americana*. There was evidence of muzzle prints in the loosened cap material suggesting that the antelope were ingesting some of the nest cap material. Geophagy by antelope also contributes to the quantity of material eroded from the nest caps during the windy season.

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