POLLEN PREFERENCES OF HONEYBEE COLONIES (*Apis mellifera* L. *anatoliaca*) IN THE BLOOMING PERIOD OF GORUKLE–BURSA, TURKEY

Görükle-Bursa'da Yoğun Çiçeklenme Döneminde Bal Arılarının (*Apis mellifera* L. *anatoliaca*) Polen Tercihleri

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Abstract: Pollen preferences of honeybees was analyzed in the blooming period of Görükle-Bursa, Turkey. Pollen loads were collected from the hives that belong to *Apis mellifera anatoliaca,* local honeybee subspecies in the region. Pollen grains of 47 taxa were identified (including unidentified), of which 11 of them reached the percentages higher than 1 % and 0,18 % of the total could not have been identified. Dominant taxa are; *Helianthus annuus* L. (34.84 %), *Trifolium pratense* L. (15.96 %), Cruciferae (15.34 %), *Paliurus spina-christi* Mill. (6.79 %), Rosaceae (6.44 %), *Papaver* spp. (6.12 %), Compositae (3.12 %), *Punica granatum* L. (1.59 %), *Melilotus* spp. (1.28 %), *Trifolium repens* L. (1.06 %), *Zea mays* L. (1.02 %) and these are representing 93.56 % of the total.

Keywords: Pollen, *Apis mellifera,* honeybee, Görükle, Bursa, Turkey.

INTRODUCTION

There are a number of studies on botanical origin of honey but there are a few studies on plant origin of pollen loads and pollen preferences of honeybees in the world (Andrada & Tellería 2005, García-García *et al.* 2001, Webby 2004). In the same way, there are a few studies about analysis of bee pollen loads in Turkey (Baydar & Gürel 1998, Sabuncu *et al.* 2003, Sorkun *et al* 2003, Süer & Sorkun 2003).

Since honeybees get the protein needed from flowers of different plants, foragers collect pollen intensively in the blooming period of flowers. Honeybee foragers collect the pollen available in their environment and bees also have some preferences of flowers. Plants may vary in the structure, color, odor of flowers and taste of their pollen that may influence bees' preferences. Therefore, honeybee foragers may prefer some plants over the others. Honeybee foraging preferences might be better understood when attractive plants bloom at the same time. Artificial flower experiments suggest that honeybee foragers in general exhibit different foraging behaviors when they were collecting nectar (Free 1993, Wells *et al.* 2000, Çakmak & Wells 2001).

The pollen is collected by the foraging bee directly from the stamens, moistened with nectar, saliva, or honey, and agglutinated on the hind legs, forming the so-called "pollen loads, ball" (García-García *et al,* 2004). Pollen grains are the most important source of proteins for bee survival. During collecting trips they pack pollen grains from the flowers into pollen pellets on their hind legs with the hairs. (Almeida-Muradian *et al.* 2005). The decision to collect pollen by honeybee foragers depends on the number of larvae (brood), amount of stored pollen in the colony, as well as forager genotype and available resources in the environment (Pankiw *et al.* 1998). Besides pollen grains, the pollen pellets contain lipidic dyes from flower anthers. Several colors of pollen pellets, changing from white and cream to dark brown, presenting yellow, orange, red, greenish and gray degrees, occur depending on the botanical taxa and the chemical composition of these substances (Stanley and Linskens 1974, Almeida-Muradian *et al.* 2005).

The present study was undertaken to determine honeybee forager preferences of plant origin in the bloom period of Görükle-Bursa.

MATERIAL AND METHODS

Sampling was performed in Uludag University Campus area Görükle-Bursa, the northwest part of Turkey, situated at 40° 13.8' N, 28° 49.8' E and at an altitude of 155 m above sea level. Campus area which has a Mediterranean vegetation and climate in general covers 16000 acres. The study area has wide range of different plants natural and planted. The floristic study in the research area that realized by Tarımcılar & Kaynak (1995); 217 genus, 252 species, 71 subspecies and 33 varieties to be found belonged to 56 families. The plant families in the study area with the higher number of species are Asteraceae, Fabaceae, Lamiaceae, Liliaceae, some large genera are *Trifolium, Vicia, Euphorbia* and *Ornithogalum* (Tarımcılar & Kaynak 1995).

To obtain pollen loads, we used twenty three colonies of *Apis mellifera anatoliaca* placed in Langstroth-type hives. We removed the accumulated pollen from the bottom pollen drawers during the days of 1 June and 1 July 2004, for every three days and took the samples into the glass bottles. In this way we collected 230 samples which kept in refrigerator at +4°C until the analyses. To identify the botanical sources that preferred by honeybees in the sampling area, 500 pollen loads separated randomly and they were classified according to their colors (Kirk 1994). Pollen loads from each color were prepared according to Wodehouse (1935) method. Identifications were made by light microscopy and percentages of the each taxon of pollen grains were calculated.

RESULTS

Pollen composition of the samples demonstrated very big variation of taxa. Total number of 47 taxa were identified (including unidentified), of which 11 of them reach the percentages higher than 1 % and 0.18 % of the total were unidentified. 14 types could be identified at family level, 14 at genus level and 18 at species level. Table 1 shows the three day alteration in diversity of pollen in which the complete list of all the taxa were identified and their average values of the total were calculated.

Dominant taxa are; *Helianthus annuus* (34.84 %), *Trifolium pratense* (15.96 %), Cruciferae (15.34 %), *Paliurus spina-christi* (6.79 %), Rosaceae (6.44 %), *Papaver* spp. (6.12 %), Compositae (3.12 %), *Punica granatum* (1.59 %), *Melilotus* spp. (1.28 %), *Trifolium repens* (1.06 %), *Zea mays* (1.02 %) and these are representing 93.56 % of the total (Tab. 1, Fig. 1). The taxa; *Cistus creticus*, *Cruciferae, Echium italicum, Papaver* spp., Rosaceae, *Sambucus nigra* and *Trifolium pratense* were collected by honeybees and the complete sampling period could be seen in Table 1.

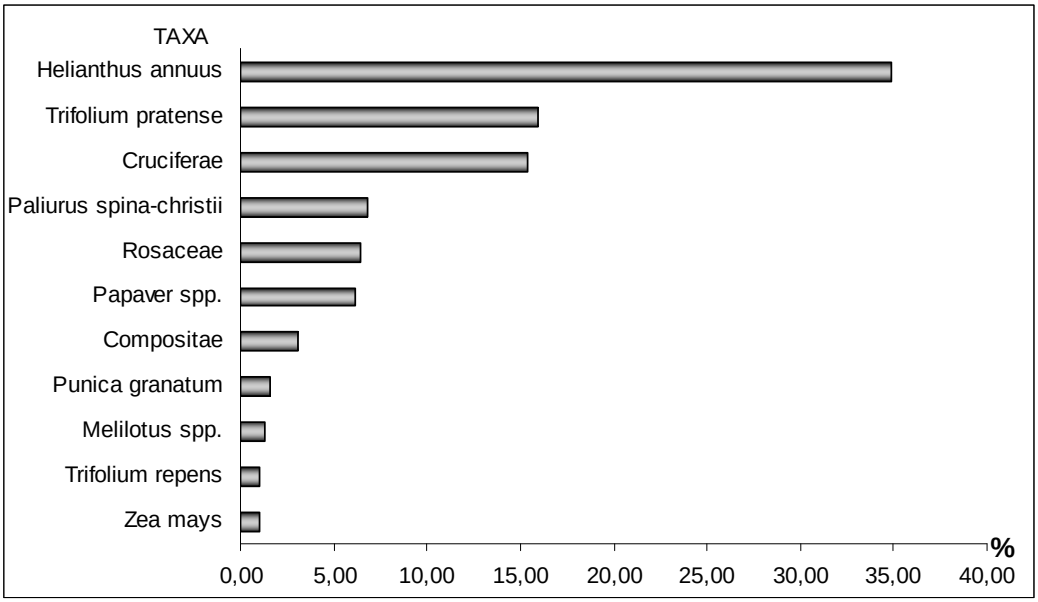

Figure 1: Total percentages of main pollen types collected by honey bees in the bloom period of Gorukle-Bursa.

Table 1: Variation and percentages of bee pollen loads collected from hives in Gorukle-Bursa.

TAXA	SAMPLING										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
Amarant./Chenopod.	-	-	-	-	-	-	-	-	0,03	-	0,003
Anchusa azurea	0,08	0,01	-	0,03	-	-	-	-	-	-	0,012
Calystegia silvatica	-	-	-	-	-	0,01	0,09	0,15	0,08	0,02	0,034
Campanulaceae	-	-	-	-	-	0,38	-	-	0,02	0,02	0,041
Carduus nutans	2,29	0,12	0,16	0,15	-	-	0,13	0,35	0,66	0,47	0,433
Chrozophora tinctoria	-	-	-	-	-	-	-	0,03	-	0,99	0,103
Cichorioideae	0,01	0,1	0,15	-	-	-	-	0,05	0,02	0,02	0,035
Cistus creticus	0,49	1,84	2,47	1,7	1,38	1,12	0,35	0,23	0,11	0,01	0,969
Compositae	8,3	7,62	3,62	2,82	3,57	1,36	0,09		0,48	3,31	3,117
***Convolvulus* spp.**	-	-	-	-	0,01	0,01	0,03	0,16	0,01	0,03	0,024
Cruciferae	28,48	41,35	30,5	31,55	9,33	2,97	3,42	3,59	0,83	1,41	15,342
Cucurbitaceae	-	-	-	-	-	-	-	-	-	0,23	0,023
Cyperaceae	-	0,1	-	0,03	-	-	-	0,13	0,05	0,08	0,039
Echium italicum	1,21	1,07	0,46	0,94	0,85	0,5	0,05	0,1	0,01	0,25	0,543
Epilobium angustifolium	-	-	-	-	-	-	-	-	0,09	-	0,009
Gramineae	0,34	0,76	2,4	0,72	0,91	0,39	0,05	0,03	0,08	-	0,569
***Helianthemum* spp.**	-	-	-	-	-	-	2,18	1,08	0,28	0,08	0,363
Helianthus annuus	-	0,01	0,47	7,18	23,89	49,03	64,62	67,01	77,76	58,46	34,842
Jasminum fruticans	-	-	-	-	-	0,14	-	-	0,04	0,9	0,109
Labiatae	-	-	0,15	-	-	-	-	-	-	-	0,015
***Ligustrum* spp.**	-	-	-	-	-	0,1	-	-	-	-	0,010
Liliaceae	-	-	0,11	-	-	-	-	0,02	-	-	0,013
***Lonicera* spp.**	0,21	-	-	-	0,08	-	-	-	-	0,17	0,046
Lotus corniculatus	0,04	-	0,15	0,23	0,12	0,02	0,03	0,1	0,26	-	0,094
Malvaceae	-	-	-	-	-	-	0,01	0,06	-	0,05	0,012
***Melilotus* spp.**	10,25	1,89	0,09	0,27	-	0,14	0,14	-	-	0,01	1,278
Olea europea	6,29	0,24	0,14	0,01	-	-	-	-	-	-	0,667
***Onobrychis* spp.**	0,15	-	-	-	-	-	-	-	-	-	0,015
Paliurus spina-christii	7,41	8,94	20	9,75	13,84	6,76	0,88	0,28	-	-	6,786
***Papaver* spp.**	22,66	12,31	10,31	9,39	3,15	1,03	0,64	0,89	0,25	0,59	6,122
***Plantago* spp.**	0,01	-	-	0,03	0,1	0,14	0,03	0,1	1,04	1,49	0,294
***Pistacia* spp.**	0,55	0,02	-	-	-	-	-	-	-	-	0,057
Punica granatum	-	0,77	1,52	3,17	0,71	3,5	3,2	1,47	1,24	0,3	1,589
Rosaceae	1,16	0,76	0,97	1,51	3,41	6,06	8,72	11,96	11,33	18,51	6,440
Sambucus nigra	0,08	0,14	0,17	0,05	0,4	0,17	0,1	0,02	0,09	0,31	0,153
***Sanguisorba* spp.**	-	0,09	0,02	0,65	0,23	0,38	1,79	1,1	0,77	0,22	0,524
***Scabiosa* spp.**	-	-	-	0,02	0,17	0,19	0,56	0,88	0,26	1,12	0,319
Scrophulariaceae	-	0,12	0,02	0,08	0,2	0,02	0,01	0,22	0,06	-	0,073
Thalictrum lucidum	-	-	-	0,88	0,01	0,36	0,47	0,57	0,59	0,6	0,348
***Tilia* spp.**	-	-	0,01	-	-	-	-	-	-	-	0,001
Trifolium pratense	6,04	17,24	24,71	27,89	34,95	24,6	12,21	8,87	2,3	0,84	15,964
Trifolium repens	2,63	3,65	0,65	0,3	2,36	0,6	0,02	0,33	-	0,09	1,064
***Tyrimnus* spp.**	-	0,72	0,61	0,23	0,02	0,02	-	0,03	-	-	0,163
Umbelliferae	0,35	0,04	0,08	0,02	0,05	-	-	0,19	0,06	0,41	0,121
***Vicia* spp.**	0,2	0,01	-	-	-	-	-	-	-	-	0,021
Zea mays	-	-	-	-	-	-	-	-	1,18	9,02	1,020
Unidentified	0,79	0,09	0,05	0,4	0,27	0,03	0,19	0,01	-	-	0,182
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,000

Helianthus annuus was the most propagated taxon with the highest pollen percentage (34.842 %) in the sampling period (Fig.1). In the nine of the ten samplings, sunflower pollen loads were gathered by the honeybees and they reached their highest value with 77.76 % in the 9th sampling as this could be seen in table 1. At the beginning of the sunflower blooming period, honeybees gathered quite more Cruciferae (41.35 %), *Trifolium pratense* (17.24 %) (Fig. 2) and *Papaver* spp. (12.31 %)

pollen grains, but in the 9th sampling only Rosaceae (11.33 %) pollen grains were found to be noticeable (Table 1).

Trifolium pratense was the second dominated taxon with the percentage of 15.964 % (Fig. 1). The study period contained nearly all blooming season of *Trifolium pratense,* and honeybees gathered pollen loads of this taxon in every sampling. They reached their highest level with 34.95 % in the 5th sampling in the middle of the June (Fig. 2) and the pollen loads were also recorded high for *Helianthus annuus* 23.89 % and *Paliurus spina-christii* 13.84 % (Table. 1).

The plant species concerning to Cruciferae are quite widespread in the study area and most of the species are flowering in the spring period. Most common ones are; *Brassica nigra* (L) Koch., *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Rapistrum rugosum* (L.) All. and *Thlaspi perfoliatum* L.. The pollen loads of them were identified in family level because of their pollen grain similarities. They are third dominant taxon in the sampling period with the percentages of 15.342 % and their highest score were 41.35 % in the 2nd sampling (Tab. 1, Fig. 2). When the honeybees gathered Cruciferae pollen loads as a dominant pollen type in the second sampling, they were also attracted by the pollen donors like the other dominant taxa *Trifolium pratense* (17.24 %) and *Papaver* spp. (12,31 %) (Table 1).

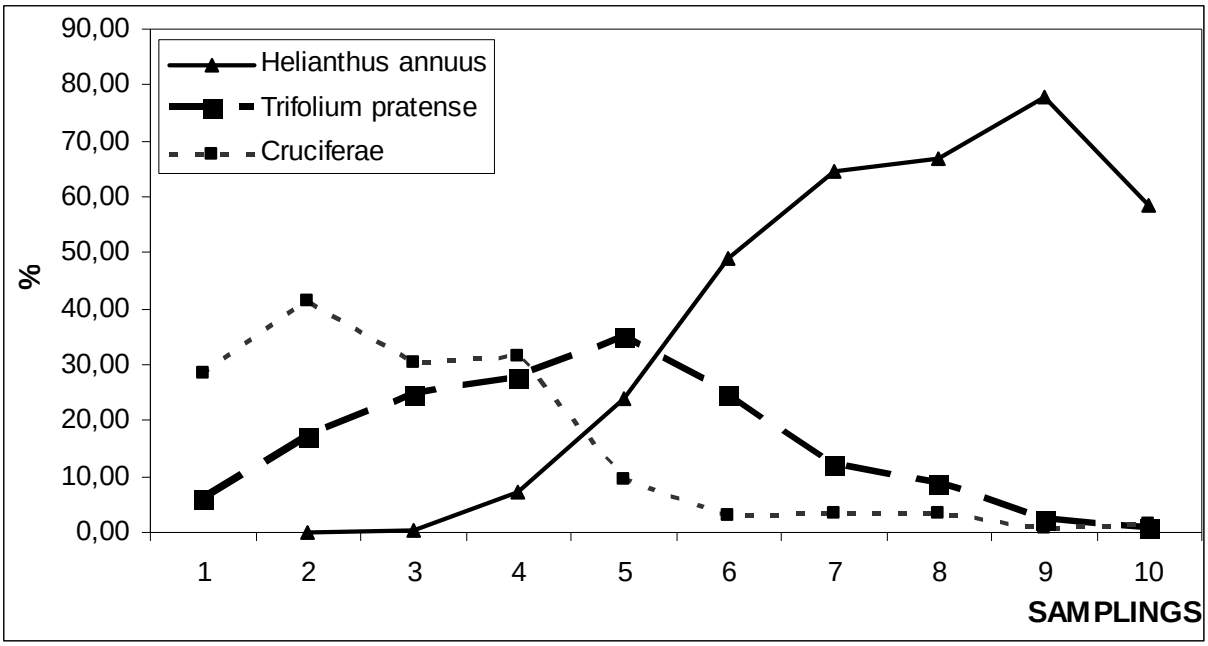

Figure 2: Dominant pollen producers and their variations in the bloom period of Gorukle-Bursa.

DISCUSSION

These three pollen types (*Helianthus annuus*, *Trifolium pratense* and Cruciferae) which gathered by the honeybees have an obvious distinction from the others about the honeybee preference in the sampling period. Cruciferae is attractive for bees for both nectar and pollen in early spring. *Helianthus annuus* and *Trifolium pratense* offer sufficient pollen and nectar loads in one visit because of flower structure. *H annuus* offer both nectar and pollen loads when the area is drier with few flowers open. *T pratense* is available in most of the season, reproduce sexually and 12% of its energy is allocated to sexual reproduction. On the other hand, *T repens* allocate only 2% to sexual reproduction and allocate 18% of its energy to vegetative reproduction. This explain why honeybee forager visit T pratense much more than T repens (Brown et al. 1992, Free 1993).

As we can see in figure 2, the peak points of the pollen loads that gathered by the honeybees didn't coincide with each other. Free and Williams (1974) suggested that when the colonies are placed short distances away from crops rather than beside, the

proportion of bees that visit the crops can be greatly diminished. On the contrary, in our study we found that honeybees prefer distant sunflower pollen grains in spite of *Rosaceae* members present nearby the hives. Honeybees have pollen preferences to concentrate their efforts on a smaller number of plants than the total available within their foraging range (Free 1963). *Helianthus annuus* is a very advantageous plant owing to its inflorescence and by the means; honeybees can collect more pollen in a short time. On the other hand, honeybees foraged on *Rosaceae* species by the side of *Helianthus annuus* because of valuable nectar producing capacity of them (Lieux 1972). Sunflower pollination due to wind was of negligible importance, and small insects rather than honeybees did not exceed 9%, confirming that the honeybee was the principal insect pollinator of sunflowers (Low & Pistillo 1986; Free 1993). Furthermore, sunflowers were widespread because of being cultivated intensively in the surroundings of the area.

Honey bees have some preference of plants for pollen collection since some of these plants are in a longer distance than the others. Even though honeybees collected pollen from 47 taxa they demonstrated a clear preference for some plants. The results suggest that honey bees concentrate on a few plant species in a certain perod of time. Bees preferred mostly Cruciferae*, Papaver, Trifolium pratense* in the sampling period of 1–5 and *Helianthus annuus*, *Rosaceae*, *Paliurus spina-christii, Trifolium pratense* in the sampling period of 6–10.

Finally we can conclude that honeybees have some preferences of plants not only for nectar collection but also for pollen collection.

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ÖZET

Dünya üzerinde balın botanik orijini ile ilgili çok sayıda çalışma bulunmasına rağmen, polen yüklerinin bitkisel orijinleri ve balarılarının polen tercihleri ile ilgili çalışmaların sayısı azdır (Andrada & Tellería, 2005; García-García *et al.,* 2001; Webby, 2004). Aynı şekilde Türkiye'de de bu konu ile ilgili olarak yapılmış az sayıda çalışma bulunmaktadır (Baydar & Gürel, 1998; Sabuncu *et al.,* 2003; Sorkun *et al,* 2003; Süer & Sorkun, 2003).

Polen, toplayıcı bal arıları tarafından çiçeğin stamenlerinden alınmakta, nektar, salya veya bal ile nemlendirilerek arka bacaklarında toplanmakta ve bu yapı polen yükü veya polen topu adını almaktadır (García-García *et al.,* 2004). Polenler, arıların yaşamı için en önemli protein kaynaklarıdır (Almeida-Muradian *et al.,* 2005). Toplayıcı bal arılarının pollen toplama kararlılıkları kovandaki larva miktarına, stoklanmış olan pollen miktarına, toplayıcıların genotipine ve çevredeki kullanılabilir kaynaklara göre değişiklik göstermektedir (Pankiw *et al.,* 1998). Bunun yanı sıra, polen yükleri içerdikleri kimyasal kompozisyon ve botanik orijinlerine göre değişmek üzere beyaz, krem, kahverengi, sarı, turuncu, kırmızı, yeşil ve gri gibi çok çeşitli tonlarda renklere sahip olabilmektedirler (Stanley and Linskens, 1974; Almeida-Muradian *et al.,* 2005)

Bu çalışmada amaç; Görükle-Bursa'da yoğun çiçeklenme döneminde bal arılarının polen tercihleri ve polen toplamak için yararlandığı bitkileri belirlemektir. Bu amaç doğrultusunda Görükle Kampus alanında (40^{o} 13.8' N, 28 ^{o} 49.8' E – Ca: 155 m) yoğun çiçeklenme döneminde bal arılarının topladığı polenler analiz edilmiştir. Bölge, Akdeniz iklim ve vejetasyonuna sahip olmakla birlikte yaklaşık 16000 hektarlık bir alanı kapsamaktadır. Polen yüklerini örneklemek için *Apis mellifera* L. *anatoliaca* ırkı bal arılarına ait olan yirmi üç adet Langstroth tip kovan kullanılmıştır. Polen çekmecelerinden polenler, 1 Haziran–1 Temmuz 2004 tarihleri arasında üçer günlük periyotlarda alınmış ve toplam 230 örnek cam şişelere konularak analiz edilene kadar +4^{o}C'de korunmuştur. Bal arılarının bölgede kullandıkları bitki kaynaklarını saptayabilmek için örnek şişelerinden 500 polen yükü rasgele seçilerek renklerine göre ayrılmıştır (Kirk, 1994). Her renkten polen yükleri Wodehouse (1935) metoduna göre preparat haline getirilmiştir. Tayinler ışık mikroskobu ile yapılmış ve her bir taksona ait yüzde oranları hesaplanmıştır. Toplanan polenler 47 taksona ait olup, bunlardan 11 tanesine ait oran % 1' den fazladır, toplanan polen yüklerinin % 0,18'i ise tanımlanamamıştır. Dominant taksonlar; *Helianthus annuus* L. (%34.84), *Trifolium pratense* L. (%15.96), Cruciferae (%15.34), *Paliurus spina-christi* Mill. (%6.79), Rosaceae (%6.44), *Papaver* spp. (%6.12), Compositae (%3.12), *Punica granatum* L. (%1.59), *Melilotus* spp. (%1.28), *Trifolium repens* L. (%1.06), *Zea mays* L. (%1.02) olup bunlar toplamın %93,56'sını temsil etmektedirler. Sonuç olarak bal arılarının sadece nektar toplayıcılığı için değil aynı zamanda polen toplayıcılığı için de bazı tercihlerinin bulunduğu ortaya konmuştur.

Anahtar Kelimeler: Polen, *Apis mellifera,* balarısı, Görükle, Bursa, Türkiye.