THE ANT FAUNA OF THE MOJAVE NATIONAL PRESERVE

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INTRODUCTION.

The biota of the Mojave National Preserve in southeastern California, hereafter referred to as "the Preserve", is rich owing to its climatic and elevational range and to its complex biogeographic history. It contains floristic elements from the Great Basin and Sierran influences as well as Hot Desert elements which approach from the south along the Colorado River valley and from the west along the Mojave River drainage.

White Fir (*Abies concolor*) is present on north-facing exposures of both New York Peak and Clark Peak (Thorne, et al, 1981). That is indicative of a much more extensive Pleistocene distribution of the northern and montane floras at elevations as much as 1,200 m lower than they extend today (Van Devender, et al, 1987; Koehler, et al, 2005; Smith, et al, 2000; Wells, 1983). Studies reviewed by Cronquist, et al (1972) suggest an "almost continuous Wisconsin-age woodland corridor between the Spring Mountains of southern Nevada and the San Bernardino Mountains of southern California".

Studies of plant remains in the ancient middens of Packrats (*Neotoma* spp), (King, 1976; Thompson, 1990) come to the same general conclusions. Koehler, et al, (2005) describe a Pleistocene flora including Juniper steppe woodlands in the valleys north of about 36^{o} N latitude and a warmer mild-mesic woodland to the south of that latitude. Woodrat midden data from across the region indicate a drying, warming trend with *Larrea divaricata* (Creosote Bush) reaching the Marble Mountains from the southeast by about 7900 years BP with a concurrent retreat by *Pinus monophylla* (Single-leaf Pinyon) southward and westward. These conclusions are reinforced by a study of relict modern populations of

Neotoma fuscipes in the region (Smith, et al, 2000). These authors (their figure 5, p 491) illustrate probable historical habitat corridors along which species could have gained access to the mountains of the Preserve. Johnson (1995) analyzed the spring bird fauna of Clark Mountain in an effort to identify the geographical origin of the fauna. The birds of the New York and the Kingston ranges show comparable patterns, (Cardiff & Remsen, 1981). The mountains of the Great Basin, Sierras, Rockies and southern Arizona provide the source populations. Together, these affinities suggest that similar patterns might exist in the ant fauna.

The ants of the Preserve have not been carefully surveyed. Considering the historical and biotic complexity of the region it is reasonable to expect an ant fauna richness corresponding to the richness of the rest of the biota in the Preserve. Wheeler & Wheeler (1986) carefully described the ants of Nevada and Snelling & George (1979) studied the ants of the Mojave Desert but they indicate (p. 4) that they emphasized the Hot Desert (Creosote Bush Scrub), considering the Cool Desert (Great Basin Sagebrush Desert) to be marginal and they generally excluded the Pinyon-Juniper Woodlands as being an element of the Cool Desert. Sanders et al (2003) surveyed the ant fauna along an altitudinal gradient in the nearby Spring Mountains, Nevada. They discovered that ant species diversity increases with elevation above about 1,100 m and is correlated with increasing precipitation and lower temperatures. The lower edge of the Joshua Tree Woodlands and Joshua/Juniper woodlands at an elevation of around 1,100 m appears to demarcate the Hot Desert influence from the Cool Desert influence. The Preserve straddles the perimeters of the only two careful taxonomic studies of ants available. The higher elevations within the Preserve can be thought of as sky islands and might constitute a refugium for montane and northern ant taxa but these areas have not previously been surveyed.

Ward (2004) observed a total of 37 species at five locations in the Preserve. All of those records appear in our annotated list. Nash et al (2004) have done the only other ant study we are aware of within the boundaries of the Preserve. All three of their study sites in the Preserve were in the Creosote Scrub community. Eight species in their list of 32 species did not appear in our survey. Seven of those are

undescribed/unidentified species and the eighth, *Pheidole sitarches,* would be a new state record. The voucher specimens for their study are deposited at the USDA-ARS Jornada Experimental Range, New Mexico. We were unable to see these interesting specimens as the authors failed to reply to our inquiries about them. We, therefore, did not include them in our annotated list. Given this preliminary state of understanding of the region's ants it was our intent to sample the ants across this biotic range.

THE REGION.

The Mojave Nature Preserve covers about 607,000 ha in the Mojave Desert and lies between N34.580^{o} – 34.717^{o} and W114.950^{o} – 116.183^{o}. The elevation ranges from about 285 m at Soda Lake to about 2410 m at Clark Peak. The rainfall varies within the preserve from about 86 mm at Soda Lake near Baker to around 229 mm in the mountains to the east. Approximately 25% of the precipitation comes as summer monsoon rain. Two research stations reside within its boundaries, The Sweeny Granite Mountains Desert Research Center of the University of California and the Desert Studies Center of the California State Universities.

A careful description of the climate of the region can be found in Thorne, et al (1981). These authors recognize 15 plant communities. However, the region is dominated by only a few of those communities – Pinyon/Juniper/Oak Woodlands, Juniper/Sagebrush Scrub, Mixed Desert Scrub, Blackbush Scrub, Joshua Tree Woodland, Creosote Bush Scrub, Desert Psammophytic Scrub and Desert Wash Scrub. The boundaries of these communities regularly interdigitate or intergrade along elevational or soil type gradients. The result is an exceedingly complex mosaic of habitats embedded within the Creosote Scrub community that typifies the Mojave Desert (Hickman, 1993). This region is also described from the point of view of ant ecologists (Snelling & George, 2003). André (2006) has inventoried the plants of the Preserve.

For most of the last century the region was subject to seasonal cattle grazing. The impact of the grazing was most severe around water sources, both artificial and natural. The cattle were removed from most of the areas we sampled in the year 2001. Since then, the forb ground cover has increased

dramatically in some areas and the populations of quail, doves and lagomorphs have shown corresponding increases (pers. obs.). However, Veblen (2010) has preliminary results showing little native vegetation recovery since 2001 with some increase in invasive species density near water sources.

MATERIALS AND METHODS.

Under authority of the appropriate research permits and access agreements in the Mojave National Preserve, San Bernardino Co., CA, ants were systematically collected throughout the year during the period 2000 – Jan 2008. A total of 33 sampling sites were established largely along road transects scattered in the Clark, Granite, Providence and New York Mountains and the north end of Midhills along Cedar Canyon Road. Another transect ran along Kelbaker Road between Granite Pass and Baker, then along Cima/Kelso Road between Kelso and Interstate Hwy 15. The perimeters of the Granite and Clark Mountains were also surveyed. Likely collecting sites and records of occurrence were also gleaned from Snelling & George (1979) and the website AntWeb.org. The most intense collecting effort was made in Caruthers Canyon between the canyon mouth and New York Peak (Figure 1). An informal effort was made to sample the range of plant communities described above.

Ants were collected by hand, pitfall traps and various bait traps on the ground and hanging in vegetation. Hand collecting included opportunistic wandering and surface scanning; turning stones, fallen logs and litter; breaking twigs; chopping in standing and fallen dead wood; lifting dead bark, digging into active nests and sieving litter.

The majority of the collection was gathered by using pitfall traps. At each sampling site an array of four plastic beverage cups (9.2 cm diameter) were placed under the north-side dripline of four haphazardly chosen shrubs, trees or overhanging boulders. Borgelt & New (2005) discuss the advantage of using traps as large as these. Each trap was protected by a 15 cm x 15 cm plastic roof that was anchored above the ground by long nails in each corner of the cover. A gap between the soil surface and the roof of a few cm was maintained to allow the free movement of ants and yet shelter the traps from falling debris and precipitation. This protocol underestimates the diversity and numbers of both arboreal

and subterranean species because, to be sampled by the pitfall traps, an individual must be moving on or very near the soil surface. The traps were filled about half full with ethylene glycol as a killing agent. This preservative was used instead of propylene glycol because it doesn't evaporate in the summer heat. These traps were left in place for approximately one year and were refreshed four or five times to allow sampling across seasons. Each time the traps were refreshed the contents of the traps were poured through a 2 mm mesh sieve and the collected contents of the site were stored for later analysis.

Ants were identified by reference to Wheeler & Wheeler (1986), Snelling (1976, 1982), Snelling & George (1979, 2003) and AntWeb.org (2008). Identifications of species were checked by Andrew Suarez (then at UC, Berkeley) and Philip S. Ward (UC, Davis). Voucher specimens are deposited in the Bohart Museum at the University of California, Davis in accordance with the permitting requirements of the Mojave National Preserve.

The areas of plant communities within the Preserve were extracted from mojavedata.gov/datasets by John Donoghue in Sept 2006.

RESULTS and DISCUSSION

Our survey involving 62,797 trap nights produced 74 native species represented by 1621 species records and 23,966 individual specimens. The collection includes five subfamilies; Ecitoninae (4 spp.), Ponerinae (1 sp.), Dolichoderinae (6 spp.), Myrmicinae (38 spp. including one newly discovered species) and Formicinae (25 spp). There were no non-native ant species detected.

Table 1 illustrates the ant species composition of the various plant communities. Our trapping effort was not representative of the relative areas of the plant communities in the Preserve. Both Creosote Bush Scrub and Joshua Tree Woodland were undersampled. As a result we cannot make any quantitative analysis of the habitat-specific distribution of ant species. However, the sheer size of the trapping effort gives us some confidence that we have a reasonable assessment of species diversity and relative abundance in both of these communities.

More than half of all species records are of members of six genera (Table 2). The genus *Pheidole*

with its 13 species represents about 21% of all the records and is by far the most commonly encountered genus. Thirteen species of *Myrmecocystus* also appear in the collection so that together with *Pheidole* they represent about 35% of the ant fauna and about 32% of the species records. The Generalist Myrmicines and the Hot Climate Specialists (Andersen, 1997) dominate the ant fauna with 38 of the 45 species that occupy these two ecological roles.

The six commonest species are all in the subfamily Myrmicinae and make up nearly 30% of the species records (Table 3). The commonest one, *Pheidole desertorum,* is an aggressive predator/scavenger that was collected in all but the sandiest, lowest elevation sites. The Functional Groups (Andersen, 1997, Blondel, 2003) represented in the collection are those that might generally be expected in hot desert regions (Table 2). *Formica (2 spp),* T*emnothorax (6 spp), Lasius (2 spp)* and *Stenamma (1 sp)* are the only Cold Climate Specialists we encountered. In contrast Sanders, et al (2003) using a short-term sampling method found, in the Spring Mountains of southern Nevada, ten species of *Formica*, six species of *Temnothorax* and two species of *Lasius* over the same elevation range that we sampled. They encountered two species of *Myrmica* above 2000 m elevation and we found none. Much of the Spring Mountains diversity occurs in Ponderosa Pine forest which is restricted to elevations above about 2000 m. This is a plant community that is entirely absent in the Preserve and from the fossil packrat midden record in the region (Koehler, 2005). So, these easily detected Cold Climate Specialists occur within 80 km of Clark Mountain and 120 km of the New York Mountains but show much diminished diversity in the much smaller sky islands of the Preserve. Snelling and George (1979) excluded the Pinyon/Juniper Woodland from their survey judging that it represented a component of the Cool Desert association. Nevertheless, the higher elevation habitats in the Preserve don't support the number of Cold Climate Specialists that might be expected from their proximity in the nearby Spring Mountains to the north and from the presence of other relict populations in the Preserve (Smith, et al, 2000). Thus our suggestion in the Introduction that we might find more representatives of the Cool Desert or Pleistocene expansions has not been borne out. Perhaps the Preserve's location in the mild, mesic woodland south of the Pleistocene

limit of Juniper steppe woodland (Koehler et al, 2005) at about 36 ^{o} N constituted a dispersal barrier to those ant species.

ANNOTATED CHECKLIST

The annotated list of species that follows includes; the Functional Group of the genus (Andersen, 1997), feeding notes, plant communities in which the species was collected, elevation ranges, months in which the species was collected, nesting notes, number of records, some representative collection sites. Additional notes about range records or vexing taxonomic problems also appear in some records. One previously unknown species, *Pyramica* ca01, was discovered and is thus far known only from a single, dealate queen collected 1 mi. west of Pichalka Spring.

The natural history notes, food, and nest records were gleaned from our own observations and from the sources cited above as well as Andersen (1997), Mackay & Mackay (2002), Snelling & George (2003), Ward (2005), Wheeler & Wheeler (1973) and Wilson (2003). The locations listed in each note are arranged more or less from south to north and most were selected with ease of access in mind and distances and elevations are expressed in miles and feet because those are the units used in the commonly available maps. Additional species records were gleaned from the literature, especially Snelling & George (2003).

Ecitoninae

Neivamyrmex leonardi (Wheeler, W. M., 1915) Cryptic Species. Predatory, subterranean raids *Pheidole* nests. Blackbrush Scrub, Pinyon/Juniper Woodland between 4900-5535 ft. May-Aug. Nests in soil. 9 records. Pichalka Spring, Curtis Canyon.

Neivamyrmex wilsoni (Snelling & Snelling, 2007). Cryptic Species. Predatory, subterranean. Probably raids on *Pheidole* nests. Pinyon/Oak/Juniper Woodland, Juniper Oak grassland at 5600-5700 ft. March. Nests in soil. 2 records by PS Ward. Caruthers Canyon.

Neivamyrmex nigrescens (Cresson, 1872) (shiny form). Tropical Climate Specialist. Predator on various ants, especially *Pheidole*, and other insects. Desert Wash, Joshua/Juniper Woodland, Blackbrush Scrub, Pinyon/Juniper Woodland between 3900-5500 ft. Jun-Oct. Bivouacs in soil, nests of other ant species and litter cavities. 22 records. Granite Pass, Dorner's Camp, Rock Spring, Cima, Pichalka Spring, Curtis Canyon. The distinction between this shiny form and the next mentioned typical form of *N. nigrescens* has been evaluated by Ward (1999).

Neivamyrmex nigrescens (Cresson, 1872). See preceding record. Desert Washes, Mojave Yucca and Blackbrush Scrub, Pinyon/Juniper woodland between 3900-5500 ft. May-Oct. 29 records. Granite

Pass, Vulcan Mine Rd, Pichalka Spring.

Ponerinae

Hypoponera ca-01 Cryptic Species. Hypogaean predator probably on collembola and other soil arthropods. Blackbrush Scrub and Pinyon/Juniper Woodland between 4900-5700 ft. Mar-Aug. Nest in fine soil. Associated with rotten roots of dead shrubs. 6 records. Caruthers Canyon, Pichalka Spring, Curtis Canyon.

Dolichoderinae

Conomyrma is a junior synonym of *Dorymyrmex*. See *Dorymyrmex*

Dorymyrmex bicolor (Wheeler, W. M., 1906. Dominant Dolichoderinae. Hemipteran tending opportunist. All habitats between 2150-4900 ft. Apr-Oct. Nest on exposed soil. 37 records. Willow Spring Basin, length of Kelbaker Rd., Rock Spring, Pichalka Spring.

Dorymyrmex insanus (Buckley, 1866). Dominant Dolichoderinae. Hemipteran tending opportunist. All habitats between 1000-5700 ft. Every month. Nest on exposed soil. 48 records. Dorner's Camp, length of Kelbaker Rd., Rock Spring, Caruthers Canyon, Pichalka Spring, Keystone Canyon.

Forelius mccooki (McCook, 1879). (=*F. foetidus*). Dominant Dolichoderinae. Hemipteran tending scavenger. All habitats between 1000-7200 ft. May-Oct. Nest in soil or under stones. 47 records. Budweiser Spring, Kelso Dunes, Rock Spring, Caruthers Canyon, New York Peak. This and the next species are very close and might hybridize (PS Ward. pers. comm., 2010).

Forelius pruinosus (Roger, 1836). Dominant Dolichoderinae. Hemipteran tending scavenger. All habitats between 1000-7200 ft. Every month. Nest in soil or under stones. 45 records. Dorner's Camp, Kelso Dunes, Rock Spring, Caruthers Canyon, New York Peak.

Liometopum luctuosum (Wheeler, W. M., 1905). Dominant Dolichoderinae. Hemipteran tending opportunist. Pinyon/Oak/Juniper associated with oaks. Mar-Sept. 5400-6100 ft. Nest in oak cavities. 23 records. Caruthers Canyon, Keystone Canyon.

Tapinoma sessile (Say, 1836). Hemipteran tending opportunist. Creosote Scrub to Pinyon/Juniper Woodland between 1000-5700 ft. May-Jan. Nest in soil or any handy cavity. 10 records. Dorner's Camp, 1.5 mi e Baker, Caruthers Canyon, Pichalka Spring, Curtis Canyon.

Myrmicinae

Aphaenogaster boulderensis M.R. Smith, 1941. Opportunist. Blackbrush Scrub, Mojave Yucca Scrub, Desert Wash, Joshua Tree Woodland between 3200-4100 ft. Every month. Nest probably under stones. 9 records. Willow Spring Basin, Coyote Spring, Cedar Canyon Rd 1.6 mi e of Kelso Cima Rd.

Aphaenogaster cockerelli (E. Andre, 1893). Opportunist. Creosote/Joshua Tree/Blackbrush Scrub between 4200 ft. Every month. Nest in exposed compact soil or under stones. 16 records. Granite Pass, Vulcan Mine Rd., 7 mi nne Kelso, Piute Spring, Morningstar Mine.

Aphaenogaster megommata M.R. Smith, 1963. Opportunist. Creosote Scrub/Desert Wash/Blackbrush between 2700-3900 ft. Sept-Jan. Nest under stones or exposed. 7

records. Vulcan Mine Rd. Kelbaker Rd 9 and 18 mi n Kelso.

Crematogaster depilis Wheeler, W. M., 1919. Generalist Myrmicinae. Tends hemiptera. All habitats except dunes and sandy washes between 3000-5700 ft. Every month. Nest, soil in and among roots. 84 records. Willow Spring Basin, Granite Pass, Rock Spring, Caruthers Canyon, Cima Rd @ Teutonia Peak Trail, Keystone Canyon, Curtis Canyon, Piute Spring.

Crematogaster larreae Buren, 1968. Generalist Myrmicinae. Tends hemiptera. Wherever Creosote Bush is common between 2900-5500 ft. Oct-May. Nest in roots and stems of creosote bush. 7 records. Dorner's Camp, Kelbaker Rd. 9 mi n Kelso, Cedar Canyon Rd 3.8 mi e Kelso Cima Rd, Pichalka Spring. This species may be synonymous with dark forms of *C. depilis* (PS Ward, pers. comm. 2008).

Crematogaster mormonum Wheeler, W. M., 1919. Generalist Myrmicinae. Tends hemiptera. All habitats except blow sand between 3600-7200 ft. Every month. Nest, in wood or under stones. 50 records. Willow Spring Basin, Kelbaker Rd, 1.5 mi e Baker, Caruthers, Keystone and Curtis Canyons.

Ephebomyrmex is a junior synonym of *Pogonomyrmex*. See *Pogonomyrmex*

Leptothorax is a junior synonym of *Temnothorax* in this list. See *Temnothorax*

Messor pergandei (Mayr, 1886). Hot Climate Specialist. Seed harvester. All habitats below the Pinyon/Juniper Woodland between 1000-5500 ft. Every month. Nest in exposed soil. 34 records. Any place on the sandy shoulder of any road in the valleys, eg. around the Kelso Station.

Monomorium ergatogyna Wheeler, W. M., 1904. (=*M. minimum?*). Generalist Myrmicinae. Omnivore. All habitats except blow sand between 2700-7200 ft. Every month. Nest in soil or handy cavity. 57 records Granite Pass, Coyote Spring, Rock Spring, Caruthers Canyon, New York Peak, Pichalka Spring, Curtis Canyon.

Pheidole barbata Wheeler, W. M., 1908. Generalist Myrmicinae. Probably a seed harvester. Blow sand Creosote Scrub, Blackbrush Scrub between 2100-3900 ft. Mar-Sept. Nest in exposed, sandy soil. 8 records. Kelso Dunes, Vulcan Mine Rd.

Pheidole bicarinata Mayr, 1870. Generalist Myrmicinae. Seed harvester, omnivore. Creosote Scrub upward through P/J, Oak Woodland between 2700-5700 ft. Mar-Nov. Nest under stones or wood. 22 records. Kelso/Cima Rd., 7.6 mi ne Kelso, Rock Springs, Caruthers Canyon.

Pheidole cerebrosior Wheeler, W. M., 1915. Generalist Myrmicinae. Seed harvester, scavenger. All habitats except blow sand between 2700-5700 ft. Every month. Nest under stones. 51 records. Granite Pass, Rock Springs, Caruthers Canyon, Pichalka Spring, Curtis Canyon. We have collected this species alive in the tumulus piles of *Pogonomyrmex rugosus*.

Pheidole clydei Gregg, 1950. Generalist Myrmicinae. Insect scavenger. Joshua Tree and Pinyon/Juniper/Oak Woodland between 4600-7200 ft. May-Jul. Nests obscure, in boulder cracks or rubble. 4 records. Rock Spring, New York Peak.

Pheidole desertorum Wheeler, W. M., 1906. Generalist Myrmicinae. Aggressive predator and scavenger, rarely gather seeds. All habitats between 2200-7200 ft. Every month. Nest under stone or exposed soil. 134 records. Granite Pass, Budweiser Spring, Kelbaker Rd, 18 mi n Kelso, Rock Spring, Caruthers Canyon.

Pheidole gilvescens Creighton & Gregg, 1955. Generalist Myrmicinae. Seed harvester, scavenger. All habitats except blow sand between 2200-5500 ft. Mar-Nov. Nest in exposed sandy soil. 39 records. Coyote Spring, Granite Pass, Kelso Dunes, Rock Spring, Pichalka Spring, Keystone Canyon.

Pheidole hyatti Emery, 1895. Generalist Myrmicinae. Omnivore and seed harvester. All habitats except blow sand between 2700-7200 ft. Jan-Oct. Nest in soil under plants. 25 records. Kelbaker Rd, 9 mi n Kelso, Midhills Campground, Caruthers Canyon, Rock Spring, Curtis Canyon.

Pheidole pilifera (Roger, 1863). Generalist Myrmicinae. Seed harvester. Pinyon/Juniper/Oak Woodland between 5700-7200 ft. May. Nest under stones or exposed soil. 2 records. Caruthers Canyon, New York Peak.

Pheidole psammophila Creighton and Gregg, 1955. Generalist Myrmicinae. Seed harvester. Creosote Scrub between 2900-3800 ft. Jul-Sept. Nest in exposed, shifting sand. 3 records. Budweiser Spring, Kelbaker Rd at Hwy I 40, Kelso Cima Rd. 7.6 mi ne Kelso.

Pheidole rugulosa Gregg, 1959. Generalist Myrmicinae. Omnivore and seed harvester. Creosote Scrub between 3000-4100 ft. May-Oct. Nest in exposed soil or under stones. 7 records. Kelso/ Cima Rd., 7.6 mi ne Kelso, Cedar Canyon Rd., 1.6 mi e Kelso Cima Rd.

Pheidole sciophila Wheeler, W. M., 1908. Generalist Myrmicinae. Omnivore, seed harvester. Yucca and Blackbrush Scrub between 3800-5500 ft. Every month. Nest obscure, often close to stem of a shrub. 14 records. Budweiser Spring, Granite Pass, Coyote Spring, Vulcan Mine Rd, Pichalka Spring.

Pheidole vistana Forel, 1914 (=*P. gallipes*). Generalist Myrmicinae. Insectivore. One record from Ft. Piute by Snelling and George (1979), Creosote Scrub at 2800 ft. October. Nest in soil under shrub.

Pheidole xerophila Wheeler, W. M., 1908. Generalist Myrmicinae. Seed harvester and scavenger. All habitats except blow sand and Blackbrush Scrub between 2900-5700 ft. Jan-Sept. Nest in exposed, sandy soil. 36 records. Granite Pass, Coyote Spring, Caruthers Canyon, Curtis Canyon, Morningstar Mine.

Pogonomyrmex californicus (Buckley, 1867). Hot Climate Specialist. Food includes seeds, vegetation, dead insects. All habitats except Blackbrush Scrub between 1000-5700 ft. Every month. Nest in exposed sandy soil. 47 records. Budweiser Spring, Granite Pass, Kelbaker Rd, 1.5 mi e Baker, Kelso Dunes, Rock Spring.

Pogonomyrmex (=Ephebomyrmex) imberbiculus Wheeler, W. M., 1902. Hot Climate Specialist. Food includes dead insects and some seeds. All habitats except sandy places between 3600-4900 ft. Mar-Nov. Nest under stones. 15 records. Budweiser Spring, Granite Pass,

Morningstar Mine Rd, Pichalka Spring.

Pogonomyrmex magnacanthus Cole, 1968. Hot Climate Specialist. Seed harvester. Blow sand, Creosote Scrub, Joshua Tree Woodland between 1000-4800 ft. Jan-Oct. Nest in exposed, sandy soil. 18 records. Kelbaker Rd, 1.5 mi e Baker, Kelso Dunes, Rock Spring.

Pogonomyrmex maricopa Wheeler, W. M., 1914. Hot Climate Specialist. Feeds on seeds, dead insects. Joshua Tree Woodland, Desert Washes between 4600-4800 ft. Jan-Oct. Nest in sandy soil. 5 records. Rock Spring. At this location the nests of *P. maricopa* are found in stable soil on the bench above the sandy wash while the nests of *P. californicus* are found in the sandy wash a few feet below.

Pogonomyrmex rugosus Emery, 1895. Hot Climate Specialist. Feeds on seeds, dead insects. All habitats except sandy places between 3600-5700 ft. Every month. Nest in exposed soil. 32 records. Budweiser Spring, Granite Pass, Caruthers Canyon, Keystone Canyon, Teutonia Peak near Cima Rd.

Pyramica ca-01. Cryptic Species. Hypogaean. Congeners feed on collembola. This previously unknown species is represented by a single dealate queen collected 1 mi w Pichalka Spring in Blackbrush Scrub at 4600 ft. Jan.

Solenopsis amblychila Wheeler, W. M. 1915. Hot Climate Specialist. Probably feeds on seeds, omnivore. Three records near Coyote Spring in the Granite Mtns. at 3290 ft in Blackbrush Scrub, Acacia Scrub. Apr-Jul. Minor workers of this and the next species can be distinguished by the lower density of standing pilosity on the anterior part of the pronotum of this species.

Solenopsis aurea? Wheeler, W. M., 1906. Hot Climate Specialist. Probably feeds on seeds, omnivore. Creosote Scrub, washes, Joshua Tree Woodland between 2700-4600 ft. Every month. Nests under objects on coarse soil. 10 records. Coyote Spring, Kelbaker Rd, 9 mi and 18 mi n Kelso, Cedar Canyon Rd, 3.8 mi e of Kelso Cima Rd. PS Ward (pers. comm. 2008) notes that some *S. xyloni* in the California desert become quite light and resemble *S. aurea*. He suspects that *S. aurea*, a desert grassland and woodland species, does not occur west of Arizona. Molecular studies will be required to resolve this uncertainty.

Solenopsis molesta (Say, 1836). Cryptic Species. Omnivorous. Blow sand, Creosote Scrub, Blackbrush Scrub between 1000-5700 ft. Mar-Oct. Nest under stones or in nests of larger ants. 13 records. Budweiser Spring, Kelso Dunes, Caruthers Canyon, Pichalka Spring, Curtis Canyon.

Solenopsis xyloni McCook, 1880 (=*S. maniosa*). Hot Climate Specialist feeds on seeds, omnivore, raids other ants. All habitats between 1000-5700 ft. All months. Nest under stones or litter, exposed soil. 101 records. Any location in the valleys, eg. Budweiser Spring, Granite Pass, Coyote Spring, Kelso Station, Pichalka Spring.

Stenamma californicum Snelling, 1973. Cold Climate Specialist. Preys on litter microarthropods. A single individual at Caruthers Cyn. in Pinyon/Oak Woodland at 5700 ft. May. Nest in litter. A surprising record for a species typically from much more mesic settings to the west.

Temnothorax andrei (Emery, 1895). Cold Climate Specialist. A generalist forager. Possibly an

inquiline. P/J Woodland, Blackbrush between 3200-7200 ft. Mar-Aug. Nest under stone. 13 records. Coyote Spring, Caruthers Canyon, New York Peak, Curtis Canyon, 1 mi w Pichalka Spring.

Temnothorax neomexicanus (Wheeler, W. M., 1903). Cold Climate Specialist. A generalist forager. Creosote Scrub, Acacia washes, Joshua to P/J Woodlands between 1000-5700 ft. Jan-Oct. Nest in soil under stone. 51 records. Budweiser Spring, Granite Pass, Rock Spring, Coyote Spring, Caruthers Canyon, Teutonia Peak, Pichalka Spring, Curtis Canyon.

Temnothorax nevadensis (Wheeler, W. M., 1903). Cold Climate Specialist. A generalist scavenging forager. Creosote Scrub, Joshua Tree Woodland, Blackbrush Scrub, Pinyon/Juniper Woodland between 3700-5500 ft. Mar-Oct. Nest in soil under stone. 14 records. Budweiser Spring, Pichalka Spring, Curtis Canyon, Rd NN699 @ Perimeter Rd near Coliseum Mine.

Temnothorax nitens (Wheeler, W. M., 1903). Cold Climate Specialist. Scavenger, preys on soil microarthropods, tend aphids. Pinyon/Juniper Woodland. One March record from Curtis Canyon Rd, Clark Mtns. at 5435 ft.

Temnothorax obliquicanthus (Cole, 1953). Cold Climate Specialist. A generalist forager. Scavenging and prey on soil microarthropods. Joshua Tree and Pinyon/Juniper Woodland between 4400-5700 ft. Mar-Sept. Nest in exposed soil. 4 records. Caruthers Canyon, Teutonia Peak.

Temnothorax whitfordi (Mackay, 2000). Cold Climate Specialist. A generalist forager. feeding ecology not known. Pinyon/Juniper Woodland between 4900-5700 ft. Mar-Oct. One nest found 8 ft above ground in beetle galleries in Juniper. 3 records. Caruthers Canyon, near Mountain Pass.

Veromessor is a junior synonym of *Messor*. See *Messor.*

Formicinae

Acanthomyops is a junior synonym of *Lasius*. See *Lasius.*

Brachymyrmex depilis Emery,1893. Cryptic Species. Tends hemipterans. A single queen record from an *Ephedra/ Acacia* wash at 3770 ft at Willow Spring Basin. October. Nest subterranean, under stone.

Camponotus fragilis (Pergande, 1894). (= *festinatus* in part) Subordinate Camponotini. Observed carrying insect parts. Creosote, Mojave Yucca Scrub, Desert Washes, Pinyon/Juniper Woodland between 2700-5700 ft. Jan-Sept. Nest under objects. 21 records. Willow Spring Basin, Granite Pass, Vulcan Mine Rd, Kelbaker Rd, 18 mi nw Kelso.

Camponotus hyatti Emery, 1893. Subordinate Camponotini. Honeydew feeder. Creosote washes, Joshua Tree and Pinyon/Juniper Woodlands between 3700-7200 ft. Apr-Oct. Nest in dead wood galleries. 14 records. Willow Spring Basin, Caruthers Canyon, New York Peak, Curtis Canyon.

Camponotus ocreatus Emery, 1893. Subordinate Camponotini. Creosote, Joshua, Blackbrush

Scrub; Pinyon/Juniper Woodland between 3000-5700 ft. Mar-Nov. Nest under stones, often on rocky slopes. 32 records. Budweiser Spring, Granite Pass, Rock Spring, Caruthers Canyon, Keystone Canyon, Pichalka Spring.

Camponotus sansabeanus (Buckley, 1866). Subordinate Camponotini. Omnivorous scavenger. Joshua Tree Woodland, Blackbrush Scrub, Pinyon/Juniper Woodland between 4800-5700 ft. Nest in soil, some under stones. 38 records. Caruthers Canyon, Keystone Canyon, Teutonia Peak, Curtis Canyon.

Camponotus sayi Emery, 1893. Subordinate Camponotini. Pinyon/Juniper Woodland at 5700 ft. Mar-Jul. Nest in tree cavities, often beetle galleries. 4 records. Caruthers Canyon.

Camponotus semitestaceus Snelling 1970. Subordinate Camponotini. Hemipteran tender. All habitats except blow sand and Yucca scrub between 4180-7200 ft. Mar-Nov. Nest under stones. 26 records. Rock Spring, Kelbaker Rd 18 mi nw Kelso, Teutonia Peak, Pichalka Spring, Curtis Canyon.

Camponotus yogi Wheeler, W. M., 1915. Subordinate Camponotini. Joshua Tree/Juniper Woodland at 4800 ft. Feb-Aug. Nest in dead wood galleries or under stones. 4 records. Rock Spring. These records represent a southward extension of the known range for the species (PS Ward, pers comm, 2010).

Formica gnava Buckley, 1866. Opportunist, tend hemiptera. Pinyon/Juniper Woodland between 5400-7200 ft. Every month. Nest in sandy soil, under stones and thatch. 42 records. Midhills, Kelso Cima Rd, 7.6 mi ne Kelso, Caruthers, Keystone and Curtis Canyons.

Formica xerophila M.R. Smith, 1939. Opportunist. Creosote Scrub, Joshua Tree Woodland, Blackbrush Scrub, Pinyon/Juniper Woodland between 2900-5700 ft. Every month. Nest in soil, exposed or under cover. 12 records. Granite Pass, Piute Spring, Caruthers Canyon, Kelbaker Rd, 9 mi n Kelso, Curtis Canyon.

Lasius (Acanthomyops) californicus Wheeler, W. M., 1917. Cryptic Species, hemipteran tender. A temporary social parasite on other *Lasius*. Pinyon/Juniper and Oak woodland between 5600-7200 ft. Nov-Aug. Nest in soil under rocks. 21 records. Caruthers Canyon, New York Peak.

Lasius (Lasius) crypticus Wilson, 1955. Cryptic Species, tends hemiptera on roots, scavenge insects. Pinyon/Juniper and Oak Woodland between 5600-7200 ft. Mar-Aug. Nest in soil under stone. 7 records. Caruthers Canyon, New York Peak.

Myrmecocystus christineae Snelling, 1982. Hot Climate Specialist. diet undescribed. Creosote/Acacia sandy scrub, Desert Washes, Joshua Tree Woodland between 3300-4200 ft. Apr-Oct. Nest a cone in exposed sandy wash (pers. obs). 12 records. Willow Spring Basin, Kelbaker Rd, 9 mi n Kelso, Morningstar Mine Rd, 9.5 mi nne Cima.

Myrmecocystus flaviceps Wheeler, W. M., 1912. Hot Climate Specialist. Scavenger-predator, honeydew gatherer. All habitats except blowsand and Yucca Scrub between 1000-5700 ft. Every month. Nest in exposed soil. 47 records. Budweiser Spring, Coyote Spring, Kelbaker Rd, 1.5 mi e Baker, Rock Spring, Midhills Campground, Rock Spring, Pichalka Spring.

Myrmecocystus kennedyi Snelling, 1969. Hot Climate Specialist. Nectar, honeydew gatherer, scavenger. Creosote Scrub, blowsand between 2100-3600 ft. Jan-Oct. Nest in exposed, coarse sandy places. 19 records. Budweiser Spring, Kelso Dunes, Kelbaker Rd, 18 mi nw Kelso.

Myrmecocystus lugubris Wheeler, W. M., 1909. Hot Climate Specialist. General forager. Creosote Scrub, blow sand at 2500 ft. April. Nests in fine, exposed sand. One California Dept. Agriculture record. Kelso Dunes. This is an old record gleaned from Snelling and George (1979) and might be viewed with some skepticism.

Myrmecocystus mendax Wheeler, W. M., 1908. Hot Climate Specialist. Predator, scavenger, gathers honeydew, nectar. All habitats except fine sandy areas and Pinyon/Juniper Woodland between 1000-4900 ft. Mar-Oct. Nest in stony soils, obscure. 10 records. Granite Pass, Morningstar Mine Rd, 9.5 mi nne Cima, 1 mi w Pichalka Spring.

Myrmecocystus mexicanus Wesmael, 1838. Hot Climate Specialist. Honeydew, dead insects, vertebrate carrion. All habitats except sandy areas between 2700-4800 ft. Jan-Sept. Nest in coarse soil on high ground. 22 records. Budweiser Spring, Coyote Spring, Granite Pass, Lanfair Valley Rd, 12 mi s Ivanpah, Rock Spring.

Myrmecocystus navajo Wheeler, W. M., 1908. Hot Climate Specialist. Tends hemipterans, flower nectar, dead insects. Creosote Scrub, sandy washes between 1800-4600 ft. Mar-Jul. Nest obscure in sandy soil. 5 records. Budweiser Spring, Cedar Canyon Rd, 3.8 mi e Kelso Cima Rd, Kelbaker Rd, 9 mi n Kelso.

Myrmecocystus placodops Forel, 1908. Hot Climate Specialist. Predator, scavenge insects, flower nectar. CreosoteScrub, washes, Mojave Yucca Scrub, Blackbrush scrub between 1000-5500 ft. Jan-Oct. Nest in exposed, stony soil. 5 records. Dorner's Camp, Vulcan Mine Rd, 1 mi w Pichalka Spr.

Myrmecocystus romainei Hunt and Snelling, 1975. Hot Climate Specialist. Omnivore. Creosote/Joshua Tree ecotone, Pinyon/Juniper Woodland between 4200-5700 ft. Mar-Apr, through summer. Nest in exposed, deep sandy soil. 4 records. Caruthers Canyon, Teutonia Peak, Morningstar Mine Rd, 9.5 mi nne Cima.

Myrmecocystus tenuinodis Snelling, 1976. Hot Climate Specialist. Nectar feeder, scavenger. Blow sand, Creosote Scrub between 1000-3000 ft. Mar-May. Nests in exposed fine sand. 7 records. Kelso Dunes, Kelbaker Rd, 1.5 mi e Baker; Kelbaker Rd, 2.3 mi s Kelso.

Myrmecocystus testaceus Emery, 1893. Hot Climate Specialist. Feeds on honeydew, plant secretions, live and dead insects. Creosote Scrub, Joshua and Pinyon/Juniper Woodlands between 3700-5700 ft. Feb-Jul. Nest in exposed soil. 21 records. Budweiser Spring, Rock Spring, Caruthers Canyon, 0.6 km ne Teutonia Peak.

Myrmecocystus yuma Wheeler, W. M., 1912. Hot Climate Specialist. Feeds on live or dead insects, honeydew. Creosote Scrub, Joshua Tree Woodland between 2900-3600 ft. Jan-Mar. Nest in exposed sand. 5 records. Kelso Cima Rd, 7.6 mi ne Kelso, Morningstar Mine Rd 9.5 mi nne Cima.

Nylanderia (=*Paratrechina*) *cf. terricola* (Buckley, 1866). Opportunist. Omnivorous scavenger. Sandy washes, Creosote Scrub, Mojave Yucca Scrub, Blackbrush Scrub, Joshua Tree Woodland between 2700-5500 ft. Jan-Oct. Nest in soil under wood or stone. 16 records. Dorner's Camp, Kelbaker Rd 18 mi nw Kelso, Pichalka Spring, Curtis Canyon.

ACKNOWLEDGEMENTS.

This study has been conducted under the authority of National Park Service permits MOJA-2001-SCI-0028, MOJA-2002-SCI-0024, MOJA-2003-SCI-0001, MOJA-2004-SCI-0003, MOJA-2005-SCI-0003, MOJA-2006-SCI-0004, MOJA-2007-SCI-0002, MOJA-2008-SCI-0020. Access to the Sweeny Granite Mountains Desert Research Center of the University of California was provided by James André. Philip Ward and Andrew Suarez checked the identity of ants and Ward read an earlier draft of the list. John Donoghue contributed his GIS skills to the project. Without their help the project could not have been completed. The complete collection records are available upon request to JdL.

LITERATURE CITED.

Andersen, AN. 1997. Functional groups and patterns of organization in North American ant communities: a comparison with Australia. J. Biogeog. 24:433-460.

Andre, J. 2006. Inventory of Plants at MOJA and MANZ – Final Report 2006. Solicitation # Q2280201178

AntWeb [Internet]. c2002-2010. San Francisco (CA): California Academy of Science. [2008]. Available from: http://www.antweb.org

Blondel, J. 2003. Guilds or functional groups: does it matter? Oikos 100: 223-231.

Borgelt, A & TR New 2005. Pitfall trapping for ants in mesic Australia: the influence of trap diameter. J. Insect Conservation. 9: 219-221.

Cardiff, SW & JV Remsen, Jr. 1981. Breeding avifaunas of the New York Mountains and Kingston Range: islands of conifers in the Mojave Desert of California. Western Birds 12(2): 73-86.

Cronquist, A, AH Holmgren, NH Holmgren and JL Reveal. 1972. Intermountain Flora: Vascular plants of the Intermountain West, U.S.A. Vol. I. Hafner Publ, NY. 270 pp.

Hickman, JC, ed. 1993. The Jepson Manual: Higher Plants of California. Univ. Calif. Press. 1400 pp.

Johnson, N. 1995. Seven avifaunal censuses spanning one-half century on an island of White Firs (*Abies concolor*) in the Mojave Desert. Southwestern Nat. 40(1): 76-85.

King, TJ. 1976. Late Pleistocene-early Holocene history of coniferous woodlands in the Lucerne Valley region, Mohave Desert, California. Great Basin Nat. 36(2): 227-238.

Koehler, PA, RS Anderson & WG Spaulding. 2005. Development of vegetation in the Central Mojave Desert of California during the late Quarternary. Palaeogeography, Palaeoclimatology, Palaeoecology 215(2005): 297-311.

Mackay W & E Mackay 2002. The Ants of New Mexico (Hymenoptera: Formicidae). The Edwin Mellen Press. 398 pp.

Mojave Desert Ecosystem Program [Internet]. Department of Defense. [2006]. Available from: http://mojavedata.gov/index.html

Nash, MS, DF Bradford, SE Franson, AC Neale, WG Whitford , DT Heggem 2004. Livestock grazing effects on ant communities in the Eastern Mojave Desert, USA. Ecol. Indicators 4(2004): 199-213.

Sanders, NJ, J Moss and D Wagner. 2003. Patterns of ant species richness along elevational gradients in an arid ecosystem. Global Ecol & Biogeogr. 12: 93-102.

Smith, FA, MD Matocq, KF Melendez, AM Ditto and PA Kelly. 2000. How isolated are Pleistocene refugia? Results from a study on a relict woodrat population from the Mojave Desert, California. J. Biogeography 27:483-500.

Snelling RR 1976. A Revision of the Honey Ants, Genus *Myrmecocystus* (Hymenoptera: Formicidae). Nat. Hist. Mus. Los Angeles Co. Sci. Bull. 24. 163 pp.

Snelling RR 1982. A Revision of the Honey Ants, Genus *Myrmecocystus*, First Supplement (Hymenoptera: Formicidae). Bull. So. Cal. Acad. Sci. 81(2): 69-86.

Snelling RR & CD George. 1979. Taxonomy, distribution and ecology of California desert ants (Hymenoptera: Formicidae). Report to Calif. Desert Plan Program, BLM, USDA 335 + 89 pp

Snelling RR & CD George. 2003. California Desert Ants. http://www.desertants.org/indexpages/mojave.html

Thompson, RS. 1990. Late Quaternary vegetation and climate in the Great Basin. Ch. 10. IN; Betancourt, JL, TR Van Devender and PS Martin. Packrat middens: the last 40,000 years of biotic change. Univ. Ariz. Press. 467 p.

Thorne, RF, BA Prigge & J Hendrickson. 1981. A flora of the higher ranges and the Kelso Dunes of the Eastern Mojave Desert in California. Aliso 10(1): 71-186.

Van Devender, TR, RS Thompson & JL Betancourt. 1987. Vegetation history of the deserts of southwestern North America; the nature and timing of the Late Wisconsin-Holocene transition. The Geology of North America. Vol. K-3, North America and adjacent oceans during the last deglaciation. Ch. 15. The Geol. Soc. Amer. p 323-352.

Veblen, K. 2010. Effects of livestock removal on recovery of Mojave NR plant communities. Investigator's Annual Report, National Park Service. Permit # MOJA-2009-SCI-0017.

Ward, PS. 1999. Deceptive Similarity in Army Ants of the Genus *Neivamyrmex* (Hymenoptera: Formicidae): Taxonomy, Distribution and Biology of *N. californicus* (Mayr) and *N. nigrescens* (Cresson). J. Hym. Res. 8(1): 74-97.

Ward, PS. 2004. Taxonomic Studies on Nearctic Ants: the Ant Fauna of the Mohave National Preserve Investigator's Annual Report, National Park Service. Permit # MOJA-2004-SCI-0012.

Ward, PS. 2005. A Synoptic Review of the Ants of California (Hymenoptera: Formicidae). Zootaxa 936: 1-68 (2005).

Wells, PV. 1983. Paleobiogeography of montane islands in the Great Basin since the last glaciopluvial. Ecol. Monogr. 53(4): 341-382.

Wheeler, GC & JN Wheeler. 1973. Ants of Deep Canyon: Colorado Desert, California. Philip Boyd Deep Canyon Desert Research Center, Univ. Calif, Riverside. 162 pp.

Wheeler, GC & JN Wheeler. 1986. The Ants of Nevada. Nat. Hist. Mus. Los Angeles Co. 138 pp.

Wilson, EO. 2003. Pheidole in the New World: a Dominant, Hyperdiverse Ant Genus.

Harvard Univ Pr. 794 pp.

Figure 1

Ikeda and des Lauriers, Ants of the Mojave Preserve

Figure 1. Caruthers Canyon drainage viewed from near New York Peak. Mouth of Caruthers Canyon at lower right.

Table 1. Ant Diversity Within Plant Communities

Plant Community	% of Preserve Area	% Trapping Effort	# Ant Species
Creosote Bush Scr.	41.2	15.6	44
Joshua Tree Woodl.	22.6	16.1	47
Mojave Yucca Scrub	15.9	13.2	25
P/J Woodland	5.9	13.3	48
Dune Scrub	3.1	6.7	15
Desert Wash	3	16	30
Blackbrush Scrub	1.7	19.1	39
Nonnative or other	6.6	0	

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Table 1. Shows the percentage of the sampled habitat types and the sampling effort in each of the habitat types. The number of species collected in each habitat type is shown in the third column. Total Preserve area = 607,000 ha. Total sampling effort = 62,797 trap nights.

Table 2. Ant Species Diversity of the Commonest Genera.

Ant Genus	Functional Group	Number of Species	Number of Sp. Records	% of Species Records
Pheidole	GM	13	346	21.3
Myrmecocystus	HCS	13	163	10.1
Crematogaster	GM	3	141	8.7
Camponotus	SC	7	139	8.6
Solenopsis	HCS/CS	4	127	7.8
Pogonomyrmex	HCS	5	117	7.2
Total		45	1033	63.7

Functional Groups		Number of species
CS = Cryptic Species		1
GM = Generalist Myrmicine		16
HCS = Hot Climate Specialist		21
SC = Subordinate Camponotine		7

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Table 2. The six commonest genera ranked by the number of species records they contributed to the collection. The large majority of species in these common genera are members of only two functional groups.

Table 3. The Commonest Ant Species.

Ant Species	Number of Sp. Records	% of Species Records
Pheidole desertorum	134	8.3
Solenopsis xyloni	101	6.2
Crematogaster depilis	84	5.2
Monomorium ergatogyna	57	3.5
Pheidole cerebrosior	51	3.2
Temnothorax neomexicanus	51	3.2
Total	478	29.6

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Table 3. The six commonest ant species in the sample. Six species out of 74 make up nearly 30% of the records.