

Exploitation of pollen resources by *Xylocopa splendidula* in the Argentine pampas

MARÍA C TELLERÍA

CONICET, Cátedra de Palinología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n°, 1900-La Plata, Argentina

(Received 13 October 1998, accepted subject to revision 4 February 1999, accepted for publication 6 October 1999)

SUMMARY

The pollen choice by native carpenter bees (*Xylocopa splendidula*) in the Argentine pampas was surveyed by means of the pollen harvest in nests. Samples were taken in January 1996, 1997 and December 1998. The data obtained were compared with data from introduced honey bees, *Apis mellifera*, in the same region (Tellería, 1993). 16 species belonging to 11 families of Angiosperms are present in the foraging spectrum of *X. splendidula*. The carpenter bees principally collected pollen from the plants which are isolated or in small populations. In contrast forage plants for honey bees are in dense populations. Such differences may be attributed to different skills needed to exploit the resources, and to displacement of native carpenter bees towards less productive environments, by introduced honey bees.

Keywords: *Xylocopa splendidula*, carpenter bees, *Apis mellifera*, honey bees, pollen, pampas, foraging behaviour, Argentina

INTRODUCTION

Melissopalynological studies carried out in the pampas phytogeographical region show close interaction between the European honey bee (*Apis mellifera*) and plants introduced from Europe, which are abundant in this region (Tellería, 1988, 1993). However, little is known about the foraging behaviour of native Apidae.

Carpenter bees are solitary or facultatively social insects, with small colonies of from one to five females (Michener, 1990). Nests are constructed either by using existing hollows in canes or by tunnelling in dead wood. Brood provisions (pollen loaf) consist of a mixture of nectar and pollen, shaped into a loaf-like structure. Apart from being used to bind the pollen, nectar satisfies the metabolic requirements of the adults (Roubik, 1992; Neff & Simpson, 1997). The female lays an egg on top of the newly made pollen loaf, and then builds a sawdust partition in the tunnel so that each individual develops in a separate cell (fig. 1).

Buzz pollination allows carpenter bees to obtain pollen from poricidal anthers, which are inaccessible to other insects (Buchmann, 1983). Carpenter bees are considered as efficient pollinators in tropical ecosystems, where they preserve biodiversity (Gross & Mackay, 1998), as well as in some farmland where they can increase crop productivity (Free, 1970; Sihag, 1993a, 1993b, 1993c; O'Toole, 1997).

Xylocopa (Schoenherria) splendidula splendidula is a common pollinator of the Pampas region, and flowers visited by this polylectic bee are mentioned in Hurd (1978). Foraging behaviour of *X. splendidula* is mentioned also by Genise *et al.* (1990) in their study of the floral biology of *Prosopis* in the Chaqueño Serrano district. Plants visited by *X. splendidula* and *X. augusti* were compared by Abrahamovich & Girarde (1991) through the analysis of their food reserves found in a single nest from an Argentine pampas area.

The aims of this work are:

- To increase knowledge about the pollen choice of native *X. splendidula* in the pampas (Cabrera, 1963) by means of the analysis of pollen stored in brood cells.
- To compare the data obtained with data from introduced *Apis mellifera* in the same region (Tellería, 1993) in order to discuss the food choices made by both introduced and native Apidae.

MATERIALS AND METHODS

The study was performed at the same location (34° 42'S and 61° 6'W) in the pampas phytogeographical region of Argentina over several years. Sampling was done in three periods: January 1996 and 1997, and December 1998. Carpenter bees are more active during these months. Field observations during December

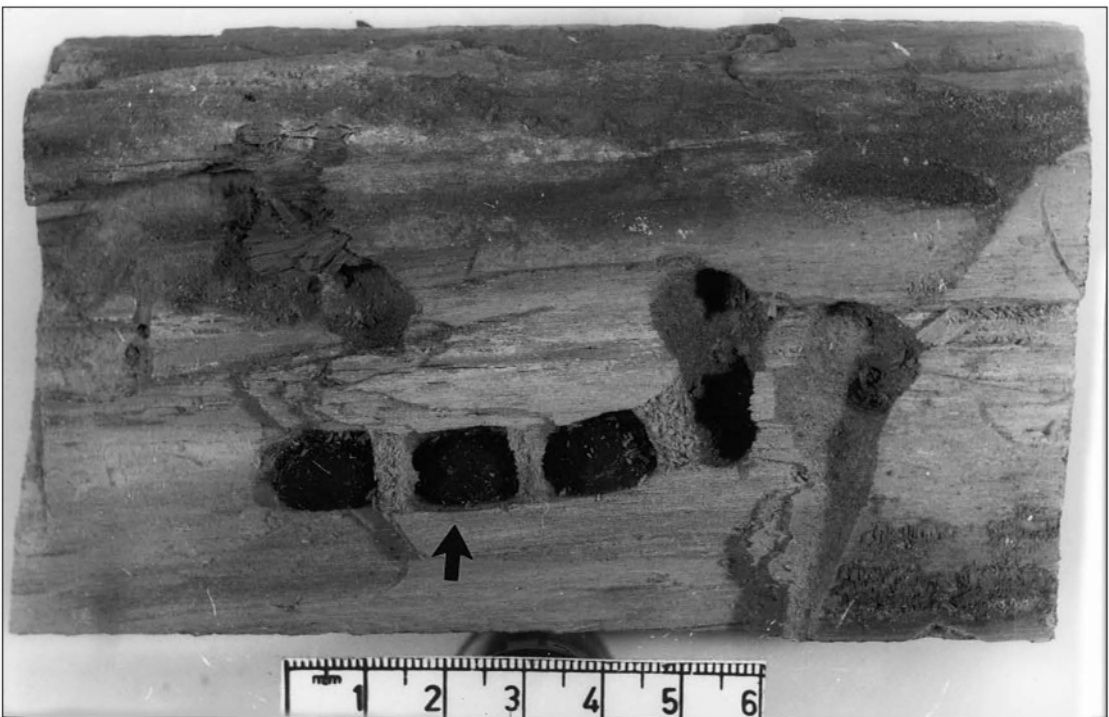


FIG.1. Incubation cells constructed by *Xylocopa splendidula* in pitch-pine beams; loaf pollen (arrow).

and January were made to detect the type of reward collected by the carpenter bees, to record the distribution of plants visited (dense populations or isolated individuals) and to locate the nests.

A total of 131 (5 in 1996, 117 in 1997, 9 in 1998) pollen loaves (weight: 54.08 g) were collected from brood cells found in dead wood from *Melia azedarach*, *Broussonetia papyrifera*, *Salix* spp. and pitch-pine beams. Each pollen loaf was dissolved in 100 ml of distilled water at 80°–90°C, first with a glass rod and then in a magnetic stirrer for 15–20 minutes. The mixture was filtered through a 250 µm mesh to remove sawdust debris. From this aqueous mixture, 5 ml was centrifuged and the pellet analysed. Preparations with both acetolyzed (Erdtman, 1960) and unacetolyzed pollen grains were made using a fuchsin dye. Pollen types were identified by comparison with a pollen reference collection of the local flora. A random sample of 300 grains was counted on two slides (150 on each slide) to establish the percentage of each pollen type. If a pollen loaf contained more than one pollen type whose proportion was greater than 1% of the pollen count, the pollen loaf was characterized as multifloral.

Data of pollen collected by *A. mellifera* during December and January in the pampas region were taken from Tellería (1993).

RESULTS

A total of 16 morphological pollen types were identified. The pollen types belong to the following families: Amaryllidaceae (*Amaryllis* spp.), Apiaceae (*Eryngium* spp.), Asteraceae (*Carduus* spp, Cichorieae, *Helianthus annuus*), Fabaceae (*Medicago sativa*, *Sesbania punicea*, *Trifolium repens*, *T. pratense*, *Styphnolobium japonicum*), Lythraceae (*Lagerstroemia indica*), Myrtaceae (*Eucalyptus* spp.), Oleaceae (*Ligustrum* spp.), Rutaceae (*Citrus* spp.), Solanaceae (*Solanum* spp., probably *S. sisymbriifolium* because intense activity was observed on their flowers) and Verbenaceae (*Verbena* spp.). Throughout the three years of sampling, foraging was constant on *Solanum* spp., while *Styphnolobium japonicum* was intensively collected in the second year and *Eucalyptus* spp. in the third. The pollen from these taxa was found both in unifloral pollen loaves and as a major ingredient in multifloral pollen loaves (table 1).

We also observed that nectar was collected from *Hibiscus* spp. (Malvaceae) and *Ballota nigra* (Lamiaceae).

The comparison between the pollen choice by *A. mellifera* and *X. splendidula* shows that honey bees foraged for pollen on plants which are in dense populations, while carpenter bees obtained pollen from plants that are isolated or distributed in small populations (fig. 2).

DISCUSSION

Pollen collected by *Xylocopa splendidula*

This work shows that harvesting activity on *Solanum* spp. was constant throughout the year, while other pollen sources were added to enrich the harvesting range. Harvesting activity was focused on arboreal and shrub-like plants. A similar behaviour was observed in solitary bees from Costa Rica (Frankie *et al.*, 1983; Vinson *et al.*, 1997) and Sudán (Lobreau-Callen, 1987). *Solanum* was the most important pollen from herbaceous plants present in the diet of carpenter bees in this study (table 1).

Pollen and nectar yielding plants, which are scarcely represented, were probably visited just for their nectar. In this sense the dietary choice of carpenter bees is similar to that of bumble bees: both feed on pollen and nectar from different sources (Liu *et al.*, 1975; Buchmann, 1983; Gerling *et al.*, 1983; Tellería, 1998).

Abramovich & Girarde (1991) found that only *Eucalyptus* spp. was dominant in the harvesting range of *X. splendidula*, while other pollen types are present in less than 1%. Genise *et al.* (1990) noted that in woods in which *Prosopis* is dominant, only carob tree pollen was harvested.

Xylocopa splendidula vs. *Apis mellifera*

A comparative palynological analysis of resources of *A. mellifera* (Tellería, 1993) and *X. splendidula* in the pampas region, reveals that pollen from *Eucalyptus* is gathered by both types of bee (fig. 2). In spite of this overlap, considerable differences were found. Honey bees forage intensively on plants introduced into Argentina from Europe; pollen from native plants is collected at the end of the summer (February–March) when they are the primary pollen and nectar source (Tellería, 1993). Carpenter bees utilize a wider range of plants, though their native *Solanum* harvesting is remarkable. In India, Sihag (1993) noted a similar behaviour in *X. fenestrata*, which harvests *Solanum* pollen intensively, while *Apis florea* and *A. dorsata* visit other species. The interaction between flowers bearing poricidal anthers, like *Solanum*, and insects that collect pollen by buzz pollination might be the result of a coadaptation process (Buchmann, 1983). Honey bees can gather *Solanum* pollen only after it has been exposed by other insects (Lobreau-Callen, 1987; O'Toole, 1997; Gross & Mackay, 1998).

Other differences between the harvesting range of both types of bee are represented by use of *Medicago sativa*, *Sesbania punicea* and *Styphnolobium japonicum*. The explosive-aperture mechanism of *Medicago sativa* flowers hinders pollinators like *A. mellifera* from obtaining pollen from them, yet carpenter bees are able to collect pollen from these flowers (table 1). The possibility of introducing *X. splendidula* to alfalfa crops in Argentina in order to increase pollination should be

investigated. In this country, the low yield of alfalfa (*Medicago sativa*) seed is often attributed to the lack of efficient pollinators. There are records of successfully controlled *Xylocopa* nest establishment, which were later moved to Cucurbitaceae crops in India (Sihag, 1993a, 1993b, 1993c), and alfalfa in South Africa (Wathmough, 1987 cited in O'Toole, 1997).

Native *Sesbania punicea*, which is grown in the pampas area for ornamental purposes, was intensively visited by carpenter bees and bumble bees (personal observation), but is absent from the harvesting range of honey bees (Tellería, 1988, 1992, 1993).

Pollen from *Styphnolobium japonicum* is collected intensively by carpenter bees, while it is poorly represented in the pollen and nectar harvesting range of honey bees (Tellería, 1988, 1992, 1993).

In general, plants visited by carpenter bees are isolated or in small populations. In contrast, those visited by honey bees are in dense populations (Tellería, 1993). Habitat utilization by both social and solitary Apidae

might be a consequence of competition: *Apis*, with a smaller body size and a larger number of individuals, occupies the most productive environments, not utilizing native plants, while *Xylocopa* lives in less productive areas, which would be unable to support an *Apis* colony (Schaffer *et al.* 1979). In Australia this displacement was demonstrated by Gross & Mackay (1998), who found that honey bees have a negative impact on the fitness of native *Melastoma affine*, which is buzz pollinated, and on the native bee-plant relationships.

In the pampas region the differences observed in the pollen spectra from native *Xylocopa* and introduced *Apis* could be attributed to:

- Different 'abilities' to exploit the resources (*Apis* cannot get pollen from *Solanum* and it is inefficient when collecting from *Medicago sativa*).
- A possible displacement of native carpenter bees toward less productive environments, by introduced honey bees.

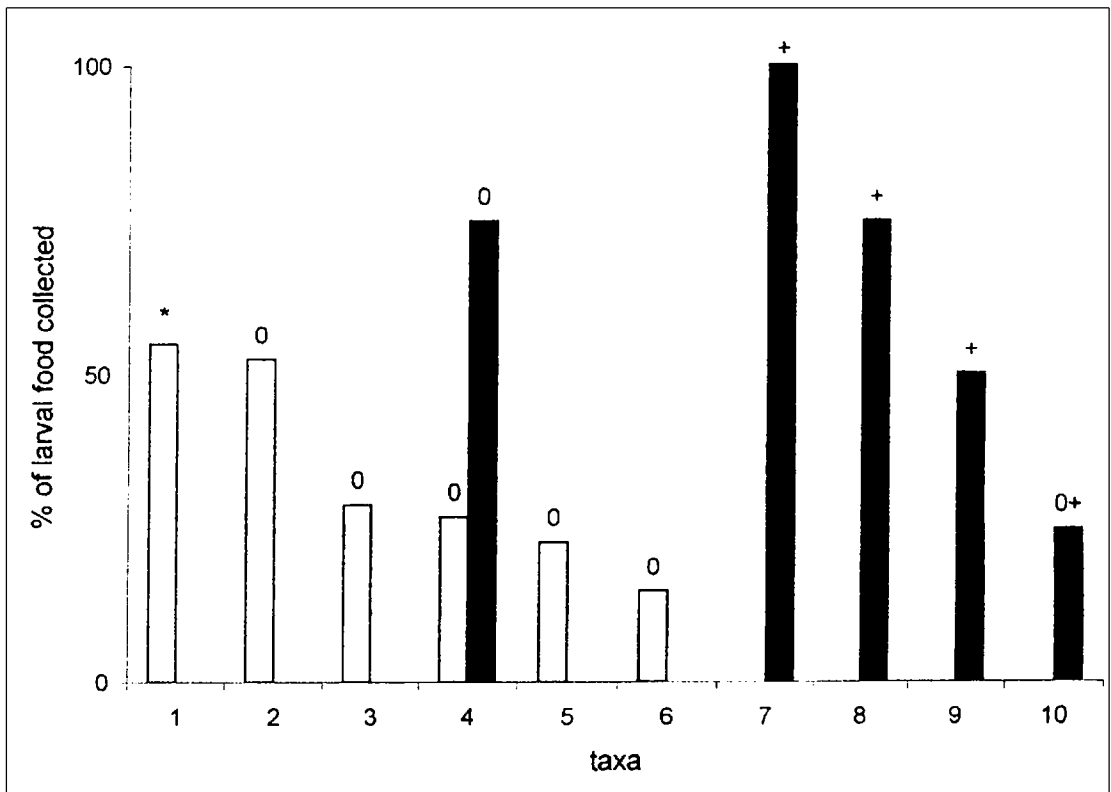


FIG.2. Main pollen types present in the larval food collected by *Xylocopa splendidula* □ and *Apis mellifera* ■ (from Tellería, 1993) during December 1998, and January 1996, in the pampas region. Distribution of plants visited: * small populations or isolated individuals; 0 cultivated (most isolated); + dense populations. (1) *Solanum* spp., (2) *Styphnolobium japonicum*, (3) *Ligustrum* spp., (4) *Eucalyptus* spp., (5) *Medicago sativa*, (6) *Lagerstroemia indica*, (7) *Hypochoeris radicata* and *Picris echioides*, (8) Brassicaceae and *Cichorium intybus*, (9) Apiaceae and *Echium plantagineum*, (10) *Trifolium pratense* and *T. repens*.

ACKNOWLEDGEMENTS

The author wishes to thank Lic. Alberto Abrahamovich for identifying the insects, Miguel Angel Tello for his assistance in procuring the carpenter bee nests and Drs K Hogendoorn and H Wells for critically reviewing the manuscript.

REFERENCES

- ABRAHAMOVICH, A; GIRARDE, S (1991) Selectividad polínica de dos especies de abejas solitarias del género *Xylocopa* en Argentina (Hymenoptera-Anthophoridae). *Turrialba* 41(3): 275–278.
- BUCHMANN, S L (1983) Buzz pollination in Angiosperms. In Jones, C E; Little, R J (eds) *Handbook of experimental pollination biology*. Van Nostrand & Reinhold; New York, USA; pp 73–113.
- CABRERA, A L (1963) *Flora de la Provincia de Buenos Aires, parte I. Colección Científica del INTA, Buenos Aires.*
- ERDTMAN, G (1960) The acetolysis methods — a revised description. *Svensk Botanisk Tidskrift* 54: 341–350.
- FRANKIE, G W; HABER, W A; OPLER, P A; BAWA, K S (1983) Characteristic and organization of the large bee pollination system in the Costa Rica dry forest. In Jones, C E; Little, R J (eds) *Handbook of experimental pollination biology*. Van Nostrand & Reinhold; New York, USA; pp 411–447.
- FREE, J B (1970) *Insect pollination of crops*. Academic Press; London, UK; 544 pp.
- GENISE, J; PALACIOS, R A; HOC, P S; CARRIZO, R; MOFFAT, L; MOM, M P; AGULLO, M A; PICCA, P; TORTOSA, S (1990) Observaciones sobre la biología floral de *Prosopis* (Leguminosae, Mimosoideae). II. Fases florales y visitantes en el Distrito Chaqueño Serrano. *Darwiniana* 30(1–4): 71–85.
- GERLING, D; HURD, P D; HEFETZ, A (1983) Comparative behavioral biology of two middle east species of carpenter bees (*Xylocopa* Latreille) (Hymenoptera: Apoidea). *Smithsonian Contributions to Zoology* 369: 1–33.
- GROSS, C L ; MACKAY, D (1998) Honeybees reduce fitness in the pioneer shrub *Melastoma affine* (Melastomataceae). *Biological Conservation* 86: 169–178.
- HURD, P D JR (1978) *An annotated catalog of the carpenter bees (Genus Xylocopa Latreille) of the Western hemisphere (Hymenoptera: Anthophoridae)*. Smithsonian Institute; Washington, DC, USA; 106 pp.
- LOBREAU-CALLEN, D (1987) Rapports plantes-insectes: analyse comparative de l'ethologie de quelques abeilles solitaires et sociales vis à vis de la végétation de climat soudanien. *Mémoires Travaux. EPHE, Institute Montpellier* 17: 41–49.
- LIU, H J; MACFARLANE, R P; PENGELLY (1975) Relationships between flowering plants and 4 species of *Bombus* (Hymenoptera: Apidae) in southern Ontario. *Canadian Entomology* 107: 577–588.
- MICHENER, C D (1990) Castes in xylocopine bees. In Engels, W (ed) *Social insects, an evolutionary approach to castes and reproduction*. Springer Verlag; Berlin, Germany; pp 123–146.
- NEFF, J L; SIMPSON, B B (1997) Bees pollination systems and plant diversity. In La Salle, J; Gauld, D (eds) *Hymenoptera and biodiversity*. CAB International; Wallingford, UK; pp 143–167.
- O'TOOLE, C (1997) Diversity of native bees and agroecosystems. In La Salle, J; Gauld, D (eds) *Hymenoptera biodiversity*. CAB International; Wallingford, UK; pp 169–215.
- ROUBIK, D W (1992) *Ecology and natural history of tropical bees*. Cambridge University Press; Cambridge, UK; 514 pp.
- SCHAFFER, W M; JENSEN, D B; HOBBS, E; GUREVITCH, J; TODD, J R; SCHAFFER, V (1979) Competition, foraging energetics, and the cost of sociality in three species of bees. *Ecology* 60(5): 976–987.
- SIHAG, R C (1993a) Behaviour and ecology of the subtropical carpenter bee, *Xylocopa fenestrata* F. 6. Foraging dynamics, crop host and pollination potential. *Journal of Apicultural Research* 33(2): 94–101.
- SIHAG, R C (1993b) Behaviour and ecology of the subtropical carpenter bee, *Xylocopa fenestrata* F. 7. Nest preferences and response to nest translocation. *Journal of Apicultural Research* 32(2): 102–108.
- SIHAG, R C (1993c) Behaviour and ecology of the subtropical carpenter bee, *Xylocopa fenestrata* F. 8. Life cycle mortality, parasites and sex ratio. *Journal of Apicultural Research* 32(2): 109–114.
- TELLERÍA, M C (1988) Analyse pollinique des miels du nord-ouest de la province de Buenos Aires (Argentine). *Apidologie* 19(3): 275–290.
- TELLERÍA, M C (1992) Caracterización botánica y geográfica de las mieles de la provincia fitogeográfica pampeana (República Argentina) I: Distrito Oriental. *Darwiniana* 31 (1–4): 345–350.
- TELLERÍA, M C (1993) Floraison et récolte du pollen dans la pampa argentine par les abeilles domestiques (*Apis mellifera* var. *ligustica*). *Apidologie* 24: 109–120.
- TELLERÍA, M C (1998) Palynological analysis of food reserves found in a nest of *Bombus atratus* (Hym. Apidae). *Grana* 37: 125–127.
- VINSON, S B; FRANKIE, G W; BARTELL, J (1997) Threats to the diversity of solitary bees in a neotropical dry forest in Central America. In La Salle, J; Gauld, D (eds) *Hymenoptera and biodiversity*. CAB International; Wallingford, UK; pp. 53–81.
- WATMOUGH, R H (1987) A leaf-cutter bee (Megachilidae) and a carpenter bee (Anthophoridae) as possible pollinators of lucerne (*Medicago sativa* L.) in the Oudtshoorn district. *South Africa Bee Journal* 59(5): 114.