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This paper has been contributed in honor of Azaria Alon on the occasion of his 90th birthday.

An evaluation of Israeli forestry trees and shrubs as potential forage plants for bees

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ABSTRACT

Loss and fragmentation of foraging habitats, and extreme seasonality in the flowering phenology of wild plants, limit honeybee populations in Israel. This problem can be alleviated by the planting of bee forage plants in forests, parks, and along roadsides. To provide recommendations for such planting, we combined a literature survey and qualitative evaluations of experts to compile a list of 266 local wild plant species that have high food potential for bees. We also quantitatively evaluated the food potential of 32 species of trees and shrubs planted by Keren Kayemeth LeIsrael—Jewish National Fund (KKL-JNF). We recorded the following parameters of each species: main flowering season; flower morphology; type of food reward; number of flowers per plant; nectar standing crop; hourly nectar production rate; type of insect visitors; and frequency of insect visits. We ranked the surveyed species according to their potential importance as food plants, assigning high ranks to species that (a) bloom between July and February (the period of dearth in flowering natural vegetation), (b) produce large amounts of nectar, and (c) are highly attractive to honeybees. Of the species surveyed, *Amygdalus communis*, *Eucalyptus camaldulensis*, *Ceratonia siliqua*, and *Ziziphus spina-christi* best combined these benefits. A regression model indicated that high nectar production rates increased insect visitation rates, while long flowers reduced them, in an inter-specific analysis. Our study highlights the importance of diversified forestry planting to address agricultural, conservation, and recreational needs.

Keywords: forestry, honeybee, nectariferous plant, nectar production

INTRODUCTION

Populations of honeybees and other pollinating insects have been decreasing worldwide in recent years, limiting the reproduction of food crops and wild plants (Allen-Wardell et al., 1998). A major reason for these population declines is loss and fragmentation of natural and agricultural foraging habitats for bees, along with their flora (Kremen et al., 2002; Goulson, 2003). Food limitation for honeybees may be particularly severe in Israel, because colonies are kept at high densities (95,000 colonies at 6,100 forage points on less than 7,000 km^2, Israel Honey Board, 2008).

The planting of forage plants for bees in non-agricultural and open areas can help sustain honeybee populations, and thus improve honey production and pollination services. Such planting is already in practice in field

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margins and small gardens in some countries (Dag et al., 1998; Comba et al., 1999; Carvell et al., 2006). Recent work has aimed at identifying the plant species that are most attractive to pollinators for such planting (Pontin et al., 2006). Designing forest areas for apiculture has been suggested in the US, especially for small privately owned plots (Hill and Webster, 1995).

Keren Kayemeth LeIsrael—Jewish National Fund (KKL-JNF) is in charge of public planting of trees and shrubs in forests, parks, and along roadsides in Israel. Planting is designed to answer a combination of needs, such as defense of extensive land tracts, soil conservation, improving environmental quality, providing outdoor leisure and recreation sites, supplying wood, and upgrading range lands (http://www.kkl.org.il/kkl/english/main_subject/forest_and_places/kkl%20afforestation%20work.htm). Enhancement of foraging areas for honeybees may also be achieved in planted forests, and requires the use of pollinator-friendly plant species. The present work aims to form recommendations for trees and shrub species that are suitable as food plants for bees, and that also meet additional forestry needs in Israel. This aim is compatible with current KKL-JNF policy to diversify the species used in forestry (Ginsberg, 2006).

Our immediate goal was to provide information about the foraging value of a number of specific trees and shrubs for honeybees. We addressed this goal both qualitatively and quantitatively. The qualitative approach consisted of compiling a list of local plant species that are attractive to insects, based on a literature survey, personal information, and consultations with experts. For the quantitative evaluation, we sampled 32 species, in use or under testing by KKL-JNF, for food value and insect visit rates. We selected only trees and bushes for the quantitative evaluation, while the qualitative list additionally covers herbaceous species. We considered both local and introduced species in the quantitative evaluation, while the qualitative list includes local species only.

More generally, we sought to identify which plant/flower traits most affect pollinator attraction in an interspecific comparison. These traits should be measured in the evaluation of further potential plant species. For this purpose we recorded several floral and plant parameters that were previously shown to influence pollinator attraction to plants within species: The number of flowers per plant (Brody and Mitchell, 1997; Goulson et al., 1998), nectar standing crops (Hodges, 1995; Pappers et al., 1999), nectar production rates (Delph and Lively, 1992; Mitchell, 1993), and parameters of floral morphology (Conner and Rush, 1996; Galen and Stanton, 1989). We tested the contribution of these parameters to the variability in visit rates among the plant species of our survey.

METHODS

Qualitative evaluation

A list of local bee forage plants was compiled based on data by Zohary (1947), Fahn (1948), Gindel (1951), Lupo and Eisikowitch (1987), Dag et al. (1993, 1998), and Reves (2004). It was updated based on consultations with researchers and apiarists (Appendix 1). The updating process allowed us to reduce an initial list of 562 potential honeybee forage plants to 266 species. Data on the plants' distribution and abundance in Israel and on their phenology were obtained from our ecological database of the Israeli flora (Shmida and Ritman, 1985).

Quantitative evaluation

Selection of plant species

The surveyed plant species are a subset of the assemblage of trees and shrubs that are grown in KKL-JNF's nurseries for wide-scale planting in forests, open areas, roadsides, and parks, or for experimental planting and evaluation. We surveyed species that were considered attractive for bees, based on qualitative preliminary observations by our team and by the staff of KKL-JNF, the Ministry of Agriculture extension service, and Department of Horticulture, Volcani Center, Agricultural Research Organization. We biased the survey toward plants that bloom in summer, autumn, and winter (July–February), since this is the period of dearth in floral food resources in Israel. The food potential of several *Eucalyptus* species for bees was assessed by a different research team (Eisikowitch and Dag, 2003). We therefore restricted our survey of *Eucalyptus* sp. to four common species that were sampled in autumn. On each day of the survey, 2–3 individuals of one species were observed. Most species were studied for two days (totaling 4–6 individuals), but some of the species were observed more intensively. Most observations were carried out in KKL-JNF nurseries, forests, and parks in Israel's coastal plain and Negev Desert. Repeated observations were conducted at different locations and flowering seasons to reduce local effects.

Plant and flower morphology

We counted the total number of flowers of surveyed individuals whenever possible, and estimated the number of flowers by counting a sector of the plant in individuals that were too large for complete counting. We recorded the following parameters of floral morphology in ten flowers from each of three individuals per species: total length of the flower (from the base of the tube to the tip of the corolla), length of the tube, and maximal diameter of the corolla.

Nectar measurements

When sampling three individuals of a species, we determined nectar standing crops for ten flowers per plant on each sampling day. When sampling two individuals, we measured nectar standing crops from 16 flowers per plant. Thus, nectar measurements are based on 30–32 flowers per sampling day. We used 1-μl or 5-μl micropipettes to measure nectar volumes, and Bellingham–Stanley hand-held refractometers to measure sugar (w/w %) concentrations. Sugar concentrations could be measured only for nectar standing crops that exceeded 1/3 μl. We bagged ten sampled, depleted flowers (3–5 per plant) with bridal-veil netting (Wyatt et al., 1992), and harvested them again after 24 h. The nectar that accumulated in the sampled flowers represents the plant's 24-h nectar production. We divided the produced nectar volume by the covering time to obtain hourly per-flower nectar production rates. We calculated mean per-plant nectar production rates for each species by multiplying the mean per-flower production rate by the mean number of flowers per plant. The logarithm of this rate was defined as the species' nectar score.

Insect visits

We observed each plant for insect visits for 10 minutes on each observation day. The observation unit was a patch of flowers on the plant that allowed convenient recording of visits. A visit was defined as a touch of the corolla, the stigma, or the stamen by an insect. We did not record numbers of arrivals to the patch, which generally correlate with the number of visits (Bar-Shai, 1995). Observations were conducted during peak pollinator activity (typically between 10 and 12 am). We classified the pollinators into the following functional groups: honeybees, large bees (larger than honeybees), small bees (smaller than honeybees), flies, butterflies, and beetles. We noted nectar-extraction behavior and loading of pollen sacs. Accordingly, we classified the visitors' food reward as pollen, nectar, or both. We recorded the number of flowers observed per individual (usually 100), and calculated the 60-minute visit rate per flower.

Insect visit rates may vary widely between dates and locations because of differences in weather conditions, proximity to honeybee colonies, or composition of the surrounding plant community. To partially correct for these confounds, we used *Rosmarinus officinalis* as a reference species. Immediately after recording insect visits to a survey species, we counted visits to nearby *R. officinalis* shrubs using the same protocol. *R. officinalis* was selected as a reference because it is abundant, has a long flowering season (August–April), and is frequently visited by honeybees. *R. officinalis* did not grow in all the survey sites, and some of the survey species were observed outside its flowering season. The reference observations could thus only be obtained for some of the survey plants.

Regression model

We tested which floral and plant parameters best predicted insect visitation rate on a between-species basis, and thus should be measured in future evaluations of additional plant species. We defined the mean per-species visit rates as the dependent variable in a regression model. We tested the following as predictive independent variable: (1) mean per-species nectar standing crops, (2) nectar production rates per flower, (3) number of flowers, (4) nectar score, (5) flower length, (6) tube length, and (7) corolla diameter.

RESULTS AND DISCUSSION

Qualitative survey

Table 1 of Appendix 2 lists 266 species from the native flora that were proposed as bee forage plants in the qualitative survey, out of an initial list of 562 potential plants. The table also reports these species' main food reward, and scores for their distribution and abundance in Israel. The seasonal distribution of blooming peaks of the potential forage species is shown in Fig. 1. The seasonal frequency of species at peak bloom is also plotted for all species of Israeli flora, for the sake of comparison. The plots show that the period between July and February is characterized by a low number of flowering local species in general, and bee forage plants in particular. This period comprises a dry season between July and November, and a rainy, cold one between December and February. These seasons of floral dearth are therefore difficult for honeybee survival, and forage plants that flower during the dearth period should be particularly useful. We therefore biased our quantitative survey towards the subset of forage plants in Table 1 that bloom outside spring. With this consideration in mind, we also included non-native species in the quantitative evaluation. We relied on the information of Table 1 to focus on species that are widespread in Israel, and attractive to insects. These considerations further aided in the selection of species for the quantitative survey.

Quantitative evaluation

The species that were included in the quantitative survey are listed in Table 2 of Appendix 2. Species that were studied during the period of floral dearth are shaded in the Table. Table 3 of Appendix 2 lists the plants' growth form, cultivation status, height (measured for

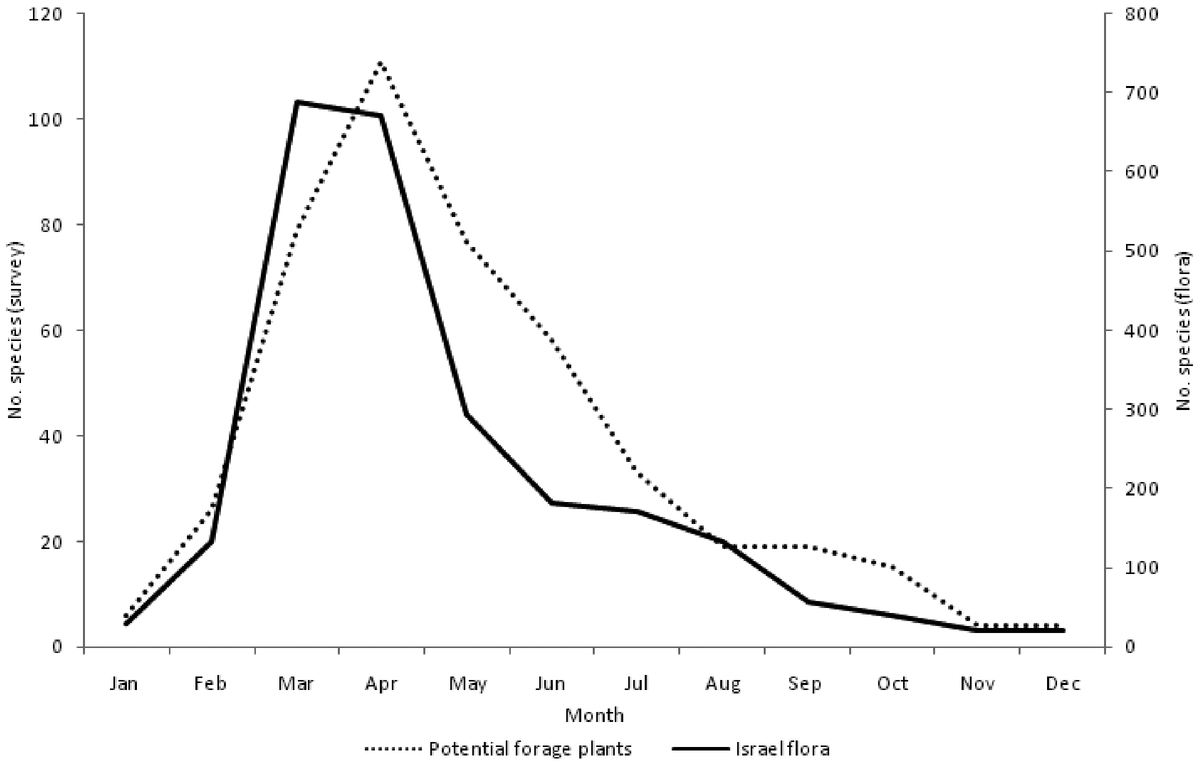

Fig. 1. The number of species at peak bloom throughout the year. Dashed: local potential bee forage plants listed in Table 1. Solid: all species of the Israeli flora.

only part of the species), number of flowers per plant, and the parameters of floral morphology. Column 2 of Table 4 in Appendix 2 provides a classification of the survey species according to their main food reward to pollinators (nectar (N), pollen (P), or both (N + P)). This classification is based on qualitative observations of pollinator behavior. Quantitative estimates of per-plant nectar production rates are provided in columns 6 and 7 of Table 4. Nectar scores for our survey species ranged between 1.5 and 4.5, i.e., across three orders of magnitude of per-plant nectar production rates. The species with the highest nectar scores (above 4.0) appear shaded in Table 4. These species have large numbers of flowers per plant, high nectar production rates per flower, or both. Table 5 of Appendix 2 lists the main pollinator groups for each of the studied species, mean visit rates, and, when available, insect visitation rates relative to visits to *R. officinalis*.

Mean per-flower nectar production rates significantly and positively affected the variation in insect visit rates among the survey species ($p = 0.001$). Total flower length negatively affected visitation rates ($p = 0.005$). The remaining parameters included in the regression model (nectar standing crop, number of flowers, nectar score, tube length, and corolla diameter) had no significant effects. The complete regression model was statistically significant ($R^2 = 0.76$, $p = 0.001$), and yielded the following regression equation: Visit rate = 0.258 × Nectar production rate – 0.762 × Flower length + 0.233.

Our qualitative and quantitative surveys focused mainly on several criteria for the selection of bee forage plants in forestry: blooming season, type of food reward, amount of food reward, and insect attraction. None of the 32 species that were studied quantitatively ranked highest according to all criteria (Tables 2, 4, 5 of Appendix 2). Nevertheless, the trees *Amygdalus communis*, *Ziziphus spina-christi*, and *Eucalyptus camaldulensis* shared the following desirable traits: blooming during the period of floral dearth, production of both nectar and pollen, high nectar scores, and high rates of visits by honeybees (compared with *R. officinalis*). These species therefore seem the most promising for pollinator-friendly forestry. *Ceratonia siliqua* should also be considered, due to its favorable flowering season, low water requirements, and large number of flowers. Plants that bloom in spring (e.g., *Styrax officinalis*, *Cercis siliquastrum*) should receive lower priority in planting as bee forage plants.

Two of the surveyed shrubs, *Myrtus communis* and *Leucophyllum frutescens*, produce pollen as their only (*M. communis*) or main (*L. frutescens*) food reward, and therefore received low nectar scores. We recommend their planting as pollen sources, in combination with other plants that can serve as sources for nectar. We further recommend the subshrub *Rosmarinus officinalis* var. Blue Lagoon, which is native to the western Mediterranean but is well adapted to the local ecosystem. This chamaephyte blooms during the summer, produces both nectar and pollen, and is frequently visited by honeybees.

Our regression analysis indicates that nectar production rates significantly explain differences among species in insect attraction. We therefore suggest that nectar production rates be determined for additional potential forage plant species in the future. Other plant traits account for the variability in pollinator attraction among individuals within a species. These include plant size (Robertson and McNair, 1995; Goulson et al., 1998), variability in nectar standing crops (Keasar et al., 2008), and flower size (Conner and Rush, 1996). However, these traits did not significantly contribute to the variability in insect visits among species in our study.

Our measurements include several confounding effects. The most important ones are climactic differences between seasons and sampling sites, which may have affected both the plants' nectar production patterns and the insects' foraging activity (Wyatt et al., 1992). In addition, the composition of the plant community surrounding the survey plants varied among sampling days, and likely affected the pollinators' attraction to the focal plants (e.g., Moeller, 2004). These confounds cannot be eliminated completely, but can be reduced by increasing sample sizes in future evaluations.

The Society for the Protection of Nature in Israel (SPNI), co-founded by Azaria Alon, has been involved in campaigns to increase the use of local tree species in public forestry. KKL-JNF's forestry policy has changed significantly in recent years, from focusing on planting of conifer stands to diversified forestry that emphasizes local tree species (Ginsberg, 2006). Diversification of forest composition in Israel promotes diversity of forest arthropods (Levanoni, 2005) and birds (Shochat and Tsurim, 2004). It is also likely to aid in conservation of the biodiversity of native bee species. Additional potential advantages of diversified planting may include reduced impacts of plant diseases and pests, and a wider range of possibilities for recreation. We conclude that multiple organisms in forest ecosystems, including bees, are likely to benefit from diversified planting of trees and shrubs.

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APPENDIX 1

Researchers and apiarists who contributed information for the qualitative survey of bee forage plants

Name of expert(s)	Organization/Locality
Arnon Dag, Haim Efrat, Sima Kagan, Yossi Slabezki	Agricultural Research Organization
Dan Eisikowitch	Tel Aviv University
Ofrit Shavit	University of Haifa
Tomer Erez	Klil
Shalom Israeli	Ayelet Hashachar
Yehuda Kendel	Kfar Pines
Pini Nahmani	Yokneam
Shmuel Nir	Eilon
Noga Reuven	Manot
Hagai Schitzer	Gamla
Ya'akov Stam	Kfar Kish
Uri Surkin	Ein Harod Meuchad
Dan Weil	Yad Mordechai Pollination Services
Eitan Zion	Yad Mordechai Apiary

APPENDIX 2

Table 1

A list of potential local bee forage plants, based on published literature and qualitative evaluations by experts. Pollination system: Z—zoophilous, W—wind; Attractivity score: + mildly attractive to bees, ++—moderately attractive, +++—highly attractive; Food reward: P—pollen, N—nectar, B—both pollen and nectar, NP—more nectar than pollen, PN—more pollen than nectar, L—very little nectar and pollen; Area score—estimated area occupied by the plants, scaled from 1 (least abundant) to 5 (most abundant); Peak blooming month—the main blooming period of the species; Total blooming months—range of blooming period throughout the plant's area of distribution; Climactic region: D—Desert (70–250 mm rain annually), H—Hermon subalpine, M—Mediterranean, O—orographic (montane) belt, on Mt. Hermon above 1300 m, T—transition between Mediterranean and desert, X—Extreme desert (1–70 mm rain annually); Cultivated / Feral (in addition to occurrence as a wild plant): C—cultivated, F—feral, O—left over after cultivation but not feral

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ Feral
Acacia gerrardii	Z	+	P	2	8–8	7890	DX	
Acacia raddiana	Z	+	P	4	10–11	123456789012	DX	
Acacia tortilis	Z	+	P	3	6–6	6789012	X	
Acer hermoneum	Z	+++	B	1	4–5	45	M	
Acer obtusifolium	Z	+++	B	3	4–4	345	M	C
Achillea falcata	Z	++	B	1	5–6	56	H	
Achillea fragrantissima	Z	++	B	4	5–6	3456789012	DX	
Achillea santolina	Z	++	B	2	3–3	34	D	
Ainsworthia trachycarpa	Z	+	P	4	4–4	3456	MT	
Alcea dissecta	Z	++	B	2	5–5	4567	M	
Alcea setosa	Z	++	B	3	5–5	456	MT	
Alkanna strigosa	Z	+++	N	3	3–3	2345	MT	
Alkanna tuberculata	Z	+	N	1	3–3	234	M	
Alyssum baumgartnerianum	Z	++	L	1	5–6	456	H	
Alyssum murale	Z	+	PN	2	5–5	4567	H	
Ammi majus	Z	+	P	2	5–6	5678	MT	
Ammi visnaga	Z	++	P	3	5–6	45678	M	
Amygdalus communis	Z	+++	B	3	2–2	123	MT	C, F
Amygdalus korschinskii	Z	+++	B	2	2–2	23	MT	
Anabasis articulata	W	+	P	4	10–11	012	DX	
Anagyris foetida	Z	++	P	1	1–3	1234 12	M	
Anemone coronaria	Z	++	P	4	2–3	123	MT	
Anthemis palaestina	Z	+	L	3	4–4	3456	MT	
Arbutus andrachne	Z	+++	N	3	4–4	45	M	
Artedia squamata	Z	+	P	1	4–4	345	MT	
Artemisia monosperma	W	++	P	4	9–10	901	MTDX	
Asphodeline lutea	Z	+++	B	1	3–4	2345	MT	
Asphodelus aestivus	Z	+++	B	4	2–3	1234 2	MTD	
Atractylis comosa	Z	+	NP	1	9–0	8901	M	
Ballota saxatilis	Z	+	N	2	5–6	4567	M	
Ballota undulata	Z	+++	N	3	5–5	1 45678 2	MTD	
Brassica nigra	Z	+	B	2	5–5	456	M	
Brassica tournefortii	Z	+	B	2	2–3	1234	MTDX	
Calamintha incana	Z	+	N	1	8–9	567890	MT	
Calendula arvensis	Z	+	B	2	2–4	12345 012	MTDX	
Calligonum comosum	Z	+++	NP	1	3–3	1234 12	DX	
Capparis aegyptiaca	Z	++	B	2	4–5	456789	DX	
Capparis sicula	Z	++	B	1	4–5	345678	MT	
Capparis sinaica	Z	++	B	0	3–5	2345678901	X	
Capparis spinosa	Z	++	B	3	5–6	345678	MTD	
Carthamus glaucus	Z	+++	NP	4	6–6	5678	MT	

Table 1 *continued*

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ feral
Carthamus nitidus	Z	++	NP	3	6–6	45678	TDX	
Carthamus tenuis	Z	+++	NP	5	6–7	5678	MT	
Centaurea aegyptiaca	Z	+	NP	2	4–4	45	DX	
Centaurea hyalolepis	Z	++	NP	3	4–5	3456	MTD	
Centaurea iberica	Z	+++	NP	4	5–5	456	MT	
Centaurea lanulata	Z	++	NP	2	3–3	12345	D	
Centaurea pallescens	Z	++	NP	4	4–4	345	DX	
Centaurea procurrens	Z	+++	NP	3	5–6	4567	MT	
Centaurea verutum	Z	++	NP	1	5–5	56	M	
Cephalaria joppensis	Z	+++	B	3	6–7	56789	M	
Cephalaria stellipilis	Z	++	B	1	6–7	5678	H	
Cephalaria syriaca	Z	+	B	1	4–4	345	MT	
Ceratonia siliqua	X	+++	B	4	9–10	89012	MT	C, O
Cercis siliquastrum	Z	+++	N	2	3–4	345	M	C, O
Chiliadenus iphionoides	Z	++	NP	3	9–10	89012	MTD	
Chiliadenus montanus	Z	++	NP	1	9–10	901	DX	
Chrozophora tinctoria	Z	+	L	3	7–8	2345678901	MTD	
Cichorium endivia	Z	+	P	3	4–5	456	MT	
Cirsium phyllocephalum	Z	+	NP	1	8–9	78901	M	
Cistus incanus	Z	+++	P	3	4–4	3456	M	
Cistus salviifolius	Z	++	P	4	4–4	3456	MDX	
Clematis cirrhosa	Z	++	B	2	12–1	1234 012	M	
Clematis flammula	Z	+	B	1	4–5	45	M	
Colutea cilicica	Z	++	B	2	5–5	4567	H	
Colutea istria	Z	++	B	2	3–4	34	D	
Convolvulus althaeoides	Z	++	N	2	4–4	3456	MTD	
Convolvulus dorycnium	Z	++	N	3	4–5	4567	MT	
Coridothymus capitatus	Z	+++	B	2	6–7	567890	M	
Crambe hispanica	Z	+	PN	1	3–3	34	MT	
Crambe orientalis	Z	+	PN	1	4–4	4	MT	
Crataegus aronia	Z	+	B	4	3–3	34	MDX	
Crepis aculeata	Z	+	PN	3	4–4	3456	MT	
Crepis aspera	Z	+	PN	4	4–4	345678	MT	
Crepis hierosolymitana	Z	+	PN	2	4–4	345	M	
Crepis palaestina	Z	+	PN	1	4–4	345	MT	
Crepis sancta	Z	+	PN	4	3–3	234	MT	
Crocus hyemalis	Z	+	P	3	12–1	12 12	M	
Crocus pallasii	Z	+	PN	2	11–12	012	M	
Crupina crupinastrum	Z	++	NP	1	4–4	345	MT	
Cynara syriaca	Z	++	NP	2	6–7	456789	M	
Cynoglossum creticum	Z	+	N	1	4–4	45	M	
Dalbergia sisso	Z	++	N	3	4–5	45	X	C, F
Daucus aureus	Z	+	L	2	5–5	4567	M	
Daucus broteri	Z	+	P	2	6–6	45678	M	
Daucus carota	Z	+	PN	3	5–6	45678	MT	
Daucus glaber	Z	+	P	2	3–3	34	M	
Diplotaxis erucoides	Z	+++	N	3	3–3	2345	MTDX	
Diplotaxis harra	Z	+	N	4	3–3	2345	DX	
Dittrichia graveolens	Z	++	PN	1	10–10	9012	M	
Dittrichia viscosa	Z	+++	B	4	9–10	89012	MT	
Ecballium elaterium	Z	++	NP	2	4–8	23456789012	MT	
Echinops adenocaulos	Z	+++	NP	3	6–6	67	MT	
Echinops gaillardotii	Z	+++	NP	3	6–6	67	M	

Table 1 *continued*

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ feral
Echinops philistaeus	Z	+++	NP	2	6–6	5678	MTD	
Echinops polyceras	Z	+	NP	4	6–6	67	DX	
Echiochilon fruticosum	Z	+++	N	3	4–4	3456	MTDX	
Echium angustifolium	Z	++	B	3	4–5	345678901	MT	
Echium glomeratum	Z	+++	B	2	5–5	4567	M	
Echium judaeum	Z	+++	B	3	3–4	34	MT	
Echium plantagineum	Z	+++	B	3	4–4	4	M	
Echium rauwolffii	Z	+++	B	2	3–3	34	DX	
Enarthrocarpus strangulatus	Z	+++	N	2	2–3	1234	DX	
Epilobium hirsutum	Z	+	B	2	7–9	56789012	M	
Eruca sativa	Z	+++	B	3	3–3	234	MT	
Erucaria hispanica	Z	+	NP	1	3–4	2345	M	
Erucaria microcarpa	Z	+	NP	4	3–3	234	DX	
Erucaria pinnata	Z	+	NP	2	3–4	234	DX	
Erucaria rostrata	Z	+	NP	4	3–3	234	TDX	
Eryngium billardieri	Z	++	B	1	6–7	56789	H	
Eryngium creticum	Z	++	B	2	5–6	45678	MT	
Eryngium glomeratum	Z	++	B	3	8–9	678901	MTD	
Eryngium maritimum	Z	++	B	1	6–6	45678	M	
Eupatorium cannabinum	Z	++	PN	1	7–8	6789012	M	
Faidherbia albida	Z	++	B	2	5–6	3456 89	MT	
Ferula communis	Z	+	B	3	4–4	345	MT	
Foeniculum vulgare	Z	+	P	4	7–9	5789012	MT	
Fumana thymifolia	Z	+	P	2	4–5	34567	MT	
Glaucium flavum	Z	++	P	0	6–7	45678	M	
Glaucium grandiflorum	Z	++	P	1	4–5	3456	MTDX	
Hedera helix	Z	++	B	1	10–10	012	M	C
Helianthemum sessiliflorum	Z	+	P	2	4–4	345	D	
Helianthemum stipulatum	Z	+	P	2	4–4	45678	M D	
Helianthemum vesicarium	Z	+++	B	2	3–4	12345	TD	
Heliotropium europaeum	Z	+	N	2	5–7	567890	MT	
Heliotropium rotundifolium	Z	+	N	2	5–7	456789	MTD	
Heterotheca subaxillaris	Z	+++	B	2	8–9	6789012	M	
Hirschfeldia incana	Z	+	PN	4	3–3	2345	MT	
Hypericum triquetrifolium	Z	++	P	3	7–7	56789	MT	
Knautia integrifolia	Z	+	B	1	4–4	45	MT	
Lamium moschatum	Z	+++	N	1	3–3	12345	M	
Lavandula dentata	Z	+++	N	2	3–4	3456	D	C
Lavandula stoechas	Z	+++	N	1	3–4	2345	M	
Leontice leontopetalum	Z	+	B	2	2–3	234	TD	
Lotus collinus	Z	++	B	2	4–4	345	M	
Lotus corniculatus	Z	++	B	2	6–6	4567	H	
Lotus creticus	Z	++	B	2	4–4	3456	M	
Lupinus palaestinus	Z	++	P	2	3–3	234	M	
Lupinus pilosus	Z	+++	P	1	3–3	234	M	
Lythrum salicaria	Z	++	N	1	7–9	678901	M	
Malcolmia crenulata	Z	+	N	1	2–2	1234	MT	
Malva sylvestris	Z	+	B	1	3–4	1234567	MTD	
Maresia pulchella	Z	+++	B	1	2–3	1234 2	M	
Medicago sativa	Z	++	B	3	4–5	4567	MT	C

Table 1 *continued*

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ feral
Medicago turbinata	Z	+	B	2	4–4	345	MT	
Melilotus albus	Z	++	L	1	7–8	4567890	M	
Mentha longifolia	Z	+	L	1	5–0	123456789012	MTDX	
Micromeria fruticosa	Z	++	B	2	9–10	8901	M	
Moltkiopsis ciliata	Z	++	N	3	4–4	345	MTDX	
Moluccella laevis	Z	++	N	3	4–5	45678	M	
Moricandia nitens	Z	++	NP	2	1–3	12345 12	DX	
Muscari commutatum	Z	+	N	1	1–2	123 012	MT	
Myrtus communis	Z	+++	P	1	5–5	5678	M	
Nasturtiopsis coronopifolia	Z	+	PN	3	3–3	1234	DX	
Nasturtium officinale	Z	+	L	2	5–6	12345678901	M	
Neotorularia torulosa	Z	+	L	3	3–3	1234	DX	
Nigella arvensis	Z	+	B	2	5–5	4567	MT	
Nitraria retusa	Z	++	B	2	3–4	1234567 12	DX	
Notobasis syriaca	Z	++	NP	3	4–4	345	MT	
Notoceras bicorne	Z	+	L	3	2–3	1234	DX	
Ochthodium aegyptiacum	Z	+	PN	2	3–3	234	M	
Ononis alopecuroides	Z	++	P	2	4–4	45	M	
Ononis hirta	Z	++	P	2	4–4	345	M	
Ononis natrix	Z	+++	P	4	4–5	3456789012	MTD	
Ononis pubescens	Z	++	P	2	4–4	3456	MT	
Ononis serrata	Z	+	P	3	3–3	34	MTDX	
Ononis spinosa	Z	+	P	2	6–7	4567890	MTDX	
Onopordum alexandrinum	Z	++	NP	2	4–4	345	TD	
Onopordum blancheanum	Z	++	B	2	5–5	456	M	
Onopordum carduiforme	Z	++	NP	1	5–5	34567	M	
Onopordum cynarocephalum	Z	++	NP	2	5–6	45678	M	
Onopordum jordanicolum	Z	+	NP	1	4–5	45	T	
Onopordum palaestinum	Z	++	NP	2	5–6	4567	T	
Opophytum forsskalii	Z	+	B	3	4–4	345	DX	
Origanum dayi	Z	++	NP	1	4–5	1 3456789012	D	
Origanum syriacum	Z	++	B	3	5–6	456789	MTD	
Ormenis mixta	Z	+	L	3	3–4	345	MT	
Papaver polytrichum	Z	+	P	2	4–4	23456	TDX	
Papaver umbonatum	Z	+	P	3	4–4	234567	MT	
Phyla nodiflora	Z	++	N	2	6–7	456789	MT	C
Picnomon acarna	Z	+	NP	3	8–8	7890	MT	
Plumbago europaea	Z	+	N	1	9–10	67890	M	
Prasium majus	Z	+++	N	2	2–4	1234567	M	
Prosopis farcta	Z	++	B	4	5–7	3456789012	MTDX	
Prunus ursina	Z	++	B	2	4–4	45	M	
Psoralea bituminosa	Z	+	N	3	4–5	34567890	MT	
Pterocephalus brevis	Z	+	B	2	4–4	3456	MT	
Ranunculus marginatus	Z	+	B	3	3–4	34567	M	
Ranunculus millefolius	Z	+	P	2	3–4	12345	MT	
Raphanus raphanistrum	Z	+++	N	2	3–3	12345	MTD	
Rapistrum rugosum	Z	+	B	1	3–3	2345	M	
Reaumuria hirtella	Z	+	L	3	4–5	3456789	DX	
Reseda alba	Z	+	PN	2	4–4	234567	MT	
Reseda arabica	Z	++	PN	1	3–3	34	DX	
Reseda boissieri	Z	++	PN	2	3–3	234	DX	
Reseda decursiva	Z	++	PN	1	3–4	345	DX	

Table 1 *continued*

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ feral
Reseda lutea	Z	++	PN	1	4–5	34567	MTDX	
Reseda muricata	Z	++	PN	2	3–4	23456789	DX	
Reseda orientalis	Z	++	PN	1	2–2	1234 2	MD	
Reseda stenostachya	Z	++	PN	1	2–3	123456789012	DX	
Retama raetam	Z	+++	NP	4	2–3	1234 2	MTDX	
Rhamnus alaternus	Z	++	B	2	4–4	234	M	F
Rhamnus lycioides	Z	++	B	4	3–4	34	MTD	
Ridolfia segetum	Z	+	P	4	5–5	456	MT	
Rosa canina	Z	++	P	2	4–5	5678	M	
Rubus sanctus	Z	++	PN	3	6–8	123456789012	MX	
Salix acmophylla	X	++	B	2	3–3	2345	MTD	
Salix alba	X	++	B	1	2–3	23	M	
Salvia aegyptiaca	Z	+	N	3	2–4	123456789012	DX	
Salvia dominica	Z	++	N	3	3–4	2345	MT	
Salvia fruticosa	Z	+++	N	4	4–4	345	M	
Salvia judaica	Z	++	B	2	4–5	456	M	
Salvia viridis	Z	++	N	2	3–3	2345	MT	
Satureja thymbra	Z	+++	N	3	4–4	345	M	
Scabiosa argentea	Z	++	B	1	7–7	4567890	M	
Scabiosa palaestina	Z	+	B	2	4–4	345	MT	
Scabiosa prolifera	Z	+++	B	3	4–4	345	M	
Scabiosa rhizantha	Z	++	B	2	4–4	45	MTD	
Scandix verna	Z	+	P	3	3–3	34	M	
Schimpera arabica	Z	+	PN	3	3–3	34	DX	
Scilla hyacinthoides	Z	++	B	1	3–3	234	M	C
Scolymus hispanicus	Z	+	P	2	6–6	45678	MT	
Scolymus maculatus	Z	+	P	3	5–5	45678	MT	
Scrophularia rubicaulis	Z	+	NP	1	3–3	234	M	
Scrophularia xanthoglossa	Z	+	NP	2	3–3	34	MTD	
Senecio glaucus	Z	++	L	3	2–3	1234 2	DX	
Senecio joppensis	Z	++	B	1	3–4	12345	M	
Senecio vernalis	Z	++	B	4	2–3	12345 12	MT	
Sideritis perfoliata	Z	++	N	0	6–7	67890	M	
Sideritis pullulans	Z	+++	N	2	7–7	567890	MT	
Silybum marianum	Z	++	NP	4	3–4	23456	MT	
Sinapis alba	Z	+++	PN	4	3–3	2345	MT	
Sinapis arvensis	Z	++	PN	4	3–3	2345	MT	
Stachys aegyptiaca	Z	+	N	1	3–5	123456 9012	DX	
Stachys distans	Z	++	N	3	5–5	56	M	
Styrax officinalis	Z	+++	NP	3	4–5	3456	M	
Tamarix aphylla	Z	+++	PN	3	9–9	890	X	C, O
Tamarix nilotica	Z	+	PN	5	4–5	3456789012	TDX	
Tamarix passerinoides	Z	+++	PN	1	2–4	1234	X	
Tamarix tetragyna	Z	+++	PN	2	2–4	234	MTDX	
Teucrium capitatum	Z	+	B	3	5–5	2345678	MTD	
Teucrium creticum	Z	+++	NP	3	5–6	45678	M	
Teucrium divaricatum	Z	+++	B	3	4–5	4567	M	
Teucrium orientale	Z	++	B	1	5–6	4567	H	
Teucrium scordium	Z	++	B	0	7–8	67890	M	
Tordylium aegyptiacum	Z	+	P	1	4–4	345	MT	
Trifolium argutum	Z	+	N	2	4- 4	12345	MT	
Trifolium fragiferum	Z	++	N	1	4–7	345678901	M	
Trifolium palaestinum	Z	++	B	2	4–4	345	M	

Table 1 *continued*

Species	Pollination system	Attractivity score	Food reward	Area score	Peak blooming months	Total blooming months	Climactic region	Cultivated/ feral
Trifolium purpureum	Z	+++	B	3	3–4	2345	MT	
Trifolium repens	Z	+++	N	2	5–7	34567890	M	C
Trifolium resupinatum	Z	++	N	3	4–4	345	MT	
Urginea maritima	Z	++	B	3	8–9	7890	MTDX	
Verbascum fruticulosum	Z	+	P	2	5–5	4567	TDX	
Verbascum gaillardotii	Z	++	P	1	6–6	56789	M	
Verbascum galilaeum	Z	++	P	0	5–5	4567	M	
Verbascum sinaiticum	Z	++	P	1	6–6	4567	TD	
Verbascum sinuatum	Z	++	P	3	6–7	456789	MT	
Viburnum tinus	Z	+	B	1	3–3	34	M	C
Vicia sativa	Z	+	N	2	3–4	2345	MT	
Vitex agnus-castus	Z	+++	B	2	6–7	5678901	MT	C
Zilla spinosa	Z	++	N	4	3–4	123456789012	X	
Ziziphora clinopodioides	Z	++	NP	2	6–7	5678	H	
Ziziphus lotus	Z	++	B	3	5–5	345	MT	
Ziziphus spina-christi	Z	+++	B	4	4–10	345678901	MTDX	
Zygophyllum dumosum	Z	++	B	4	2–3	12345 2	DX	

Table 2
List of surveyed species, and the months in which they were surveyed, during 2000–2002. Numbers denote survey days within a month. 2–3 individuals per species were studied on each day of the survey. Species surveyed between October and February, the period of floral dearth, are shaded

Species	Months surveyed												Peak blooming	Total blooming
	January	February	March	April	May	June	July	August	September	October	November	December	months	months
Acacia salicina									2				9–10	901
Amygdalus communis		1	1										1–2	123
Arbutus andrachne		1		1									3–4	34
Bauhinia variegate				2									5–6	4567
Callistemon phoenicus		2												
Cassia sturtii				1				1						
Ceratonia siliqua										2			10–11	012
Cercis siliquastrum			1	1									3–4	34
Delonix regia						1			1				5–8	567890
Eremophila maculata		1							1				6–9	45678910
Eucalyptus camaldulensis											2		5–6, 9–11	3456789012
Eucalyptus kruseana									2				11–4	1234 12
Eucalyptus leucoxylon var. *macrocarpa*									2	1			9–3	123 9012
Eucalyptus torwood										2	1	1	11–3	123 12
Jacaranda acutifolia					2								5–6	4567
Lantana camara		1			1								4–11	45678901
Lavandula dentata		2											4–5	45678
Leucophyllum frutescens var. heavenly cloud					1					1			6–9	4567890
Micromeria fruticosa								1	1				8–10	678901
Myrtus communis						2							5–6	56
Origanum syriacum						2							5–6	456
Parkinsonia aculeata										1	1		6–9	5678901
Retama raetam	2												2–3	234
Rosmarinus officinalis var. erect	1									1		1	6–12,1–3	123456789012
Rosmarinus officinalis var. spreading										1		1	4–12	456789012
Rosmarinus officinalis var. Blue Lagoon										9	3	2	4–12	456789012
Salvia canarensis						2							4–5	456
Styrax officinalis			1		1								4	4
Tamarix nilotica								1	1				4–8	3456789012
Tecoma allata						1					1		6–8	67890
Vitex agnus-castus						1		2					6	678
Ziziphus spina-christi								1			2		4–10	45678901

Table 3

Data on plant and flower morphology of the survey species. Growth form: C—chamaephyte (up to 0.5 m), S—shrub (0.5–2 m), T2—tree of 2–4 m height, T4—tree of 4–8 m height, T8—tree above 8 m, V—vine; Cultivated/Feral: C—cultivated, F—feral, O—left over after cultivation but not feral, W—wild; NR—flower length is not relevant when the flower tube is rather wide and does not restrict insect foraging

Species	Growth form	Cultivated/ Feral	Plant height (cm)	No. flowers/ plant	Flower length (cm)	Tube length (cm)	Corolla diameter (cm)
Acacia salicina	T4	C	636 ± 167	1067 ± 1328	0.6 ± 0.1	0.16 ± 0.06	0.25 ± 0.11
Amygdalus communis	T4	F	422 ± 131	6403 ± 5313	NR	0.44 + 0.76	3.79 ± 4.29
Arbutus andrachne	T4	W	416 ± 253	41888 ± 16794	0.71 + 0.01	0.67 + 0.01	0.63 ± 0.06
Bauhinia variegata	T8	O	723 ± 353	700 ± 369	NR	1.69 ± 1.31	8.50 ± 3.11
Callistemon phoenicus	T2	C		1774 ± 1834	2.36 ± 0.49	0.40 ± 0.06	0.85 ± 0.59
Cassia sturtii	S	C		213 ± 216	0.47 ± 0.01	0.00 ± 0.00	1.32 ± 0.12
Ceratonia siliqua	T8	W	692 ± 354	7200000 ± 4011068	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Cercis siliquastrum	T4	W	415 ± 171	205522 ± 196766	1.69 ± 0.17	0.56 ± 0.10	0.86 ± 0.31
Delonix regia	T8	O	850 ± 256	662 ± 601	NR	1.31 + 0.22	9.83 ± 1.86
Eremophila maculata	S	C		49 ± 36	3.19 ± 0.29	0.76 ± 0.18	0.90 ± 0.43
Eucalyptus camaldulensis	T8	O	1205 ± 428	277200	0.93 ± 0.13	0.03 ± 0.03	1.39 ± 1.19
Eucalyptus kruseana	T4	C		5391 ± 6206	1.30 ± 0.32	0.16 ± 0.06	1.28 ± 0.41
Eucalyptus leucoxylon	T8	C		1247 ± 1228	2.16 ± 0.30	0.60 ± 0.28	2.55 ± 0.58
Eucalyptus torwood	T4	C		337 ± 191	2.30 ± 0.35	0.71 ± 0.32	3.23 ± 0.72
Jacaranda acutifolia	T8	C	880 ± 438	10000 ± 2828	4.59±0.50	0.88 ± 0.30	2.15 ± 0.47
Lantana camara	S	F	160 ± 95	5517 ± 6104	1.33 ± 0.20	0.96 ± 0.12	0.78 ± 0.16
Lavandula dentata	C	W		450 ± 12	0.82 ± 0.90	0.57 ± 0.08	3.60 + 0.41
Leucophyllum frutescens	S	C		90 ± 42	2.21 ± 0.30	0.21 ± 0.06	2.21 ± 0.29
Micromeria fruticosa	C	W	66 ± 21	372 ± 334	0.76 ± 0.10	0.45 ± 0.08	0.47 ± 0.08
Myrtus communis	S	W	284 ± 160	4890 + 1680	NR	0.00 ± 0.00	1.52 ± 0.29
Origanum syriacum	C	W	38 ± 16	3875 ± 1548	0.47 ± 0.06	0.26 ± 0.43	0.26 ± 0.02
Parkinsonia aculeata	T4	F	475 ± 167	670 ± 755	NR	0.17 ± 0.13	2.24 ± 0.39
Retama raetam	S	W	197 ± 55	3499 ± 2226	1.27 ± 0.15	0.41 ± 0.03	0.63 + 0.23
Rosmarinus officinalis (erect)	C	C		144 ± 66	1.03 ± 0.18	0.21 ± 0.05	0.99 ± 0.22
Rosmarinus officinalis (spreading)	C	C		1400 ± 1400	1.02 ± 0.21	0.41 ± 0.06	1.31 ± 0.16
Rosmarinus officinalis (Blue Lagoon)	C	C		207 ± 90	1.40 ± 0.15	0.37 ± 0.07	1.58 ± 0.12
Salvia canarensis	C	C		430	2.48 ± 0.23	1.50 ± 0.69	0.34 ± 0.06
Styrax officinalis	T4	W	353 ± 65	463 ± 161	1.85 ± 0.06	0.46 + 0.44	1.91 + 0.74
Tamarix nilotica	T4	W	390 ± 258	180858 ± 142504	0.30 ± 0.04	0.00 ± 0.00	0.17 ± 0.05
Tecoma allata	T4	C		522 ± 560	4.94 ± 0.42	1.95 ± 1.96	2.73 ± 0.45
Vitex agnus-castus	V-S	F	275 ± 73	10,210 ± 13,839	0.98 + 0.11	0.67 + 0.05	0.78 ± 0.01
Ziziphus spina-christi	T4	W	570 ± 275	434143 ± 1065994	0.51 ± 0.07	0.00 ± 0.00	0.51 ± 0.07

Table 4
Reward parameters of survey species. Main food reward collected by visitors: N—nectar, P—pollen, N + P—nectar and pollen; NSC—nectar standing crop; NP—nectar production; NP/plant—mean NP per flower × mean number of flowers; Nectar score—log (NP / plant)

Species	Main food reward	NSC	NP/flower	Nectar concentration	NP/ plant	Nectar score	Comments
Acacia salicina	P	0 ± 0	0.0 ± 0.0		0		
Amygdalus communis	N + P	3.09 ± 7.92	1.7 ± 2.9	61.2 ± 18.7	4355.4	3.6	
Arbutus andrachne	N	0.1 ± 0.4	0.8 ± 0.7				
Bauhinia variegata	N	0.5 ± 0.7	2.5 ± 4.7	13.4 ± 13.7	1750	3.2	
Callistemon phoenicus	N	1.8 ± 3.5	4.7 ± 6.9	6.4 ± 4.9	8337.8	3.9	
Cassia sturtii	P	0.0 ± 0.0	0.0 ± 0.0		0		
Ceratonia siliqua	N + P	0.0 ± 0.0	0.04 ± 0.0		1800	3.3	(1)
Cercis siliquastrum	N	5.2 ± 17.6	1.0 ± 0.49	28.3 ± 24.3	817	2.9	
Delonix regia	N + P	0.05 ± 0.16	8.46 ± 23.5	34.0 ± 1.7	5600.5	3.7	
Eremophila maculata	N	0.39 ± 0.64	6.99 ± 7.80	10.5 ± 13.6	342.5	2.5	
Eucalyptus camaldulensis	N + P	0.23 ± 0.82	1.61 ± 1.63	27.3 ± 36.9	5654.3	3.8	
Eucalyptus kruseana	N + P	0.98 ± 3.1	3.13 ± 3.86	32.0 ± 0.05	16873.8	4.2	
Eucalyptus leucoxylon	N + P	1.23 ± 3.07	4.51 ± 3.72	33.8 ± 34.6	5624	3.8	
Eucalyptus torwood	N + P	1.79 ± 5.27	5.39 ± 8.69	60.1 ± 25.9	1816.4	3.3	
Jacaranda acutifolia	N	0.70 ± 0.98	3.40 ± 3.24	13.2 ± 14.5	34000	4.5	
Lantana camara	N	0.18 ± 0.26	0.37 ± 0.28	17.5 ± 13.1	2041.3	3.3	
Lavandula dentata	N	0.03 ± 0.05	0.12 ± 0.13		54	1.7	
Leucophyllum frutescens	N + P	0.01 ± 0.03	0.38 ± 0.54		34.2	1.5	
Micromeria fruticosa	N + P	0.02 ± 0.06	10.88 ± 5.54		21216	4.3	(2)
Myrtus communis	P	0.00 ± 0.00	0.00 ± 0.00		0		
Origanum syriacum	N + P	0.06 ± 0.18	0.01 ± 0.01		38.8	1.6	
Parkinsonia aculeata	N + P	0.01 ± 0.06	0.45 ± 1.73	18.3 ± 19.5	301.5	2.5	
Retama raetam	N	0.01 ± 0.02	0.16 ± 0.2		53.4	1.7	
Rosmarinus officinalis (erect)	N	0.20 ± 0.32	0.50 ± 0.46		72	1.9	
Rosmarinus officinalis (spreading)	N	0.00 ± 0.00	0.07 ± 0.10	3.3 ± 6.4	98	2	
Rosmarinus officinalis (Blue Lagoon)	N	1.44 ± 0.96	1.10 ± 1.31		227.7	2.4	
Salvia canarensis	N	1.33 ± 1.03	2.52 ± 1.14	18.9 ± 8.5	11760.8	4.1	
Styrax officinalis	N	0.01 ± 0.04	1.87 ± 1.18		486.2	2.7	
Tamarix nilotica	N + P	0.00 ± 0.01	0.00 ± 0.00		0		
Tecoma allata	N	0.00 ± 0.00	1.96 ± 2.09	25.0 ± 1.01	1023.1	3	
Vitex agnus-castus	N + P	0.04 ± 0.11	0.37 ± 0.35	20.0 ± 27.4	3777.7	3.6	
Ziziphus spina-christi	N + P	0.00 ± 0.01	0.03 ± 0.04		13024.3	4.1	

(1) Nectar and pollen in male trees, nectar only in female trees.
(2) Honeybees collect mostly nectar, small bees collect mostly pollen.

Table 5

Insect visits to survey species. Main visitors: HB—honeybees, LB—large bees, SB—small bees, F—flies. Visit rate: number of visits per flower per hour. Visit rate compared to *R. officinalis*: The ratio of visits observed on the surveyed species and on nearby flowering *R. officinalis* shrubs

Species	Main visitors	Visit rate	Visit rate compared to *R. officinalis*	Non-*Apis* bee taxa
Acacia salicina	SB	0.84 ± 0.96	2.02	
Amygdalus communis	HB, LB,SB	1.14 ± 6.78	0.89	*Anthophora pubescens, Anthophora* spp., *Andrena* spp., *Xylocopa violacea*
Arbutus andrachne	LB,HB	1.08 ± 0.96		*Meletoides meletoides, Bombus terrestris*
Bauhinia variegata	HB	0.78 ± 0.54	0.3	
Callistemon phoenicus	HB	1.62 ± 2.70	3.46	
Cassia sturtii	HB	0.42 ± 0.96		
Ceratonia siliqua	HB	8.94 ± 9.84	1.84	
Cercis siliquastrum	HB,LB	0.96 ± 0.96	1.59	*Anthophora* spp., *Bombus terrestris, Calicodoma mont., Synhalonia* sp.
Delonix regia	HB,LB	3.66 ± 2.64	1.89	*Xylocopa* spp.
Eremophila maculata	HB	0.78 ± 1.26	0.19	
Eucalyptus camaldulensis	HB	4.50 ± 4.14	0.48	
Eucalyptus kruseana	HB	0.96 ± 1.26	5.35	
Eucalyptus leucoxylon	HB	9.00 ± 4.50	1.44	
Eucalyptus torwood	HB	7.14 ± 5.16	2.45	
Jacaranda acutifolia	HB	0.18 ± 0.24		
Lantana camara	HB	0.18 ± 0.18	20.74	
Lavandula dentata	HB	0.60 ± 0.84	15.5	
Leucophyllum frutescens	HB	0.12 ± 0.06		
Micromeria fruticosa	HB, SB	28.08 ± 1.08	0.66	
Myrtus communis	HB, SB	7.80 ± 5.94		*Lassioglosum* spp., *Hylaeus* sp., *Proxylocopa olivieri*
Parkinsonia aculeata	LB,SB	0.72 ± 0.78		*Xylocopa pubescense, Hoplites* sp., *Lassioglosum* spp.
Retama raetam	HB,LB	0.30 ± 0.24		*Anthophora* spp., *Colletes* sp., *Calicodoma* sp., *Osmia* sp.
Rosmarinus officinalis (Blue Lagoon)	HB, LB,SB	6.90 ± 3.18		
Rosmarinus officinalis (Erect)	HB	1.80 ± 0.00		
Rosmarinus officinalis (Spreading)	HB	1.56 ± 1.68		
Salvia canarensis	LB, SB	0.90 ± 0.48		
Styrax officinalis	HB, LB	0.24 ± 0.18		
Tamarix nilotica	SB	2.40 ± 2.46	6.71	
Tecoma allata	HB, LB	0.24 ± 0.30	2.19	*Xylocopa pubescens*
Tipuana tipu	HB	0.84 ± 0.24		
Vitex agnus-castus	HB, LB, SB	1.08 ± 1.02	1.3	*Xylocopa violacea & pubescens, Bombus terrestris, Amegilla* spp., *Hylaeus* sp., *Proxylocopa olivieri*
Ziziphus spina-christi	HB, SB, F	7.74 ± 7.20	0.31	