

Foraging Behavior of the Honey Ant
Myrmecocystus mexicanus,
in Colorado

Dr. John R. Conway
Department of Biology
Elmhurst College
Elmhurst, Illinois 60126

ABSTRACT

Five nests were observed over a four year period in the Colorado Springs area for periods up to 453 days to determine the method of foraging of the honey ant, Myrmecocystus mexicanus, and the nectar sources utilized to fill swollen storage ants in each colony, called repletes. Honey ants forage at night at temperatures ranging from 0.6 to 27 C between March and November. The maximum foraging distance was 19.8 m and the rate of progression varied from 0.28 to 0.94 m/min. At times workers forage on poorly defined trails and at other times in a diffuse pattern. Workers gather nectar from Cynipid galls on scrub oaks, from yucca capsules, and occasionally from aphids. They also scavenge dead insects and arachnids. Notes on predation and interactions with other ants are also represented.

INTRODUCTION

Although the foraging activities of the nocturnal honey ant, *Myrmecocystus mexicanus*, have been discussed by a number of investigators (McCook, 1882; Wheeler, 1908; Slocumb, 1966 and Snelling, 1976) this paper attempts to reexamine, discuss, and extend their findings in light of data collected in Colorado Springs. This site was chosen since it was the location of McCook's original investigation of this species.

Five nests were observed for periods of 52, 100, 422, 422, and 453 days, and many other colonies were watched for much shorter periods of time. The evening observations were made by the light of a double-mantle Coleman lantern and were useful in ascertaining the method, speed, duration of foraging, and maximum distances traveled. Seasonal activity and climatic effects on foraging were noted. Information was also obtained on nectar sources, carnivorous habits, predation, and interactions with other species of ants. All times were expressed as Mountain Standard Time.

RESULTS AND DISCUSSION

Method of foraging

Usually a number of workers assemble on the crater each evening about sunset before moving off to forage. But sometimes the early exodus failed to materialize due to too few ants emerging, or emerging but not leaving the crater, or emerging but then retreating back into the entrance again. Surprisingly, all nests observed for any period of time exhibited a complete lack of early-evening foraging on a number of nights. For example, at one colony the early-evening exodus did not occur on 23 evenings between July 3 and October 4. However, on three of these occasions, the ants were seen foraging later in the evening, or early the next morning. At another colony, foraging activity was very weak to nonexistent on ten evenings between May 9 and September 10, and at a nest in the Garden of the Gods, no foraging occurred during five early vigils (7-8 PM) between June 6 and 17.

Although honey ants from a given colony forage in various directions during the year and at times exhibit a diffuse searching pattern, at other times they march off in one direction leading to a nectar-bearing plant night after night. For example, the workers of one colony marched to a scrub oak thicket, 10.4 to 10.7 m south of the crater, 22 times between June 26 and August 29. On these evenings the ants streamed south on a worn pathway and reached the trees between 7:58 and 8:35 PM. They often stopped and regrouped in small clearings before resuming their march, and sometimes a few workers began to return to the nest only five minutes after having left. Occasionally, they even reversed their main line of march, as on June 4, when they advanced 76 cm southwest of the crater, then returned seven minutes later, and went off on a northerly course.

These findings contradict Snelling's (1976) observations that there are no foraging trails as such, and that the workers radiate in all directions before finally arriving at previously visited food sources.

The trails generally follow bare ground and do not go through dense grass or other vegetation. The paths are certainly not as definitive as those of some species of ants and show no evidence of construction. As McCook (1882) noted, the trails wind somewhat and seem to avoid surface inequalities.

As mentioned, the advance workers of the column stop and regroup periodically in small clearings before resuming the march, but there appears to be no definite leadership on the trail. McCook (1882) also stated there were no leaders, but then contradicted himself by noting on one occasion that a dwarf led most of the way, until a worker-minor finally took over as head of the column. The two were separated from each other and the main column by about 20 to 25 cm.

It is doubtful that honey ants leave a scent trail, since they were not seen pressing their abdomen tips to the ground, but how they navigate is unknown. Lantern light did not seem to disorient ants on the trail, and a rock placed in their path only confused a few momentarily; most went up and over the obstacle.

When honey ants visit two or more nectar sources in the same general direction, the trail may bifurcate a short distance from the entrance. For example, in the nest discussed previously, the ants not only visited oaks 10.4 to 10.7 m south of the crater, but also went to oaks 9.8 m southeast of the colony. The path to the southeast branched from the trail south a short distance from the entrance. At another nest, the trail forked 69 cm east of the nest, one path going south while the other headed east.

Honey ants may also switch nectar sources during two consecutive years or even within the same season. As noted, ants from the nest above mainly visited the two yuccas 19.9 m north of the crater during the second year, but in the year previous they exploited yuccas in several different locations as well. They were on the yucca closest to the nest, 0.9 m north, on August 6 and 8. They visited a yucca 10.1 m to the east on July 18 and August 8. They were on a yucca 11 m to the southeast on July 21, and on another 16.8 m to the southeast on July 18 and 21. And once, on July 21, they were observed on a yucca 23.6 m to the south, although it is not certain that they emanated from this nest.

The nests observed foraged mainly on yuccas or scrub oaks, but not both. Whether the exclusive utilization of one plant species during the season is the norm is not known, but it would appear not to be from what others have reported (see section, Foraging on Other Plants).

At other times, honey ants from a given nest went off in several directions simultaneously, and not in well-defined columns. Presumably they used this diffuse-foraging pattern either to scavenge for dead arthropods or to locate nectar-producing plants.

Duration of foraging

Myrmecocystus mexicanus does most of its foraging between sunset and sunrise. The initial activity begins slowly with the emergence of one to four workers, apparently in response to lowered light intensity. The first ant out is almost as likely to be a small worker as a major and it was noted that workers of all sizes subsequently forage.

The first worker came out at times ranging from 5:45 PM on October 7 to 7:57 PM on July 14, but usually between 7:18 and 7:49 PM, except at the time of swarming when emergence occurred somewhat earlier (6:54 to 7:05 PM). On the average, the first ant came out at 7:30 PM.

The principal activity of the evening occurs when the workers mass on the crater and/or begin to leave in numbers to forage. Ants are often sluggish when they first emerge from the formicary, but gradually become more active as night falls and their numbers increase. The main exodus occurred at times ranging from 5:50 PM on October 7 to 8:13 PM on July 16, but generally between 7:22 and 8:13 PM. The average time of the main exodus was 7:46 PM. Thus, the time between the appearance of the first worker (7:30 PM) and the mass exodus (7:46 PM) averaged 16 minutes.

Sometimes workers returned to the nest shortly after the mass exodus. For example, ants left one nest at 7:40 PM, and by 7:45 PM several were already coming back.

But typically, ants returned later in the evening, often with a major influx occurring just before sunrise. Nevertheless, some ants were observed leaving the nest even as daylight approached. Several were seen going out a short distance as late as 4:50 AM, and on June 16, at 5:43 AM, a small worker marched off 3.4 m before she was lost from view. McCook (1882) reported that *mexicanus* workers begin to return about midnight and continue until 4 or 5 AM.

Maximum foraging distances

The maximum foraging distances for the nests in my study ranged from 8.8 to 19.8 m (possibly 23.6 m). McCook (1882) noted ants out as far as 15.2 m and Slocumb (1966) reported that workers would travel up to 32.9 m to feed on the plains east of Colorado Springs, although distances of 15.2 to 24.4 m were more common.

Effect of climatic factors on foraging

Honey ants foraged at air temperatures ranging from 0.6 °C to 27 °C. Kay (1974) worked on the thermal physiology of several diurnal and nocturnal honey ant species near Las Cruces, N. Mexico and reported that *mexicanus* was not out of the nest at temperatures lower than 2 °C or above 30 °C.

Kay concluded that *mexicanus* can remain active at much lower temperatures than most desert ants and that the low temperature-tolerance of this species probably reflects an adaptation to nocturnal foraging since temperatures below 15 °C occur frequently at night in warm desert areas. This ability to forage at temperatures below 10 °C allows *mexicanus* to be active at night throughout much of the year in southern New Mexico and as late as November and as early as March in Colorado.

Kay (1974) noted that although nocturnal species have critical thermal maxima which are at the lower end of the range of diurnal species, they do not forage above 30 °C, well below the critical thermal maxima, and therefore rarely, if ever, encounter lethal high temperatures. Thus, while temperature sets upper limits on surface activity for diurnal species of *Myrmecocystus*, this is apparently not true for nocturnal species such as *mexicanus*. Thus, the limiting factor for the nocturnal species may well be light intensity, possibly coupled with temperature.

Other observations on temperature and humidity tolerances of honey ants by Kay (1974) are also of interest. In all species, the preferred temperature was higher during the hot summer months than at other seasons, suggesting some acclimation. And one curious finding was that the nocturnal *mexicanus* seemed less adversely affected by desiccation than the workers of the diurnal species.

Workers were noted on several occasions foraging in the rain, sometimes as far away from the nest at 19.8 m, but none were ever observed drinking water, even though they were on leaves covered with rain drops. Therefore, the source of water for the swollen aquapletes reported by Snelling (1976) and chemically analyzed by Conway (1977) remains unknown.

Effect of lantern light on foraging

Since most investigators, myself included, have used lanterns to observe the nocturnal activities of *mexicanus*, the effect of the light on its behavior is of interest, but unfortunately remains rather enigmatic. Lantern light sometimes disrupts foraging behavior, but at other times does not seem to affect it. Workers carrying prey far from the colony were sometimes disoriented by the light and took a long time to return or even went away from the nest. However, when a dead insect was being transported close to the crater, the worker generally brought it directly to the entrance despite the lantern's presence.

Lantern light did not seem to disorient the ants moving along trails, but McCook (1882) reported just the opposite, namely that it did disturb workers in the column and that they would go toward the lantern as it sat on the ground near the trail.

Sometimes lantern light caused workers on the crater to withdraw into the entrance, particularly if they had recently emerged, but at other times it seemed to have no effect. McCook (1882) reported that sentries around the entrance were always more or less excited by the light, and that he had to delicately manipulate the illumination to preserve natural behavior.

Seasonal activity

Workers foraged as late in the fall as November 7, and as early in spring as March 17, but were more active in the summer months of June, July and August. It was also noted that nests in the same area may exhibit different degrees of activity on any given evening.

Foraging on scrub oaks

Honey ants foraged on scrub oaks (*Quercus gambellii* Nutt.) in the vicinity of three nests at distances of 9.8 to 13.4 m. McCook (1882) observed workers going in a column to a thicket of scrub oak 15.2 m from the colony.

Workers generally visited the oaks between July 7 and August 29, but were sighted on trees around two colonies as early as May 26. McCook (1882) also mentions honey ants on scrub oaks in July and August, but did not give specific dates.

Honey ants may forage on oaks in two different locations at the same time. Ants from one colony visited an oak thicket 10.4 to 10.7 m south of the crater 22 times between June 26 and August 29, but also went to oaks 9.8 m southeast of the crater on seven occasions between July 9 and August 29.

Sometimes ants from a colony visited both yuccas and scrub oaks, but did not feed on the oaks. Ants from one nest were on oaks 13.4 m southeast of the colony only on May 26 and August 4 of two consecutive years, but did not feed on galls. At another colony there was only one observation, on May 26, of a worker on scrub oaks 12.5 m to the northwest, but again no galls were present and the rest of the time the ants fed mainly on yuccas.

Workers left the colonies for the scrub oaks between 7:22 and 8:10 PM, or approximately the same times, 7:30 and 8:00 PM, reported by McCook (1882).

Only the honey ants from one nest were ever observed feeding (Fig. 1) on the clear sweet droplets on reddish oak galls, and only between July 9 and August 13. These data contradict McCook's (1882) original study which seemed to suggest that gall nectar was the main source of carbohydrates for the species. The workers' abdomens visibly inflated while imbibing the gall nectar and the swollen ants returned to the nest.

The ants covered distances of 9.8 to 13.1 m to reach the oak galls and their rate of progression ranged from 0.28 to 0.88 m per minute, or an average of 0.55 m per minute. McCook (1882) reported that honey ants visited the same oak tree repeatedly and covered the 15.2 m to it in 17 minutes, for a faster speed of 0.90 m per minute.

When the ants reach the oaks, they fan out over the trunk, branches, and leaves, and finally seek out the reddish-brown galls, the work of the gall wasp, *Holcaspis perniciosus* (Cynipidae). The galls are usually in groups of two or more along the branches and gradually exude small droplets of clear nectar. McCook (1882) pointed out that the galls give off at least three series of exudations

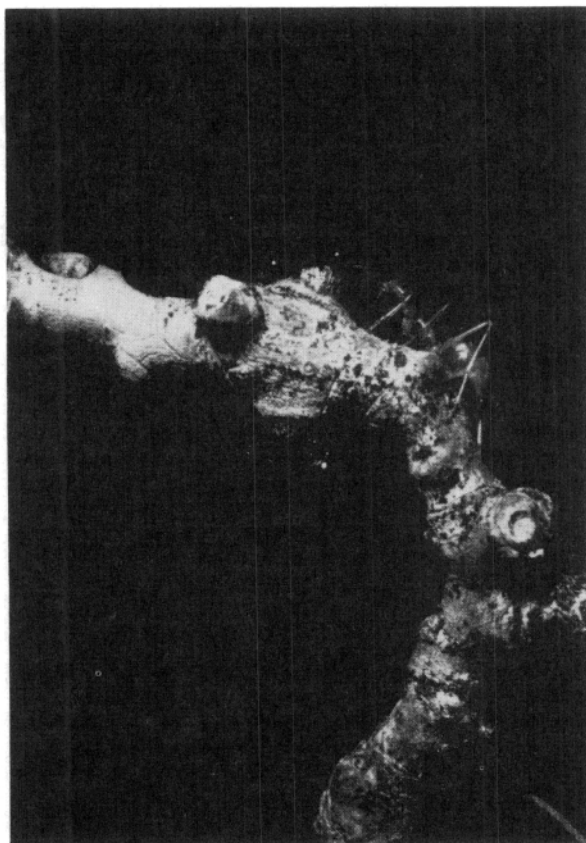


Fig. 1. Honey ant drinking clear nectar droplet on Cynipid gall on scrub oak (*Quercus gambellii*) southeast of *Myrmecocystus mexicanus* nest (2.5X).

during the night, which explains the continual flitting of the ants from branch to branch and gall to gall. The successive exudations also invite the frequent return of workers to the galls from which they had formerly fed. The galls gradually dry up and by October the nectar is no longer flowing.

Wheeler (1910) believed that the secretions of the galls furnished only a portion of the food, and that most of their honey was obtained from the coccids and aphids on the oaks and other plants in the vicinity. Unfortunately, this speculation has not been confirmed by my field observations. Workers were never observed feeding on coccids and aphids on oaks, and only rarely on aphids on yuccas. But Hutchins (1962) did report that his wife once trailed a foraging column to a wild rosebush and saw them "milking" a herd of aphids, or plant lice, in addition to feeding on scrub oaks.

Foraging on yuccas

Honey ants visited yuccas (*Yucca glauca* Nutt.) in the vicinity of four nests between June 20 and August 10, but most often during the month of July. Workers were observed on plants as far as 19.8 m (perhaps 23.6 m) from the colonies. Data from one nest indicate that the ants covered the 19.8 m in 21 to 51 minutes on different evenings, and hence their speed ranged from 0.39 to 0.94 per minute, or an average of 0.62 m per minute.

Honey ants from one colony shifted their foraging pattern during successive years. During the first year they visited a number of yuccas in different locations (see Method of foraging), but during the second year the workers foraged primarily on two yuccas north of the nest.

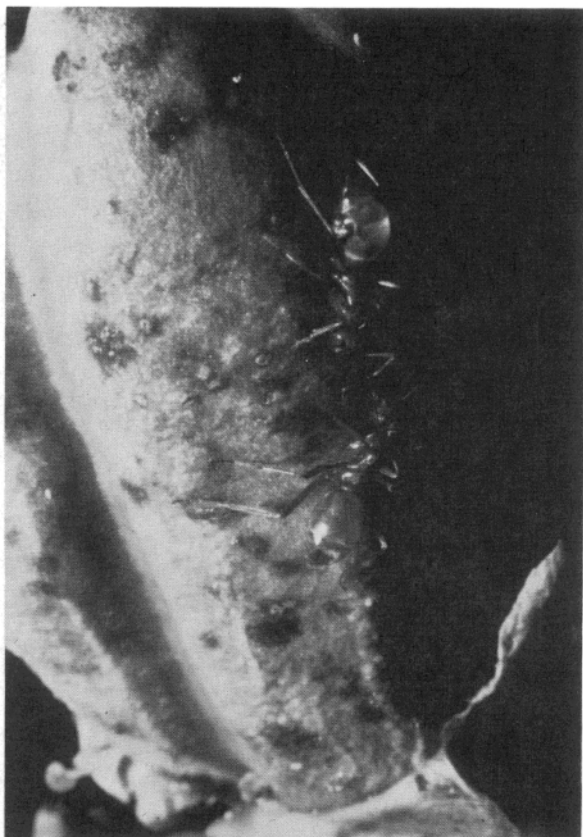


Fig. 2. *Myrmecocystus mexicanus* workers (upper one distended) scraping surface of a green yucca, (*Yucca glauca*) capsule 19.8 m north of the colony (3.1X).

The first workers to reach the yuccas often scale the spiked leaves or grass at the base before finding the main stalk bearing the capsules. Once on the green capsules, they move about and seem to secure nectar by scraping the surface, or licking already injured areas (Fig. 2). Once, on July 18, the workers appeared to be feeding on small whitish objects on the capsules which may have been coccids.

Honey ants can exploit the yucca capsules only during a short period in the summer. Yuccas were in full bloom on June 20, but their capsules began to dry up as early as July 21, and by mid-September they were shriveled and dehiscing, and therefore useless as a nectar source.

Workers from two colonies were observed on yuccas infested with aphids on four occasions between June 20 and July 21. (Fig. 3). And although they drank aphid honeydew, they were never observed actually "milking" the insects.

The amounts of honeydew produced by some aphids are prodigious, with outputs ranging from 1.9 to 133% of body weight per hour. When unaided by ants, the aphid disposes of the droplets by flicking them away with its hind legs, or cauda, or by expelling them by contracting its rectum or entire abdomen. Many ants collect this honeydew from the ground or vegetation where it falls (Wilson, 1971). This phenomenon might explain the presence of some of the droplets on the yucca capsules which the honey ants are so fond of.



Fig. 3. *Myrmecocystus mexicanus* workers tending aphids on a yucca (*Yucca glauca*) capsule. Note drop of honeydew suspended from rear end of aphid (arrow) (2.1X).

Foraging on other plants

Since McCook's original in-depth study, many other plants have been implicated as nectar sources besides scrub oaks. However, the ants in my study fed only on scrub oaks and yuccas. Occasionally they were observed on cacti and grass, and, on rare occasions, they brought back a small flower or seed-like objects.

Slocumb (1966) saw plains honey ants utilizing many species of plants, such as the leaves and stem nodes of *Lupinus plattensis* Wats, the nodes of *Psoralea lanceolata* Pursh, *Chrysopsis villosa* (Pursh) Nutt. = *Heterotheca villosa* (Pursh) Shinner, and the nodes of the New Mexican Prickly Pear Cactus, *Opuntia phaeacantha* Engelm. He also saw workers crawling on blue grama grass, *Bouteloua gracilis* (H.B.K.) Lag., but never observed them feeding on it. He concluded that honey ants feed on almost any plant in their environment, and although there are some they favor more for the amount of nectar that can be collected, or the flavor, if one plant is missing they can change their feeding habits and utilize a wide variety of plants.

Cazier and Statham (1962) reported *M. mimicus* feeding on or gathering the pollen and nectar from at least two plants in October and November, *Parthenium incanum* H.B.K. and *Euphorbia albomarginata* Englm., and they may have been getting honey-dew from aphids which were abundant on the underside of the leaves of the latter plant. During August and September they were observed carrying animal booty and were not found on flowers, even though many plants were in full bloom. It may be that in late fall the ants fill the repletes with nectar as a winter supply of food, or they might be filling a newly developed batch of repletes for this purpose.

Leonard (1911) reported the workers of *M. mojave* feeding on the exudates of flowers of the California pepper-tree, *Schinus molle*, on *Euphorbia setiloba*, on *Echium simplex*, a cultivated flower, and from the blossoms of the fragrant wild shrub, *Ceanothus cuneatus*. At other times he

found workers "milking" aphids upon roses and carnations at night. He felt it probable that almost all the wild flowers are visited by the foraging ants. But like other investigators, he found evidence of non-foraging at certain times, as when an *Echium simplex* in full bloom 8.2 m from the nest, was not exploited for three weeks.

Most recently, Snelling (1976) observed *mexicanus* taking juices from bruised or broken fruits, such as those of cacti (*Opuntia* spp.) and also nectar from a wide variety of flowers and extrafloral glands. He feels that perennial and annual desert plants are a very important nectar source, but that the ants also derive much nourishment from the exudates of aphids and pseudococcids. On several occasions he also saw *mexicanus* collect dry head-capsules from the chaff piles of *Pogonomymex* spp.

One unusual nectar source was the report by Shields (1973) of finding *kennedyi* tending larvae of *Philotes rita pallescens* (Lepidoptera: Lycaenidae) on flowers of *Erigonum kearneyi* var. *kearneyi* in Nye Co., Nevada. The ants also fed in the flowers.

Foraging on sweet solutions placed near nest

The communication of the food source between workers is not clear. When blue sugar water was placed on a glass slide a few centimeters from a *mexicanus* entrance, many workers clustered around it within several minutes. The first few individuals drank, developed swollen blue abdomens, and then gradually returned to the nest, where they excitedly bumped into nonswollen workers on the crater. Later several ants with blue abdomens emerged again and returned to the sucrose solution a second time.

At another nest, workers were given diluted bee honey on green leaves near the crater. But this time, the ants seemed to come to the honey by chance, and did not appear to communicate the location of the food source to others.

Other authors have commented on the reaction of honey ants to bee honey placed close to the nest. Leonard (1911) smeared a little bee honey on a piece of glass near a *M. mojave* nest. The honey was quickly surrounded by 40 to 50 ants who climbed upon each other to reach it, and in two or three minutes were fully loaded and staggered off towards the nest. They were willing to regurgitate when appealed to on their way back by a worker.

Slocumb (1966) reported that *mexicanus* can consume its food more efficiently if it is spread over a larger area. A feeding dish with a drop of bee honey concentrated in the center, attracted only three or four workers. But if the drop was spread out, as many as 30 ants could feed on it.

Insectivorous and carnivorous habits

Most investigators have noted that honey ants are primarily scavengers on dead arthropods, and that this prey constitutes an essential component of the total food supply. The fact that McCook (1882) did not, is perhaps the most glaring omission in his famous study.

Honey ants brought dead arthropods to every nest observed for any period of time, and were seen carrying prey from April 19 to October 22. Dead arthropods are also commonly scattered among larvae in excavated formicaries, and probably serve as essential protein and fat for brood development. In fact, larvae have often been observed feeding on dead insects (including honey ant workers) in artificial colonies.

The booty brought back to the nests was diverse and included many unidentified arthropods and fragments, as well as the following: Hemiptera (one Nabidae, one Lygaeidae), Homoptera (one Psyllidae, one Membracidae, one Cicadellidae, and one Aphidae), Orthoptera (two grasshoppers and two grasshopper legs), Diptera (a fly, a deer fly, and three mosquitoes), Coleoptera (unidentified beetles and one Curculionidae), Lepidoptera (moths and a caterpillar), Hymenoptera (ants, a small black wasp, and a bee exoskeleton), Arachnida (spiders and solpugids), larvae, and a leaf with a cocoon-like structure inside. The greatest number of insects and fragments brought to a nest in a given period of time occurred on June 4, when 23 were carried back between 7:23 and 9:00 PM.

Cazier and Statham (1962) also reported a diverse array of animal booty being brought back to the nests of *M. mimicus*. The prey included Hymenoptera (dead remains and one live bee), Orthoptera, Neuroptera, Hemiptera (some alive), Lepidoptera, Coleoptera (some alive), Diptera and Phalangida. There were also occasional pieces of feathers, seeds, leaves and flowers.

Snelling (1976) mentioned one unusual case where *mexicanus* was found actively feeding on dead rodents in traps in the Kingston Range, San Bernardino Co., Cal.

Usually each *mexicanus* worker transports a single insect or fragment, but occasionally two to seven cooperate to move larger prey. Four or five workers were seen carrying a live caterpillar, a dead moth and a grasshopper on different occasions, and, in one instance, it took seven ants to bring back a grasshopper. Workers are reluctant to part with their victim, and if they are picked up while transporting an insect, they will continue to cling to it, at least for a short time.

Although *mexicanus* is not an active predator and rarely attacks live arthropods, it will attack and kill small insects when the opportunity presents itself (Snelling, 1976). Workers were seen pursuing prey on several occasions. Once they were clustered around a small spider with a worker attached to it, and they sometimes chased ladybird beetles while foraging on yuccas. In another instance, they were around a beetle in the grass 86 cm from the nest.

Honey ants attempt to subdue their prey by grasping the victim in their mandibles and then spraying a fluid (formic acid) into the wounds, from a gland situated in the tip of the gaster. Leonard (1911) saw two caterpillars, 3.8 cm long and 0.6 cm in diameter, succumb to the spray in a few minutes before being dragged into a *M. mojave* nest.

Snelling (1976) reports that on several occasions *mexicanus* and *testaceus* workers did not carry back the freshly-killed insect, but rather masticated the corpse and then brought back the body fluids to fill a special type of replete, one filled with the juices of insect prey. This behavior was not observed in my study.

In addition to their normal fare, workers were also given disabled prey on a number of occasions which they attacked and took in. This supplemental sustenance included moths, solpugids, ants (*Camponotus vicinus*), small wasps, beetles (June beetles), damselflies, a fly, a mosquito and a small green inchworm. Some of these insects were attracted and injured by lantern light. When a large, gravid beetle was killed and placed beside one nest on August 16, the workers immediately took in the eggs. By August 22, the carcass was almost stripped, and only small brownish ants of another species continued to feed on the remains.

As mentioned, honey ants are not effective predators and have difficulty subduing prey. Often their quarry escapes, as when a velvet ant was twice put down a *mexicanus* entrance, and twice escaped and fled despite their assault. In another instance, when a large wood ant (*Camponotus vicinus*) was dispatched and put near the entrance, the honey ants at first alternately approached it and retreated. Later, when it was moved closer, the workers finally seized it and took it into the nest after nipping at it several times as if it was still a dangerous foe. Snelling (1976) noted that if the victim was much smaller than the ant, it was carried away, but if the prey was approximately equal to the ant in size and struggled, it was released and the honey ant darted away.

Predation on honey ants

Little predation on honey ants was observed during the four years of observation in Colorado. On July 8, a dead ant was found on the trunk of an oak, and on July 12, a spider (Fig. 4) was observed carrying a worker near a gall on a scrub oak. At another nest, a disabled worker came back to the colony at 5:01 AM on June 16. Honey ants on two occasions brought back dead nest-mates and once carried back a worker injured by the author.

Others have recorded a few instances of predation by larger animals. Hunt (1973) found *Myrmecocystus* to be the prey of two lizard species, *Sceloporus occidentalis* and *Uta stansburiana*, in San Diego Co., Calif., based on examination of stomach contents.



Fig. 4. Spider carrying dead honey ant on a scrub oak (*Quercus gambellii*) south of nest *Myrmecocystus mexicanus* (1.3X).

Parks (1929) reported that the nests of *placodops* (reported as *melliger orbiceps*) are regularly dug out by the coyote, *Canis nebrascensis texensis* Bailey, throughout southwestern Texas, and Kay (1974) noted a nest of *mexicanus* dug out by a vertebrate in New Mexico in the spring of 1973. On a least one occasion, I also observed a nest dug out by some large animal.

Interactions with other ants

Honey ants were occasionally observed interacting with other ants close to the entrance. Small black ants (possibly *Dorymyrmex pyramicus* (Roger) were found around one *mexicanus* nest on several occasions; namely, July 6, August 10, 16, and 22 of one year, and on July 18, 21, and 26 of the next. They seemed to inhibit the dispersal of the honey ants, who were ringed around the entrance in what appeared to be a defensive posture. In one instance, a small black ant ventured into the entrance and disappeared, apparently due to seizure by a sentinel. But on another occasion, when the black ant wandered into the crater and made contact with a guard, it was the guard that withdrew into the entrance. The black ant did not follow, but left instead.

Others have also observed interactions between honey ants and *Dorymyrmex pyramicus*. Leonard (1911) reported that *M. mojave* tolerated *D. pyramicus* close to the nest. The black ants gathered around the honey ant nest to lap up honey he had put at the entrance, but there was no hostility expressed towards them. Cazier and Statham (1962) noted that raids by *D. pyramicus* would stop all outside activity and that *M. mimicus* workers would stay inside the nest entrance or

occasionally bring a piece of debris out onto the crater and then quickly retreat.

When a *mexicanus* trail crossed the entrance of a black ant colony, they chased the honey ants away whenever they ventured too close.

Large wood ants, *Camponotus vicinus*, interacted with honey ants and were found in the vicinity of a *mexicanus* nest on June 7, 8, 13, 15 and 19. The wood ants seemed to forage at will close to the honey ant crater, and at time headed directly for the entrance, or even wandered into it, before being chased away. But sometimes when a *vicinus* worker and honey ant came into contact close to the crater, the honey ant lunged, causing the wood ant to flee. Once a honey ant carrying a dead ant bumped into a wood ant, but then continued on unmolested.

Honey ants foraged on scrub oaks and yuccas with other ants and occasionally interacted with them. For example, both honey ants and small black ants (possibly *Dorymyrmex pyramicus*) drank clear droplets from the same oak galls, but never simultaneously.

Honey ants were seen foraging on yuccas with other ant species. On seven occasions, the members of one *mexicanus* colony were observed on yuccas with other ant species, and in four of these instances, the other species was a small black ant. The interactions with the other ants varied. In one case, the honey ant approached the alien worker, and then quickly retreated. Another time, the other species briefly chased the honey ant after their encounter. And finally, a honey ant collided with a black ant feeding on a droplet on a capsule, and both fled in opposite directions.

Observations on two *mexicanus* colonies showed that the yuccas closest to the honey ant crater were monopolized by small black ants and the honey ants foraged on more distant yuccas. For example, on July 6, the yuccas closest to one honey ant nest were occupied by small black ants, but on yuccas farther away there were small black ants, larger ants with a black head and abdomen and brownish-red thorax, and honey ants. There seemed to be a dominance hierarchy among the three species with *mexicanus* at the bottom. Upon contact, the small black ants chased the honey ants, but the former were in turn intimidated by the larger black and brown workers.

Honey ants were also observed on the same yuccas with two other species, *Camponotus vicinus* Mayr and *Crematogaster lineolata emeryana* Creighton, on June 20, but the other species were not as numerous as the honey ants. These species generally intimidated the honey ants upon contact, and at times even chased them.

The only direct evidence of interspecific confrontation occurred on September 30, when a small brown ant, *Myrmica sabuleti americana* Weber, was found clinging to the leg of a small honey ant about 1.7 m from the *mexicanus* nest. Honey ants also brought back dead ants of several species, such as *Camponotus vicinus*, *Formica fusca*, *Formica pallidefulva nitidiventris*, and *Dorymyrmex pyramicus*, but they may have been dead when the honey ants chanced upon them.

SUMMARY

Five nests were observed over a four year period in the Colorado Springs area for periods of 52 to 453 days to determine the foraging methodology of *Myrmecocystus mexicanus*.

The workers usually emerge and assemble on the crater each evening about sunset (7:46 PM on the average) before leaving to forage, but often the early-evening departure fails to materialize. Most foraging occurs between sunset and sunrise.

The maximum foraging distances around each colony varied from 8.8 to 19.8 (possibly 23.6) m, and the rate of progression averaged 0.55 m/min to 0.62 m/min.

Honey ants foraged as late in the fall as November 7 and as early in the spring as March 17, but were most active during the months of June, July, and August. They were out at air temperatures ranging from 0.6 C to 27 C, and in the rain. Light from the observation lantern sometimes disrupted their activity, but at other times did not seem to affect it.

Each nest exhibited both diffuse- and trail-foraging during the season. The diffuse-pattern is probably used to scavenge dead arthropods or to locate nectar-bearing plants. The trails are not as definitive as those of some ants, but they lead to nectar-bearing plants. Sometimes they bifurcate a short distance from the formicary and go to plants in two different locations.

Honey ants may return to the same plants during two consecutive summers, but they may also change nectar sources during successive years, or even within the same season.

Although most investigators report honey ants utilizing a variety of plants, the nests in the Colorado Springs area foraged primarily either on yucca or scrub oak, but not both.

Three nests foraged on scrub oaks (*Quercus gambellii* Nutt.) between May 26 and August 29, but only the workers from one colony were ever observed feeding on the sweet droplets exuding from oak galls, and then only between July 9 and August 13.

Honey ants visited yuccas (*Yucca glauca* Nutt.) in the vicinity of four nests between June 20 and August 10, but most often during the month of July. The workers sought out the green yucca capsules, and seemed to secure nectar by either scraping the surface of the capsules with their mandibles or drinking droplets already present. These droplets may emanate from injured areas on the capsule or from secretions cast off by aphids.

While other investigators have speculated on the importance of aphid honeydew as a carbohydrate source for this species, this did not prove to be the case in my study. Workers from two colonies were only observed on yuccas infested with aphids on four occasions between June 20 and July 21, and although they drank honeydew, they did not "milk" the insects.

Honey ants are primarily scavengers and bring back a diversity of dead arthropods to the nests. They were seen transporting prey from April 19 to October 22. Usually each worker carries a single insect or fragment, but on occasion two to seven ants worked together to move larger prey. Dead arthropods probably provide essential protein and fat for the colony, particularly for the developing larvae who are often seen feeding on them.

Honey ants sometimes attack live arthropods, particularly if they are small or close to the entrance. They grasp the victim in their mandibles and then bend their abdomens forward and spray fluid (probably formic acid) into the wounds. Larger, armored insects usually flee unharmed despite being repeatedly assaulted.

There appear to be a few natural predators on honey ants. Once a spider was observed carrying a *mexicanus* worker on a scrub oak and one nest was dug out by a large animal. Their greatest enemy in the Colorado Springs area is the realtor and developer since several nests were destroyed by new homes and restaurants.

Honey ants are usually intimidated by other species of ants, and often flee upon contact. Sometimes the yuccas closest to the nest were monopolized by another species and the *mexicanus* workers foraged on yuccas further away. Specifically, interactions were noted with *Dorymyrmex pyramicus*, *Camponotus vicinus*, *Crematogaster lineolata emeryana*, and *Myrmica sabuleti americana*. Honey ants also brought several species of ants back to the nests, but they were probably dead when the workers chanced upon them.

ACKNOWLEDGEMENTS

I am indebted to R.E. Gregg for consultation on the results and identification of ant species. Grants from the Walker Van Riper Fund of the University of Colorado Museum and from the Kathy Lichty Memorial Fund of the University of Colorado Biology Department furnished financial support for the study.

LITERATURE CITED

- CAZIER, M.A. and M. STATHAM, 1962. The behavior and habits of the myrmecophilous scarab *Cremastocheilus stathamae* Cazier with notes on other species (Coleoptera: Scarabaeidae). Jour. N.Y. Entomol. Soc. 70:125-149.
- CONWAY, J.R., 1977. Analysis of clear and dark amber repletes of the honey ant, *Myrmecocystus mexicanus hortideorum*. Ann. Entomol. Soc. Amer. 70:367-369.
- HUNT, J.H., 1973. Comparative ecology of ant communities in Mediterranean Regions of California and Chile. Unpubl. thesis, Univ. Calif. Berkeley. 131 pp.
- HUTCHINS, R.E., 1962. Living honey jars of the ant world. Nat. Geogr. Mag. 121:405-411.
- KAY, C.A., 1974. Aspects of the thermal physiology of honey ants (genus *Myrmecocystus*). Unpubl. thesis, New Mex. St. Univ., Las Cruces. 74 pp.
- LEONARD, P., 1911. The honey ants of Point Loma, California. Trans. San Diego Soc. Nat. Hist. 1:85-113.
- McCOOK, H.C., 1882. The honey ants of the Garden of the Gods, and the occident ants of the American Plains. J.B. Lippincott and Co., Phil. 188 pp.
- PARKS, H.B., 1929. The honey ant *Myrmecocystus melliger* at San Antonio, Texas. Bull. Brook. Entomol. Soc. 24:32-34.
- SHIELDS, O., 1973. Studies on North American *Philotes* (Lycaenidae). I. Roosting behavior, tending ants, parasites and predators. Bull. Allyn Mus. 10:1-5.
- SLOCUMB, L.B., 1966. A report on the honey ants of the plains. M.A.T. Thesis, Colorado College. 31 pp.
- SNELLING, R.R., 1976. A revision of the honey ants, genus *Myrmecocystus*. Nat. Hist. Mus. Los Angeles Co. Sci. Bull. 24:163 pp.
- WHEELER, W.M., 1908. Honey ants, with a revision of the American Myrmecocysti. Bull. Amer. Mus. Nat. Hist. 24:345-397.
- — —, 1910. Ants, their structure, development and behavior. Columbia University Press, New York. 663 pp.
- WILSON, E.O., 1971. The insect societies. Belknap Press of Harvard University Press, Cambridge, Mass. 548 pp.