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Author(s) :Laura C. Sarzetti and Jorge F. Genise
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Predation of Soil-Nesting *Centris muralis* (Insecta: Apidae) by Armadillos (*Zaedyus pichiy*) (Mammalia: Cingulata) in La Rioja Province, Northwestern Argentina

Laura C. Sarzetti[1] and Jorge F. Genise
CONICET—División Icnología, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Av. Angel Gallardo 470, Buenos Aires 1405, Argentina

ABSTRACT: This paper documents the predation of *Centris muralis* by *Zaedyus pichiy*. It presents the first detailed observations of the predation of solitary bee nests by a mammal in soils and reports the alternative use of soil mounds as a nesting site by *Centris muralis*.
KEY WORDS: *Centris muralis*, solitary bees, predation, armadillo, *Zaedyus pichiy*

Predation of bee nests by mammals such as tayras, kinkajous, coatis, tamanduas, armadillos, grisons, bears, skunks, opossums, rats (Laurie and Seidensticker, 1977; Roubik, 1989; Nogueira-Neto, 1997; Hilário and Imperatriz-Fonseca, 2002), apes and humans (Roubik, 1989; Kajobe and Roubik, 2006) has been reported in the literature. These records mostly involve social bees from tropical regions that construct their nests in trees. However, Roubik (1989) mentioned the excavation of stingless bee nests by armadillos. Kajobe and Roubik (2006) also documented the predation of terrestrial nests of *Meliponula* and Stephen *et al.* (1969) mentioned the predation of *Antophora* species in North America.

This paper presents records of nest burrows of a solitary bee, *Centris muralis* (Hymenoptera, Apidae) attacked by pichis (Xenarthra: Dasypodidae: *Zaedyus pichiy*) (Fig. 9), which are small (about 1 kg), diurnal and semi-fossorial armadillos that live in arid and semi-arid habitats of Argentina and Chile (Superina, 2007). Pichis are opportunistic feeders that feed primarily on insects such as adult beetles or their larvae, mainly Scarabeidae and Tenebrionidae, as well as ants and larvae of Diptera. Secondarily, they forage on Arachnida, plant material, fungi, and rarely on geonematodes and small vertebrates (Superina, 2007; Superina *et al.,* 2009).

Results

These observations were made from November 24 to November 30, 2008 in Vinchina, La Rioja province, Argentina (28°49′07″S, 68°11′26″W). The bee nests were found in a formerly plowed field of approximately 150 m^2 with no vegetation (Fig. 1). The surface showed low longitudinal and parallel mounds. The nests occupied most of this plowed area (Figs. 1, 2). The soil was dry and loose on the surface and firmly packed below 10 cm.

The few undisturbed *Centris muralis* nests, located on the slopes of the mounds, showed irregular tumuli, with open circular entrances. (Fig. 3). Two complete nests were studied in some detail. A dead female was found in the entrance of one of the nests (Fig. 4). The nests consisted of main burrows of 12 cm and 13 cm long respectively, oriented at a gentle angle (20°) to the soil surface. In one of the nests,

[1] Corresponding author; e-mail: lsarzetti@macn.gov.ar

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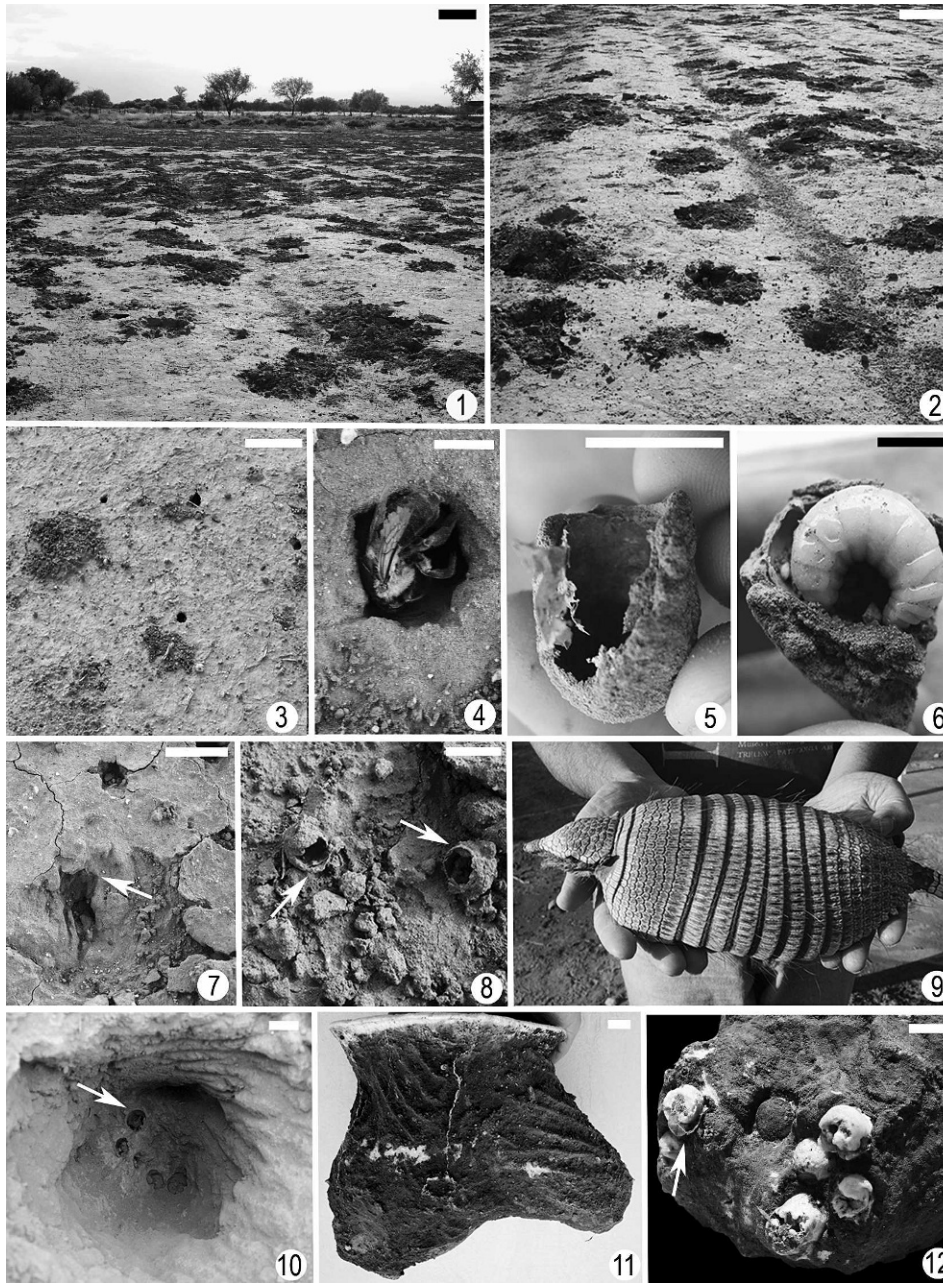

Figs. 1–12. 1. General view of the study site at Vinchina. (La Rioja province), scale bar: 15 cm; 2. Excavations made by pichis, scale bar: 10 cm; 3. View of bee nest entrances and tumuli, scale bar: 10 cm; 4. Dead female of *Centris muralis* at the entrance of a nest, scale bar: 1 cm; 5. Complete cell, scale bar: 1 cm; 6. Cell with mature larva, scale bar: 0.5 cm; 7. First scratches of a pichi at a bee nest entrance (arrow), scale bar: 5 cm; 8. Remains of bee cells within soil removed by pichis (arrows), scale bar: 1 cm; 9. Carapace of a pichi found at the study area; 10. Pichi burrow showing claw marks on the walls and bee cells at the bottom (arrow), scale bar: 1 cm; 11. Branched burrow cast showing the claw mark pattern, scale bar: 1 cm; 12. Bee cells, with linings (arrow), attached to the bottom of one cast, scale bar: 1 cm.

the tunnel ended in a series of three slanting cells, whereas in the other nest it branched into six cells, at different angles, arranged in a cluster. The cells had an average length of two cm and an average width of one cm ($N = 9$); the cell walls were made of consolidated soil. Cells were easily removed; they had a waterproof inner lining (Fig. 5) and each contained a mature larva. (Fig. 6). Cell closures had a spiral pattern visible from within.

Predation of the bee nests was evident at first glance due to the high density of mammal diggings (about three-five per m^2), with removed soil on the surface, which contained remains of bee cells (Fig. 8). Bee cells were preferentially distributed on the sides of the mounds. The mammal excavations were almost vertical, showed scratch marks on the walls, and had an average oval cross section of 11 cm $\times$ 14.7 cm, and an average maximum depth of 10 cm ($N = 20$). Claw marks were visible all around the excavated depression. They consisted of sets of three to four parallel grooves oriented in an acute angle with respect to the surface (Figs. 10, 11). The removed soil formed a ring or a crescent around the excavation. Several depressions were half-filled with loose soil, at the bottom of which were found the remains of bee cells (Fig. 10). Casts were made to illustrate the shape of the excavations, the pattern of the scratches, and most importantly the presence of bee cells in the excavated areas (Fig. 11). The casts showed that the dug up areas may be simple, ending in a rounded bottom, or they may bifurcate to reach more than one bee best with a single excavation (Fig. 11). Remains of lined bee cells were found at the bottom of the excavations (Fig. 12).

Discussion and Conclusions

Most records of mammal predation on bees involve social species from tropical regions that nest in live or dead trees. However, mammal predation has been reported for two species which nest in soils. Of these one is social and one is solitary, and only one of them is from the subtropics (Laurie and Seidensticker, 1977; Roubik, 1989; Nogueira-Neto, 1997; Hilário and Imperatriz-Fonseca, 2002; Bargali *et al.,* 2004; Kajobe and Roubik, 2006). In Africa, primates like chimpanzees (*Pan*), gorillas (*Gorilla)*, civets (*Civettictis*), and baboons (*Papio*), as well as humans, commonly destroy honeybee hives (Roubik, 1989; Kajobe and Roubik, 2006). Pangolins (*Manis*) can also attack nests of *Apis* (Roubik, 1989). In India, the sloth bears (*Ursus*) can consume bees during winter (Bargali *et al.,* 2004). In South America, the largest bee nest predator is the bear *Tremarctos* (Ursidae), whereas other predators, such as opossums (*Didelphis*), and mustelids, such as tayras (*Eira*), and grisons (*Galictis*) attack nests of stingless bees or honeybees (Roubik, 1989; Nogueira-Neto, 1997). Xenarthrans, such as *Dasypus*, *Euphractus*, *Myrmecophaga*, *Cyclopes* and *Tamandua*, frequently prey on honey bee hives and stingless bee colonies using their powerful claws to excavate trees (Roubik, 1989; Hilário and Imperatriz-Fonseca, 2002). In contrast, another xenarthran, the giant armadillo *Priodontes* was recorded excavating nests of stingless bees in soil (Roubik, 1989). There is another previous record of mammalian predation on a ground-nesting solitary bee, namely the account of Stephen *et al.* (1969) of a skunk (Mephitidae) digging up the nests of *Anthophora occidentalis* in North America.

According to Superina (2007), armadillos that live in cultivated areas tend to ingest more insects than those that inhabit other areas. A study of the stomach

contents of *Zaedyus pichiy* documented that the armadillos feed mostly on insects, principally beetle larvae and ants (Superina *et al.,* 2009). The animal's fondness for *C. muralis* nests probably stems from the high density of nests and the loose soil where the nests were located. Redford (1985) included the genus *Zaedyus* in the generalized carnivores-omnivores that ''probably eat whatever they can whenever they can''. The bifurcated excavations (Fig. 11) reveals that pichis fed on contiguous bee nests, thus reducing the cost of digging.

The observations presented here demonstrate that *Centris muralis* can nest in soil as long as there are sloping surfaces. The few previous studies about *C. muralis* nesting habits recorded that this species constructs their nests in vertical adobe walls or sloping river banks (Rolón and Cilla, 2009; Genise pers. obs.). However, our new data indicate that this species can also nest in soils such as are used by other species of the genus including *C. mixta* (Toro *et al.,* 1991), *C. transversa*, *C. anthracina* (Batra and Schuster, 1977), *C. rhodopus* and *C. cockerelli* (Alcock *et al.,* 1976). The presence of mounded soil, which provided sloping surfaces, could have enabled this unusual behavior.

The observations presented herein report the first detailed observations of the predation of solitary bee nests in soils by a mammal, and of consumption of bee larvae by *Zaedyus pichiy*. In addition, it depicts the alternative use of soil mounds as nesting sites by *Centris muralis*.

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