THE HABITS OF *PHEIDOLE* (*CERATOPHEIDOLE*) *CLYDEI* GREGG (HYMENOPTERA: FORMICIDAE)

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Although the subgenus *Ceratopheidole* has been recognized for almost three-quarters of a century, virtually nothing is known about the habits of the species included in it. The present study is based upon four nests of *Ph.* (*C.*) *clydei* Gregg. Three of these were situated in Deep Canyon on the grounds of the Desert Research Center of the University of California. This spectacular and forbidding canyon, cut into the eastern slopes of the Santa Rosa Mountains, is about seven miles southeast of Palm Desert, California. The fourth nest was at Horse Tanks in the Castle Dome Mountains of Arizona. It is probable that the Deep Canyon colonies would have gone unnoticed had not a lucky series of events led to their discovery. Mr. Charles Musgrove of the Entomology Division of the Citrus Research Station of the University of California showed me a single minor worker which Professor William Ewart, also of that Division, had taken in Deep Canyon while sweeping for thrips. Dr. Ewart was good enough to point out to me bush from which the minor of *clydei* had come. Even with this advantage it was some time before the Deep Canyon nests were found, for their placement is most unusual.

Gregg's original description of *clydei,* published in 1950 (1) was based upon a small series of minor workers taken by C. P. Stroud near Carizozo, New Mexico. Since these were strays it was impossible for Dr. Gregg to give any nesting data for *clydei.* Later, however, he published on specimens of both major and minor castes (2) which the writer had taken from a nest at Split Mountain in the Anza Desert State Park, California. Certain features of this nest were so peculiar that both Gregg and I hesitated to accept it as a normal nest of *clydei.* It was situated in crevices beneath a weathered lamina of stone which had partially split off from the top of a large boulder that was buried in the sand of the canyon floor. The crevices were fully three feet above the sand and there was not the slightest indication that any of them extended into it. It is now clear that the only abnormal thing about the Split Mountain colony was that the boulder selected as a nest site was far smaller than usual.

The three colonies of *clydei* found in Deep Canyon were in

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crevices on the tops of enormous boulders twelve to fifteen feet high and twenty to thirty feet across. The base of each of these boulders was embedded in the gravel and sand of the canyon floor and the back face of each was buried in a mass of rubble that formed the bottom of a talus slope extending downward from the steep canyon wall. It may be seen that the crevices in which *clydei* was living were at least twelve feet above the canyon floor and even further removed from the talus slope at the rear of the boulder. The nests appeared to be completely isolated from any contact with soil although, since it was impossible to determine the extent of the crevices, there was a remote chance that they might extend through the boulder to the soil at its base or to the talus slope at the rear. The action of the foragers made this seem unlikely, for if there had been any soil connection at the bottom or rear of the boulder heavily laden minors would scarcely have struggled to the top of the boulder when returning to the nest with food. But the character of the nest at Horse Tanks definitely ruled out any chance of a connection with the soil. This nest was situated on the face of a ledge which overhung the pool or "tank" at its base. The ledge was about twenty-five feet high and so nearly vertical that it could not be climbed. All that could be done was to watch the ants until they went out of sight up the ledge. But it was plain that there could be no connection with soil here, for the ledge was a part of a basin of solid stone in which the pool lay. Thus it seems clear that *clydei* customarily nests in the crevices of large boulders or ledges and not in the soil.

The writer knows of no other North American species of *Pheidole* which behaves in this fashion. While several species of *Pheidole* (*grallipes, subdentata, hyatti,* etc.) will sometimes nest in the crevices between separated layers of stone, these crevices are always filled with soil and the nest passages run into the soil in which the layers of stone are buried. Such nests are not isolated from the soil, as are those of *clydei.* This peculiar nesting response of *clydei* is not easy to explain. The writer at first believed that *clydei* selected nest sites that would protect it from flash floods, which are heavy and destructive both in Deep Canyon and in the Split Mountain area. There is enough truth in the above view to make it dangerous, for the elevated position of the *clydei* nests undoubtedly puts them above flash flood levels. But this view fails to take account of the fact that *clydei* might secure equally good flood protection, as do most of the ants which live in Deep Canyon, by nesting in the talus slopes above the flash flood levels. The protection afforded by nests in rock crevices may be of another sort. In several of the areas where *clydei* occurs

the environmental conditions are extreme enough to tax the hardiest xerophiles. This is shown by the fact that few of them can survive in these areas. Competition for food in such areas is severe and considerable advantage must derive from a type of nest that no predator could enter except through a fixed and easily guarded opening.

As soon as the nests of *clydei* were found, observations were begun on its foraging activities. The observations were made in late March and early April. At that time the ants were foraging mainly in the period between 9:00 A. M. and 1:00 P. M. The nests were in shade until 8:30 A. M. but there was a thirty minute period after the sunlight reached them when no foragers emerged. About 1:00 P. M. foragers ceased to emerge from the nest but during the next hour or so many foragers returned to it. Observations made after dark showed nothing that could be regarded as foraging, although minors could be brought out of the nest if the entrance was sufficiently illuminated. It appears that all the foraging is done by the minors. The majors leave the nest only to assist the minors in dealing with some large item of food when this has been brought close to the nest entrance. While the minors obviously follow scent trails they do not forage in columns for the foragers are well separated. Except for one minor, who brought in the withered anther of a flower, all material brought to the nest during the period of observation consisted of arthropods or their disarticulated remains. Much of this was too fragmentary for identification but on several occasions entire arthropods were brought in. There were two dead spiders, two dead majors of *Ph. grallipes,* one dead fly, one dead geometrid larva and one living termite nymph. No seeds were ever brought in, although there were a number of plants in the area which had gone to seed. On the basis of these observations it may be concluded that *clydei* is not a harvester but carnivorous. But, like many xerophiles, it appears to be an opportunist where food is concerned. Since the only way to get the ants out of the nest was to bait them out and since I wished to set up artificial nests, I spent considerable time at first looking for suitable insect bait. Later I discovered that sugar cookies or cheese crackers worked just as well. On one occasion a bit of sugar cookie about the size of a quarter was inadvertently left at the entrance of one of the nests at the conclusion of the observations. The following day there was no trace of it and the members of the colony which had acquired this prize were so full or so busy with their bits of cookie that they did not begin foraging again until the next day.

As already noted the major of *clydei* has a secondary role in foraging activities. When entire arthropods are brought in by the minors

they may be too large to take into the nest without dissection. The majors are very efficient at this for they have powerful mandibles and use them effectively. But their main function seems to be to guard the nest entrance. They stand so close to the nest entrance that it is often possible to see them and they savagely attack any object thrust into the nest entrance. This attack consists of locking the jaws on the intruding object and the major will often hold on so firmly that it can be pulled out of the nest. It appears that a cluster of majors is normally present just inside the nest entrance and it is easy to appreciate why this would make the nest virtually impregnable to any intruder. For, since the walls of the nest are solid rock, the guarding majors cannot be outflanked.

Despite the fact that the minors of *clydei* occasionally bring in living victims I believe that this species is best regarded as a scavenger. This view is based on the lack of pugnacity in the minor. Experiments with this caste in artificial nests showed that the minor of *clydei* is slow to attack other insects and equally slow to defend itself when attacked by them. Since I had observed foraging minors of *clydei* entering termite passages it was a surprise to find that when termites were introduced into the artificial nests they usually killed the minors of *clydei* even when the latter outnumbered them. It seems safe to assume that most of the termites or termite remains brought back to the nests of *clydei* are dead or moribund individuals secured by stealth rather than by predation. This behavior is entirely unlike that of the species of *Pheidole* which are carnivorous and predatory. Dr. Gregg and I have shown (3) that *Ph. titanis,* which conducts well-organized forays against termite nests, has a minor that is fully as pugnacious as the major. Both castes participate in the foray and, when this is successful, both castes return to their nest with live termites in their jaws.

In conclusion I wish to point out a suggestive feature in the response of *clydei* to elevation. The insect is now known from five stations. These show little latitudinal difference since all five occur in an east-west band less than a hundred miles wide of which Lat. 33° is the approximate center. Yet the elevational range shown by these five stations is striking. It is given below:

STATION	ELEVATION
Carizozo, New Mexico	5429 feet
Windy Point, Sta. Catalina Mts., Ariz.	7100 feet
Horse Tanks, Castle Dome Mts., Ariz.	1200 feet
Deep Canyon, Sta. Rosa Mts., Calif.	1200 feet
Split Mountain, Anza Desert, Calif.	500 feet

It may be added that *clydei* is not confined to the 1200 foot level

in Deep Canyon. Dr. Evert Schlinger of the Entomology Division of the Citrus Research Station has written me that he has taken several colonies of *clydei* at higher elevations there. Few xerophilic ants possess such a large elevational tolerance, but those which can equal it or come anywhere near it are commonly encountered over large areas. This suggests that *clydei* may be much more abundant than has been supposed and that its "rarity" is mainly the result of an unusual nesting habit which has kept it out of the hands of collectors.

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