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Pollen Preferences of Honey Bees (Apis mellifera L.*) on Marmara Island*

Marmara Adasında Bulunan Bal Arılarının (Apis mellifera L.*) Polen Tercihleri*

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Abstract

Islands have a special importance in terms of biodiversity. At the same time, it is important to follow the feeding behavior of pollinators that ensure the continuation of biodiversity throughout the island. In this study, it was aimed to follow the pollen collection activities of honey bees (*Apis mellifera* L.) on Marmara Island and to determine the pollen sources. Pollen sampling was carried out weekly during the 14 weeks from the first week of April to the first week of July when honey bees intensively carried out pollen collection activities. The sampled pollen grains were classified according to their color and examined by light microscopy. A total of 34 taxa were identified from the pollen grains. The taxa represented in significant proportions were; Rosaceae, Fabaceae, and *Centaurea,* Ericaceae, Brassicaceae, *Cistus, Helianthemum, Vitis* and *Salix*. They constitute a total of 79.37%. Rosaceae family pollen has been found as the most preferred taxa by honey bees for 8 weeks. The first two weeks of May was the most productive period in terms of pollen species in Marmara Island and the amount of pollen brought to the hives decreased in early July. In this study, it was tried to shed light on the pollen collection preferences of honey bees and pollination periods of honey bee used plants under conditions of Marmara Island.

Keywords: *Apis mellifera*, Honey bees, Pollen preferences, Marmara Island

Özet

Adalar biyoçeşitlilik açısından özel bir öneme sahiptir. Aynı zamanda ada genelinde biyoçeşitliliğin devamını sağlayan polinatörlerin beslenme davranışlarının takip edilmesi önemlidir. Bu çalışmada Marmara Adası'nda bal arılarının (*Apis mellifera* L.) polen toplama faaliyetlerinin takip edilmesi ve polen kaynaklarının belirlenmesi amaçlanmıştır. Bal arılarının

yoğun olarak polen toplama faaliyeti gerçekleştirdiği Nisan ayının ilk haftasından Temmuz ayının ilk haftasına kadar 14 hafta boyunca haftalık olarak polen örneklemesi yapılmıştır. Örneklenen polen taneleri renklerine göre sınıflandırılmış ve ışık mikroskobu ile incelenmiştir. Polen tanelerinden toplam 34 takson tespit edilmiştir. Önemli oranlarda temsil edilen taksonlar; Rosaceae, Fabaceae ve *Centaurea*, Ericaceae, Brassicaceae, *Cistus*, *Helianthemum*, *Vitis* ve *Salix*'tir. Bunlar toplamda %79.37'lik bir oranı oluşturmaktadır. Rosaceae familyası polenleri, 8 hafta boyunca bal arıları tarafından en çok tercih edilen takson olarak bulunmuştur. Marmara Adası'nda Mayıs ayının ilk iki haftası polen türleri açısından en verimli dönem olmuş ve Temmuz ayı başında kovanlara getirilen polen miktarı azalmıştır. Bu çalışmada Marmara Adası koşullarında bal arılarının polen toplama tercihlerine ve bal arılarının kullandıkları bitkilerin tozlaşma periyodlarına ışık tutulmaya çalışılmıştır.

Anahtar Kelimeler: *Apis mellifera*, Bal arıları, Polen tercihleri, Marmara Adası

1. INTRODUCTION

Honey bees live by forming colonies. Worker bees dominate within the hive. These worker bees, which have taken on different roles, collect pollen and nectar intensively during the spring and summer seasons to raise their offspring and survive the winter. Pollen is collected directly from plants and stored in specialized baskets called corbicula and brought into the hive. The collected pollen is stored as bee bread. Pollen pellets collected from different plant sources at different times are used in brood rearing (Goodman, 2003). Pollen is an important source of protein, especially for larval bees. The decisions of honey bees regarding pollen collection activities are influenced by various factors such as the number of eggs or larvae in the hive, weather conditions, the genetic structure of the bees, available resources in the environment, and the amount of stored pollen (Dreller et al., 1999; Latshaw & Smith, 2005).

The pollen production of colonies can be monitored through pollen traps at the hive entrance. This allows for gathering information about the pollen preferences of honey bees, as well as the timing and weather conditions under which pollen collection activities occur. Under favorable conditions, honey bees initiate their pollen collection activities early in the morning and reach their maximum levels around 10 a.m. The majority of the daily collected pollen is usually gathered in the morning hours before noon. During the afternoon, honey bees focus more on collecting water and nectar. On rainy days, pollen collection activities almost cease, but they quickly resume and reach maximum levels shortly after the rain (Ngo et al., 2021).

Studies have shown that temperature is the most significant factor in pollen collection activities. Pollen collection increases during spring and especially summer when the weather is warmer. Cloudy, windy, and humid conditions have a negative impact on flight and, consequently, on pollen collection activities (De Mattos et al., 2018).

Flora is shaped by climate, topography, and biogeographic location and varies from region to region. Since floral elements are the natural resources of honey bees, their diet is also directly affected by the structure of the flora. For this reason, the palynological content of any product (e.g., honey, pollen, propolis) taken from one colony is not always compatible with the same product taken from a different region, and it is necessary to determine the resources honey bees use in different areas. However, the islands are very important regions in terms of biodiversity, and it is known that different bee varieties can be found on the islands.

Many researchers indicate that foraging patterns and abundance of native pollinators are altered in the presence of honey bees on the islands (Gross, 2001; Hansen et al., 2002; Roubik, 1978; Schaffer et al., 1983; Vaughton, 1996; Wenner & Thorp, 1994). For this reason, it is important to know the pollination ability or pollination preferences of the honey bees in a region, especially on an island. Also, honey bees (*Apis mellifera* L.) forage in 2·3 km meanly and the circle enclosing 95% of the colony's foraging activity had a radius of 6 km (Visscher & Seeley, 1982), but later studies reported the long-range foraging for the efficient source e.g., 9.5 km (Beekman & Ratnieks, 2000). The distances become even more important when the place is an island as the bee cannot rest on the sea surface.

This study aims to determine the timing of the main pollen flow period for honey bees in a special island ecosystem, to reveal the important pollen sources used by honey bees, to determine the pollination periods of pollen sources and to prepare a beekeeping pollen calendar for the blooming period for Marmara Island.

2. MATERIAL and METHODS

2.1. Study Area

The Marmara Islands are located in the southwest of the Marmara Sea. The largest of these islands is Marmara Island, which has an area of 117 km^2 with an altitude of 0-800 m. The coast of Marmara Island is approximately 5.5 km from the coast of the nearest Avşa Island, and the mainland is approximately 20 km to the north and 9.5 km to the south (Figure 1).

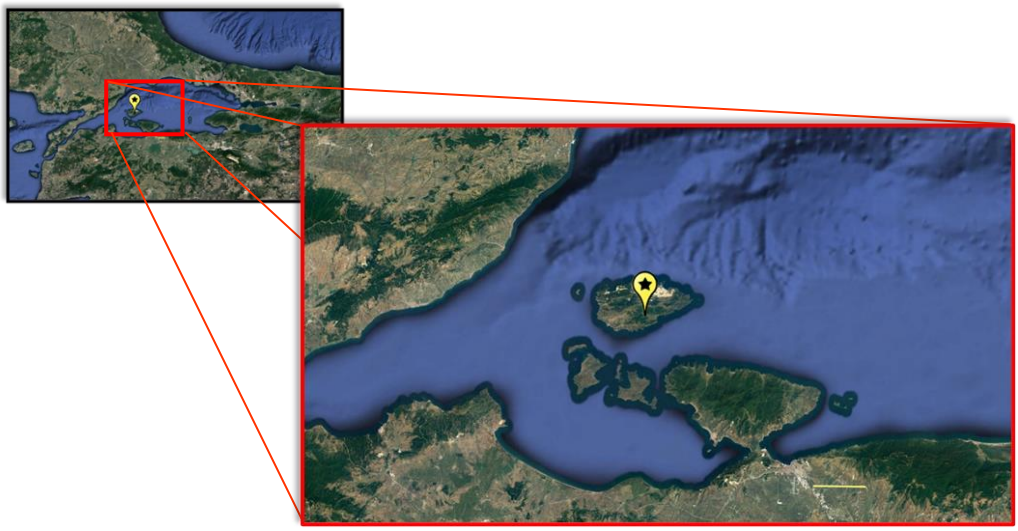

Figure 1. Location map of Marmara Island (Anonymous, 2023).

Among the Islands, Marmara Island receives the highest amount of rainfall. The coldest month on the island is January, and the hottest month is July with an average temperature of 24.6 ℃. The island experiences a Mediterranean climate, but the northern parts are influenced by moist air masses coming from the Black Sea. As a result, the northern region is more humid compared to the southern region. The southern part mainly consists of maquis formations (Tunçdilek et al., 1987). The characteristic species found on the southern slopes include; *Ficus carica* L., *Pistacia terebinthus* L., *Cercis siliquastrum* L., *Olea europaea* L., *Quercus coccifera* L., *Rhus coriaria* L., *Juniperus oxycedrus* L., along with *Sarcopoterium spinosum* L., *Cistus* sp., *Rubus fruticosus* L., *Spartium junceum* L., *Rosa canina* L., *Jasminum fruticans* L., and *Thymus vulgaris* L. among these formations. An increase in *Matricaria*, *Papaver rhoeas* L., and *Eryngium cucrulea* is observed in the region with the spring rains (Tunçdilek et al., 1987). In the northern region, the characteristic plants include; *Pinus brutia* Ten., *Arbutus andrachne* L., *Arbutus unedo* L., *Olea europaea* L., *Erica arborea* L., *Myrtus communis* L., *Pistacia terebinthus* L., *Strax officinalis* L., *Phillyrea latifolia* L., *Quercus coccifera* L., *Rhus coriaria* L., *Laurus nobilis* L., *Buxus* sp., and *Cercis siliquastrum* L. (Tunçdilek et al., 1987). Additionally, *Castanea sativa* Mill. can be observed at elevations of 300-350 meters on the northern slopes (Coşkun, 1999).

2.2. Sampling and Pollen Analyses

Sampling was carried out in selected 7 Langstroth-type hives of honey bees (*Apis mellifera* L.) with brood and pollen drawers located in the Topağaç region of the Marmara Island (40°36’14.90” N 27°38'12.03" E). From April 4th, sampling was continued weekly until the amount of pollen in the drawers dropped below the sampling level. Sampling was terminated

after July 10th as no hives were brought 500 pollen pellets weekly. For this reason, sampling was carried out for a 14-week period when honey bees were intensively collecting pollen on Marmara Island.

Color classification and calculation method was followed for pollen preparations and calculations of percentage values (Almeida-Muradian et al., 2005; Bilisik et al., 2008; Mărgăoan et al., 2014). The collected samples were stored in a refrigerator at +4 ℃ for diagnosis, and 83 samples were collected within the specified dates. After the sampling process was completed, 500 randomly selected pollen grains were separated from each pollen sample and classified based on their colors (Kirk, 1994). A piece of each pollen load from each color was mixed with glycerin-jelly, and stained using basic fuchsine, and the unacetolysed pollen grains were examined (Wodehouse, 1935). Pollen identifications were made using light microscopy and compared with the reference slide collection of the Bursa Uludag University Palynology Laboratory. From this data the percentages of the each taxon of pollen grains were calculated (Almeida-Muradian et al., 2005; Bilisik et al., 2008; Mărgăoan et al., 2014).

For the preparation of pollen calendar; taxonomic groups detected in over 45%, 16-45%, 3-16%, 3-1%, less than 1% respectively, of the 500 pollen grains analyzed per sample, which modified from Louveaux et al. (1978) and Lau et al. (2019) relative abundance values.

3. RESULTS

As a result of the study, 34 different taxa were identified from pollen pellets. Among these, 13 plant families, 15 genera, and 6 species were determined. Parallel with the floristic opulence, May had the highest pollen diversity, with 22 taxa foraged by honey bees. On a weekly basis, 19 different taxa were used as pollen sources in the 6th week (2nd week of May) of the sampling period. The 5th week was the second highest, with 17 different taxa (Figure 2).

Nine taxa, exceeding 3% of the overall total, were evaluated as pollen species highly preferred by honey bees for the region as follows: Rosaceae (29.6%), Fabaceae (11.69%), *Centaurea* (8.33%), Ericaceae (6.88%), Brassicaceae (6.76%), *Cistus* (4.81%), *Helianthemum* (4.67%), *Vitis* (3.58%), and *Salix* (3.05%) and these pollen types comprised 79.37% of the overall (Table 1). From these, Rosaceae, *Centaurea*, and Ericaceae pollen were found in more than 45% and reported as weekly dominated pollen types (Figure 2).

During the sampling period, Rosaceae was the most preferred honeybee pollen source on Marmara Island. From the first week of sampling until the last week, honey bees have consistently preferred and utilized Rosaceae members as an efficient pollen source. Rosaceae

members account for the highest total percentage with 29.6%, and honey bee foragers mostly prefer Rosaceae pollen 2-3, 5-9, and 14th weeks as a primary source with high constancy (26.73-52.23%). The second week of May, which corresponds to the 6th week of the sampling period, is observed to have the highest weekly percentage of Rosaceae pollen (>45%) as the preferred pollen source, with a weekly rate of 52.23% (Figure 2, Table 2).

Table 1. Total percentages of pollen pellets collected from honey bee hives on Marmara Island

TAXA	TOTAL %
Rosaceae	**29.60**
Fabaceae	**11.69**
Centaurea	**8.33**
Ericaceae	**6.88**
Brassicaceae	**6.76**
Cistus	**4.81**
Helianthemum	**4.67**
Vitis	**3.58**
Salix	**3.05**
Boraginaceae	2.72
Ranunculus	2.55
Fraxinus	2.04
Cichorioideae	2.03
Papaveraceae	1.95
Echium	1.72
Trifolium pratense	1.42
Iridaceae	1.24
Trifolium repens	0.83
Quercus	0.79
Papaver	0.68
Laurus nobilis	0.63
Asteraceae	0.47
Sarco / Poterium	0.45
Ailanthus	0.32
Tribulus terrestris	0.18
Punica	0.15
Lamiaceae	0.12
Dipsacaceae	0.11
Paliurus spina-christii	0.07
Oleaceae	0.06
Veronica	0.03
Juglans	0.03
Liliaceae	0.03
Asphodelus	0.01

The second most preferred pollen type, with a total percentage of 11.69%, was represented by the Fabaceae family (Table 1). Fabaceae was preferred throughout the entire sampling period as Rosaceae (Figure 2). The highest weekly percentages were observed in the 11-12 and 14th weeks (20.55-28.50%) of the sampling (2-3rd weeks of June and the first week of July) (Table 2). According to the generated pollen calendar, Rosaceae and Fabaceae were consistently used as pollen sources by honey bees for 14 weeks (Figure 2).

Centaurea was the third most preferred pollen species, utilized as a pollen source during the last four weeks of the sampling period, represented 8.33% of the total pollen (Table 1). Honey bees collected *Centaurea* pollen from the 11th week until the end of the sampling period, the 14th week (Figure 2). The highest preference for *Centaurea* pollen was observed in the 13th week as a week's dominated pollen type (47.52%) on the last week of June (Table 2).

Pollen loads of the Ericaceae family constitute 6.88% of the total (Table 1). Pollen collection from Ericaceae by honey bees was intense in the early weeks and ceased in the 7th week of the sampling period (Figure 1). The percentage, initially recorded as 47.64% (week's dominated pollen type with >45%) in the first week (early April), gradually decreased as the weeks progressed, reaching a weekly value of 0.62% in the 7th week (Table 2). Ericaceae pollen was found in over 45% of the first week of April as a week's dominated pollen (Figure 2).

Brassicaceae was preferred by honey bees from the first week to the 10th week of the sampling period (Figure 1). The highest intensity was observed in the 4th week, with a weekly value of 31.61%. The percentage increased until the 4th week, reaching the highest value, then decreased in the 5th and 6th weeks. It experienced a second peak in the 7th week, with 18.22%. In the 10th week, the end of the sampling period, and the first week of June, it concluded with 0.44% (Table 2). It constitutes 6.76% of the total pollen load (Table 1).

Cistus pollen loads were observed starting from the 5th week of the sampling period, the first week of May (Figure 1). Honey bees visited *Cistus* and collected its pollen from the 5th week until the 14th week. The highest value, with a percentage of 37.65%, was reached in the first week of June (the 10th week of the sampling period). It constitutes 4.81% of the total pollen load (Table 1).

Helianthemum pollen pellets constitute 4.67% of the total pollen load (Table 1). Honey bees started visiting *Helianthemum* in the 5th week of the sampling period and continued until the 12th week (from the first week of May to the third week of June) (Figure 1). The highest

weekly percentage, with a value of 20.03%, was observed in the 9th week of the sampling period (the last week of May) (Table 2).

Vitis, which refers to grapevine, has been used as a pollen source by honey bees starting from the 4th week of the sampling period (last week of April) (Figure 1). The highest weekly percentages were observed in the 8th week (12.15%) and 9th week (11.62%). In the 10th week, *Vitis* was not preferred, and the use of *Vitis* as a pollen source ended in the 11th week with a percentage of 9.79% (Table 2). *Vitis* accounts for 3.35% of the total pollen load (Table 1).

Salix pollen pellets were present from the first week of the sampling period until the 7th week. They were used as a pollen source by honey bees from the first week of April until the 3rd week of May (Figure 1). The most preferred week for *Salix* was the 3rd week of the sampling period, with a percentage of 10.79% (Table 2). *Salix* accounts for 3.05% of the total pollen load (Table 1).

The number of pollen species that are not among the most preferred taxa but are significantly preferred by honey bees and exceed 1% of the total is 8. These are Boraginaceae (%2.72), *Ranunculus* (%2.55), *Fraxinus* (%2.04), Cichorioideae (%2.03), Papaveraceae (%1.95), *Echium* (%1.72), *Trifolium pratense* L. (%1.42), and Iridaceae (%1.24) (Table 1). Among the taxa that constitute less than 1% of the total, the following taxa are included: *Trifolium repens* L. (0.83%), *Quercus* (0.79%), *Papaver* (0.68%), *Laurus nobilis* L. (0.63%), Asteraceae (0.47%), *Sarcopoterium*/*Poterium* type (0.45%), *Ailanthus* (0.32%), *Tribulus terrestris* L. (0.18%), *Punica* (0.15%), Lamiaceae (0.12%), Dipsacaceae (0.11%), *Paliurus spina-christii* L. (0.07%), Oleaceae (0.06%), *Veronica* (0.03%), *Juglans* (0.03%), Liliaceae (0.03%), and *Asphodelus* (0.01%) (Table 1).

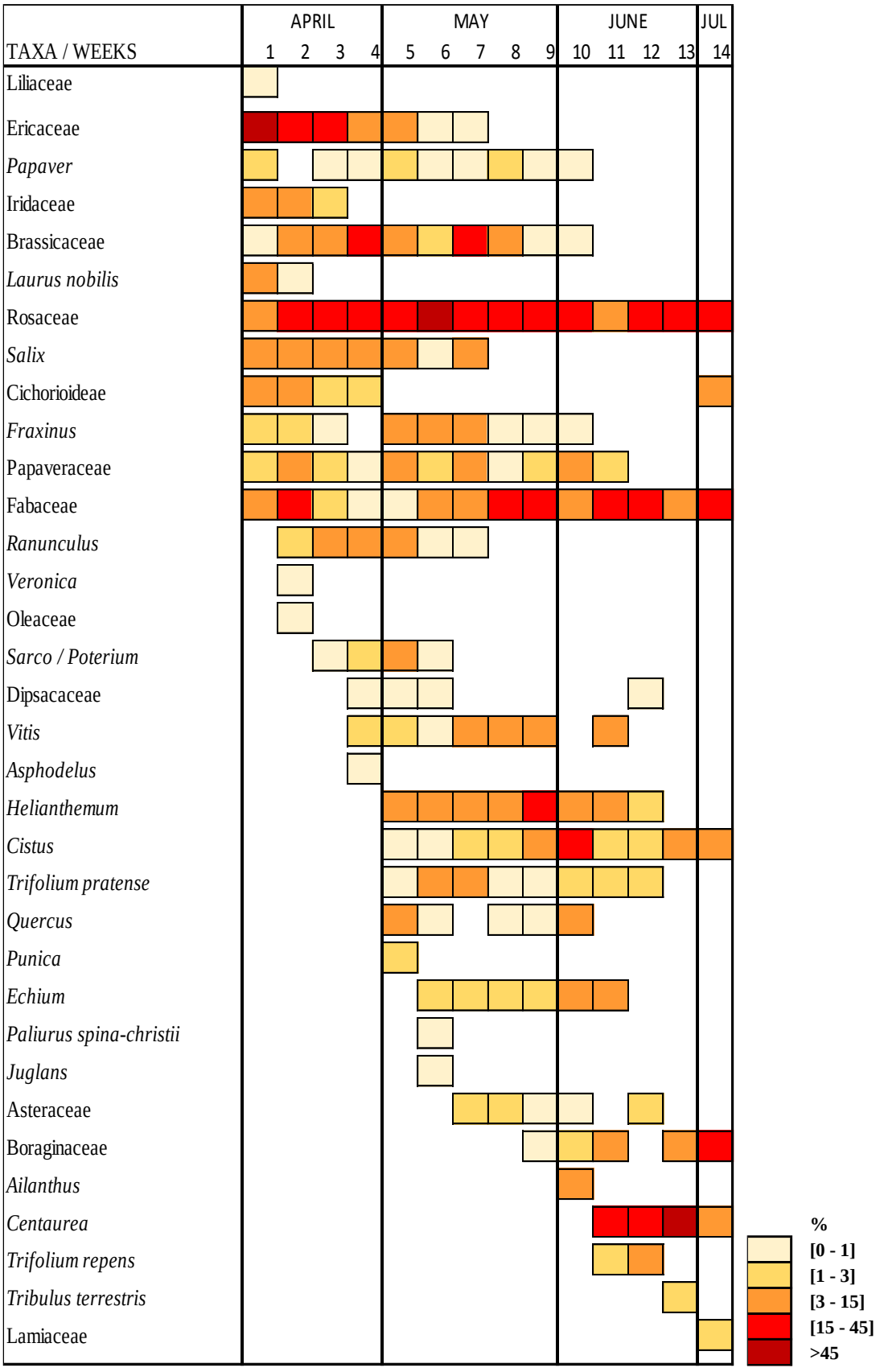

Figure 2. Pollen calendar, weekly and monthly variation of pollen types preferred by honey bees on Marmara Island

Table 2. Weekly mean pollen frequency of beehives in Marmara Island

TAXA / WEEKS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Liliaceae	0.43													
Ericaceae	47.64	18.23	18.11	6.98	4.49	0.30	0.62							
Papaver	2.42		0.74	0.27	2.10	0.36	0.32	2.59	0.06	0.66				
Iridaceae	9.61	5.17	2.61											
Brassicaceae	0.09	7.07	10.79	31.61	14.52	2.40	18.22	9.09	0.36	0.44				
Laurus nobilis	8.31	0.48												
Rosaceae	7.04	26.73	35.49	31.01	37.30	52.23	30.41	38.39	39.90	17.58	12.76	21.49	28.67	35.40
Salix	3.53	6.87	10.79	9.13	8.04	0.85	3.52							
Cichorioideae	9.33	11.63	1.87	1.48										4.06
Fraxinus	2.36	1.63	0.17		6.96	6.38	9.26	0.83	0.65	0.33				
Sarco / Poterium			0.40	1.21	4.38	0.27								
Dipsacaceae				0.47	0.15	0.03						0.84		
Papaveraceae	1.21	4.15	2.50	1.07	4.26	2.31	3.90	0.61	1.35	4.70	1.22			
Helianthemum					3.14	5.95	6.27	11.95	20.03	10.17	5.24	2.62		
Vitis				2.75	1.35	0.76	11.72	12.15	11.62		9.79			
Ranunculus		1.50	14.20	13.42	5.84	0.39	0.38							
Veronica		0.48												
Oleaceae		0.82												
Cistus					0.60	0.15	1.20	2.34	5.67	37.65	2.62	2.52	8.19	6.38
Asphodelus				0.10										
Trifolium pratense					0.19	9.11	3.81	0.11	0.76	1.22	2.27	2.41		
Quercus					3.93	0.79		0.36	0.70	5.25				
Punica					2.10									
Echium						2.16	2.93	1.65	2.95	8.13	6.29			
Paliurus spina-christii						0.97								
Juglans						0.46								
Asteraceae							2.40	2.07	0.14	0.33		1.68		
Boraginaceae									0.73	2.38	4.72		5.05	25.15
Ailanthus										4.53				
Fabaceae	8.03	15.24	2.33	0.50	0.67	14.12	5.04	17.87	15.10	6.63	28.50	20.55	8.00	21.08
Centaurea											25.00	37.84	47.52	6.19
Trifolium repens											1.57	10.06		
Tribulus terrestris													2.57	
Lamiaceae														1.74
WEEKLY TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

4. DISCUSSION

In early spring, honey bees prefer early-blooming plants such as Liliaceae, Ericaceae, Iridaceae, *Laurus nobilis*, *Fraxinus*, *Salix*, and Cichorioideae. Among the preferred taxa in April are Liliaceae, Ericaceae, *Papaver*, Iridaceae, Brassicaceae, *Laurus nobilis*, Rosaceae, *Salix*, Cichorioideae, *Fraxinus*, Papaveraceae, Fabaceae, *Ranunculus*, *Veronica*, Oleaceae, *Sarco*/*Poterium*, Dipsacaceae, *Vitis*, and *Asphodelus* (Figure 2). The highest pollen diversity is observed in May during the study period, with a total of 22 taxa being used as pollen sources. In May, honey bees prefer Ericaceae, *Papaver*, Brassicaceae, Rosaceae, *Salix*, *Fraxinus*, Papaveraceae, Fabaceae, *Ranunculus*, *Sarco*/*Poterium*, Dipsacaceae, *Vitis*, *Helianthemum*, *Cistus*, *Trifolium pratense*, *Quercus*, *Punica*, *Echium*, *Paliurus spina-christii*, *Juglans*, Asteraceae, and Boraginaceae as pollen sources. In June, the preferred taxa include *Papaver*, Brassicaceae, Rosaceae, *Fraxinus*, Papaveraceae, Fabaceae, Dipsacaceae, *Vitis*, *Helianthemum*, *Cistus*, *Trifolium pratense*, *Quercus*, *Echium*, Asteraceae, Boraginaceae, *Ailanthus*, *Centaurea*, *Trifolium repens*, and *Tribulus terrestris.* As the number of eggs and larvae decreases within the hive, there is also a decrease in the pollen requirement and the amount of pollen entering the hive. In July, the preferred taxa are mainly Rosaceae, Cichorioideae, Fabaceae, *Cistus*, Boraginaceae, *Centaurea*, and Lamiaceae (Figure 2).

Rosaceae and Fabaceae family pollen grains are mostly preferred by honey bees than other taxa (Reis et al., 2023; Toopchi-Khosroshahi & Lotfalizadeh, 2011; Topal et al., 2023). However, when we consider identified members of the Asteraceae family within the family, we see that Asteraceae is also represented with a value of 10.83%. Honey bees show a strong preference for the Asteraceae. Similarly, when *Cistus* and *Helianthemum* are considered as the Cistaceae family, they represent 9.48% of the total. The Cistaceae is particularly preferred by honey bees as a pollen source, especially during the summer months, and an attractive pollen source for honey bees (Dimou et al., 2014). If *Echium* is classified under Boraginaceae, it can be seen that Boraginaceae, with a value of 4.44%, was also able to have an important position among the taxa exceeding 3%. This may be a result of the different amino acid compositions of pollen or the need-oriented pollen content of some species compared to others (e.g. Cook et al., 2003; Kim & Smith, 2000; Pernal & Currie, 2001).

During the spring, woody plants, including trees and shrubs, are heavily used as pollen sources by honey bees. If we exclude Rosaceae and Ericaceae, the proportion of trees and shrubs used as pollen sources is 7.14% of the total, and most likely, many members of the Rosaceae and Ericaceae, which are used as pollen sources in the early period, are also woody plants.

Specifically, *Salix*, and *Fraxinus* are also important early spring blooming woody perennials honey bees prefer (Forcone et al., 2011) as in our study.

As predicted, Vitis cultivated in the region was heavily favored by honeybees. However, *Olea*, which is also cultivated on the island, was not represented in our study and was not preferred by honey bees. It is known that *Olea* is anemophilous, meaning its pollination occurs through wind dispersal. However, it is also noted that sometimes it can undergo entomophilous pollination (Marcucci et al., 2008). Nevertheless, the honey bees in the region do not use *Olea* members as a pollen source. This situation may be parallel to the fact that the region where olive trees are dense is far from the colonies. Also, according to our observations, *Melia azaderach*, *Salvia*, and *Arbutus* are used as the main nectar sources by honey bees. However, this was not observed in the pollen pellets.

Although various types of pollen were collected by honey bees, the amount of pollen and brood decreased in the colonies due to the heat in the region in July, and sampling was terminated when there was not enough pollen in the drawers. Honey bees may not work below 13 °C and rarely above 38 °C (Abou-Shaara, 2014). Honey bee foragers forage less pollen in the hottest period, and a decrease in pollen collection activity is observed at high ambient temperatures (Cooper et al., 1985). In our study, the decrease in pollen in the drawers in July was attributed to this.

On the other hand, an interesting deficiency was noted in the study results. It is known that there are small chestnut tree communities in the northern part of Marmara Island, where Euro-Siberian phytogeography dominates. However, according to the results of our study, honey bees did not engage in foraging activities in June from the hives located in the south of the island to the north for the resource (*Castanea sativa*) to which they are addicted. The hives are located in the southern part of Marmara Island, and in the case of the Marmara Sea, the north-facing slopes (far from honey bee colonies used for this study outside of the range) are included in the Euxine belt of the European-Siberian phytogeographic region, and the south-facing slopes are included in the Mediterranean phytogeographic region. Therefore, although Marmara Island is a small island, it is understood that honey bees do not travel the distance from the south to the north of the island. This can also be evaluated from another perspective as follows: Most likely, the honey bees in the location where we worked did not engage in foraging activities by flying from the island to another island or land.

5. CONCLUSION

In conclusion, a pollen calendar has been suggested to be used for the beekeepers and researchers based on the pollen types preferred by the honey bees in Marmara Island. In this calendar, Rosaceae, Fabaceae, and *Centaurea* pollen loads characterize the southern part of the region, particularly Marmara Island, and are frequently recorded. Knowing the species that bees utilize in different regions is important for regional or migratory beekeepers. However, since the study area is an island and these types of pollination studies are important for explaining the biogeography and biodiversity of the islands, much more detailed studies are needed. In addition, according to other studies conducted in nearby regions (Bilisik et al., 2008), it has been noted that the pollen flow in the region ends slightly earlier and there was a period in which there was a negligible amount of pollen in the hives. This situation in our study can be explained by the fact that the southern slope of the island is very dry after June under the influence of the hot Mediterranean climate. Further research is needed to understand the potential impact of annual weather conditions or the conditions within the hive on this phenomenon.

DECLARATIONS

The authors declare that they have no conflicts of interest.

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