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Nectar Sugar Composition and Pollinators for the Naturalized Exotic *Leonurus japonicus* (Lamiaceae) in Central Argentina

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ABSTRACT

Volumes of nectar and sugar concentration were measured in different populations of the naturalized exotic *Leonurus japonicus* Houtt. (Lamiacaea) in central Argentina. Qualitative and quantitative nectar sugar composition were determined and compared between populations. In general, nectar sugar concentration was high and volume per flower was very low for all populations. Nectar sugars were glucose, fructose and sucrose for all populations, but sucrose clearly predominates over hexoses. Honeybees and bumblebees were recorded as the main pollinators in this region. Bumblebees preferences for sucrose-high nectars can be indicating that this exotic species can attract these pollinators and assure seed production to expand their populations. On the other hand, honeybees can use this nectar resource because they are generalist and have enzymes to break the sucrose in hexoses. New interesting studies can be settled considering the invasion process as theoretical framework, and developing field experiments to link plant reproductive biology, nectar traits and pollinator preferences.

Keywords : Nectar sugar composition, bumblebees, honeybees, pollinator preferences

INTRODUCTION

Plants with biotic pollination attract their pollen vectors generally offering rewards. Of the diverse floral rewards offered by plants, nectar is the most important. Nectar, a dilute aqueous solution basically composed of sugar, water, and other components but in very low quantity, is the main food reward and source of energy for most pollinators. Nectar traits that were related to the main group of pollinators are volume, concentration and sugar composition (Baker & Baker 1983, Galetto & Bernardello 2005). Volume and concentration of nectars have generally been associated with flower shape. Tubular flowers diminish water loss through evaporation in comparison with open flowers, and consequently nectar traits are more stable in flowers with deeper corollas (Petanidou 2007 and references therein). Sugars dominate the total solute in floral nectar: these are mainly sucrose, fructose and glucose in varying proportions according to the main groups of animal visitors of the species (Percival 1961, Baker & Baker 1983, Torres & Galetto 2002, Galetto & Bernardello 2003, 2005). Different proportions of these three sugars have been associated with different types of pollinators as part of the "pollination syndrome" concept (Baker & Baker 1983, Proctor *et al.* 1996). Although these nectar–pollinator associations have been questioned (van Wyk 1993, Perret *et al.* 2001, Galetto & Bernardello 2003), more specialized, insect-pollinated flowers (e.g., by long-tongued bees) tend to show high-sucrose nectars whereas non-specialized flowers (e.g., pollinated by short-tongued bees, flies, wasps or butterflies) high-hexose nectars (Petanidou 2007 and references therein). Nevertheless, in Chaco and arid Patagonia from Argentina bee flowers did not show a consistent pattern in their nectar sugar composition (Galetto & Bernardello 2003), but in the Temperate forests of South America long-tongued bees tend to show nectars with sucrose predominance (Chalcoff *et al.* 2006).

Leonurus is a genus distributed in Asia and Europe and comprehends around 10 species. *L. japonicus* Houtt. is native from Asia, adventitious in America, and widely distributed in central, NW and NE Argentina (Crespo 1979). As far as we know for this species, few data were published on the reproductive biology and pollinators (Moyano *et al.* 2003 and references therein). For central Argentina, Moyano *et al.* (2003) reported the pollen adhesive secreted from glandular trichomes of the anthers of *L. sibiricus*, and that the flowers were visited by bumblebees (*Bombus morio*, *B. opifex* and *B. bellicosus*) looking for nectar. In this contribution

we studied six populations of *L. japonicus* (Lamiaceae) from central Argentina to analyze nectar traits in relation to the preferences of the main guild of pollinators that visit their flowers. In particular and to explore the nature of the association between nectar traits and pollinators, we predicted that the flowers of this bumblebee pollinated species will show high-sucrose nectars and medium volume and concentration values considering that this species presents tubular corolla.

MATERIAL AND METHODS

Samples of nectar and data on floral visitors were obtained from living plants in natural populations from Argentina, Córdoba Province, Dept. Santa Maria: Los Aromos. Floral visitors were recorded occasionally on populations of several flowering individuals, totalizing 12 h of observations. We considered visitors as pollinators if animal touch anthers and stigma when visiting the flowers.

Two nectar variables were measured in the field, volume of nectar using graduated microcapillaries, and sugar concentration (percentage sucrose, w/w) with a pocket refractrometer (Atago®, Tokyo, Japan, 28-62%). Nectar sugar composition was compared in nectar samples taken from unvisited flowers of one individual of each population. Nectar drops were placed on Whatman #1 chromatography paper and quickly dried; in the laboratory, nectar was re-dissolved and sugar separation was accomplished by gas chromatography. Nectar was lyophilized and silylated according to Sweeley et al. (1963). The derivatives were then injected into a Konik KNK 3000-HRGS gas chromatograph equipped with a Spectra-Physics SP 4290 data integrator, a flame ionization detector, and a SE 30 capillary column (30 m long, 0.25 mm diameter and 0.25 ìm thickness of the inner pellicle). Nitrogen was the carrier gas (2 ml/min) and the following temperature program: 200ºC/1 min, 1ºC/min until 208ºC, 10ºC/min until 280ºC for 2 min. Carbohydrate standards (Sigma Chem.) were prepared using the same method.

RESULTS

Nectar volume per flower was very low and nectar sugar concentration was high (Table 1). Nectar sugars were glucose, fructose and sucrose for all the samples (Table 1). Percentage of disaccharides dominates over hexoses, with a range from 53 to 85.6 % of sucrose (Table 1).

Flowering individuals (Fig. 1 A) were generally visited from the base of the inflorescence to the top. Most frequent pollinators were *Apis mellifera* (Fig. 1 B) and bumblebees. Among *Bombus* species, the most frequent was *B. opifex* (Fig. 1 C), *B. morio* was seen occasionally, and *B. bellicosus* visits were uncommon.

DISCUSSION

Long-tongued bees visit preferentially flowers with nectar sugar composition dominated by sucrose in central and North America (Baker & Baker 1983), in Mediterranean communities (Petanidou 2007), and also in temperate forests from South America (Chalcoff *et al.* 2006). Although this general pattern was not verified for flowers visited by long-tongued bees in the Chaco from central Argentina (Galetto & Bernardello 2003), some native species of *Ipomoea* (Convolvulaceae), *Cologania* (Fabaceae), and *Mandevilla* (Asclepiadaceae) are frequently visited by bumblebees and showed high-sucrose nectars (Torres & Galetto 1998, Galetto & Bernardello 2004, Musicante & Galetto 2008). Thus, it is not surprising that the exotic *Leonurus japonicus* that is frequently visited by bumblebees

Table 1 — Nectar volume, concentration, and sugar composition in different populations of *Leonurus japonicus* from central Argentina.

Sample (individual)	Volume (ul)	Concentration (%)	Sugars (%)		
			Sucrose	Fructose	Glucose
1	<1	59	54.1	22.8	23.1
2	1	52	76.1	11.5	12.4
3	1	43	76.2	11.6	12.2
4	<1	50	77.1	11.5	11.4
5	<1	61	85.6	7.7	6.7
6	1	52	53.3	23.2	23.5

Fig. 1A-C — A. Flowering individual of *Leonurus japonicus*. **B.** *Apis mellifera* visiting a flower for nectar. **C.** *Bombus opifex* gathering nectar. Bar in A = 2 cm, in B = 1 cm and it is valid also for C.

(Moyano *et al.* 2003, our data) showed nectar dominated by sucrose as was predicted.

Petanidou (2007) explained the differentiation between the nectar sugar composition of the flowers visited by short- and long-tongued bees on the basis of the aptitude to perform or not sucrose digestion by the different groups of pollinators. This hypothesis was verified for the generalist *Apis mellifera* that collect nectar of very different sugar composition but can modify sugars by hydrolysis during the conversion of nectar to honey (von der Ohe 1994). This possibility can differentiate pollinators between those that do not prefer high-sucrose nectars because they do not digest this disaccharide, of those that can be specialized in flowers secreting nectars dominated by sucrose.

In the context of the invasion theory, it is interesting to consider that nectar sugar composition can be one of the important traits that the exotic plant would be matching with the native community. On one hand, it is necessary that native plant species with similar flower types secrete nectar of the same kind of the exotic plant species to support the putative pollinators for the exotic throughout the season. On the other hand, pollinator nectar preferences would restrict or increase the possibilities of reproductive assurance and the expansion of the geographical range of the exotic in accordance of its nectar sugar composition. New interesting studies can be settled considering the invasion process as theoretical framework, and developing field experiments to link plant reproductive biology, nectar traits and pollinator preferences.

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