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Scientific note

Scientific note: first global report of a bee nest built only with plastic

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Abstract – Agricultural plastic waste can alter wildlife diversity and behavior. Species survival will depend on their ability to adapt to new environmental conditions. In a seed-producing farm, a *Megachile* sp. nest made fully with plastic was found in a trap nest. This record represents the first one worldwide on revealing the use of plastic in the total construction of a bee nest.

solitary bees / plastic / adaptive flexibility

1. INTRODUCTION

Conventional farms depend largely on the use of external inputs (Scarascia-Mugnozza et al. 2012). Many of these inputs generate plastic waste. The discarding of agricultural plastic waste is frequent, and it subsequently accumulates in agroecosystems (Hemphill 1993) (Figure 1a). Plastic is used in many ways, including greenhouses, mulching, small tunnels, temporary coverings of fruit trees, liquid agrochemicals' containers, fertilizer bags, and hoses for drip irrigation, among others (Briassoulis et al. 2013).

The accumulation of plastic waste has as a consequence several environmental impacts (Barnes et al. 2009), such as changes in wildlife behavior and biodiversity (Suárez-Rodriguez et al. 2017). The adaptive capacity to selective pressures exerted in the landscapes enables some species to persist over others (Shochat et al. 2006). An indication of this adaptive capacity of species over human disturbances could be the exploitation of artificial materials present in the habitat (MacIvor and Moore 2013). The use of human-made materials has been recorded in animals, although there are very few documented cases for insects (Medler 1966, MacIvor and Moore 2013).

Pollinators are a key component of the insect diversity associated to agroecosystems, as they provide a key service for its proper functioning (Klein et al. 2007; Garibaldi et al. 2013). However, numerous populations of different bee species are currently decreasing in an alarming way worldwide (Potts et al. 2010; IPBES 2016). One of the main causes of their decline is human disturbance (Rundlöf et al. 2015).

Bees (Hymenoptera: Apiformes) are the most efficient pollinators worldwide (Free 1993; Michener 2000). Species of the family Megachilidae are solitary bees and many of them nest in preexisting cavities using materials collected from landscape such as mud, stones, leaves, petals, and resins to build brood cells (Sheffield 2017). Each cell holds a larva which will develop into an adult bee.

During 2017–2018 spring–summer, a study was conducted on pollinators of chicory (*Cychorium intybus*) for seed production in San Juan, Argentina (31°40′58.7″ S, 68°31′25.3″ W). In addition to other sampling methods, 63 trap nests were placed on the crop's edges. The trap nests were checked monthly to record nest building. Only three nests were found, two belonging to *Megachile jenseni* Friese made out of

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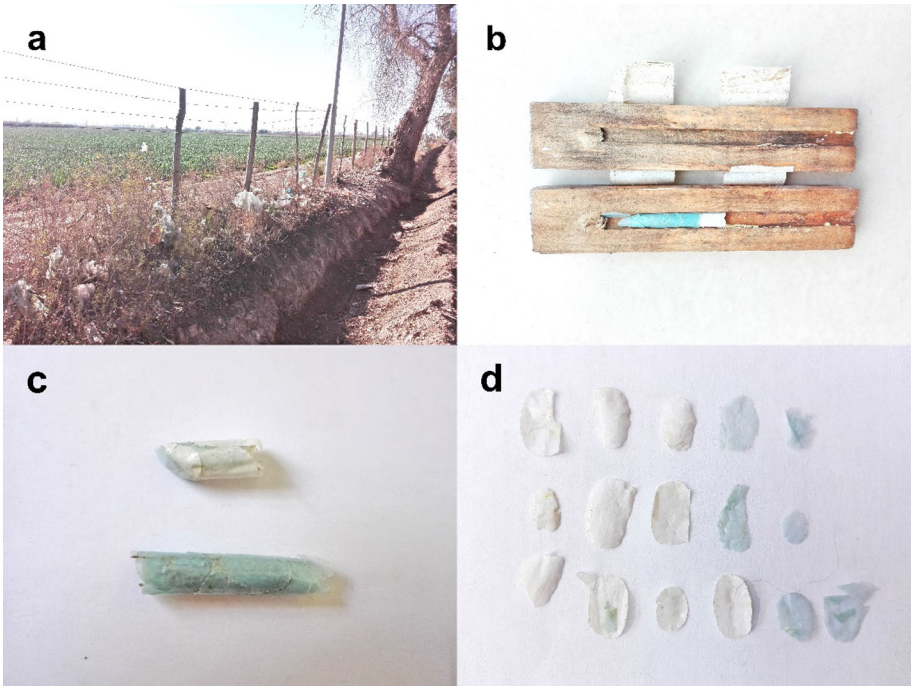

Figure 1 a Plastic waste on crop's edges, **b** plastic nest of *Megachile* sp. (Megachilidae) built in a nest trap, **c** plastic brood cells built in a nest trap, **d** circular and oblong plastic pieces of the cells.

petal cells and mud partitions (confirmed by the emergence of five adults) and one with cells built fully with two types of plastic (Figure 1b).

The plastic nest found was formed by three cells of 1.27 ± 0.12 cm (Figure 1c). The cells were composed by circular and oblong plastic pieces (9.76 ± 1.81 × 6.57 ± 0.96 mm, $n = 54$) arranged in an imbricated manner (Figure 1d). The first two cells were only formed by light blue plastic of shopping bag consistency. The third cell was made entirely of white plastic, thicker than the previous one. Among the three cells, one contained a dead larva; from the other, the adult seemed to have emerged from the nest; and the third cell was not finished. For this reason, we do not know the identity of the species that built the nest. However, it could be *Megachile rotundata* (Fabricius), an exotic species caught in flowers of our study site, and for which there is a record of plastic use as brood cell material (MacIvor and Moore 2013). This exotic species of *Megachile* has been introduced for commercial purposes and is widely established in Argentina (Álvarez et al. 2012). In addition, for commercial populations of this species (cited as *M. pacifica* Panzer), Richards (1978) reports the use of artificial substrates including plastics such as polymers, styrofoam, and polystyrenes. Furthermore, taking into account that the selection of leaves by *Megachile* species has probably evolved as an adaptation to the local environment (Kambli et al. 2017) and that *M. rotundata* is an exotic species in Argentina, the idea that the nest has been built by a female of this species could certainly be a possibility.

So far, the only record of plastic use by bees in the nest construction was that described by MacIvor and Moore (2013). Nests of *M. rotundata* and *M. campanulae* (Robertson) were found, where three and two cells were respectively constructed with plastic. However, the nest reported here is novel in two ways: (1) plastic is the only material used for brood cell construction in the nest and (2) two types of plastic were used.

The use of plastic as a resource for nest construction suggests that certain species of bees would have adaptive flexibility in the face of changes in environmental conditions. The replacement of natural materials by plastic could appear in response to a limitation in the availability of vegetation in the fields, which could be directly linked to the use of herbicides (Nicholls and Altieri 2013). On the other hand, the use of plastic as the only resource for the construction of the nest could be associated with the preference of this material over natural ones. Some evidence shows that the use of synthetic materials in nesting could bring adaptive advantages (Suárez-Rodríguez et al. 2012). We cannot determine if plastic in the construction of the nest would

bring adaptive advantages to bees. However, it could highlight bees' response capacity in the search for alternative materials for the construction of their nests in the face of human disturbance.

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AUTHOR CONTRIBUTIONS

MLA and HJM conducted field sampling; MLA, HJM, JD, and JPT analyzed the data and wrote the paper. All authors read and approved the final manuscript.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest The authors declare that they have no conflict of interest.

Note scientifique: premier rapport mondial sur un nid d'abeille construit uniquement en plastique

abeilles solitaires / plastique / flexibilité adaptative

Wissenschaftliche Notiz: Erster weltweiter Nachweis, dass ein Bienennest ganz aus Plastikresten gebaut sein kann

solitäre Bienen / Plastik / adaptive Flexibilität

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