EJONS International Journal on Mathematic, Engineering and Natural Sciences | ISSN 2602 - 4136

Article Arrival Date: 20.05.2020 | Article Type: Research Article | Article Published Date: 15.09.2020

Doi Number: http://dx.doi.org/10.38063/ejons.265

MELLIFEROUS PLANTS OF IŞIKLAR (GANOS) MOUNTAIN (TEKIRDAĞ)

IŞIKLAR (GANOS) DAĞI'NIN (TEKİRDAĞ) BALLI BİTKİLERİ

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ABSTRACT

Located within the boundaries of the province of Tekirdağ, Işıklar (Ganos) Mountain, the second highest mountain in Thrace, is rich in plant diversity due to its geographical location. This highland stretches in the southwest-northeast direction from Tekirdağ to Sarköy. Reaching almost 924 meters above the sea level, it is located between 40°35' to 40°52' north latitude and 26°58' to 27°27' east longitude. The present work reveals the floristic richness of the mountain with special emphasis on the most melliferous taxa used by honey bees (*Apis mellifera L.*) for honey production in the region. The plants were collected during a 24-month period, photographed and taxonomically identified. Pollen preparations were examined, and a collection was established to serve as a reference source for use in identification of melliferous plants in honey in the future. Mostly from Fabaceae, Asteraceae, Lamiaceae, Rosaceae, Brassicaceae and Boraginaceae 98 taxa from 33 families were listed. Of these, which plants reward bees with pollen, nectar and/or honeydew; and the potential to produce them were mentioned. Furthermore, the most represented and widespread taxa were highlighted. Pollen morphology of all taxa was presented.

Keywords: Işıklar (Ganos) Mountain, Tekirdağ, melliferous, pollen, flora

ÖZET

Tekirdağ il sınırları içerisinde yer alan Işıklar (Ganos) Dağı, Trakya'nın en yüksek ikinci dağıdır ve coğrafi konumu nedeniyle bitki çeşitliliği bakımından oldukça zengindir. Tekirdağ'dan Sarköy'e kadar, güneybatı-kuzeydoğu doğrultusunda uzanır. Deniz seviyesinden 924 metreye ulaşır ve 40° 35' ile 40° 52' kuzey enlemi, 26° 58' ile 27° 27'

doğu boylamları arasında bulunur. Bu çalışmanın amacı, bölgedeki arılarının en çok tercih ettiği bal yapan bitkilerine özel vurgu yaparak, dağın floristik zenginliğini ortaya koymaktır. Bitkiler 24 aylık süre zarfında toplandı, fotoğraflandı ve taksonomik olarak tanımlandı. Polen preparatları incelendi ve gelecekte bal yapan bitkilerin tanımlanmasında kullanılacak referans kaynağı olarak kullanılmak üzere bir koleksiyon oluşturuldu. Çoğunlukla Fabaceae, Asteraceae, Lamiaceae, Rosaceae, Brassicaceae ve Boraginaceae'den 33 familyaya ait 98 takson listelendi. Bunlardan hangileri arıları polen, hangileri nektar ve/veya tatlı özsu ile ödüllendirdiği ve bunları üretme potansiyelleri belirtildi. En fazla temsil edilen ve yaygın olan taksonlar vurgulandı. Tüm taksonların polen morfolojisi sunuldu.

Anahtar kelimeler: Işıklar (Ganos) Dağı, Tekirdağ, ballı, polen, flora

INTRODUCTION

Most of the Thracian part of Turkey-in-Europe is fertile with vast agricultural fields where the economically important plants such as sunflower, canola and cereal crops are cultivated. The floristic richness of the region is concentrated in the natural habitats of the Yıldız (Istıranca) and Işıklar (Ganos) mountains. These natural habitats are very important for beekeepers as they provide rich pastures for honeybee and are far from the agricultural chemicals and pesticides. The availability of various sources and the variety of flowers are reflected in the quality of honey. The honey produced here is polyfloral and is the most preferred.

Pollen analyses of honey samples from various regions were performed by many melissopalinologists of the world. Lazarova et al. (2010) determined the botanical origin and inorganic content of honey in Northeast Bulgaria. Atanassova et al. (2009) revealed the palynological, physical and chemical data of the honeys of the Kazanlak region and the sources of plant nectar that are important for bees. Makhloufi et al. (2010) described Algerian honey by palynological and physicochemical methods. In Turkey, melliferous plants have gained importance in production of high quality honey in recent years. However, most of the studies are based on pollen analysis in honey. Silici and Gökçeoğlu (2007) examined the pollen content from monofloral and polyfloral honeys obtained from the provinces situated on the Mediterranean coast of Anatolia. Kaya et al. (2005) analysed pollen in honey samples from various parts of Turkey, including Tekirdağ and Kırklareli from Turkish Thrace. Taşkın and Ince (2009) conducted pollen analyses in the honeys of Burdur region. Sıralı and Deveci (2002) compiled the plants which are important for honey bee in Thrace region. Çelemli and Sorkun (2012) determined the plants which bees prefer from the propolis samples in Tekirdağ.

Studies on the floristic diversity of nectariferous plants are rather less. Grozeva (2011) conducted a taxonomic study on the possibilities of nectariferous plants in bee pastures in Sinite Kamani national park. Tashev and Pancheva (2009) described the systematic structure of the honey plants of Bulgarian flora. Farkas and Zajácz (2007) have compiled a general review on nectar and honey production of the most important honey plants in Hungary. Dongock et al. (2007) determined the spectrum of honey-producing plants used by *Apis mellifera adansonii* in the western mountainous regions of Cameroon. Antonie (2014) demonstrated the biodiversity and economic value of honey-making plants in the Romanian Sebes region. Sekine et al. (2013) demonstrated the honey-producing plants of the Ubiratã and Nova Aurora provinces of Brazil and the

pollen characterization of honey obtained from the hives of these regions. Sorkun (2008) presented in detail the most nectariferous plants of Turkey. Koçyiğit et al. (2013) studied the pollen morphology of some *Trifolium* species, which are favorite plants of honeybees in Istanbul. Koçyiğit (2014) demonstrated the melliferous plants of Apiaceae from Istanbul. Eminağaoğlu et al. (2015) introduced 51 of the 260 honey-bearing plants that give pollen and honey in Artvin. Güneş Özkan et al. (2016) presented melliferous plants that can be used by the honey bees in Düzce-Yıgılca region.

Turkish Thrace is a transition region between Europe and Asia; hence it was subject of many ecological, floristic and dendrological works (Baytop 1961, 1968, 1969, 1971; Özhatay 1975, Kantarcı 1976; Eliçin 1981; Yarcı 1997; Asan and Yarcı 1993). The flora of the Işıklar Mountain was studied by Eliçin (1982) and Yarcı (2000). While floristic and phytosociological data are available, there is no specific study on melliferous plants in this region.

In order to estimate the quality of honey of a region, the floristic sources of this region as well as the pollen morphology of these plants should be well known. The aim of the present work is to reveal the floristic richness of Işıklar (Ganos) Mountain with special emphasis on the most melliferous taxa used by honey bees for honey production in the region.

MATERIAL AND METHODS

Işıklar (Ganos) Mountain is located within the borders of Tekirdağ province. It is the second largest mountain of the Turkish Thrace and lies between Tekirdağ and Sarköy. Due to its geographical location, it is very rich in plant diversity. It extends in northeast-southwest direction between Tekirdağ and Şarköy. Its height reaches 924 m (Uçaktaşı Tepe) and it is located between 40 ° 35'- 40 ° 52 'north latitude and 26 ° 58'- 27 ° 27' east longitude. The mountain is bordered by the Marmara Sea in the east and south, Işıklar, Semetli, Tatarlı, Ormanlı and Beyoğlu villages in the north and extends to Şarköy in the west (Figures 1, 2).

Plant material was collected during the vegetation periods at regular intervals between early spring and late autumn for two years. Plant samples were dried and numbered as herbarium specimens. Initial investigations were done on fresh specimens, mostly in the field. In addition, pollen samples from fresh flowers were collected into envelopes for use in pollen preparation.

Flora of Turkey and the East Aegean Islands (Davis 1965-88; Güner et al. 2000) and regional taxonomic works were used in the identification of the collected plants (Eliçin 1982; Yarcı 2000).

In palynological studies, 5-10 flowers of each species were used. For the morphological examination of the pollen, preparations were prepared according to the Wodehouse method (1935). Examining, measuring and photographing of the pollen were done with SC30 Olympus digital camera, Cell Software micro image and measurement system compatible with CX41 Olympus microscope.

Pollen dimensions were determined by measuring polar axis (P) and equatorial axis (E). In monocotyledonous taxa the polar axis was defined as (L) and equatorial axis as (l). For the spheroidal pollen only pollen diameter (PD) was measured.

Figure 1. Map of the Işıklar (Ganos) Mountain

Figure 2. South slopes of Işıklar (Ganos) Mountain

Melliferous potential was evaluated in three groups: nectar production, pollen production and honeydew production potential. For each, a rating denoting its potential from highest to lowest was determined as dominant (∗∗∗∗), secondary (∗∗∗) minor (∗∗) and trace (∗) according to melliferous literature (Bijov et al. 2003; Sorkun 2008; Eminağaoğlu et al. 2015) and our own observations.

RESULTS and DISCUSSION

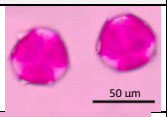
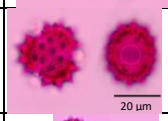
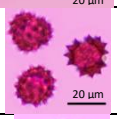
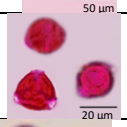
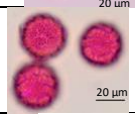
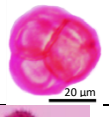
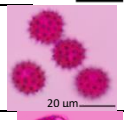
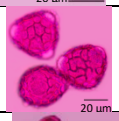
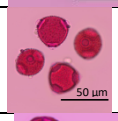
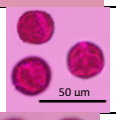
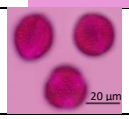
During our floristic study, 98 melliferous taxa belonging to 33 families were identified from the data obtained from the literature and our own observations (Table 1). The plants most preferred by bees belong to the families Fabaceae (13), Asteraceae (14), Lamiaceae (8), Rosaceae (7), Brassicaceae (6), Boraginaceae (5). As the most melliferous plants of the region; *Arbutus unedo*, *Cirsium steirolepis*, *Cirsium vulgare*, *Crataegus monogyna*, *Crepis vesicaria* subsp. *vesicaria*, *Echium vulgare* subsp. *vulgare*, *Helianthus annuus*, *Hippocrepis emerus* subsp. *emeroides*, *Lamium amplexicaule* var. *amplexicaule*, *Lepidium draba*, *Lythrum salicaria*, *Onobrychis viciifolia*, *Pyrus amygdaliformis* var. *amygdaliformis*, *Rubus canescens*, *Salvia verbenaca*, *Thymbra spicata* subsp. *spicata*, *Thymus longicaulis* subsp. *longicaulis*, *Trifolium angustifolium*, *Trifolium campestre* subsp. *campestre* var. *campestre*, *Trifolium hybridum* var. *hybridum*, *Trifolium purpureum* var. *purpureum*, *Valeriana officinalis* and *Vicia cracca* subsp. *stenophylla* have been identified.

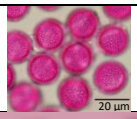
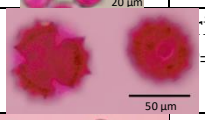
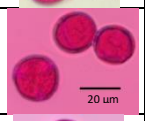
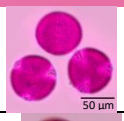
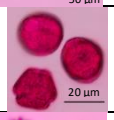
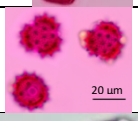
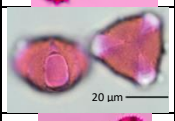
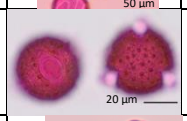
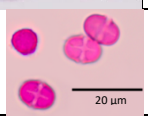
Cornus mas (cranberry), which blooms in February-March and is very common; is very important for the early spring development of bees and queens in terms of pollen and nectar they provide to them. Early blooming *Salix alba* (willow), *Pyrus amygdaliformis* var. *amygdaliformis* (wild pear), *Prunus spinosa* (blackthorn) are a very good source of pollen to bees and play a role in the reinforcement of the hive. *Tilia tomentosa* (linden) is quite common at all altitudes from sea level on both the north and south slopes of the mountain. It is one of the most honey producing trees with high amount of nectar produced in late May and June. The shrubby *Paliurus spina-christi* is another plant which is very common on mountain slopes and secures good nectar by giving a highly valuable honey.

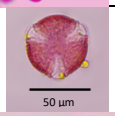
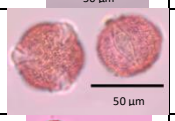
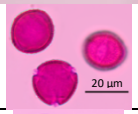
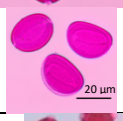
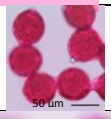
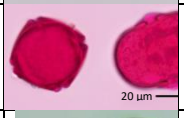
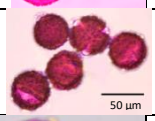
In addition to being a good source of pollen and nectar for bees, *Cercis siliquastrum* (Judas tree) has the potential to produce honeydew after flowering. *Aphid* insects produce honeydew from *Tilia tomentosa* (linden) and *Quercus* (oak) species also.

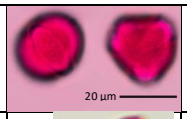
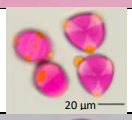
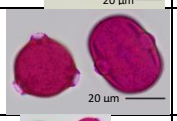
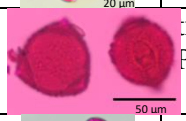
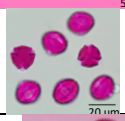
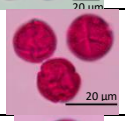
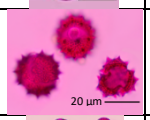
In conclusion, Işıklar Mountain is one of the richest floristic centres of Thrace region. Therefore, it is home of many honey-producing plants that bloom between early spring and late autumn. The data obtained from our study will form the basis of more comprehensive regional research to be carried out from now on. The pollen archive will serve as a reference source for pollen analysis of honey produced in this region.

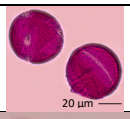
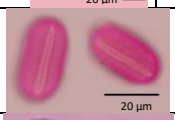
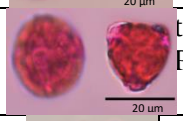
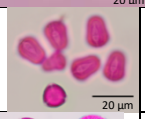
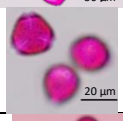
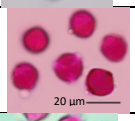
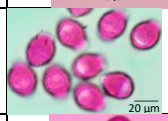
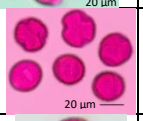
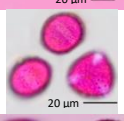
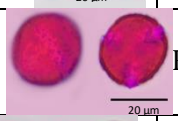
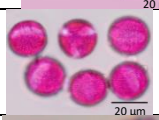
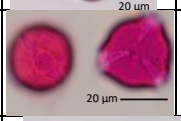
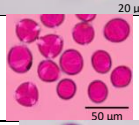
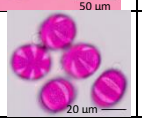
Table 1. Melliferous taxa of the study area

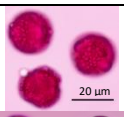
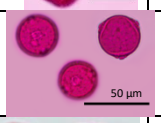
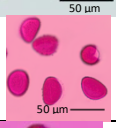
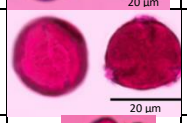
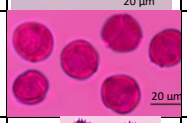
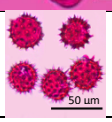
Taxon	Family	Flowering period	Pollen	Pollen type / Pollen dimensions (µm)	Melliferous potential		
					Nectar production	Pollen production	Honey dew/ production
Acer platanoides L.	Sapindaceae	4-5		tricolpate P=31.07±1.12	**	***	
Achillea coarctata Poir.	Asteraceae	5-7		tricolporate P=28.07±1.22	*	**	
Achillea millefolium L. subsp.	Asteraceae	4-9		tricolporate P=21.97±1.63	*	**	
Alcea rosea L.	Malvaceae	5-9		pantoporate PD=146.48	*	****	
Althaea cannabina L.	Malvaceae	7-8		pantoporate PD=136.86	**	***	
Anagallis arvensis L.	Primulaceae	5-9		tricolporate P=20.46±1.58	*	*	
Anemone hortensis L.	Ranunculaceae	3-4		spiraperturate PD=35.86±		****	
Arbutus unedo L.	Ericaceae	9-11		in tetrads, single grain	***	**	
Bellis perennis L.	Asteraceae	5-9		tricolporate P=18.89±1.64	*	***	
Bituminaria bituminosa (L.)C.H.Stirt.	Fabaceae	5-8		tricolporate P=38.33±0.94	**	**	
Campanula lingulata Waldst. et	Campanulaceae	5-6		triporate P=29.86±3.12	**	***	
Campanula rapunculus L. subsp.	Campanulaceae	4-7		triporate P=29.36±2.33	**	***	
Cardamine flexuosa With.	Brassicaceae	4-7		tricolpate P=29.36±2.33	**	**	
Cardamine hirsuta L.	Brassicaceae	4-6		tricolpate P=25.04±2.62	**	**	

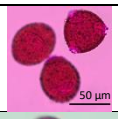
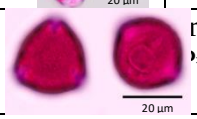
Cardamine pratensis L.	Brassicaceae	4-5		tricolpate P=20.83±0.69	**	**	
Carduus nutans L.	Asteraceae	4-6		ricolporate =52.85±1.54	****	****	
Centaurium erythraea Rafn.	Gentianaceae	4-6		tricolporate P=24.95±3.14		***	
Cercis siliquastrum L.	Fabaceae	3-5		tricolporate P=23.12±1.23	***	***	*
Cirsium steirolepis Petr.	Asteraceae	7-8		tricolporate P=44.40±1.32	****	***	
Cirsium vulgare (Savi)Ten.	Asteraceae	7-10		tricolporate P=39.00±1.62	****	***	
Cistus salviifolius L.	Cistaceae	3-5		tricolporate P=41.86±0.64	*	****	
Clematis vitalba L.	Ranunculaceae	4-6		tricolpate P=23.63±1.08	****	***	
Convolvulus arvensis L.	Convolvulaceae	5-8		tricolpate P=68.00±4.52	*	**	
Cornus mas L.	Cornaceae	3		tricolporate P=20.63±1.90	***	***	*
Cota tinctoria (L.) J.Gay ex. Guss	Asteraceae	4-8		tricolporate P=27.38±1.32	**	***	
Crataegus monogyna Jacq.	Rosaceae	4-6		tricolporate P=29.00±1.47	***	**	
Crepis vesicaria L. subsp.	Asteraceae	5-7		tricolporate P=32.14±0.83	*	***	
Crocus flavus Weston subsp. *flavus*	Iridaceae	3-4		spiraperturate PD=67.29±	*	***	
Cyanus depressus (M.Bieb.)	Asteraceae	5-7		tricolporate P=44.23±1.40	**	**	
Cynoglossum creticum Mill.	Boraginaceae	3-5		tricolporate P=10.82±0.57	**	*	

Doronicum orientale Hoffm.	Asteraceae	4-5		tricolporate P=29.67±1.15	*	***	
Echium vulgare L. subsp.	Boraginaceae	5-8		tricolporate P=11.88±0.68	****	*	
Euphorbia characias subsp.	Euphorbiaceae	4-7		tricolporate P=45.12±1.38	**	**	
Euphorbia myrsinites L.	Euphorbiaceae	3-7		tricolporate P=47.88±1.12	**	**	
Fraxinus ornus L.	Oleaceae	4-5		tricolpate P=20.57±0.98	**	****	**
Galanthus elwesii Hook. f.	Amaryllidaceae	2-4		monosulcate L=27.84±1	*	*	
Geranium molle L.	Geraniaceae	4-7		tricolporate P=66.50±3.35	**	**	
Glaucium flavum Crantz	Papaveraceae	5-9		tricolpate P=30.39±1.06	*	***	
Helianthus annuus L.	Asteraceae	7-8		tricolporate P=35.91±1.24	****	***	bak
Heliotropium europaeum L.	Boraginaceae	6-9		hexacolporate P=35.46±2.	***	***	
Hippocrepis emerus (L.) Lassen	Fabaceae	5-6		tricolporate P=25.25±1.23	***	***	
Hypericum montbretii Spach	Hypericaceae	4-7		tricolporate P=20.00±0.89	*	***	
Hypericum perforatum L.	Hypericaceae	6-8		tricolporate P=19.75±1.29	*	***	
Iris suaveolens Boiss.& Reut.	Iridaceae	4-5		monosulcate L=103.29±		*	
Jurinea macrocalathia K.Koch	Asteraceae	5-6		tricolporate P=46.83±1.46	**	**	
Lamium amplexicaule L. var.	Lamiaceae	3-7		tricolpate P=26.50±1.12	**	*	

Lamium garganicum L.	Lamiaceae	4-6		tricolpate P=28.31±1.10	**	*	
Lamium purpureum L. var.	Lamiaceae	3-6		tricolpate P=26.95±0.81	**	*	
Lathyrus digitatus (M.Bieb.)	Fabaceae	4-6		tricolporate P=43.00±1.57	**	**	
Lathyrus laxiflorus (Desf.)	Fabaceae	4-6		tricolporate P=41.42±2.11	**	**	
Lathyrus nissolia L.	Fabaceae	4-6		tricolporate P=31.58±1.21	**	**	
Lepidium draba L.	Brassicaceae	4-6		tricolpate P=20.87±0.62	***	***	
Linaria pelisseriana (L.) Mill.	Scrophulariaceae	3-7		tricolporate P=15.60±0.71	**	**	
Lonicera caprifolium L.	Caprifoliaceae	5-6		tricolporate P=54.15±1.75	****	*	
Lysimachia atropurpurea L.	Primulaceae	5-8		tricolporate P=21.41±0.69	**	***	
Lysimachia punctata L.	Primulaceae	5-9		tricolporate P=18.56±2.22		**	
Lythrum salicaria L.	Lythraceae	6-9		tricolporate P=19.83±1.92	****	***	
Matricaria chamomilla L.	Asteraceae	5-10		tricolporate P=26.11±0.99		**	
Melissa officinalis L. subsp.	Lamiaceae	6-8		hexacolpate P=25.34±1.	****	*	
Mentha longifolia (L.) L.	Lamiaceae	6-9		hexacolpate P=23.33±1.	****	*	
Muscari neglectum Guss ex Ten.	Asparagaceae	3-5		monosulcate L=25.44±0	**	**	
Myosotis arvensis subsp.	Boraginaceae	4-9		tricolporate P=5.27±0.19	***	*	

Nigella arvensis L. var. *glauca*	Ranunculaceae	6-8		tricolpate P=48.97±2.55	*	*	
Onobrychis viciifolia Scop.	Fabaceae	5-6		tricolpate P=32.20±1.08	****	**	
Ononis spinosa L.	Fabaceae	4-9		tricolporate P=24.19±2.08	***	***	
Onosma heterophylla Griseb.	Boraginaceae	5-7		tricolporate P=15.90±0.30		*	
Ornithogalum nutans L.	Asparagaceae	3-5		monosulcate L=60.10±2	*	*	
Paliurus spina-christi P. Mill.	Rhamnaceae	5-6		tricolporate P=22.21±0.67	****	**	
Prunus spinosa L.	Rosaceae	3-5		tricolporate P=15.10±2.18	***	**	
Pyrus amygdaliformis Vill.	Rosaceae	4-5		tricolporate P=33.15±2.44	****	***	
Quercus sp.	Fagaceae	4-5		tricolpate P=28.17±1.57	*	***	**
Ranunculus constantinopolitanus (DC.)	Ranunculaceae	4-6		tricolpate P=25.60±1.62	*	**	
Ranunculus ficaria L. subsp.	Ranunculaceae	4-6		tricolpate P=24.48±2.23	*	**	
Rorippa thracica (Griseb.)	Brassicaceae	5-6		tricolpate P=25.74±1.25	***	***	
Rosa canina L.	Rosaceae	5-7		tricolporate P=29.67±0.94	*	**	
Rubus canescens DC.	Rosaceae	5-8		tricolporate P=23.23±1.05	****	****	
Salix alba L. subsp. *alba*	Salicaceae	3-4		tricolpate P=23.23±2.34	****	****	
Salvia verbenaca L.	Lamiaceae	4-6		hexacolpate P=28.40±0.	****	**	

Sambucus ebulus L.	Adoxaceae	7-8		tricolpate P=20.27±1.44	*	*	
Sanguisorba minor L.	Rosaceae	5-7		tricolporate P=33.25±1.48		*	
Scabiosa atropurpurea L.	Caprifoliaceae	5-8		tricolpate P=69.13±2.98	**	**	
Scilla bifolia L.	Asparagaceae	2-3		monosulcate L=41.83±0	**	**	
Sinapis arvensis L.	Brassicaceae	5-10		tricolpate P=25.38±2.06	***	***	
Sorbus torminalis (L.) Crantz	Rosaceae	5-6		tricolporate P=26.95±0.81	**	**	
Thymbra spicata L. subsp. *spicata*	Lamiaceae	6-8		hexacolpate P=23.67±1.	****	***	
Thymus longicaulis C. Presl	Lamiaceae	5-8		hexacolpate P=32.78±1.	****	***	
Tilia tomentosa Moench.	Tiliaceae	6-7		tricolporate P=23.78±2.19	****	***	*
Torilis arvensis (Huds.) Link	Apiaceae	6-8		tricolporate P= 26.10±1.22	***	***	
Trifolium angustifolium L.	Fabaceae	4-6		tricolporate P=48.10±1.09	****	**	
Trifolium campestre Schreb.	Fabaceae	2-4(-9)		tricolporate P=23.12±1.54	****	**	
Trifolium hybridum L. var. *hybridum*	Fabaceae	5-9		tricolporate P=23.29±0.96	****	**	
Trifolium purpureum Lois.	Fabaceae	3-7		tricolporate P=27.47±1.82	****	**	
Tuberaria guttata (L.) Fourr.	Cistaceae	4-5		tricolporate P=20.75±0.83	**	**	
Tussilago farfara L.	Asteraceae	4-6		tricolporate P=35.18±1.71	**	***	

Valeriana officinalis L.	Caprifoliaceae	4-6		tricolpate P=48.32±1.62	****	****	
Verbascum speciosum Schrad.	Scrophulariaceae	5-9		tricolporate P=23.06±1.18	*	****	
Veronica persica Poir.	Scrophulariaceae	5-8		tricolpate P=29.18±1.64	**	**	
Vicia cracca L. subsp.	Fabaceae	4-5		ricolporate =40.25±2.05	****	**	

Acknowledgements

We thank scientific research projects coordination unit of Tekirdağ Namık Kemal University (Project number: NKUBAP.00.10.AR.12.06) for the financial support of this study.

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