Pollen preferences of *Hoplosmia bidentata* and *Lithurgus cornutus* (Hymenoptera: Megachilidae)

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In this study pollen from the scopae of two species of solitary bees was identified from five sites in Turkey in the vicinity of the Central Anatolian cities Ankara, Eskişehir and Çankırı. The samples of *Lithurgus cornutus* (Fabricius) and *Hoplosmia bidentata* (Morawitz) (Hymenoptera: Megachilidae) were collected between June and August. Most of the 162 specimens contained more than one type of pollen. *L. cornutus* (Fabricius) was provisioned with pollen from eight families, *H. bidentata* (Morawitz) from eleven families. New types of pollen for both species were also identified.

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1. Introduction

Pollen collected by adult female bees provides the major source of protein and other nutrients for their larvae. Types of pollen can be correlated with growth and survival of the larvae during development (Dobson & Peng 1997, Michener 2000, Jensen *et al.* 2003). The types of pollen collected also affect the efficiency of bees as pollinators of cross-pollinated plants, a subject of particular interest to those managing bees for fruit or seed production (Free 1993). Information regarding the pollen types collected cannot always be determined from flower visitation records alone, because bees may visit flowers solely to obtain nectar. Thus, in order to determine the pollen types collected by bees during actual pollen-collecting trips, it may be necessary to examine either the pollen present in nest provisions (Cripps & Rust 1989a) or that found on the foraging bees' scopae (Cripps & Rust 1989b).

Lithurgus cornutus (Fabricius) and *Hoplosmia bidentata* (Morawitz) (Hymenoptera: Megachilidae) are widely distributed and abundant in Central Anatolia, but virtually nothing is known about their pollination efficiency. Data collected on pollinators' diversity and abundance, preferred host plant records and nesting requirements would provide crucial information required to protect natural pollinators and to form new pollination management systems.

In this study, the plant species preferred by these two bee species were investigated by identifying pollen from the scopae of collected bees at five sites in Turkey in the vicinity of Ankara, Eskişehir and Çankırı, Central Anatolia. The results of this study will give important insights for the future pollination studies.

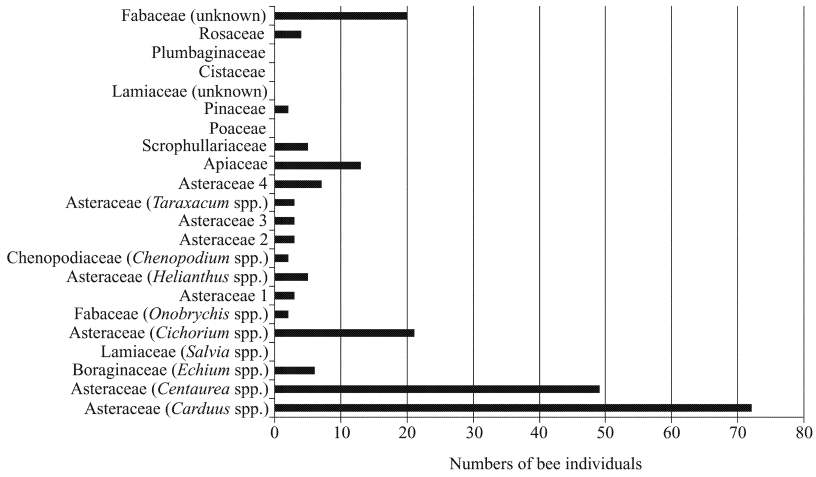

Fig. 1. Pollen records for *Lithurgus cornutus*.

2. Materials and methods

2.1. Field area

A total of 162 female specimens of *L. cornutus* (72) and *H. bidentata* (90) were collected during their main flight period, between June and August 2001, in the field study conducted in the Central Anatolia. The specimens were all caught on flowers from Ayaş (Yağmurdede), 58 km north-west of Ankara; Gölbaşı (Yağlıpınar), 30 km south of Ankara; Güdül (Sorgun), 98 km north-west of Ankara; Ilgaz, 53 km north of Çankırı and Mihalıççık (Yunusemre), 119 km east of Eskişehir while they were searching for nectar or pollen. The field studies were carried out throughout the day in the second and fourth week of each month.

2.2. Pollen analysis

Metasomae separated from the mesosomae via dissection were kept in eppendorf tubes at –70°C for pollen analysis. In order to separate pollen from the scopae, metasomae were placed inside 25 ml glass tubes. Five ml of 70% alcohol was added to the tubes and mixed by glass baget for 15 min. The contents were filtered into clean tubes using wire filter of 250 mm pore size. The sample tubes were centrifuged at 3,500 rpm for 30 min. The supernatant was decanted and 5 ml distilled water was added to each pollen pellet. The tubes were centrifuged at 3,500 rpm for 15 min. The supernatant was decanted and the tube caps were left open on the benchtop for 10 min for the pellet to dry.

Basic fucsin-glycerin-gelatine mixture taken with the edge of a sterile needle was added to each pollen pellet. The stained sample was transferred on a microscope slide and put on a hotplate set at 40°C. When the gelatine melted, 18×18 mm cover slips were placed on the samples. The analysis was carried out with a Nikon Eclipse E400 microscope. Diagnosis was made according to literature (Erdtman 1969, Markgraf & D'Antoni 1978, Nilsson *et al*. 1983, Faegri & Iversen 1989, Moore *et al*. 1991, D'Albore 1997). Reference slides prepared from previously identified plant species's pollen were used to confirm the diagnosis.

3. Results and discussion

Eight pollen types were found from scopae of *L. cornutus* (Fig.1), whereas 11 pollen types existed in scopae of *H. bidentata* (Fig. 2). They were all identified to be dicots. These pollen types were diagnosed to belong to *Carduus*, *Centaurea*, *Cichorium*, *Helianthus*, and *Taraxacum* (Asteraceae), *Onobrychis* (Fabaceae), *Chenopodium* (Chenopodiaceae), *Echium* (Boraginaceae), and *Salvia* (Lamiaceae). Some pollen diagnosed as Asteraceae but not completely identified were named Asteraceae 1, 2, 3 and 4. Pollen belonging

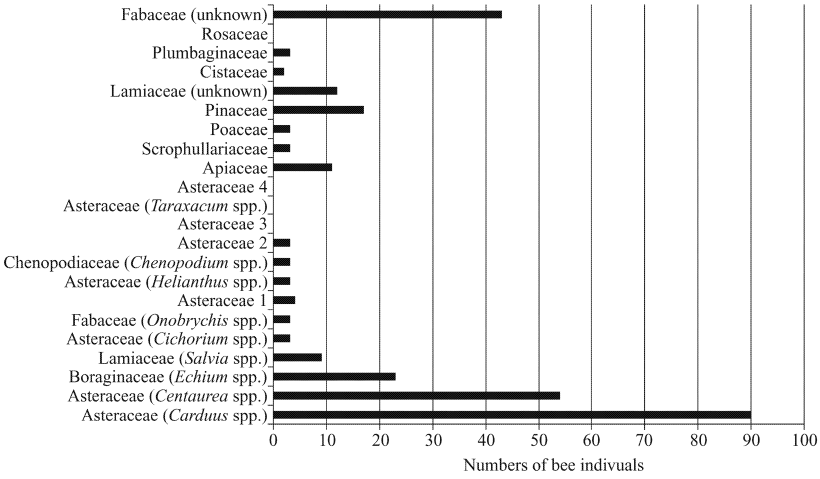

Fig. 2. Pollen records for *Hoplosmia bidentata*.

to Lamiaceae and Fabaceae that could not be diagnosed were all suggested to represent one genus. These samples were named as unknown. Apiaceae, Rosaceae, Scrophullariaceae, Pinaceae, Poaceae, Cistaceae and Plumbaginaceae could not be diagnosed at genus level. Furthermore, *Tilia* (Tiliaceae) and *Trifolium* (Fabaceae) found on *L. cornutus*, and *Bellis* (Asteraceae) and *Plantago* (Plantaginaceae) found on *H. bidentata* were not taken into account, because they were found on the scopae of only one individual, which may be accidental.

Echium, *Cichorium*, *Helianthus*, *Chenopodium* and *Taraxacum* were firstly recorded for *L. cornutus*. *Salvia, Cichorium, Onobrychis*, *Helianthus* and *Chenopodium* were also recorded from *H. bidentata* for the first time.

These findings indicate that both species preferred mostly *Carduus* and *Centaurea* species belonging to the Asteraceae (Table 1). *Carduus* was recorded from all 162 bee scopae. This result is shown in Table 1 with a percentage of 100. The analysis of the microscope slides showed that the pollen of the *Carduus* and *Centaurea* were recorded to be either very frequent (>45%) or frequent (16–45%). Müller (1996) suggested that if 95% of pollen on any scopa belong to a single family, subfamily or tribe, then the related bee category can be regarded as oligolectic. The *Carduus* and *Centaurea* are classified in the same tribe (Cardueae). The *Cirsium*, *Arctium* and *Onopordum*, which were recorded to be host plants of *L. cornutus* and *H. bidentata* in literature (Özbek 1979, Özbek & Zanden 1992, 1994) also belong to the tribe Cardueae. Thus, it is possible to state that these two species as oligolectic. Similarly, Banaszak and Romasenko (1998) and Amiet *et al*. (2004) argued that these two bee species are oligolectic and that they are specialists on the Asteraceae. However, Wcislo and Cane (1996) and Michener (2000) observed that *Lithurgus* species in Antillean and North America are oligolectic on the Cactaceae. Species belonging to the *Lithurgus* visit various host families within their distribution areas. This behavior can be also seen in the other bee groups and this phenomenon

Table 1. Percentage distribution of the most preferred pollen types of *Lithurgus cornutus* and *Hoplosmia bidentata*.

	Carduus	*Centaurea*	*Cichorium*	Fabaceae (unknown)	*Echium*	Apiaceae	Pinaceae
L. cornutus	100	68.1	29.2	27.8	8.3	18.1	2.8
H. bidentata	100	60	3.3	47.8	25.6	12.2	18.9

is called host change. It occurs under an evolutionary process due to reasons such as avoiding competition and occupying empty niches (Wcislo & Cane 1996).

D'Albore (1997) assigned a grading system between 1 (the minimum) and 4 (the maximum) to rate plant species according to pollen and nectar productivity for honeybees. In this system, species of *Carduus* scored 3 and 4 for pollen and nectar productivity, respectively, whereas the scores for *Centaurea* were 3 and 3, respectively. In other words, both genera are very rich in regard to pollen and nectar productivity. Furthermore, flowering period of many species of the *Carduus* and *Centaurea* are synchronized with the flight seasons of these two bee species. Asteraceae is the family with the highest species number in Turkey (Davis 1975, Güner *et al.* 2000). The forementioned results allow for the conclusion that these two bee species prefer the Asteraceae as a pollen source.

The unknown sample of Fabaceae was the third and fourth most abundantly collected pollen type from the scopae of *H. bidentata* and *L. cornutus*, respectively (Table 1). Baydar and Gürel (1998) reported that pollen from the Fabaceae are much richer in protein and mineral content compared to pollen from other families. Thus, it is plausible that the quality of pollen is important in bees' pollen preferences.

Because of their restricted distribution and lower biodiversity in Central Anatolia, other plant families were thought to be less preferred. This condition can be attributed to their early flowering. The presence of modified facial hairs specialized to remove pollen from nototribic flowers (i.e. these flowers are characterised by only two fertile stamens of which the connectives are modified to act as levers) of Lamiaceae and Scrophulariaceae (Thorp 2000), floral morphology (depth, width and height of corolla tube), petal color morphs (Inouye 1980, Conner *et al.* 1995, Wcislo & Cane 1996, Small *et al.* 1997), and differences in the scents of flowers and pollens (Dobson 1987) can affect the food preference of bees. These possibilities should be studied thoroughly.

According to the "optimal foraging theory" the consumer should (1) prefer the more profitable food items; (2) feed more selectively when profitable food items are abundant; (3) include less profitable items in the diet when the most profitable foods are relatively scarce; and (4) ignore unprofitable items, however common, when profitable prey are abundant (Smith 1990, Stiling 1992, Pianka 1994). Thus, the two bee species studied may prefer plants in which both pollen and nectar productivity is high and families with high species variety. In conclusion, we suggest that *H. bidentata* and *L. cornutus* make optimal decisions in their pollen preference.

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