06-05

Changes over 20 years in populations of the Mexican leafcutting ant, *Atta mexicana*, at Organ Pipe Cactus National Monument, Arizona.

A report to the National Park Service and Western National Parks Association.

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The leafcutting ant *Atta mexicana* reaches its northern range limit in North America at Organ Pipe Cactus National Monument (ORPI), and provides a spectacular case of marginal rarity. The main range of this ant species lies in Mexico, with a southern limit in Guatemala and El Salvador (Smith, 1963). *A. mexicana* was first collected at Organ Pipe Cactus National Monument by R.E. Gregg in 1948 and L.F. Byars in 1949, who collected them near a gravel pit 1 km north of current park headquarters (Byars, 1949). W.S. Creighton visited Organ Pipe in 1952, but did not encounter these ants; they were not listed in his comprehensive monograph, *The Ants of North America* (Creighton, 1950).

At Organ Pipe, the large nests of *A. mexicana* are occupied by colonies that access an annual foraging area that may be >2 ha, using a system of lateral tunnels that may extend >130 m from the nest (Mintzer 1989, 1994). The queen of *A. mexicana* is the largest known North American ant, and daytime foraging behavior of worker ants draws attention from park visitors in the winter. At Organ Pipe, colonies of *A. mexicana* near monument headquarters have been a dependable target for interpretive walks led by ranger-naturalists. In the course of a year, established colonies may collect about 200 kg (dry weight) of leaf and flower material (Mintzer, 1994). All of this forage becomes substrate for the growth of their unique symbiotic fungus, which is cultured in large chambers, probably 5-15 m underground.

Although National Park Service staff at Organ Pipe have been aware of these ants since the 1970s, knowledge about colonies in the backcountry was nonexistent until December 1985, when I conducted a systematic survey in the park for this ant to assess the population size, distribution, and status. In the Sonoran desert, *A. mexicana* inhabits riparian (arroyo channel drainage) and floodplain habitats with fine soils. Supported by the Southwest Parks and Monuments Association and several field assistants, I conducted a ground search along 11 arroyo channels in the southern one-third of the park. Aerial photographs were used to identify arroyo channel systems of sufficiently large size with abundant vegetation to provide suitable habitat for the ants. The aerial photographs also proved invaluable in the field to pinpoint and map colony locations within the twisting and braided channel systems. A total of 38 colonies were found during the 1985 search, which revealed several widely scattered local clusters or demes of colonies, with several outlier colonies (Mintzer and Mintzer, 1988). Approximate age of colonies was inferred from the size and condition of superficial accumulations of excavated soil above the central nest (Fig. 1,2). Colonies of all ages were found, indicating a history of successful reproduction and population recruitment.

At ORPI, a few *A. mexicana* colonies have been found beyond these arroyo survey transects: in Lukeville (1996), on the west (2001) and east (1989) park boundaries, and within 2 miles of the north park boundaries (1987). No colonies have been reported from the Tohono O'odham lands immediately to the east of ORPI; this ant species is not known to occur elsewhere in the United States.

Resurvey of the 11 arroyo transects in January 1996 revealed 46 colonies (Mintzer, 1997). GPS coordinate data was recorded during this ground search. Substantial colony death and recruitment occurred in the 10 years between the first and second surveys. All five arroyo channel systems that contained colonies in the December 1985 survey still had colonies in January 1996; we found colonies in two additional arroyo

systems that lacked colonies in 1985. Of the 46 living colonies found in January 1996, 15 were new since the first survey. Nine colonies located in the 1985 survey had died by January 1996. Five colonies appeared to be new recruits within local populations identified in the first survey.

Methodology for the Current Survey

The arroyo channel transects along the south boundary of the park were re-walked over 11 days between Dec. 27, 2005 and Jan. 8, 2006, between 9 AM and 5 PM MST. In late December 2005 and early January 2006, the park population of *Atta mexicana* was resurveyed and all the arroyo channel systems searched in the original 1985 survey were walked again. The same search methodology was used: with 1-4 assistants spread laterally across the various banks and channels of the drainage system, the arroyos were walked during daylight hours (0900-1700 h) when ant foraging activity would be conspicuous in the wintertime. Although aerial photographs were again used to navigate and pinpoint colony locations, the colonies located were not physically tagged. As in 1996, a GPS (global positioning system) reading was taken as close to the colony center as possible. Colony age was estimated; young colonies have fewer nest craters and smaller fungal dump deposits than middle-aged, mature nests. Growing colonies have extensive accumulations of excavated soil in neat, sharp-edged craters above their center (Fig. 1). As colonies age past maturity, the surface earthworks begin to erode away, even as the fungal dump mass continues to grow. For very old colonies, the earthworks may be completely absent (Fig. 2). We attempted to relocate rebar-staked tags placed at colonies in 1986-87, which would likely be concealed by silt and debris deposited by flooding events or vegetative growth in the intervening years. Although it was often impossible to relocate these tags, detailed locational information from the 1985 survey, the aerial photographs, and existing GPS data allowed us to ascertain colony locations without much difficulty. As in previous surveys, we recorded the placement of the nest center in relation to the nearest arroyo channel, and any associated vegetative cover.

Results

The 2005-06 *A. mexicana* resurvey revealed little successful recruitment and significant colony mortality in the past 10 years. A total of 25 living colonies was found along the arroyo survey transects (Fig. 3-7). Only 4 or 5 colonies first located in 1985 were still alive in 2005-06, indicating that typical field colony lifespan is less than 20 years. Decline of populations west of highway 85 was especially notable. No new colonies were noted in the deme near monument headquarters; only one colony in this area was still alive in January 2006. Unlike in previous surveys, few younger colonies were seen, and surviving colonies appeared older.

Here are results of the ground searches along major arroyo channels, listed by geographic area from WEST to EAST:

1. Two miles of Lower Aguajita Wash, along Puerto Blanco (PB) Drive in broad channel and associated mesquite bosque; completed 1/7/2006. No *A. mexicana* colonies were found. No colonies were found in this area of complex braided channels and mesquite bosques in previous surveys in 1985/86 and 1996.

2. Four miles, from Senita Basin Rd. 0.5 mi from its terminus at picnic area, SW to arroyo crossing at South PB Drive (about 1.5 mi W of its junction with Senita Basin Rd.); completed 12/30/2005. The colony at the north end (start point) of this hike, previously active between 1992 and 2003, has died. No new colonies were found.

3. Four miles, from Senita Basin Rd. about 1 mi N of junction with South PB Drive, ENE into Lost Cabin Basin and return to Rd, cross and follow wash 1.2 mi S to South PB Dr.; completed 12/29/2005. One colony, previously observed between 1995 and 2002, has died. No new colonies were found.

4. One mile, from south PB Drive about 2 miles W of hwy 85, WSW to PB Drive about 1.2 mi E of junction with Senita Basin Rd.; completed 12/31/2005. No living colonies were found. This well-vegetated large channel also did not support colonies during the two previous surveys.

5. Four miles, from south PB Drive about 1 mi W of hwy 85, NNE to W side of Campground; completed 12/28/2005. One colony first observed in 1996 is still alive; a younger colony that appeared after that survey (noted in 2003) has apparently died.

6. Four (4.5) miles, from south PB Drive 0.3 mi W of hwy 85, N/NNE to Visitor Center and "tiger cage" area; completed in two segments on 12/27 and 12/28/2005. Four colonies identified in previous surveys were found living; three others had died since 2003. No new colonies were found.

7. Five miles, from Camino Dos Republicas Rd. 0.5 mi E of hwy 85, N/NNE to Ajo Mtn. Dr., with 1-mi side exploration of wash 0.5-1 mi S of Ajo Mtn Dr.; completed in two segments on 1/2 and 1/4/2006. Four new colonies were found. Two colonies identified in 1996 were still alive; six other colonies found in 1996 have died since then.

8. Three miles, from Camino Dos Republicas Rd. 1.5 mi E of hwy 85, N along major wash; completed 1/4/2006. This wash had no colonies in 1985; three colonies were found in 1995/6. One of these three colonies is still living. One new colony was found.

9. Two miles, from South Boundary Rd. about 4 mi E of Lukeville Port-of-entry, NE along multi-channel large wash; completed 1/3/2006. This wash did not support colonies in 1985; four living colonies were found in 1995/6. Two of these four colonies are still alive, and one new colony was found.

10. Two miles, from South Boundary Rd. about 7 mi E of Lukeville, NE/ENE along densely vegetated complex wash, historically with many colonies; completed 1/6/2006. Six living colonies were found.

11. Two miles, from South Boundary Rd about 9 mi E of Lukeville, NE along wash with many colony records; completed 1/5/2006. Two colonies first found in 1985 are still alive. Five other colonies noted in 1985/6 or 1996 have died since then.

Discussion

Several factors may have contributed to this recent population decline, and may have significant long-term future impacts on *A. mexicana* at Organ Pipe:

1. Climate change, whether long-term natural cycles or anthropogenic effects, probably is the most important factor. These ants are living at their limits of tolerance for arid conditions. The American Southwest in general and ORPI in particular are experiencing extended drought conditions. The timing and quantity of summer and winter rainfall determines the health of host plants and the availability of foliage, flowers, and fruits for harvest. In the Sonoran desert, *A. mexicana* colonies along arroyo channel margins have access to a mix of important host plants: larger trees such as *Cercidium, Parkinsonia, Olneya,* and *Acacia* along the channels, and *Larrea* in the open desert away from these channels. The ants depend upon these plants throughout the year. Increased shade and soil moisture along arroyo channels is probably vital for new colony foundation and population recruitment. Successful reproduction of *A. mexicana* depends upon swarming of winged reproductive ants. These ants disperse from mature colonies in predawn darkness and mate, the morning after summer storms that deliver >1 cm of rainfall. Although such storms still occur every summer, their frequency has declined in the past 10 years, especially in the western parts of Organ

Pipe (NPS, unpub. data). Since the late 1980s, Resource Management at ORPI has had an extensive monitoring program in place and has data on physical conditions such as precipitation and soil moisture (to 1 m depth) from many remote field stations in the park. This data will be valuable and should allow comparison of initial conditions before 1995 with changes that occurred since then, as the drought began.

2. Increased local resident human population in Sonoyta, Mexico, probably is another important factor. Although the rate of increase has slowed in the past 10 years, Sonoyta continues to grow. Clearance of land for agriculture is isolating park populations of *A. mexicana* from source populations to the south, with possible effects on genetic diversity and population recruitment. Dispersal of winged reproductive *Atta* females is probably less than 5 km (Moser, 1967). Pesticide drift and groundwater depletion associated with intensive agriculture could also affect host plants and ant populations near the international boundary. Woodcutting from *Olneya* and *Prosopis* trees in riparian habitats near the boundary could also have an impact. Nighttime illumination affects dispersal of winged reproductive ants in predawn hours.

3. Increased immigration and smuggling activity is another factor. This activity has increased significantly in the past 10-15 years, and is concentrated along the large arroyo channel systems that are preferred habitat of *A. mexicana* in the Sonoran desert. Transient pedestrian traffic probably has a minor effect on ant foraging behavior. Accumulation of trash probably has no effect on established colonies. As long as large host plants (*Larrea, Parkinsonia, Cercidium, Olneya, Prosopis, Acacia)* are not damaged by transient activity, this impact will be minor; the deep nests are highly resistant to local disturbance.

4. Increased border security infrastructure, while unlikely to have had any effect so far, has potential to amplify effects outlined under (2) above. Construction of a vehicle barrier along the international boundary began in 2003. The very limited vegetation clearance and 2-m deep posthole excavation associated with the vehicle barrier have not had a major impact on colonies along the south boundary. However, proposed clearance of broad strips of habitat and use of nighttime illumination in association with multi-layer high-tech border security will have a negative effect on *A. mexicana* populations at Organ Pipe.

5. Other factors to be considered include invasion of exotic plants buffelgrass (e.g. *Pennisetum ciliare*) that would affect plant community structure at Organ Pipe; and increases in populations and impacts of natural ant predators (e.g. bats, nighthawks) that could affect ant reproductive success.

Atta mexicana has become an increasingly rare ant at Organ Pipe Cactus National Monument in the past 10 years, and elevated concern for its future in the park is appropriate. The majority of colonies now alive are old and likely to die within the next 10 years. In the absence of successful recruitment, the population size will continue to decline significantly and local extinction is possible within 20-30 years. Despite the logistical obstacles, increased frequency of surveys is indicated along the southern boundary of ORPI, to check for new colony recruitment over the next decade.

Population declines in *A. mexicana* are largely beyond intervention by resource managers. The negative factors discussed above are large-scale, long-term, and generally not accessible to local remediation, even if arthropod population management was a park priority.

The local extinction of *A. mexicana* would be a real loss for park visitors, American entomologists and students of social insects, and North American desert naturalists. Although ants rarely get the attention they merit in comparison to large vertebrates and plants, *A. mexicana* is a charismatic invertebrate that is accessible to the nonscientist. Its local stature is comparable to that of Cardon cacti and Baobab trees among

botanists, and lions and elephants among zoologists. It is not a small, inconspicuous species in an obscure genus, with little habit differentiation from other local ants-- although it may serve as a proxy for the fates of many such Madrean or Neotropical species (ants and others) living at the margin of their natural ranges in southern Arizona. *A. mexicana* is a large ant with a compelling natural history, a unique and unexpected resident of these dry lands.

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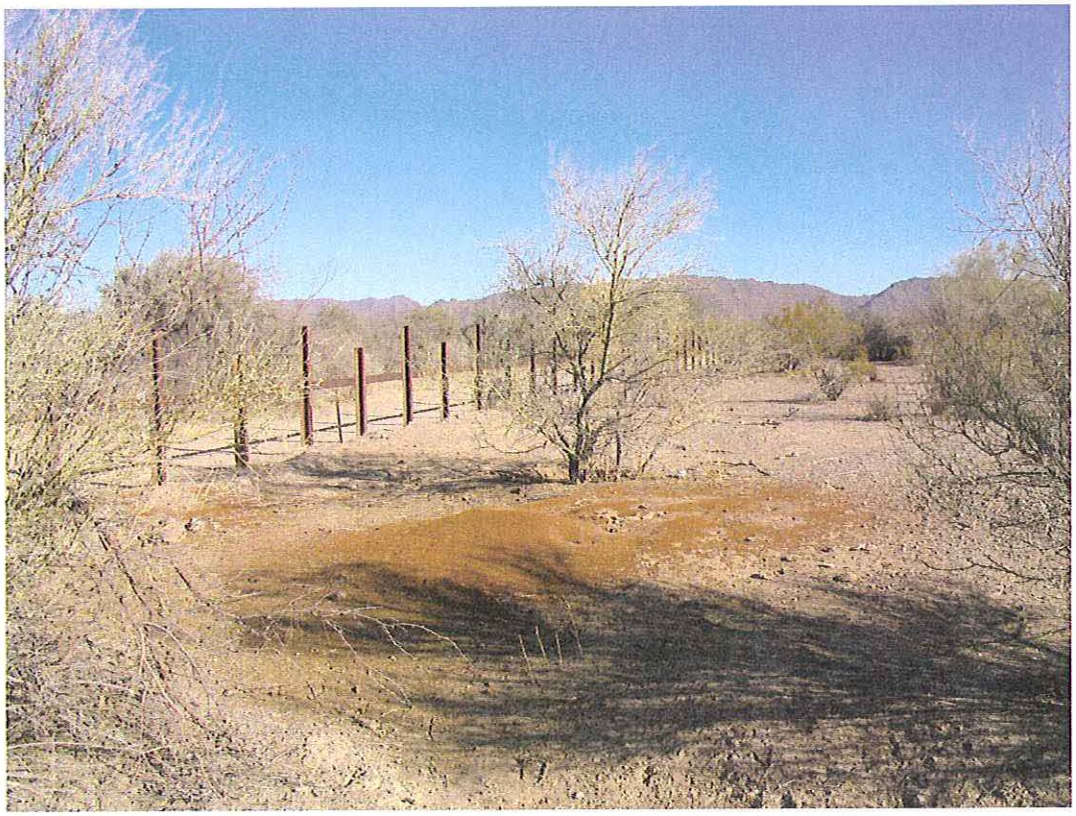

Fig. 1 (top) View of colony 28 in 1985, looking W along international boundary. The center of this vigorous younger colony is indicated by numerous craters of excavated soil.
Fig. 2 (bottom) View of colony 28 in 2006, looking E along international boundary. The center of this still active but aging colony is indicated by extensive accumulation of fungus waste material and lack of craters of excavated soil, which have eroded away in the intervening 20 years.

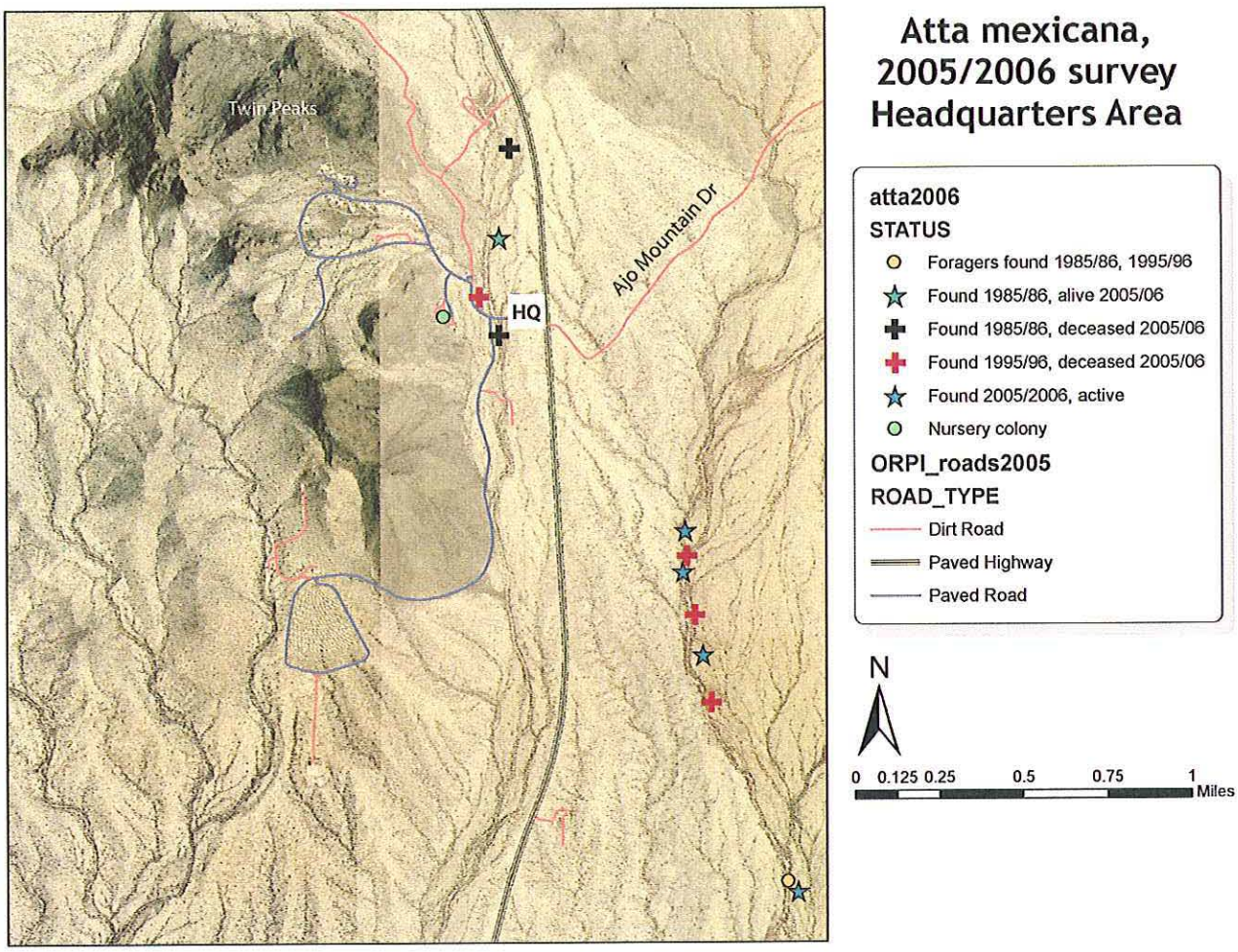

Fig. 3. Distribution and status of *Atta mexicana* colonies near park headquarters (HQ). Only one aging colony was still alive in January 2006 within easy access of the visitor center.

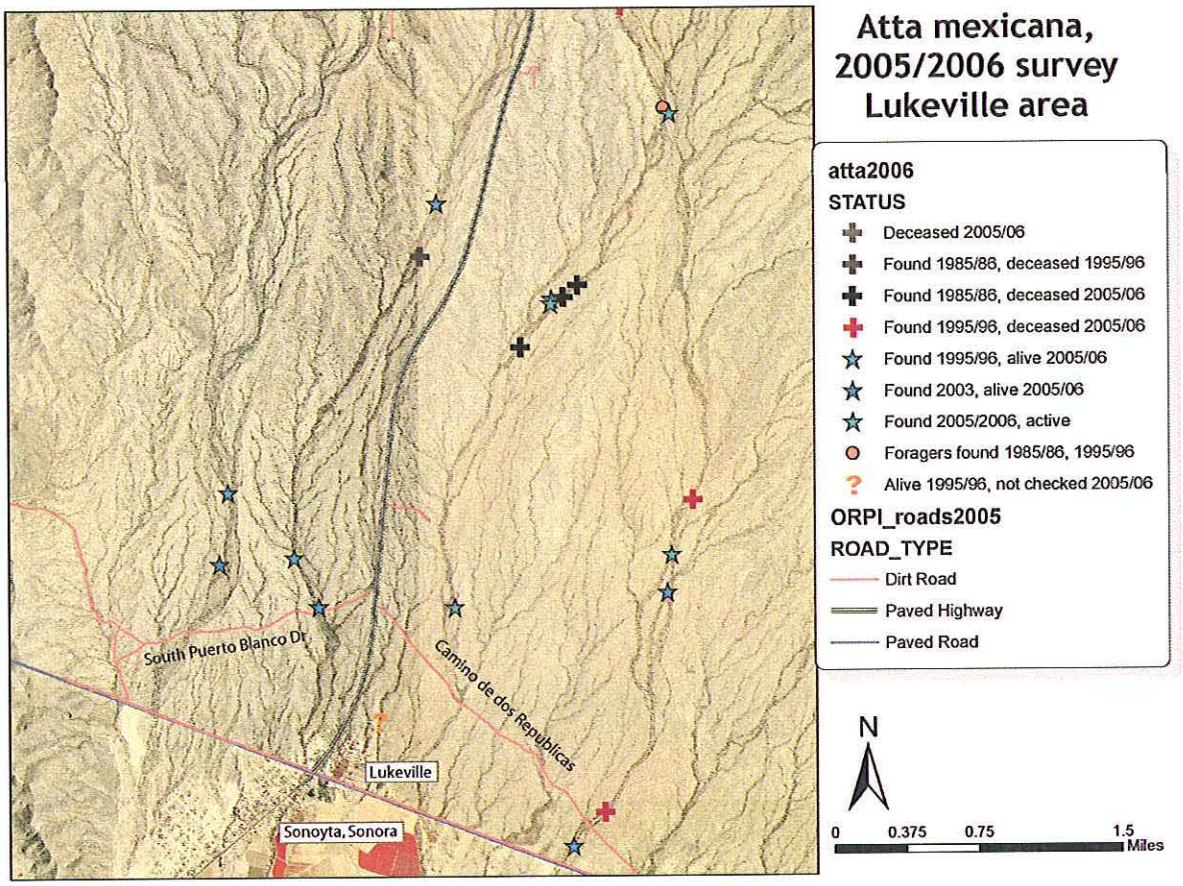

Fig 4. Distribution and status of *Atta mexicana* colonies near Lukeville/Sonoyta international border crossing. Most of these surviving colonies are at least 10 years old, with limited population recruitment since 1996.

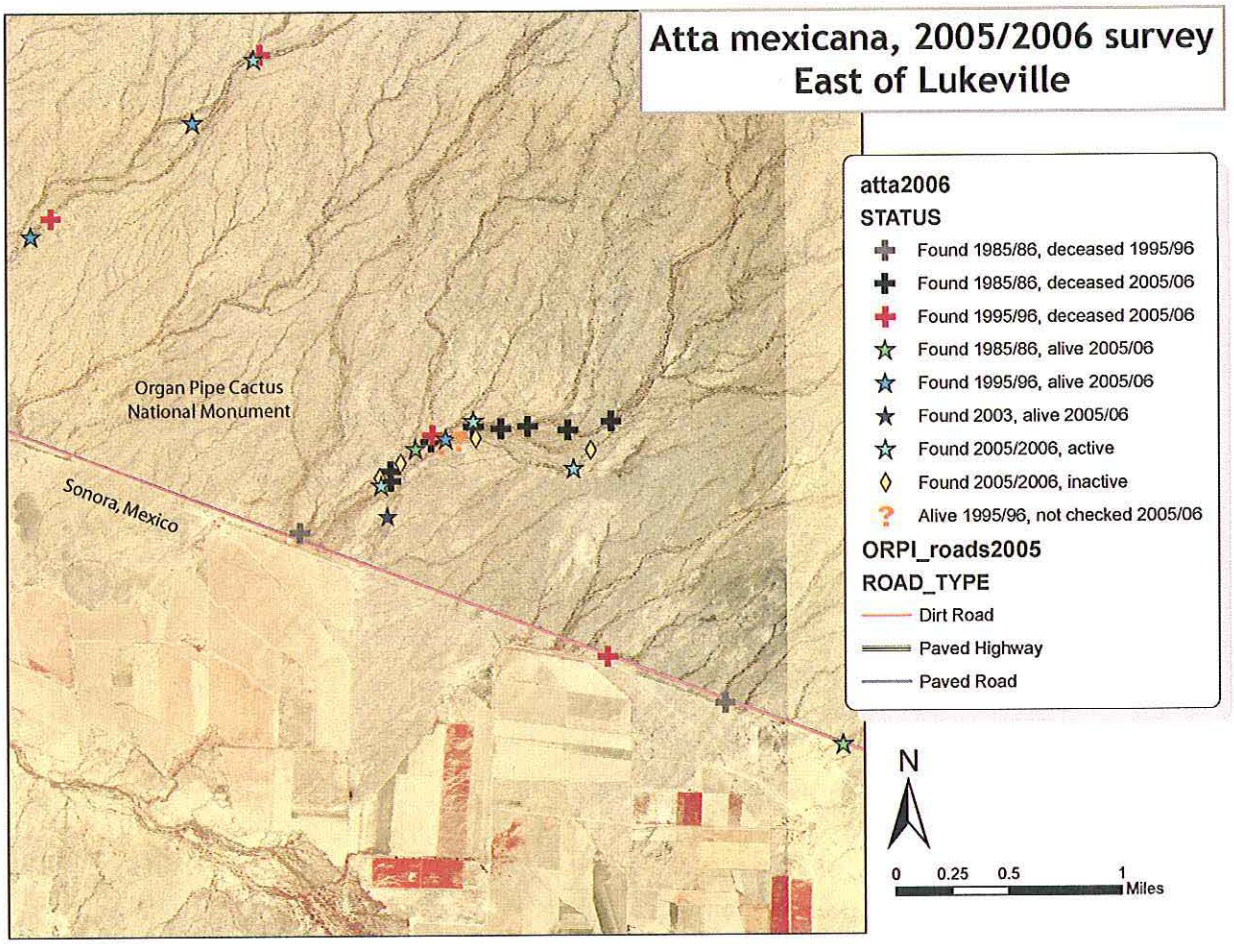

Fig. 5. Distribution and status of *Atta mexicana* colonies along arroyo channels and international boundary east of Lukeville. Colony 28 (shown in Fig. 1-2) is indicated by star at lower right. Since 1985, the number of *Atta* colonies has declined by about 50% in this area.

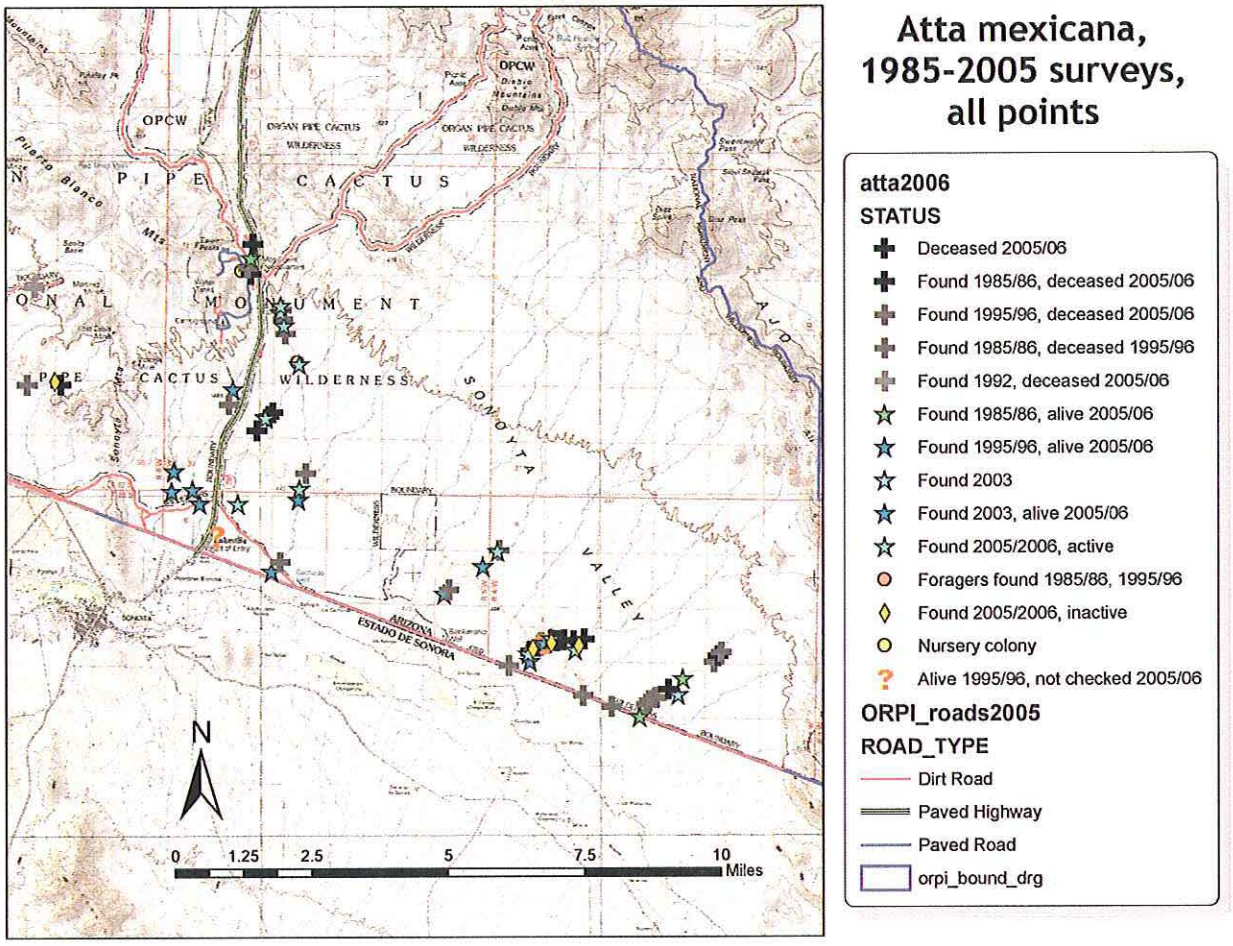

Fig. 6. Summary of status and distribution of *Atta mexicana* colonies along southern boundary of Organ Pipe Cactus National Monument. The preferred habitat of these ants is the margins of well-vegetated arroyo channels, in fine soils of the lower bajada.