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# First report of phoresy by silken fungus beetles on *Bombus funebris* (Hymenoptera: Apidae: Bombini) in the Southern Andes of Ecuador

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**Bumblebee / Cryptophagidae / Ectosymbiont / Neotropics / Phoretic**

## 1. BEETLE PHORESY ON *BOMBUS FUNEBRIS*

Bumblebees species are very important as pollinators in natural environments along with being critical pollinators of agricultural crops. Bumblebees are highly susceptible to environmental changes (Goulson 2010), and as such, they provide an excellent monitoring system to evaluate environmental degradation.

Bumblebees are currently considered key species to evaluate and monitor the effects of global change (climate change, exposure to pesticides, introduction of parasites, deforestation, pollution, etc.) (Whitehorn et al. 2012; Goulson et al. 2015). But currently, many species, especially in the northern hemisphere, are already threatened (Whitehorn et al. 2012; Goulson et al. 2015; Herbertsson et al. 2021), which has intensified research into the conservation of these species in recent years.

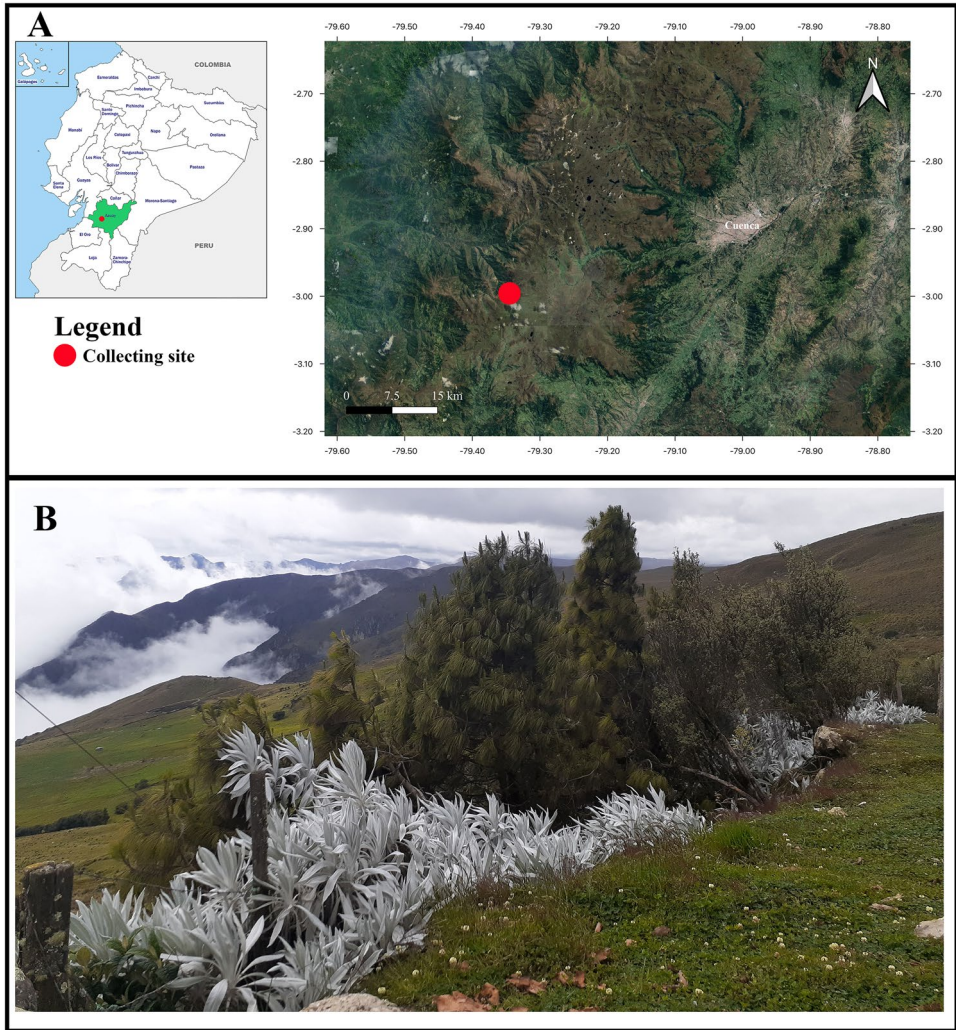
A part of the research directed toward the preservation of bumblebees includes the possible interactions between organisms, which is well known for many species. These interactions are important for the development and survival of many organisms, and this is true for bumblebees

as well (Chavarria 1994; Goulson 2010). One of these interactions is phoresy in which an organism is temporarily transported mechanically from one place to another by another organism without physiological interactions (Signe et al. 2017). Phoresy is usually initiated when the phoretic organism needs to move to a better location in search of food or a mate, or when its current location deteriorates and it needs to migrate to a better place for survival (Renee 2022). It is known that some beetles act as phoretic organisms (Renee 2022) and have been previously reported as phoretic for neotropical bumblebee species (Roubik and Wheeler 1982; Chavarria 1994; González et al. 2004; Posada-Flórez and Téllez-Farfán 2021).

The studies outlined above indicate the importance of the investigation of bumblebees and their interactions with other organisms in general, but it is particularly important to study unknown species. Historically, the natural history of neotropical species of bumblebees has been rarely studied. In the study presented here, we report, for the first time, the phoresy of a beetle in its interaction with an endemic Andean bumblebee species.

During a field trip on a cloudy day on February 6, 2022, to the locality of Pimo (−2.99516°, −79.34378°) located in the province of Azuay at 3845 m (Fig. 1A), a bumblebee was discovered around 1315 h. Its body was black with patches of white hair on the last

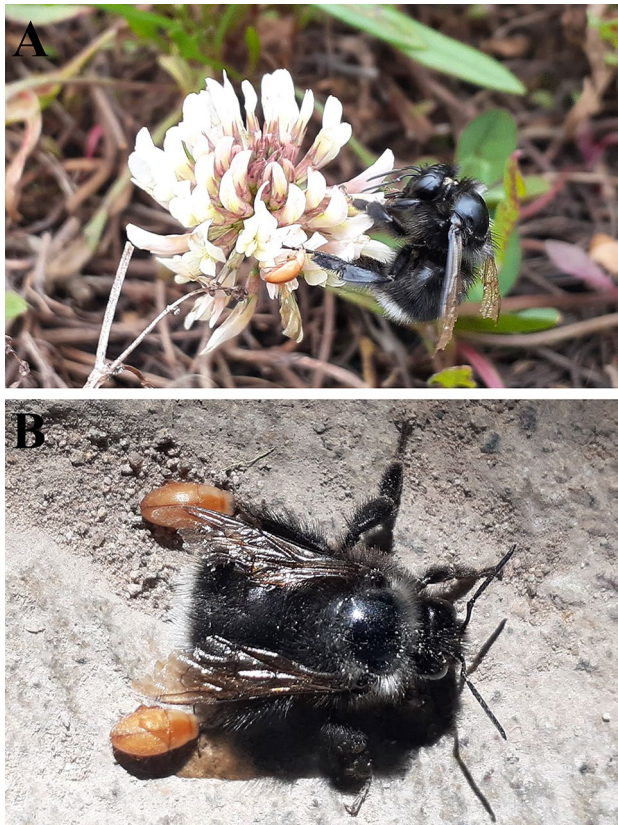
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**Figure 1.** A Map showing the location of the place where the phoresis observation was made in Ecuador. An ecosystem where the observation was made in the western foothills of the Andes.

segment of the metasoma and on the prothorax. In addition, it had clear wear on both wings. The bumblebee was actively visiting flowers of white clover *Trifolium repens* L. (subfamily Faboideae), a common flowering plant within altered ecosystems (Fig. 2A). The bumblebee caught our attention because it had something attached to its left hind leg. We carefully approached and took a couple of photos, then the bumblebee flew to a distant bush of yellow flowers and then disappeared. Later, when reviewing

the photos, we realized that a beetle was firmly attached by its jaws to the left tarsus of the bumblebee's rear leg (Fig. 2A). The next sighting occurred at the same location 2 days later on February 8, 2022, at 1519 h. A bumblebee, with the same external morphological characteristics as the first one, was resting on the ground on a cement sidewalk outside a house. This time, the bumblebee was stationary, and on each hind leg, it had a beetle attached (Fig. 2B). We took some photos before it flew away.



**Figure 2.** *Antherophagus* beetle attached to the hind tarsus of *Bombus funebris*. **A** Interaction observed on February 6, 2022. **B** Interaction observed on February 8, 2022.

The weather during these days was mostly cloudy with sporadic appearances of the sun. The average temperature was 8° C, and the place where we made our observations was located on the western side of the Andes mountain range. This area has small remnants of paramo in the upper parts of the mountains, but the vast majority of the landscape was degraded. There were potato crops, livestock, and the presence of various species of exotic plants such as the pine *Pinus radiata* D. Don, white clover *Trifolium repens* L. along with other plants (Fig. 1B).

For the identification of the observed insects we used, for the bumblebee, the keys from Rasmussen (2003) and Pinilla-Gallego et al. (2016), and for the beetle, we used the genus key for the subfamily Cryptophaginae proposed by Bousquet (1989).

The bumblebees were identified as *Bombus funebris* (Smith 1854), based on their black body with tufts of white hairs on the mesoscutum and in the last terga of the metasoma. *Bombus funebris*, which was originally described from a specimen collected near Quito Ecuador (Smith 1854), is a common western high-elevation Andean species. It can be found actively visiting flowers in the wild and in urban ecosystems from Colombia to Bolivia and northern Chile at elevations ranging from 610 to 3810 m (Abrahamovich et al. 2004; Packer and Ruz 2017). In Ecuador, it has been recorded mostly on the western side of the Andes mountains, in the inter-Andean valleys, and sporadically near the eastern foothills (INaturalist 2022). The natural history of this species is almost unknown, other than some information regarding which plants it visits (Rasmussen

2003), and more recently, Plischuk et al. (2020) reported the presence of phoretic mites in males and females of this species in the highlands of Bolivia and Peru.

The beetle belongs to the genus *Antherophagus* Dejean, 1821 (Coleoptera: Cryptophagidae), commonly called silk fungus beetles. This genus can be identified by a combination of features present on the antennae, eyes, and pronotum (see Bousquet 1989). There are 11 species within this genus (Bousquet 1989); however, we were unable to identify the specific species in the photographs because we could not collect the beetles. Collection and microscopic examination are required to verify specific morphological characteristics in order to be certain of the exact species.

The genus *Antherophagus* has previously been reported as phoretic on northern hemisphere bumblebee species (Wheeler 1919; Frison 1921; Parks 2016). For neotropical bumblebee species, there are few reports of phoresis (Roubik and Wheeler 1982; Chavaria 1994; González et al. 2004; Posada-Flórez and Téllez -Farfán 2021); and only two reports pertaining to the Andes mountains. The first report was for *Bombus pauloensis* Franklin 1913, and the second for *Bombus atratus* Franklin, 1913, (González et al. 2004; Posada-Flórez and Téllez -Farfán 2021) both in Colombia. The observation reported here is the first for *B. funebris*, a restricted high Andean bumblebee, and constitutes the first observation within Ecuador. Finally, we checked for the presence of these beetles on 260 observations of *B. funebris* uploaded on the iNaturalist platform (Reviewed on February 18, 2022), and we could not find evidence of the presence of these beetles.

The influence of the observed phoretic interaction is poorly known. The beetle's larvae and adults are thought to feed on organic detritus within host nesting sites acting as scavengers (Bousquet 1989; Chavarria 1994; Goulson 2010). Therefore, they are likely to be beneficial to bumblebees; but because some phoretic interactions are known to lead to parasitism over time (Signe et al. 2017), we consider it important to study this interaction in greater detail.

It is also important to point out that certain characteristics of the nest, such as age, size of

the colony, and location, have been identified as determinants of the presence of phoretic insects or other “tenants” (Roubik and Wheeler 1982; Posada-Flórez and Téllez -Farfán 2021). Additionally, there are no identified characteristics of the host that are thought to promote this interaction, but the bumblebees observed and reported here had visible evidence of wing wear, which in bumblebees indicates their age (Cartar 1992), where individuals with marked signs of deterioration in their wings are considered older individuals. This could suggest that age may be a factor that promotes an organism to become the host of a phoront, but to confirm this hypothesis, more information is needed.

Finally, most of what we currently know about phoresis by Cryptophagidae beetles in bumblebees comes from sporadic and random observations in northern species. For this reason, we think it is important in the future to focus our research on bumblebee nests, especially of neotropical species, such as the endemic *B. funebris*. This will allow us to learn more about phoresis in general and will help us to obtain important ecological information that is essential to any conservation program trying to protect these bumblebees in the Andes.

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## AUTHOR CONTRIBUTION

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by MEV and PSP. The first draft of the manuscript was written by PSP, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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**DATA AVAILABILITY**

Not applicable.

**CODE AVAILABILITY**

Not applicable.

**DECLARATIONS****Ethics approval** Not applicable.**Consent to participate** Not applicable.**Consent for publication** Not applicable.**Competing interests** The authors declare no competing interests.**REFERENCES**

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