



## SHORT NOTE

## Floral Resources Partitioning by Two Co-occurring Eusocial Bees in an Afromontane Landscape

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### Article History

#### Edited by

Cândida Aguiar, UEFS, Brazil

Received 02 January 2018

Initial acceptance 02 May 2018

Final acceptance 03 May 2018

Publication date 02 October 2018

#### Keywords

Apinae, *Apis mellifera*; honeybee; stingless bees; interspecific interactions; pollination.

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### Abstract

Floral preferences of generalist foragers such as eusocial bees influence the success of pollination of many flowering plants, as well as competition with many other bee species in tropical communities. Eusocial bees are important for the pollination success of many flowering plants, as well as for food resources availability for many other species. However, their foraging preferences are still unknown in many tropical areas, especially in the Afrotropics. We studied the foraging activity of two syntopic eusocial bees with large colonies, the honeybee *Apis mellifera* Linnaeus and the stingless bee *Meliplebeia ogouensis* (Vachal), on seven plant species in the Bamenda Highlands, Cameroon, in two consecutive years. Simultaneously, we quantified intra- and inter-annual changes in the food resources. We observed resource partitioning among the two bee species. Although both species are considered as generalists, their short-term food niches overlap was very low. Their preferences to the most often visited plants differed even more strongly inter-annually. Our results bring the first evidence on such relatively strong resource partitioning among two dominant eusocial bee species from West/Central Africa.

Eusocial bees with large colonies are crucial actors in many ecosystems. In addition to pollinating numerous plants, they affect other flower visitors' behaviour and food choice by consuming a large part of floral resources due to their high numbers and biomass (e.g. Whitfield et al., 2006). Individual species of eusocial bees influence the food niche of each other as well. In the tropics, such interspecific interactions in competition for food sources have been studied mainly among various bee species with an introduced honeybee, *Apis mellifera* Linnaeus (e.g. Sommeijer et al., 1983; Ramalho et al., 2007; Franco et al., 2009; Liu et al., 2013; Hilgert-Moreira et al., 2014). On the other hand, we have surprisingly limited knowledge on resource partitioning among eusocial bees in the Afrotropics, where *A. mellifera* is native (Whitfield et al., 2006). To

our knowledge, the only study from this region focused on the pollen foraging of *A. mellifera* and two stingless bee species of *Meliponula* in Uganda (Kajobe, 2007). Nevertheless, such data are crucial to understanding the dynamics in flower visitor insect communities, as well as to the role of eusocial bees on the evolution of plant pollination systems.

To fill this gap, we bring the first data on food partitioning among two dominant eusocial bees, *A. mellifera* and the stingless bee *Meliplebeia ogouensis* (Vachal), from the Afromontane landscape of Mendong Buo, NW Cameroon (6°5'21" N, 10°18'11" E). It is a mosaic-like landscape of montane forest remnants and open habitats (Tropek & Konvicka, 2010). From late November till early January (i.e. the first half of the dry season) of 2007/2008 and 2008/2009 we recorded



the two bee species visiting flowers of seven plant species whose flowers dominated the studied sites in stream gallery vegetation (Acanthaceae: *Brillantaisia lamium*, *Hypoestes aristata*; Campanulaceae: *Lobelia columnaris*; Hypericaceae: *Hypericum revolutum*, *H. roeparianum*; Lamiaceae: *Pycnostachys eminii*; Rubiaceae: *Virectaria major*; see Bartoš et al. (2012, 2015) for the plants characterisation, pictures and functional specialisation). All of them produce nectar, except *H. roeparianum* (Bartoš et al., 2012). Only *B. lamium*, *H. aristata* and *P. eminii* have flowers of mellitophilous pollination syndrome. In our previous studies (Padyšáková et al., 2013; Bartoš et al., 2015), *H. aristata* and *H. roeparianum* were shown to be flowers more commonly visited by *A. mellifera*, while *H. revolutum* was visited mainly by *M. ogouensis*.

The bee visits were recorded along sixteen 15 m transects of gallery vegetation, where 5-min observations of each plant species per sampling session were equally distributed within the day (between 9 to 16 h) and study periods (altogether 29 and 33 sampling days in the two sampling periods, respectively). During the sessions, only visitors of a single observed plant species were recorded; one visiting individual was counted just once independently on the number of visited flowers.

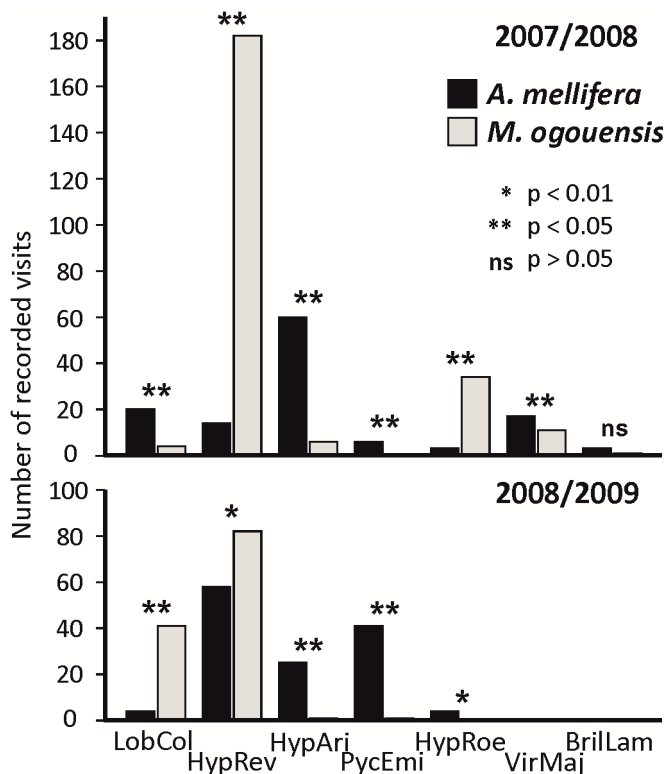


Fig 1. Number of visits to each plant species by the two bee species, in the Afromontane landscape of Mendong Buo, NW Cameroon, in two sampled dry seasons. LobCol: *Lobelia columnaris*, HypRev: *Hypericum revolutum*, HypAri: *Hypoestes aristata*, PycEmi: *Pycnostachys eminii*, HypRoe: *Hypericum roeparianum*, VirMaj: *Virectaria major*, BriLam: *Brillantaisia lamium*.

Each plant species was observed for about 10 hours in total (Bartoš et al., 2012). The possible partitioning of resources by the bees was analysed by a chi-square test of a contingency table (7 plants  $\times$  2 bees) with frequencies of visits in individual cells, performed in R v. 2.15.0 (R Development Core Team, 2012; Fig. 1). We also calculated the Schoener index of niche overlap combining the proportions of visits of both bee species on flowers of the particular studied plants (Schoener, 1968; Aguiar et al., 2017). The numbers of flowers along the transects were counted seven and four times in the two successive sampling periods, respectively (Janeček et al., 2012), and they remained mostly constant during both sampled dry season beginnings (Fig. 2). As the exceptions, flower numbers increased for *L. columnaris* and decreased for *P. eminii* during both sampled periods, whilst the flower numbers of *V. major* and *B. lamium* decreased during the second sampling period only.

Altogether 253 *A. mellifera* and 373 *M. ogouensis* bee-plant interactions were observed in both sampling periods: 121 and 238 visits in 2007/2008, and 132 and 135 visits in 2008/2009 (Fig 1; Online Resource 1). During the sampling, *A. mellifera* visited mainly *H. aristata* (n = 60), followed by *L. columnaris* (n = 20), *V. major* (n = 17) and *H. revolutum* (n = 17) in 2007/2008, whereas it visited *H. revolutum* (n = 58), *P. eminii* (n = 41) and *H. aristata* (n = 25) in 2008/2009. *M. ogouensis* visited mainly *H. revolutum* (n = 182) and *H. roeparianum* (n = 34) in 2007/2008, and *H. revolutum* (n = 82) and *L. columnaris* (n = 51) in 2008/2009.

Although both bees are generalists, each species preferred only part of available floral sources ( $X^2 = 215.9089$ ; df = 6;  $p < 0.01$ ; Fig 1), revealing thus a food source partitioning between them and low overlap of their niches. This was confirmed also by low Schoener index: 0.23 and 0.48 for the two periods, respectively, while the niches are considered to be overlapped for values over 0.6 (Schoener, 1968; Aguiar et al., 2017). Such niche partitioning among *A. mellifera* and various stingless bees was already described from various regions, usually interpreted as a result of differences in foraging behaviour, although an aggressive interspecific interference driven by larger honey bees is also sometimes hypothesised (e.g. Sommeijer et al., 1983; Ramalho et al., 2007; Kajobe, 2007).

The visitation rates of individual plants by both bees, however, differed during and between sampling periods (Fig 1 and 2). The strongest shift in resource partitioning among the two bee species involved the flowers of *L. columnaris*, between years, and the flowers of *H. revolutum*, intra-annually. During the first year, preference of *A. mellifera* toward *L. columnaris* followed its blooming during the second half of the period, while it visited *H. aristata* more or less during

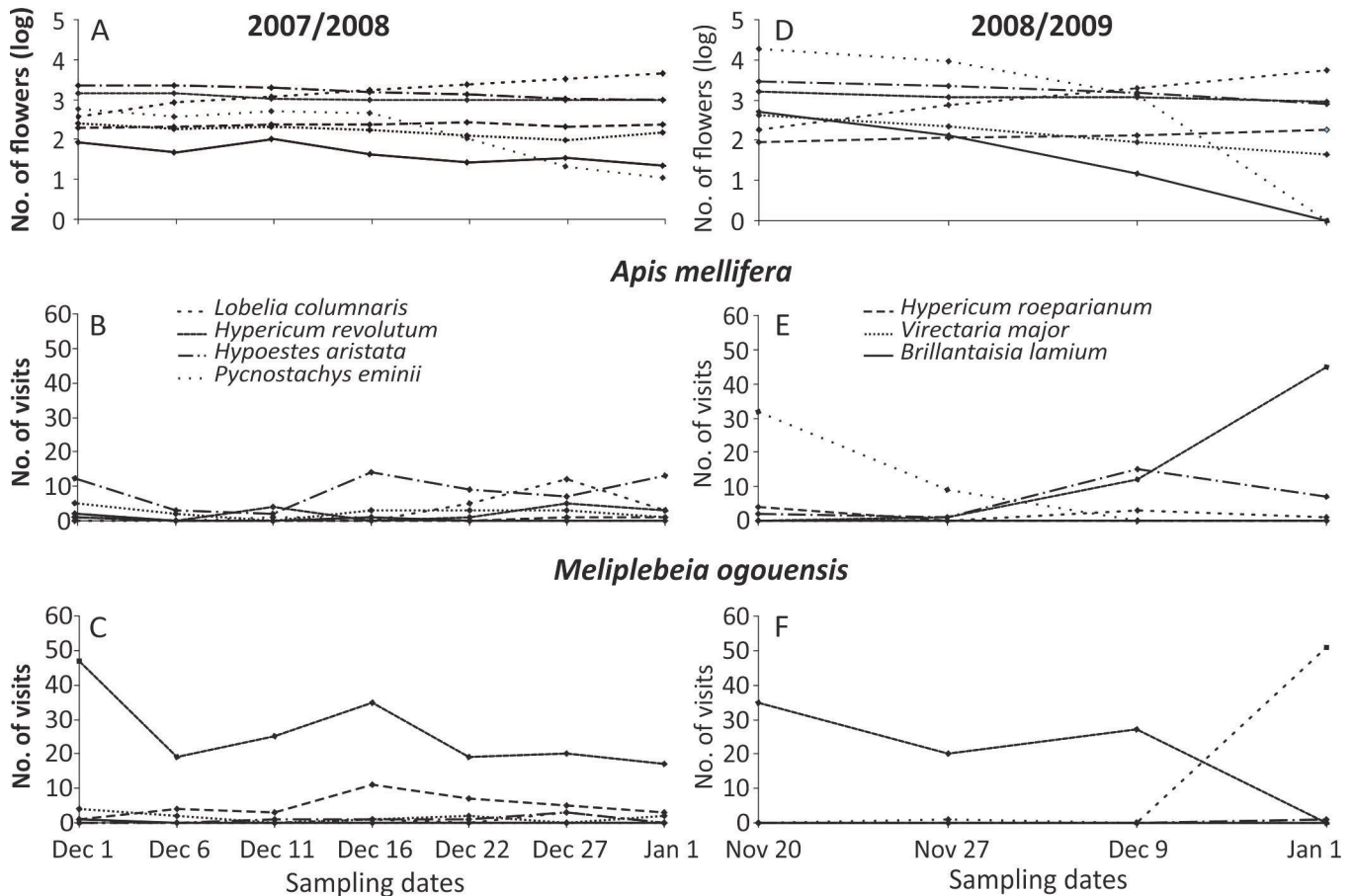


Fig. 2. Number of flowers of each-plant species (A, D), and number of visits by *Apis mellifera* (B, E) and *Meliplebeia ogoensis* (C, F). All the charts are visualised separately for the two studied years.

the whole period. *A. mellifera* strongly dominated on *P. eminii* in the beginning, switching to *H. revolutum* later after the first species overflowed, mainly in the second year. *Meliplebeia* strongly preferred *H. revolutum* in the beginning of both sampled periods, but almost entirely switched to *L. columnaris* later in the second year. Such temporal specialisation of honey bees and stingless bees for floral choice has already been described as a result of both optimisation of resource usage and competition avoidance (Leonhardt et al., 2014); without other data we cannot exclude other possible factors. Nevertheless, our study has confirmed an interesting phenomenon of food niche partitioning among two eusocial bee species in the overlooked landscape of Afrotropical mountains.

#### Acknowledgements

We would like to thank L. Spitzer and M. Janda for their help with the data collection, J. Straka for *Meliplebeia* identification, and M. Sweny for English corrections. Our research was funded by the Czech Science Foundation (14-36098G, 16-11164Y) and by the Charles University (PRIMUS/17/SCI/8 and UNCE 204069).

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