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Pollen morphology of some taxa in the family Lamiaceae (Labiatae) from Turkey

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Abstract

The family Lamiaceae is often uttered as the mint family, and the plant family of flowering plants. In Turkey, 609 species of 46 genera in the Lamiaceae family are naturally distributed, and almost half of these are endemics. The aim of this study is to examine the pollen characteristics of some species in the Lamiaceae family. The family is a source of pollen and nectar, which is important for honey bees, and the medicinal and aromatic use of inflorescence reveal the importance of identifying the species.

In this study, pollen of 14 different species belonging to 12 genera in the Lamiaceae family were examined. The equatorial axis of the examined pollens is in the range of 50.6-22.4 µm and the polar axis of the examined pollens is in the range of 55.6-18.3 µm. It is stated that the pollen morphology of the Lamiaceae family can be used as an important character in the differentiation of taxa at the species level. It is also stated to be an important feature in the classification of the Lamiaceae family. As a result, these data obtained by light microscopy are fundamental data for taxonomic, morphological and melisopalynological studies.

Keywords

Endemic, Lamiaceae, LM, pollen, Turkey, wodehouse.

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INTRODUCTION

Turkey is a country rich in plant species and diversity, as it is located at the intersection of different climatic zones. It is one of the leading countries in the world market in the export of tea plants and spices, and it is the first among the plant species traded in the Lamiaceae (Labiatae) family (Akalin *et al.*, 2020). In addition, our country is an important gene center in terms of Lamiaceae plants, which have an important place in alternative medicine (Kocabas and Karaman, 2001; Akalin *et al.*, 2020). The promising biological and pharmacological activities of these species within the family have been known for years (Bozin *et al.*, 2006; Akman *et al.*, 2007).

The Lamiaceae family is often uttered as the mint family, and the plant family of flowering plants. They consist of shrubs or herbs that produce and release the aromatic smell, which consists of more than 3,000 species in the Lamiaceae family (Secmen *et al.,* 1998). The family is a source of pollen and nectar for honey bees due to its aromatic properties (Ozhatay *et al.* 2012). The largest genera of Lamiaceae plant family are *Salvia* L., *Scutellaria* L., and *Stachys* L. (Michel *et al.*, 2020). In Turkey, 609 species of 46 genera in the Lamiaceae family are naturally distributed, almost half of these are also endemics, and the endemism rate is 44.5% (Guner *et al.*, 2012).

Most of the plants belonging to the Lamiaceae family are used as folk remedies in the treatment of various diseases, as well as in medicine, food industry, perfumery and cosmetics. In addition, the plants of this family are included in many preparations used in rational phytotherapy today (Saleem, 2000).

Some genera such as *Thymus* L., *Satureja* L., *Teucrium* L., *Sideritis* L., *Lamium* L., *Stachys* L. and *Ajuga* L. are known to be used therapeutically (Baytop, 1984; Baytop, 1991). Inflorescence and leaves of some species belonging to the genus *Sideritis* L., *Stachys* L. and *Phlomis* L. are widely used as an appetizer (Sezik and Ezer, 1983; Sezik 1984). Although it is known by many different names in Anatolia, the herba or inflorescence of *Sideritis* and *Salvia* species, which are generally called "Mountain tea, Yayla tea, Sage", have been used as tea and folk remedy for a long time (Duman, 2000; Duman *et al.,* 2005).

Pollen, the male reproductive unit of seed plants, was first described by Grew as spermatic globules. The term pollen was first used by Carl von Linné in his work titled "Philosophia Botanica" which was published in 1751 (Bryant *et al.,* 1990). Pollen shapes differ between taxa. This difference varies according to the pollination patterns of the taxa, the environment in which they are located, the structure of the sporoderm layers, the aperture type and the ornamentation of the pollen (Karamanoglu *et al.*, 1975). The layer on the outer surface of the pollen is the exine layer. Exine stratification is quite distinct in the pollen of vascular plants, and various researchers have given different names to these layers. Terminologies used today in naming exine layers were developed by Erdtman (Fagrei and Iversen, 1975). Classification of the Lamiaceae family based on pollen morphology data was first made by Erdtman (1966). Erdtman formed two subfamilies in the Lamiaceae family, according to their pollen morphology (colpus numbers). He determined that there were two types of pollen with 3 colpus and 6 colpus, and he divided the family into two subfamilies, Lamioideae and Nepetoideae (Cantino and Senders, 1986).

The aim of this study is to examine the pollen characteristics of some species in the Lamiaceae family. The family is a source of pollen and nectar, which is important for honey bees, and the medicinal and aromatic use of inflorescence reveal the importance of identifying the species. Pollen analysis of the species examined in this study is intended to contribute to the identification of the species.

MATERIALS AND METHODS

The samples in the herbarium of Istanbul University, Faculty of Pharmacy were used in the study (Table 1). 14 taxa in the family Lamiaceae were investigated by light microscope. The pollen slides were prepared according to the Wodehouse (1935) technique. All measurements were determined on at least 20 pollen grains. The investigations and measurements of pollen grains were conducted with Olympus BX53 light microscope at magnifications ranging from ×200 to ×1000 with KAMERAM program.

Table 1: Voucher specimens of examined taxa in the family Lamiaceae with Turkish names and Voucher numbers.

	Scientific names	Turkish Names	Voucher number (ISTE)
1.	***Clinopodium graveolens* (M.Bieb.) Kuntze (Sin. *Satureja graveolens* (M.Bieb.) Caruel)**	Filiskin	100623
2.	***Lamium galeobdolon* (L.) L. (Sin. *Galeobdolon luteum* Huds.)**	Sarıbalıcak	98342
3.	***Lamium purpureum* L.**	Ballıbaba	50370
4.	***Nepeta obtusicrena* Boiss. & Kotschy ex Hedge (endemic)**	Kumpisiği	81761
5.	***Ocimum basilicum* L.**	Fesleğen	54441

6.	***Origanum acutidens* (Hand.-Mazz.) Ietsw. (endemic)**	Zemul	96917
7.	***Phlomis grandiflora* H.S.Thomps.**	Bahargülü	51272
8.	***Prunella vulgaris* L.**	Gelinciklemeotu	109843
9.	***Salvia rosmarinus* Spenn., (Sin. *Rosmarinus officinalis* L.)**	Biberiye	23054
10.	***Salvia virgata* Jacq.**	Fatmanaotu	54916
11.	***Scutellaria albida* L.**	Akkaside	92249
12.	***Sideritis libanotica* Labill.**	Gevreğen	83710
13.	***Stachys cretica* L.**	Deliçay	78026
14.	***Teucrium chamaedrys* subsp. *syspirense* (K.Koch) Rech.f.**	Sıcakotu	93761

RESULTS

In this study, pollen of 14 different species belonging to 12 genera in the family Lamiaceae were examined (Figures 1, 2, 3). Pollen characteristics of these species, such as pollen shape, pollen symmetry, polar axis length (P), equatorial axis length (E), P/E ratio, pollen shape, colpus number, colpus length, colpus width and exine layer thickness have been examined with a light microscope (Table 2). The studied pollen grains have isopolar polarity. Additionaly, their colpus number was either tricolpate or hexacolpate and their shape was either oblage-spheroidal or prolate-spheroidal.

The smallest polar diameter was observed in the pollen grains of *Scutellaria albida* (18.3 ± 0.5 µm), while the largest polar diameter was observed in the pollen grains of *Salvia virgata* (81 ± 1 µm). Additionally, the pollen grains of *Scutellaria albida* have the smallest equatorial axis length (22.4 ± 0.5 µm) and the pollen grains of *Salvia virgata* are the largest equatorial axis length (83.5 ± 0.3 µm) (Figure 2). The P/E ratio of the examined taxa have been ranged between 0.81-1.1. According to this measurement, *Origanum acutidens, Ocimum basilicum* and *Phlomis grandiflora* species have prolate-spheroidal pollen shapes, while in other species the pollen shapes are oblate-spheroidal.

The shortest colpus length was measured as 18.5 ± 0.4 µm in the pollen grains of *Scutellaria albida*, and the longest colpus length was measured as 72.2 ± 0.5 µm in the pollen grains of *Salvia virgata*. The narrowest colpus width was measured as 2 ±0.2 µm in the pollen grains of *Scutellaria albida*, and the widest was measured as 19.5 ± 0.7 µm in the pollen grains of *Stachys cretica*.

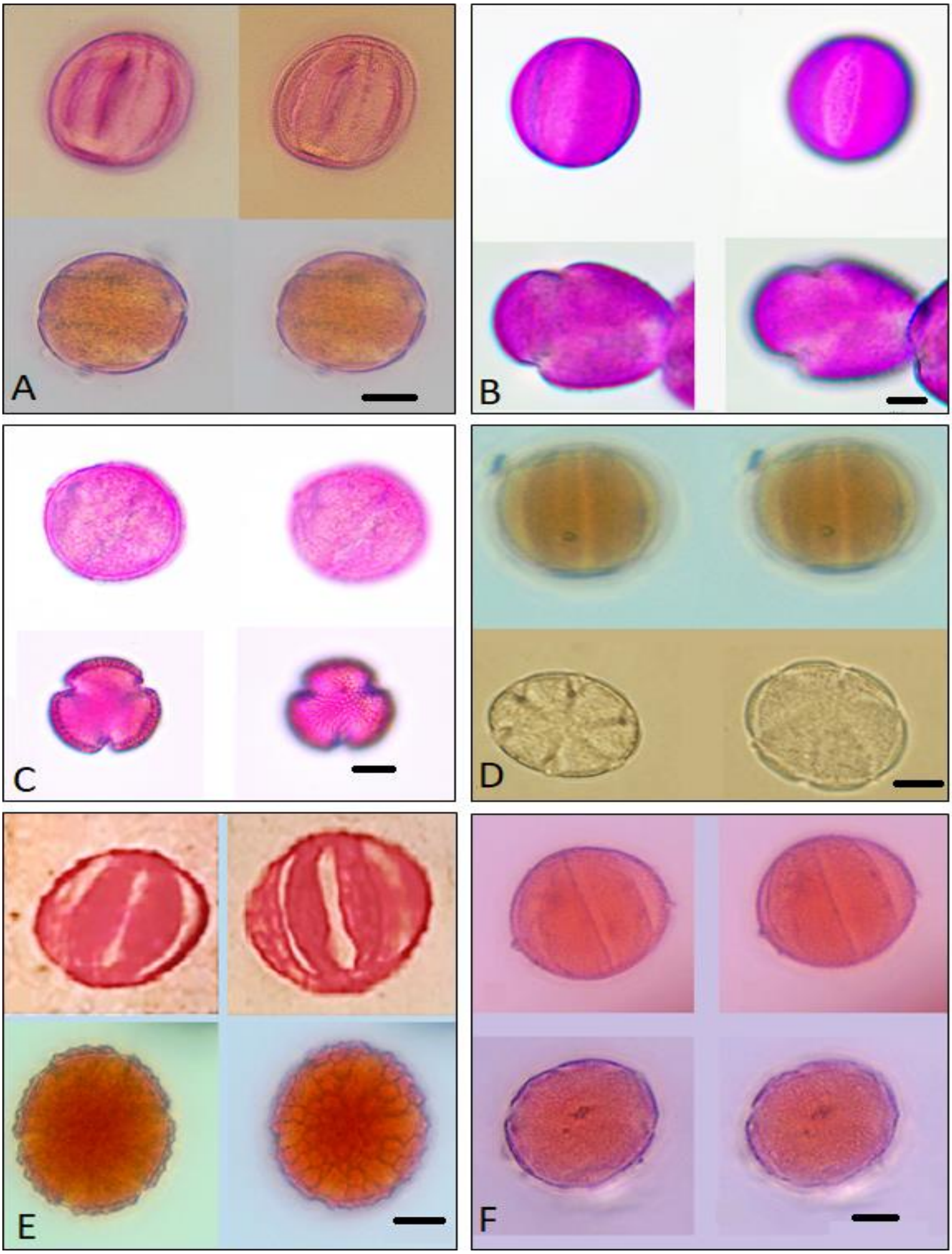

Figure 1: Light micrographs of pollen morphology in the examined species.
A) *Clinopodium graveolens* (Sin. *Satureja graveolens),* B) *Lamium galeobdolon* (Sin. *Galeobdolon luteum*), C) *Lamium purpureum,* D) *Nepeta obtusicrena,* E) *Ocimum basilicum,* F) *Origanum acutidens* (Scale bars=0.01 mm).

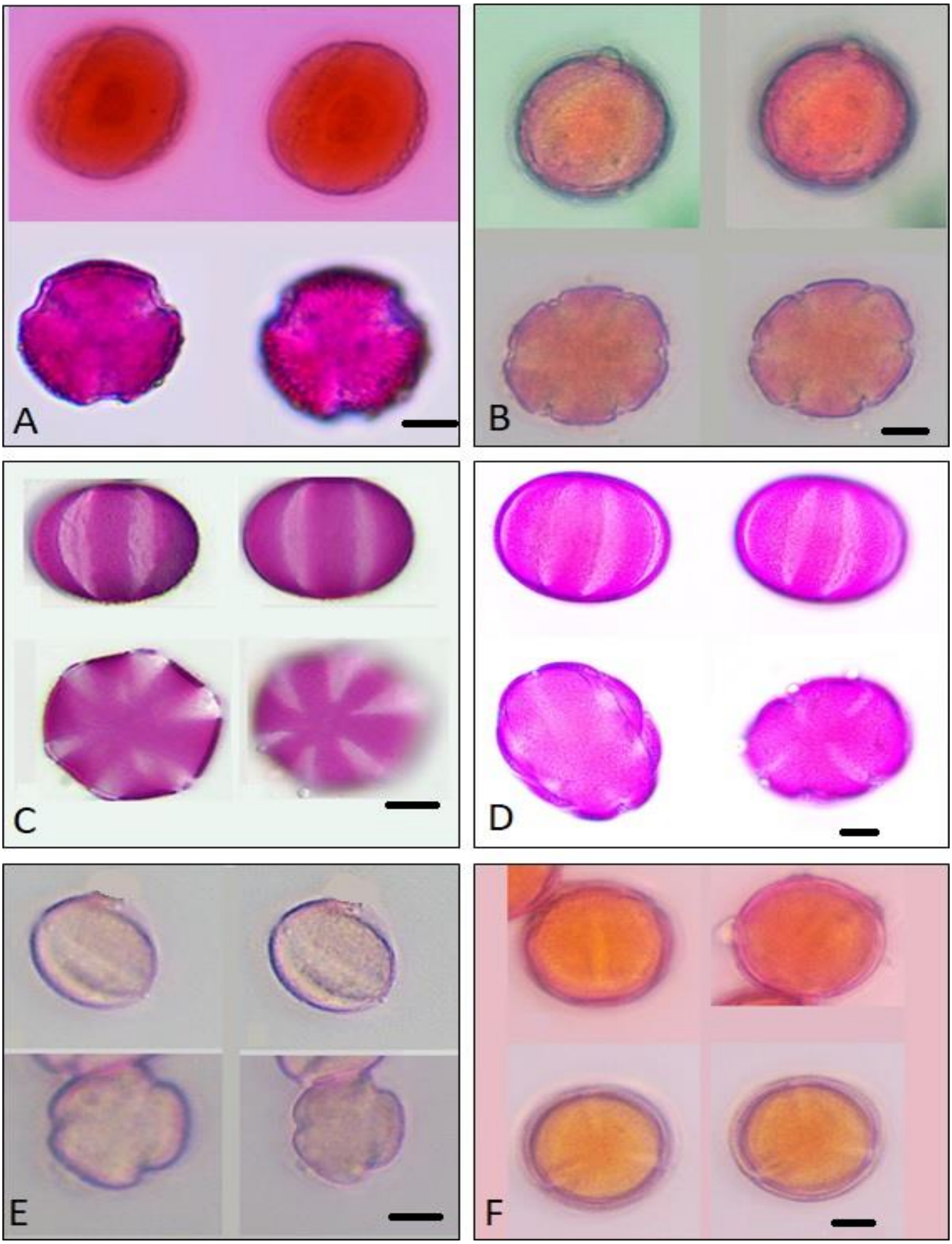

Figure 2: Light micrographs of pollen morphology in the examined species.
A) *Phlomis grandiflora,* B) *Prunella vulgaris*, C) *Salvia rosmarinus* (Sin. *Rosmarinus officinalis*), D) *Salvia virgata,* E) *Scutellaria albida,* F) *Sideritis libanotica* (Scale bars=0.01 mm).

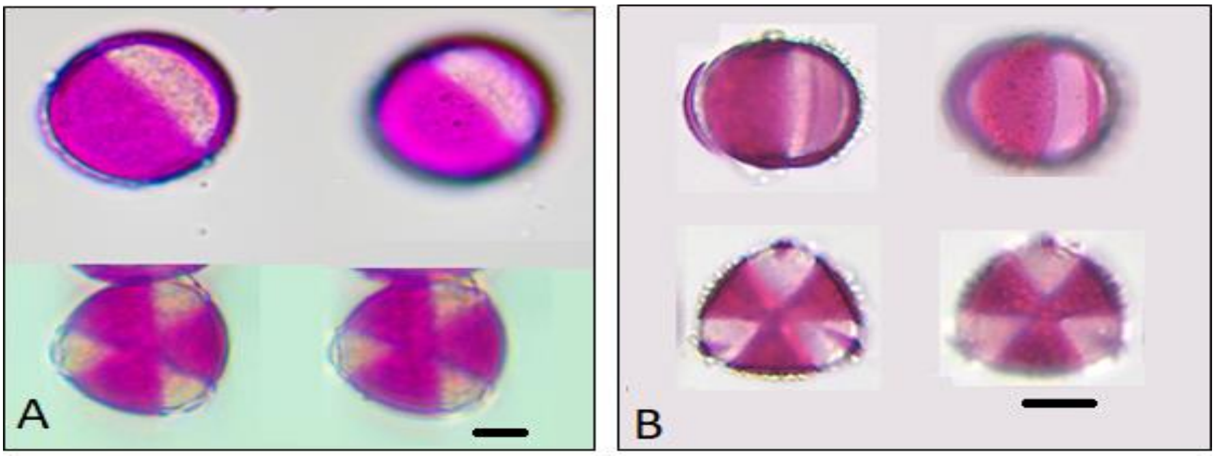

Figure 3: Light micrographs of pollen morphology in the examined species.
A) *Stachys cretica,* B) *Teucrium chamaedrys* subsp. *syspirense* (Scale bars=0.01 mm).

Table 2: Palynological features of the examined species in the family Lamiacaeae (Wodhouse).

Codes of examined species (Table 1)	Equatorial axis (E) (µm)	Polar axis (P) (µm)	Colpi	Colpus length (µm)	Colpus width (µm)	Exine thickness (µm)	P/E	Pollen shapes
1	37.3 ± 0.2	36.4 ± 0.2	6	32.5 ± 1.6	3.9 ± 0.4	2 ± 0.2	0.98	oblat-sferoidal
2	29.3 ± 0.5	28.4 ± 5.8	3	26 ± 0.6	11 ± 0.2	2.1± 0.4	0.97	oblat-sferoidal
3	30.2 ± 1.1	28.3 ± 1.2	3	26.7 ± 0.3	6.1 ± 0.2	3.2 ± 1.2	0.93	oblat-sferoidal
4	28.9 ± 0.5	24.9 ± 0.2	6	22.7 ± 0.7	5 ± 0.8	1.9 ± 0.3	0.86	oblat-sferoidal
5	50.6 ± 0.6	55.6 ± 0.6	6	48.2 ± 0.6	18.5 ± 0.7	2.14 ± 0.5	1.1	prolat-sferoidal
6	39.7 ± 0.5	40.6 ± 0.8	6	38.5 ± 1.2	3.1 ± 0.4	2.3 ± 0.1	1.02	prolat-sferoidal
7	48.5 ± 0.3	49.1 ± 1.1	3	40.5 ± 1.1	2.7 ± 0.3	2.6 ± 0.2	1.01	prolat-sferoidal
8	35.9 ± 1.1	33.8 ± 0.2	6	29.7 ± 1.4	5.6 ± 0.1	2.5 ± 0.4	0.94	oblat-sferoidal
9	33.5 ± 0.4	27.1 ± 0.1	6	30.9 ± 0.2	6.2 ± 0.2	1.2 ± 0.2	0.81	oblat-sferoidal
10	40.5 ± 0.2	39.2 ± 1.2	6	38.2 ± 0.5	13.7 ± 1.5	4.2 ± 0.7	0.97	oblat-sferoidal
11	22.4 ± 0.5	18.3 ± 0.5	3	18.5 ± 0.4	2 ± 0.2	1.4 ± 0.1	0.82	oblat-sferoidal
12	35.8 ± 0.6	35.1 ± 0.6	3	27.5 ± 1.6	2.4 ± 0.2	2.9 ± 0.5	0.98	oblat-sferoidal
13	30.1 ± 1.1	28.6 ± 1.7	3	24.2 ± 0.6	19.5 ± 0.7	2.6 ± 0.4	0.95	oblat-sferoidal
14	32.1 ± 0.7	27.9 ± 0.1	3	25.6 ± 1.2	15.1 ± 0.9	1.6 ± 0.9	0.87	oblat-sferoidal

DISSCUSSION

Erdtman, who examined the pollen morphology of the Lamiaceae family in detail, combined the results of his own studies with the results of other studies on this family and proposed a system in which each of the pollen type characterizes a subfamily (Erdtman, 1966). According to this system, the family is divided into two subfamilies: Lamioideae and Nepetoideae. Lamioideae contains pollen with 3 colpi (rarely 4 colpi), while Nepetoideae contains pollen with 6 colpi. Seven species included in this study, *Galeobdolon luteum*, *Stachys cretica, Lamium purpureum, Sideritis libanotica, Scutellaria albida, Phlomis grandiflora, Teucrium chamaedrys,* have tricolporate pollen which are in Lamioideae subfamily; and the other 7 species, *Salvia libanotica*, *Origanum acutidens, Prunella vulgaris, Ocimum basilicum, Salvia rosmarinus* (*Rosmarinus officinalis*), *Satureja graveolens* and *Nepeta obtusicrena* which are in the Nepetoideae subfamily with their hexacolpate pollen type.

According to the study of Pozhidaev, pollens with three colpi are considered more primitive than those with six colpi (Pozhidaev, 1991).

Abu - Asab and Cantino (1994), after examining the pollen morphology of the family in detail, determined that there are two basic pollen types with characteristic three colpi and six colpi. Brozova (1962) showed that the hexacolpate pollen is derived from the tricolpate pollen. Huynh (1972) supported this while working on the genus *Sideritis* and stated that the basic pollen type of the family Lamiaceae is tricolpate.

The genus *Galeobdolon* has been placed under the genus Lamium according to the systematic studies carried out in the recent years. In addition, the pollen characteristics support this similarity as well (Atalay *et al.*, 2016).

In a study involving pollens of *Ocimum basilicum*, the existence of different pollen types is mentioned (Khosla, 1993). Akolpate, monocolpate, bicolpate and hexacolpate pollen types can be observed in *O. basilicum* (Arogundade and Adedeji, 2009), but only hexacolpate pollen type was observed in this study.

Jamzad et al. (2003) and Jamzad (2013) examined the pollen morphologies of three new *Nepeta* L. species. They identified the species from Iran and stated that the palynological characteristics differed among the species supporting other morphological and molecular characters.

Perveen and Qaiser (2003) investigated the pollen morphology of family Lamiaceae in Pakistan and they stated that pollen morphology can be used as an important character in the differentiation of various taxa at the species level in the Lamiaceae family. Also, Abu-Asab and Cantino (1994) stated that the pollen morphology is an important feature in the classification of Lamiaceae family. As a result, these data obtained with the light microscope are systematically important. This study is a basic data for taxonomical, morphological and melisopalynological researches.

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