

## First Record of Brazil nut Pollinators Outside Amazon Biome

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### Abstract

We present the first records of insect visitors and pollinators of *Bertholletia excelsa* (Lecythidaceae) in a 25 years plantation outside the Amazon biome, flowering and producing Brazil nuts. We installed a platform to observe and photograph the insects. The collected insects were stored, mounted, and identified by specialists. Six species were observed, three of them classified as potential pollinators (*Centris lutea*, *Eulaema nigrata*, *Eulaema cingulata*). The species *E. nigrata* and *E. cingulata* were already reported as a pollinators of Brazil nut in Amazon. This is the first record of *C. lutea* as potential pollinators for *B. excelsa*.

**Keywords:** bees, *Bertholletia excelsa*, *Centris*, *Eulaema*, nuez boliviana.

## 1. INTRODUCTION

The Brazil nut tree (*Bertholletia excelsa* Bonpl.; Lecythidaceae), also known as the Pará nut tree, occurs naturally in the Amazon rainforest, and in Brazil occurs in the states of Acre, Amazonas, Pará, Roraima, Rondônia, and part of Mato Grosso (Flora do Brasil, 2019). Its main commercial product is a nut, known as the Brazil nut by importing countries, which is consumed *in natura* or in the form of a by-product, such as oil or milk. In 2018, Brazil nut exports reached 11,000 tons (CONAB, 2019), highlighting its economic and social importance for local communities that rely on forest resources for income and labor.

In its natural habitat *B. excelsa* is pollinated by large robust native bees, which have sufficient strength to uncurl the hood of the flower and reach the nectary (Cavalcante et al., 2012).

These bees, some of them also commonly known as carpenter bees, require favorable conditions to inhabit the region and perform pollination, and the decrease in the populations of these large bees directly impacts the fruiting of the Brazil nut tree, which is allogamous and self-incompatible (Maués, 2002; Maués & Oliveira, 2010; Cavalcante et al., 2012; Maués et al., 2015), requiring cross pollination between tree individuals.

Regarding the production outside its natural occurrence area, there are few studies on the establishment of Brazil nut plantations outside the Amazon region (Homma et al., 2014), but there are no reports of *B. excelsa* fruiting on a large scale outside its natural occurrence area. However, this rule does not apply in a plantation established in January of 1996, in Lavras, southern Minas Gerais, Brazil (21°13'29.92"S 44°58'23.14"W, 922 m elevation).

The plantation is an agroforestry system of *B. excelsa* intercropped with *Hevea brasiliensis* (Euphorbiaceae), with approximately 90 plants spaced 9 m<sup>2</sup> apart. The *B. excelsa* seeds were brought from the northern region of the state of Mato Grosso. During the last 25 years the management consisted at constant weed and ant control, and no thinning or pruning was performed.

Among the 78 *B. excelsa* survival trees in the area, six trees with flowers were identified in the 2019, 11 were identified in the 2020, and 12 at 2021 flowering season; in addition to flowering, these trees also produced fruits. The first fructification was observed when the trees were 20 years old, and since then, the number of fruit-producing individuals has increased, and so has the number of fruits each year. The flowering and fruiting trees are the largest in the area and dominate the canopy.

A platform of approximately 18 m high was erected at the same level of the canopy to facilitate the observation

and capture of the potential pollinators and the recording of other floral visitors. In addition, photographic monitoring was performed to obtain images of the insects with a Canon Power Shot SX 50 HS digital camera, and observations were performed using Nikon Action 08 X 40 binoculars.

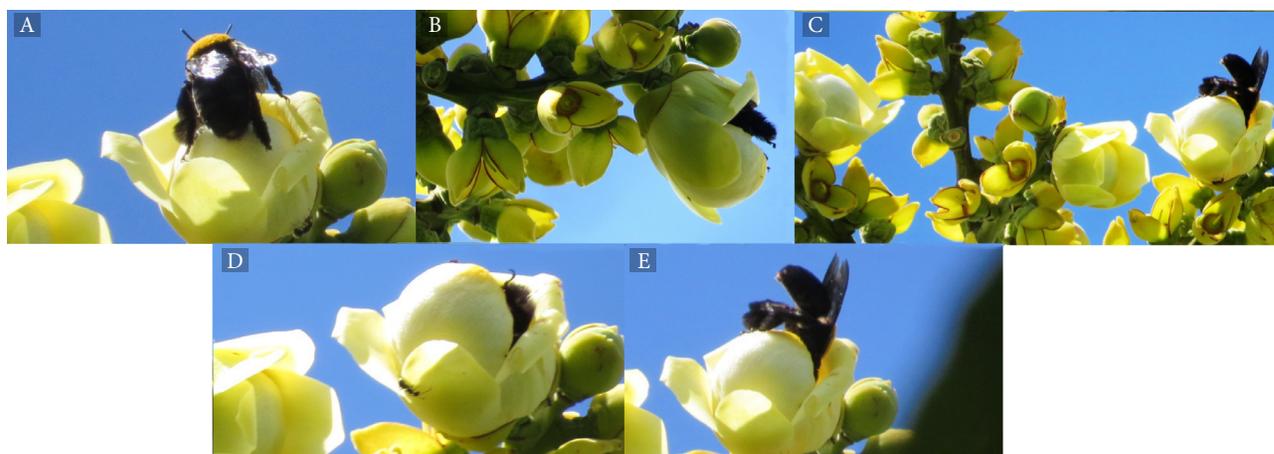
Insect survey occurred during the flowering season (January to April), five days per week, during 6 hours (from 6 am to 12 pm). Insects visiting the flowers were collected with an entomological net, stored in 70% alcohol (v/v) and subsequently mounted on entomological pins and identified by experts from the Department of Entomology of the UFLA and Laboratory of Bionomy, Biogeography and Insect Systematics (BIOSIS) of the Biology Institute of the Federal University of Bahia (UFBA) using taxonomic keys and the recorded images.

Six insect species of the order Hymenoptera were observed visiting *B. excelsa* flowers (Table 1). The insects recognized as potential pollinators were all bees of the Apidae family (Figure 1).

**Table 1.** List of Hymenoptera species (Insecta) observed visiting the flowers of Brazil nut (*Bertholletia excelsa* Bonpl.; Lecythidaceae) plantation located in an ecotonal region between Cerrado and Atlantic Rainforest domains in the municipality of Lavras, Minas Gerais, south-eastern Brazil.

Family	Tribe	Species	Potential Pollinator	Floral Visitor	Record type
Apidae	Centridini	<i>Centris (Xanthemisia) lutea</i> Friese, 1899	X		V, P
Apidae	Euglossini	<i>Eulaema (Apeulaema) nigrita</i> Lepeletier, 1841	X		V, C
Apidae	Euglossini	<i>Eulaema (Apeulaema) cingulata</i> (Fabricius, 1804)	X		V*, C
Apidae	Euglossini	<i>Euglossa (Euglossa) cordata</i> (Linnaeus, 1758)		X	V, C
Apidae	Meliponini	<i>Trigona hyalinata</i> (Lepeletier, 1836)		X	V, P
Formicidae	Crematogastrini	<i>Crematogaster</i> sp.		X	V, P
2		6	1	5	

Legend: V = visualization, V\* = viewed flying over/landing on flowers, P = photography and C = collected.



**Figure 1.** A: *Centris (Xanthemisia) lutea* Friese, 1899 in a *Bertholletia excelsa* Bonpl. (Lecythidaceae) flower. B: *Centris lutea* inside the *Bertholletia excelsa* flower to reach the nectary. C: *Centris lutea* opening the hood of *Bertholletia excelsa* flower. D: *Centris lutea* inside the *Bertholletia excelsa* flower. E: *Centris lutea* opening the hood of *Bertholletia excelsa* flower (picture in greater magnification). All photos were taken at the campus of the Federal University of Lavras (UFLA) south-eastern Brazil. (Photos: Aloysio S. de Moura).

The classification of the species observed in this study (i.e., floral visitors and pollinators) may vary if we consider that the studied plant is far from its natural area of occurrence.

Among the potential pollinators, *Centris* (*Xanthemisia*) *lutea* Friese, 1899 (Figure 2), belongs to the oil collecting bees group. The genus *Centris* has a great diversity of species within Brazil and a wide geographic distribution (Moure et al., 2007). The species of the genus nest in wood, soil, termites, among other substrates (Gaglianone, 2005). They are generally floral oil collectors, acting as pollinators of several forest species (Pinheiro & Sazima, 2007; Kiill et al., 2012). This genus bees are also important in the agricultural production of species such as *Passiflora alata* Curtis (Passifloraceae) (sweet passion fruit), *Passiflora edulis* Sims. (Passifloraceae) (yellow passion fruit), *Malpighia emarginata* DC. (Malpighiaceae) (barbados cherry), *Anacardium occidentale* L. (Anacardiaceae) (cashew) (Freitas & Paxton 1998; Hoffmann et al., 2000; Vilhena & Augusto 2007).

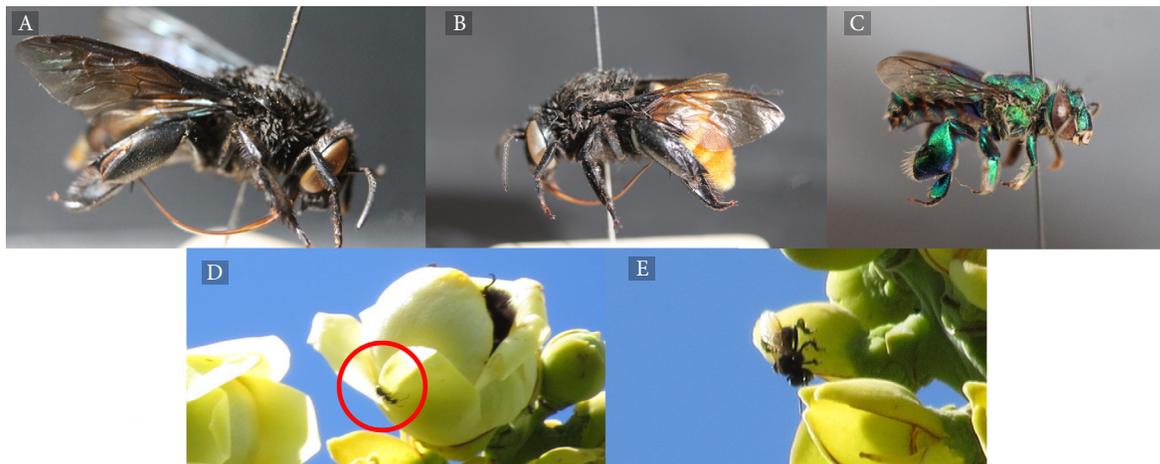
The genus *Eulaema* is composed by large bees, ranging from 20 to 30 mm (Oliveira, 2006), with a considerable presence in the Cerrado biome (Nemésio & Faria Júnior, 2004), acting as important pollinators of native forest (Pinheiro & Sazima, 2007), and agricultural species, most notably *Passiflora edulis* (yellow passion fruit) (Hoffmann et al., 2000).

Despite the species *Xylocopa* (*Neoxylocopa*) *frontalis* (Olivier, 1789) (carpenter bee of the family Apidae) being one of the most abundant and frequent species in

pollination studies in the Brazilian south-eastern region, and has been recorded as a pollinator of Brazil nut trees in the northern and north-eastern regions of Brazil (Maués, 2002; Oliveira-Filho & Freitas, 2003; Cavalcante et al, 2018) there was no visual or collected records of such species on the present study.

Three other insect species visited the flowers, but they were not found to be effective pollinators due to their small body size what makes it impossible for them to lift the hood of the flowers and reach the nectary [*Euglossa* (*Euglossa*) *cordata* (Linnaeus, 1758), *Trigona hyalinata* (Lepeletier, 1836) bees of the family Apidae and *Crematogaster* sp. (Formicidae)] (Figure 2). The fact that these insect species are not strong enough to raise the hood of *B. excelsa* flowers hinders pollination but does not prevent them from being successful in collecting food (Figure 2).

The successful establishment and production (flowering and fruiting) of Brazil nut under a different climatic zone is relevant on an ecological, economic and social aspect. We can zone areas with the possibilities of nut cultivation due to the presence of potential pollinators, in addition to the edaphoclimatic characteristics. Possibly the viability will be associated with the presence of large size bees. The widespread cultivation of Brazil nuts will generate income for the farmer and entrepreneur. The promotion of long-term projects deepens the man-land relationship, and increases food security for the families involved.



**Figure 2.** A: *Eulaema nigrita* collected in the canopy of the *Bertholletia excelsa* Bonpl. (Lecythidaceae) plantation. B: *Eulaema* (*Apeulaema*) *cingulata* (Fabricius, 1804) collected on flowers of *Bertholletia excelsa*. C: *Euglossa* sp. collected in the canopy of the *Bertholletia excelsa* plantation. D: *Crematogaster* sp. (specimen inside the red circle) visiting *Bertholletia excelsa* flowers (in red circle). E: *Trigona hyalinata* (Lepeletier, 1836) visiting *Bertholletia excelsa* flowers. All photos were taken on the campus of the Federal University of Lavras (UFLA), south-eastern Brazil. (Photos: Aloysio S. de Moura).

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