

Additional observations on the behavior of a tropical forest dung beetle, *Megathoposoma candezei* (Coleoptera: Scarabaeidae)

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ABSTRACT: Contrary to previous reports, *Megathoposoma candezei*, while avidly seeking human excrement will eat almost any other kind, including cattle manure. The beetles are active (searching for food) during the morning hours, and gradually decrease their activity to almost zero during the afternoon.

These beetles are able, if necessary, to abandon their food balls, which they can find again by smell. They react rather actively to any food source placed up to 50 m away, occasionally to that at 75 m, but not at 100 m.

A population density of 14.7 beetles per hectare confirms previous estimates.

From a colony of beetles kept in our laboratory, it was found that they construct brood pearls and that the life cycle is probably six months.

The present paper is a continuation of a study on *Megathoposoma candezei* (Harold), a typical Mesoamerican tropical forest dung beetle (WILLE, 2). An error in the published version of the previous paper should be corrected; where it is stated that "there are from 15 to 19 beetles per 50,000 m²" should read "there are from 15 to 19 beetles per 5,000 m²". However, later data suggest that there were from 15 to 19 beetles per hectare.

More complete data about the ecological habitat of these beetles is now available. *M. candezei* lives in the tropical moist forest of the Pacific slope of Costa Rica, with an annual average rainfall of 2,000-4,000 mm, and a

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maximum dry season of two months. The region is limited by the mean annual isotherm of 24 C. The forest is composed of tall trees (30-40 m), with the canopy almost completely closed. The big trees are usually well spaced, and their tops are often hidden by the crowns of the smaller ones. The ground is covered by a thick layer of organic debris, and close to the forest floor there is a stratum composed mainly of herbs and seedlings, such as the dwarf palms of the genus *Asterogyne*, and many piperaceous and melastomaceous plants.

The beetles show a marked preference for the more level forest floor, being apparently scarce on the slopes. The altitudinal distribution of these beetles was further studied; only one food source was used at each level. The results were as follows: at 1,083 m, none; at 995 m, 1 beetle; at 960 m, 6 beetles; at 780 m, 18 beetles; at 753 m, 15 beetles; at 690 m, 6 beetles; at 600 m, 1 beetle; at 550 m, none. The altitudes were taken from north to south, from the peak of Cerro Nara down. However, their distribution from east to west, with a more uniform altitude, is, curiously, much more restricted. For instance, about 7 km (2 hours on foot) west of our area of study, and at an altitude of 810 m, not a single beetle arrived. The same happened toward the east, where food was placed from 780 m to 700 m.

These beetles avidly seek human excrement, which they apparently prefer over the natural excrements found in the region. For instance, excrement of a wild pig as well as that of birds placed in the area, did not attract a single beetle during an hour's observation. Human excrement, placed at 2 m from the others, attracted a beetle within the first 4 minutes, and soon after other beetles showed up. However, the beetles are able to eat almost any kind of excrement, including cattle dung. A beetle was seen to land on some cow manure about 1.5 m away from a human excrement bait. The bait was immediately removed from the area. The beetle stayed on the cow dung without moving for 20 minutes, then started to make a ball. The ball, 3 cm in diameter, the largest so far observed, was completed in 15 minutes. Both the beetle and ball were covered by a glass tube; about three hours later the original ball was made into three smaller ones (15, 12, 7 mm in diameter), and eventually eaten.

The beetles become active (searching for food) during the early morning hours (5:30 - 5:40 AM). Activity increased until it reached its peak about 10 AM, then gradually decreased to almost zero during the early afternoon.

Previous observations showed that when the beetles are ready to bury their dung balls, they may abandon them for 30 minutes or more while a more suitable place to dig is found. The question was raised as to how the beetles could find their dung balls again. Being Coleoptera, the most logical method would be by smell. In order to clarify this, the following experiment was carried out: an area of about 20 m² was cleared of all litter, and a food source placed in the center. Soon, several beetles arrived and proceeded to roll the excrement into balls. Fortunately, one of them, after trying to go

over a superficial root, 3.18 m from the food, abandoned the ball, and walked about 1.5 m away, apparently in search of a more suitable spot. A glass tube 24 cm in length by 7 cm in diameter was placed over the ball and sunk around it. The beetle, after walking around, flew in semicircles close to the ground, apparently looking for its ball, and was unable to find it. However, as soon as the glass was removed the beetle flew directly to the ball. This experiment was repeated several times by separating the beetles from their balls. In all the cases when the ball was covered by the glass, the beetle, failing to find it, usually desisted searching after 5 to 10 minutes, and returned to the main food source to start a new one. When the beetle is less than 1 m away from the ball it locates it just by walking; when the distance is greater it flies in semicircles.

During this searching activity, a beetle will appropriate the first ball it finds and enter into combat upon being challenged. In one instance both beetles were very persistent in combat, and after a long struggle they ended the fight by dividing the ball in two halves, from which they made two smaller ones. In another case a beetle was rolling its dung ball and found another along its way (the owner was busy at that moment excavating a chamber) and made one huge ball from the two. However, the new ball was so large that the beetle was unable to handle it and had to cut off a piece and start over again.

When a beetle is ready to excavate its chamber, it usually leaves the dung ball near the place of digging. Making the chamber and placing the ball in it usually takes about one hour. Only in a few cases, mostly because of an obstacle, does the beetle leave the ball in order to find a more adequate site. From the above observations it seems obvious that in these few situations the beetles find their way back to the dung balls by the sense of smell.

In an isolated and rectangular forest area of 38,000 m² (3.8 hectares) three populations of beetles were marked: No. 1 with 15 beetles (painted white), No. 2 with 12 beetles (painted red) and No. 3 with 18 beetles (with combined colors). The distance between No. 1 and 2 was 103 m, and between No. 2 and 3, 213 m. The beetles were attracted with human excrement, captured, painted, and then released, without allowing them to eat.

Later, by placing food at different distances from the release areas, it was possible to determine the distances at which the marked beetles could react to the scent of the food sources. All the experiments indicate that *Megathoposoma candezei* reacts rather actively to any food source placed up to 50 m away. Occasionally they sensed human excrement at 75 m, but at 100 m not a single beetle reacted to the scent.

The above observations were carried out between January and February of 1973. Ten live beetles were collected from outside of our study area, and taken to the University of Costa Rica in San José. During six months these beetles were kept alive quite well in captivity. However, at the end of July, four of them were found dead, but the most interesting thing was the finding

of a brood pear. Unfortunately the pear, containing a full-grown larva, was crushed accidentally. According to HALFFTER and MATTHEWS (1) the normal life cycle, from egg to adult, in Scarabaeidae is 30 to 50 days; they also mentioned a few species, mostly of large size, in which this period is longer (four months to almost two years). The life cycle of our species is, apparently, six months.

During July of the same year another expedition was made to Cerro Nara to attempt to collect all the population from the isolated and rectangular forest area of 38,000 m². A total of 56 beetles were captured. This would mean 14.7 beetles per hectare, which is quite close to the previous report of 15 to 19 beetles per hectare. Only four of these 56 beetles showed very faint signs of paint; apparently the paint had either rubbed off or could not stand the humid forest environment. The whole population was taken alive to the University of Costa Rica, where, together with the former population, the colony increased to 66 individuals. Here it was possible to observe two copulations on the food source; one lasted 25 minutes and the other 30 minutes. From August on, however, the population started to die off until not one was left alive. These events occurred as follows: August 1, 4 dead; August 7, 1; August 8, 1; August 9, 9; from August 13 to September 6, 18; September 24, 1; September 25, 1; September 28, 1; from September 30 to October 10, 23.

From the above data, one is inclined to speculate whether the dying of the population in captivity would represent a normal event in nature. From August to November is when the rains are the heaviest in the region. It would be interesting to know if, during those months, the natural population goes down to almost zero. Perhaps it is during those months that the brood pears are the only representatives of the species left in the forest. Further investigation is needed to clarify this phenomenon.

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RESUMEN

El presente trabajo es una continuación de un estudio ecológico sobre *Megathoposoma candezei* (Coleoptera: Scarabaeinae), llevado a cabo en la selva tropical húmeda, situada en la base sur del Cerro Nara (17 km N de la desembocadura del río Savegre), en la costa del Pacífico de Costa Rica.

Estos abejones son atraídos rápidamente por el excremento humano, aunque pueden alimentarse de cualquier tipo de heces, incluso boñiga. Su ac-

tividad en la búsqueda del alimento es mayor durante la mañana; hacia el mediodía decrece casi por completo.

M. candezei localiza la fuente de alimento por medio del olfato, sobre todo si éste se encuentra en un radio de 50 m; ocasionalmente lo hace a 75 m, pero no así a 100 m. Los abejones no fueron atraídos al excremento que se les colocó 20 m fuera del bosque, con lo que se demuestra su hábitat naturalmente selvático.

En un bosque de 3.8 hectáreas, rodeado por potreros, se capturó casi toda la población (56 abejones). De aquí se obtiene una proporción de 14.7 escarabajos por ha, valor muy cercano al calculado anteriormente (15 a 19 abejones/ha).

Una colonia de estos abejones se mantuvo viva en el laboratorio, en donde se pudo observar que copulan sobre el excremento y que la cópula dura de 25 a 30 minutos. Con el excremento construyen una especie de pera que servirá de alimento para las crías. El ciclo de vida probablemente dura seis meses.

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