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Scientific note

A scientific note on the first record of nesting sites of *Peponapis crassidentata* (Hymenoptera: Apidae)

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Peponapis is a genus of solitary bees that breeds once a year, nests in the ground, and is distributed exclusively in the Americas. Mexico is considered its center of origin, holding all 15 currently known species of *Peponapis* (Hurd et al. 1971; Ayala and Griswold 2012). *Peponapis* spp. are closely associated with the plant genus *Cucurbita* (Hurd et al. 1971; Hurd et al. 1974), whose center of origin is also Mexico (Lira-Saade 1995). *Peponapis pruinosa* (Say, 1837) in North America and *Peponapis limitaris* (Cockerell, 1906) in Mexico are the most effective pollinators of *Cucurbita* spp. (e.g., Canto-Aguilar and Parra-Tabla 2000; Minter and Bessin 2014). The pollen of *Cucurbita* also seems to be the main food source of some *Peponapis* sp. larvae (Hurd et al. 1974). Little is known about the natural history of most *Peponapis* species, and only nest descriptions of *P. pruinosa* (Mathewson 1968; Hurd et al. 1974), *P. fervens* (Smith, 1879) (Michener and Lange 1958; Krug et al. 2010), and *P. utahensis* (Cockerell, 1905) (Rozen and Ayala 1987) are known under natural conditions. Most studies of *Peponapis* are taxonomic descriptions and observations of *Cucurbita* flower visitation by these bees (Hurd and Linsley 1966; Wille 1985; Ayala and Griswold 2012). Here, we describe the nesting sites and the structure of nests of *Peponapis crassidentata* (Cockerell, 1949).

P. crassidentata (Figure 1a) is distributed from southern Texas (USA) to Costa Rica (Wille 1985; Giannini et al. 2011), and it has been observed foraging on *Cucurbita* flowers (Wille 1985). No other information has been reported for this species. We searched for nesting sites of *P. crassidentata* near *Cucurbita moschata* Lam. crops in the coastal region of Jalisco state, Mexico. In November and December 2014, we found two nesting sites (sites 1 and 2), and in January 2016, a third nesting site (site 3, Table I). These sites were found along temporary streams with riparian vegetation surrounded by tropical dry forest. We registered 188 nests (Table I). Nesting activity occurred within the flowering season of nearby cultivated *C. moschata* (Jul–Dec 2014 and Nov 2015–Mar 2016) and wild *Cucurbita argyrosperma* Huber (Jun–Dec 2014 and 2016). From February onwards, we did not observe bees provisioning nests or visiting flowers at any site. In January 2016, there was no activity of adult bees at the nests found in 2014.

Nest descriptions We found nests in bare vertical walls of sandy soil and mud in river banks shaded by vegetation, making nest entrances inconspicuous. All nests formed a tunnel, and their entrances

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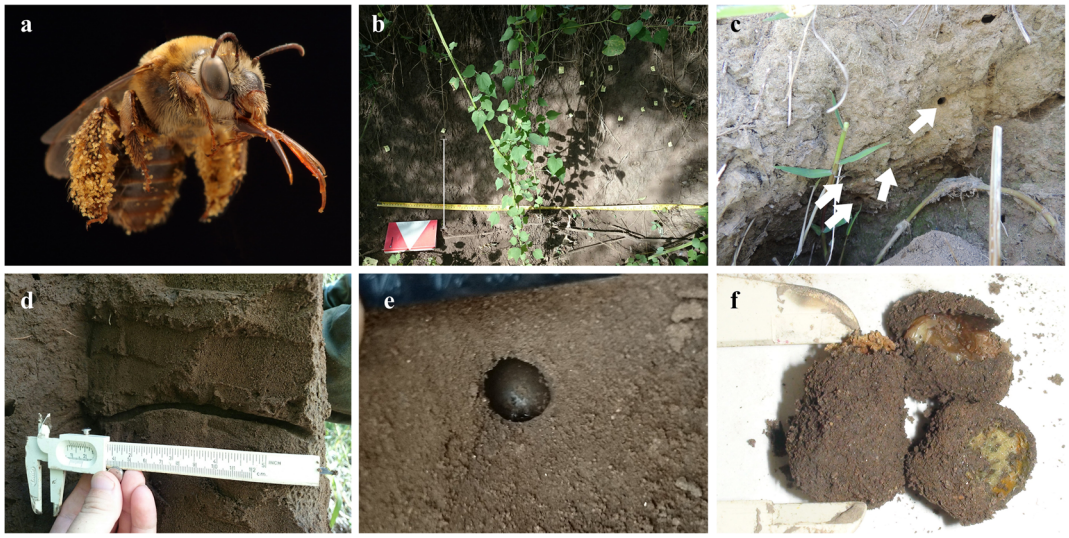

Figure 1. a *Peponapis crassidentata* female. **b** Nests on a river wall. Each nest is marked with a yellow piece of paper. **c** Nests on the roof of a cavity at a river wall; *white arrows* show the active nests. **d** Cross section of active nests. **e** Chamber with a waterproof and shiny lining. **f** Cells containing larvae of *P. crassidentata*.

were located horizontally on the walls (Figure 1b) and vertically on the roof of a cavity (Figure 1c). Beneath the entrance of active nests, we found loose soil and *Cucurbita* pollen. We excavated two nests in 2014, and no antechamber was observed. Tunnels wound and descended horizontally (Figure 1d); the tunnel substrate was of homogeneous, sandy, moist soil, and in the brood cells, the floor was also moist but more clayey. The tunnel walls were smooth. The brood cells were at 35–95 cm from the entrance. The cells were located vertically adjacent to the tunnel floor but separated by soil from the main tunnel. The first nest was 120 cm long and contained 14 brood cells. The second nest was 95 cm long and contained only one cell. The interior walls of the brood cells were smooth and dark, with a waterproof and shiny lining (Figure 1e), similar to the cell walls of *P. pruinosa* (Mathewson 1968), *P. fervens* (Michener and Lange 1958), and *P. utahensis* (Rozen and Ayala 1987). The brood cells were ovoid chambers, each containing one larva with its respective pollen supply (Figure 1f) or one pupa. Due to a large number of nests, it was not possible to determine if all 14

Table I. Description of the three nesting sites of *Peponapis crassidentata*. Values for nest traits are mean ± sd

Site	Geographical coordinates	Number of nests	Wall length × height (m)	Distance (cm) from the nest entrance to the horizontal plane of the floor (white bar in 1b)	Nest diameter (cm)	Distance from the nearest crop (m)
1	19° 36′ 11″ N 105° 6′ 15.1″ W	164	4.2 × 1.8	112.8 ± 38.2	0.67 ± 0.05	100
2	19° 35′ 15″ N 105° 6′ 7.8″ W	16	5 × 0.9	46.1 ± 11.5	0.68 ± 0.04	20
3	19° 23′ 19.2″ N 104° 58′ 15.4″ W	8	9.5 × 1.9	82.5 ± 0.75	0.65 ± 0.04	55

cells belonged to the same nest that was originally dug up. The cells of the first excavated nest contained an exarate pupa, six pupae, and seven larvae, the cell of the second nest contained one larva. We sampled pollen from excavated cells and confirmed under a microscope that all samples contained only *Cucurbita* pollen. This coincides with the observation, in the same period, of individuals of *P. crassidentata* foraging on *C. mos chata* and *C. argyrosperma* in the area.

Discussion Previous reports on the nesting biology of *Peponapis* spp. contrast with some patterns observed here for *P. crassidentata*. While *P. pruinosa*, *P. utahensis*, and *P. fervens* nest on flat ground with vertical entrances located in proximity to their pollen sources (Mathewson 1968; Hurd et al. 1974; Rozen and Ayala 1987; Krug et al. 2010), *P. crassidentata* nests on vertical river banks, mainly with horizontal nest entrances. Another notable difference is that *P. pruinosa* and *P. fervens* nest in exposed and semi-exposed sites (Michener and Lange 1958; Mathewson 1968; Krug et al. 2010), whereas *P. utahensis* and *P. crassidentata* prefer shaded sites near riparian habitats. Such feature is possibly associated with temperature regulation of nests during the day. A shared characteristic by all *Peponapis* spp. studied is their gregarious nesting habit during the flowering period of nearby *Cucurbita* flowers.

By nesting on the walls of river banks, away from main crops, *P. crassidentata* may be less susceptible to destruction by plowing. In contrast, because *P. pruinosa* nests on flat ground, agricultural practices can affect population density by delaying the emergence of offspring (Ullmann et al. 2016; Shuler et al. 2005). Other disturbances such as fire, agrochemicals, and sand and gravel extraction are important threats to all *Peponapis* species, including *P. crassidentata*. Such knowledge must be conveyed to farmers, who are often unaware of the identity and biology of *Peponapis* species that are the most efficient pollinators of *Cucurbita* cultivars. This study will allow identification, protection, and perhaps creation of potential nesting sites of *P. crassidentata.*

Our study suggests that riparian habitats are essential for *P. crassidentata* nesting. Riparian habitats cover only 4% of the study area but provide resources for the maintenance of many other animal species, particularly during the dry season (Sanchez-Azofeifa et al. 2009). These areas are key for maintaining the biodiversity and ecosystem services of tropical dry forests and deserve special attention to ensure the integrity of pollination services, such as the important evolutionary interaction of *Peponapis* spp. with squashes in Mesoamerica (Hurd et al. 1971).

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Contributions All authors have contributed equally to the work.

Note scientifique sur la première observation de sites de nidification de *Peponapis crassidentata* (Hymenoptera: Apidae)

Eine wissenschaftliche Anmerkung über die erste Beschreibung des Nistplatzes von *Peponapis crassidentata* (Hymenoptera: Apidae)

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