# POLLEN MORPHOLOGY OF SOME *THYMUS* L. (LAMIACEAE) TAXA USED AS SPICE IN ANATOLIA

## ANADOLU'DA BAHARAT OLARAK KULLANILAN BAZI *THYMUS* L. (LAMIACEAE) TAKSONLARININ POLEN MORFOLOJİSİ

**İlginç Kızılpınar*, Barış Özüdoğru*, Burcu Tarıkahya*, Cahit Doğan*, Sadık Erik***

***Summary:*** *Thymus species have an ethnobotanical usage as a spice and the main pollinators are bees. T. longicaulis C. Presl subsp. longicalis var. subisophyllus (Borbas) Jalas, T. sipyleus Boiss. subsp. sipyleus var. sipyleus, T. sipyleus Boiss. subsp. rosulans (Borbas) Jalas, T. leuchotricus Hal. var. leuchotricus and T. cappadocicus Boiss. var. globifer Jalas are woody subshrubs, mainly distributed in Central Anatolia. Pollen grains of these taxa are 6-colpate, spheroidal, oblate-spheroidal or suboblate in shape, and have reticulate ornamentation. Light microscope images, stem and leaf graphs of comparative polar and equatorial axes and AMB diameters were given. Also, morphological observations and measurements of pollens were summarized as a table. Taxonomical descriptions, habitats, flowering periods and distributions of the investigated taxa were given in the Appendix.*

***Keywords:*** *Pollen morphology, Thymus longicaulis, Thymus sipyleus, Thymus leuchotricus, Thymus cappadocicus*

***Özet:*** *Thymus türleri arılarla tozlaşır ve halk arasında baharat olarak kullanımı vardır. T. longicaulis C. Presl subsp. longicalis var. subisophyllus (Borbas) Jalas, T. sipyleus Boiss. subsp. sipyleus var. sipyleus, T. sipyleus Boiss. subsp. rosulans (Borbas) Jalas, T. leuchotricus Hal. var. leuchotricus ve T. cappadocicus Boiss. var. globifer Jalas İç Anadolu bölgesinde yayılış gösteren odunlu yarıçalılardır. Bu taksonların polenleri 6-kolpat, siferoid, oblat-siferoid ya da suboblat şekilli ve retikülat süslenmeye sahiptir. Işık mikroskobu görüntüleri, karşılaştırmalı polar, ekvatoral eksen ve AMB çapları dal yaprak grafiği şeklinde verilmiştir. Ayrıca polenlerin morfolojik inceleme ve ölçüm sonuçları tablo şeklinde özetlenmiştir. İncelenen taksonların taksonomik betimleri, habitatları, çiçeklenme dönemleri ve yayılışları ekte verilmiştir.*

***Anahtar kelimeler:*** *Polen morfolojisi, Thymus longicaulis, Thymus sipyleus, Thymus leuchotricus, Thymus cappadocicus*

## Introduction

Honey bees and nectar plants have a special relationship. Each benefits the other. Nectar plants give food for honey bees; in turn, bees provide pollination for many plants, enabling them to reproduce. Honey bees visit flowers to collect pollen and nectar for food. Pollen is essential to bees because it is their only natural source of protein. The biggest family that visited by bees is Lamiaceae of 48 taxa, followed by Fabaceae with 35 taxa and Asteraceae takes the third place with 29 taxa (Fakir and Babalık 2009).

Lamiaceae is the third largest family with 574 species in Turkey (Erik and Tarıkahya 2004) and the genus *Thymus* L. has 57 taxa in the Flora of Turkey (Davis 1982). The main pollinators of *Thymus* are *Apis mellifera* L. and some species of *Bombylius* L. The genus is gynodioecious, as for most species of *Thymus* (Morales 1986; Manicacci et al. 1998).

Honey is usually produced from several plant species (multifloral), while honey that originates predominantly from a single botanical source (unifloral) generally implies larger efforts by the beekeepers. Thyme honey is known to be underrepresented in terms of pollen analysis (Maurizio 1975; Moar 1985), a minimum of 20% thyme pollen being required (Moar 1985) for classification as a unifloral honey. Gül (2008) analyzed the

** Hacettepe University, Faculty of Science, Biology Department, 06800 Beytepe, Ankara, Turkey*
*e-mail: kizilpinar@hacettepe.edu.tr*

Aegean, Central Anatolian, Black Sea and East Anatolian thyme honeys and found out that these honeys are unifloral. In the Mediterranean area, the thyme honeys are mainly produced in Greece, Italy, Morocco and Spain (Ricciardelli D'Albore 1998). Thyme honey is prized by consumers for its golden/dark amber colour, strongly aromatic scent and its slow rate of granulation (Sáenz-Laín and Gómez-Ferreras 2000).

*Thymus* has a common name, kekik, in Turkey. It is used for common cold (Başer et al. 2006). *T. longicaulis* C. Presl is used for stomach ache (Öz Aydın et al. 2006) All *kekik* species are used as herbal tea and spice for cooking in western Anatolia. *Kekik* is traditionally used as digestic and diuretic. Also essential oils produced by *kekik* species have been used for respiratory tract infections, and are used as ethnic medicines for cold (Satıl et al. 2006, Tarıkahya and Erik 2006). *Thymus* species are used for wound healing in Anatolia (Tümen et al. 2006). Thyme honey is considered as the most qualified and delicious sort of honeys (Mannaş and Altuğ 2007). In addition thyme honey is a very important food. It is used especially to strengthen lungs and liver. Has refreshing and disinfectant activity for diseases in respiratory system, lungs and dyspnoea. It promotes weeping and also is a good supporter to heal stomach diseases and sickliness. (http://www.ekoses.com).

Thyme pollen is represented with a mean of 42% in the pollen spectrum, of the Greek thyme honeys with a range of 18 to 80% (Tsigouri and Passaloglou 2000). Thyme honeys contain between 15% and 73% of the pollen of *Thymus* (*Thymus mastichina* L. and *Thymus capitatus* (L.) Hoffmanns. & Link in Spain (Terrab et al. 2004). *Thymus longicaulis* honey has 25% of glucose, 37% fructose, 2% sucrose, 2% ash with pH 6.2 and it has high enzyme content in Turkey (Sorkun 2008). Thyme honey has diastase activity (Thrasyvoulov and Monikis, 1995).
Palynological properties of some *Thymus* species were investigated before (Mártonfi 1997; Ricciardelli D'Albore 1998; Şakıyan 1998; Satıl et al. 2005).

*T.cappadocicus* Boiss. var. *globifer* Jalas and *T. sipyleus* Jalas subsp. *sipyleus* are endemic taxa. Our aim is to present palynological and morphological properties, flowering periods and localities of *T. longicaulis* subsp. *longicalis* var. *subisophyllus* (Borbas) Jalas, *T. sipyleus* subsp. *sipyleus, T. sipyleus* subsp. *rosulans, T. leuchotricus* Hal. *var. leuchotricus* and *T. cappadocicus var. globifer* that will be helpful for beekeepers and melissopalynological investigations.

## Material and Methods

Several individuals of each taxon have been collected for morphological studies. Localities and voucher numbers are given in Table 1. The samples were dried and prepared as herbarium specimen to deposit at HUB. Descriptions have been based on Flora of Turkey (Davis 1982) and have been enlarged by some new characters and measurements for the first four taxa mentioned above. The new characters include leaves and bracts. The enlarged characters for the four taxa are given inTable 3 in the Appendix.

For palynological studies, only a single representative from each taxon was selected. Pollen slides were prepared by using Wodehouse method (1935) as fallows: Pollens were collected from mature flowers and they were put on an object slide and 2-3 drops of 96% ethyl alcohol were added to dissolve resin and fats on pollen grains. Then slides were heated at 30-40 $^{\circ}$C to evaporate alcohol with a special care, in order not to separate exine and intine from each other. After evaporation of the alcohol, 1-2 mm$^3$ of glycerin-gelatin with basic fucsin was added to the stuck pollen grains on the object slide due to amount of pollens. These object slides were heated on a 30-40$^{\circ}$C heater to melt glycerin-gelatin. Then this was mixed with a platinum pin to make pollen grains free from the object slide. Then it was covered with a cover glass and turned upside-down to make pollen grains close to upper surface, until glycerin-gelatin freeze. All object slides then were labeled with names and voucher numbers. Measurements and morphological observations were made using an Olympus Cx41 microscope. The measurements of AMB, apocolpium (t) size, polar (P), equatorial(E) and colpus axes, exine and intine thickness for 30 pollen grains were conducted under immersion object-lens (×1000). In Figures 6.1, 6.2 and 6.3 stem and leaf graphs formed by comparison of polar, equatorial axes and AMB diameters were given. The results were summarized in Table 2. In addition,

exine ornamentation and structure were established. The terminology used in accordance with Erdtman (Erdtman 1969). All statistical analyses of AMB, P, E values and thickness of exine and intine were calculated with the computer program SPSS.

## Results

***T. longicaulis*** subsp**.** ***longicaulis*** var. ***subisophyllus*** (Fig. 1, Table 2)

Pollen grains isopolar, hexacolpate, oblate-spheriodal (P/E 0.98), polar axis (P) 31.00 µm, equatorial axis (E) 31.36 µm. Amb hexagonal. Exine 1.47 µm thick at polar view and exine sculpturing is reticulate. Sexine and nexine are not distinctly distinguished. Intine 0.98 µm. Colpi long and terminal edges rounded, narrowing at the poles, surface granulate. Clg 25.02 µm, Clt 2.87 µm. Distance between colpi ends 5.58 µm. Apocolpium small. Colpus membrane is granulate.

***T. sipyleus*** subsp. ***sipyleus*** var. ***sipyleus*** (Fig. 2, Table 2)

Pollen grains isopolar, hexacolpate, spheroide (P/E 0.92), polar axis (P) 29.04 µm, equatorial axis (E) 31.52 µm. Amb hexagonal. Exine 1.56 µm thick at polar view and exine sculpturing is reticulate. Sexine and nexine are not distinctly distinguished. Intine 0.89 µm. Colpi long and terminal edges rounded, narrowing at the poles. Clg 22.14 µm, Clt 2.54 µm. Distance between colpi ends 6.14 µm. Apocolpium small. Colpus membrane is granulate.

***T. sipleyus*** subsp. ***rosulans*** (Fig. 3, Table 2)

Pollen grains isopolar, hexacolpate, suboblate (P/E 0.88), polar axis (P) 30.02 µm, equatorial axis (E) 33.77 µm. Amb hexagonal. Exine 1.30 µm thick at polar view and exine sculpturing is reticulate. Sexine and nexine are not distinctly distinguished. Intine 0.98 µm. Colpi long and terminal edges rounded, narrowing at the poles, surface granulate. Clg 23.16 µm, Clt 2.84 µm. Distance between colpi ends 6.07 µm. Apocolpium small. Exine sculpturing is reticulate. Colpus membrane is granulate.

***T. leuchotricus*** var. ***leuchotricus*** (Fig. 4, Table 2)

Pollen grains isopolar, hexacolpate, prolate-spheriode (P/E 1.01), polar axis (P) 34.13 µm, equatorial axis (E) 33.71 µm. Amb hexagonal. Exine 1.50 µm thick at polar view and exine sculpturing is reticulate. Sexine and nexine are not distinctly distinguished. Intine 0.81 µm. Colpi long and terminal edges rounded, narrowing at the poles, surface granulate. Clg 28.19 µm, Clt 2.61 µm. Distance between colpi ends 5.74 µm. Apocolpium small. Colpus membrane is granulate.

***T.cappadocicus*** var. ***globifer*** (Fig. 5, Table 2)

Pollen grains isopolar, hexacolpate, suboblate (P/E 0.88), polar axis (P) 28.87 µm, equatorial axis (E) 32.53 µm. Amb hexagonal. Exine 1.76 µm thick at polar view and exine sculpturing is reticulate. Sexine and nexine are not distinctly distinguished. Intine 0.89 µm. Colpi long and terminal edges rounded, narrowing at the poles, surface granulate. Clg 21.98 µm, Clt 3.39 µm. Distance between colpi ends 7.12 µm. Apocolpium small. Colpus membrane is granulate.

## Discussion

The genus *Thymus* belongs to the Mentheae tribe in Nepetoideae (Lamiaceae). The pollens grains of subfamily Nepetoideae, are hexacolpate with 3 nuclei (rarely 8, 10, 12 colpate) (Bayram et al. 2004).

Pollen grains of Lamiaceae are in general tri- or hexacolpate, depending on the number of nuclei. Threenucleate species are found in the genera of *Salvia*, *Rosmarinus*, and *Thymus. Thymus* appear to be 6-colpate, whereas pollen grains of 2-nucleate species in the *Scutelaria* group appear to be 3-colpate (Erdtman 1969). The *Thymus* species investigated in the present study are 6-colpate.

Oybak Dönmez et al. (1999) studied the pollen ornamentation of 32 *Teucrium* species distributed in Turkey using the scanning electron microscopy. Exine ornamentations observed in the study was verrucate (in the sections *Teucrium* L., *Scordium* Boiss., *Chamaedrys* Benth., *Pollium* Benth., *Stachybotrys* Benth., and *Scorodonia* Benth.) and reticulate (in the section *Isotriodon*).

The pollen grains of the genus *Marrubium* L. (Lamiaceae) are radial symmetric and isopolar, pollen shape prolate- spheroidal and oblate- spheriodal, number and type of apertures are trikolpat. However some species were hexacolpate, apertural membrane is usually psilate, seldom granulate. Ornemantation types are psilate-perforate, psilate-foveolate, regulate-re-

ticulate and psilate-perforate (Akgül et al. 2008). The *Mentha* L. species investigated by Çelenk et al. (2008) are hexazonocolpate with granular membranes and have a circular amb, varying in shape from prolate-spheroidal to suboblate. The exine is bireticulate in section *Pulegium* and reticulate in section *Menthae*.

Mártonfi (1997) investigated 11 species of *Thymus* with light and electron microscope. According to this research, *T. serpyllum* L. has the smallest pollen grains, and *T. pulcherrimus* Schur. the largest. The pollen grains of all 11 species are hexazonocolpate, varying in shape from suboblate to euprolate. The exine is bi-reticulate and scrobiculate.

Şakıyan (1998) has observed some of the Inner Anatolian *Thymus* species with light microscope in her thesis and has concluded that pollen grains are isopolar, hexacolpate, suboblate, oblate-spheroidal and prolate-spheroidal; AMB is circular or hexagonal.

Satıl et al. (2005) examined the Eastern Anatolian *Thymus fedtschenkoi* Ronniger var. *handelii* (Ronniger) Jalas and *T. migricus*is Klokov&Shost. in means of morphology, anatomy and palynology. According to them, pollen morphology of two species are similar to each other. Pollen grains of the two species are isopolar, hexacolpate, suboblate, amb hexagonal. Exine is thicker at the poles than equator in both species. Exine sculpturing is reticulate under light microscope, whereas it is microreticulate in *T. migricus*, it is suprareticulate in *T. fedtschenkoi* var. *handeli*.

According to Ricciardelli D'Albore (1998), pollen grains of *Thymus capitatus* (L.) Hoffmanns.&Link. are monads of medium size. They have six colpi (hexazonocolpate) with irregular edges, rounded ends, narrowing at the poles. The symmetry is radial with isopolar polarity and oblate spheroidial shape. In polar view, they are hexagonal or oval, and in equatorial view, they are depressed and ovate. The exine reveals a reticulate pattern with ectexine thicker than endexine.

In *Pal dat* (http://www.paldat.org/), *Thymus pulegioides* L. subsp. *carniolicus* (Borbás) P. Schmidt pollens are monad, medium-sized (26-50 µm), oblate, equatorial outline: elliptic, 6-colpate, ornamentation: reticulate, tectum: semitectate.

Our palynological results are concordant to previous researches about Lamiaceae and *Thymus* pollen investigations. *T. longicaulis* subsp. *longicalis* var. *subisophyllus, T. sipyleyus* subsp. *sipleyus* var. *sipyleyus, T. leuchotricus* var. *leuchotricus, T. cappadocicus* var. *globifer* and *T. sipleyus* subsp. *rosulans* species' pollen grains are 6-colpate, spheroidal, oblate-spheroid or suboblate in shape, and have reticulate ornamentation. The present study reveals that *T. leuchotricus* var. *leuchotricus* has longer equatorial axis and AMB diameter lengths when compared to the other taxa examined (Fig. 6.1-6.3). *T. cappadocicus* var. *globifer* has the longest polar axis length from other four taxa (Fig. 6.2).

It is important for beekeepers to know the distribution and flowering period of the plants, in order to increase the productivity. Therefore they can take their colonies to places where plants flower to make the bees closer to pollen resources. Also the origin and the quality of the honey can be easily recognized when the palynological properties are known.

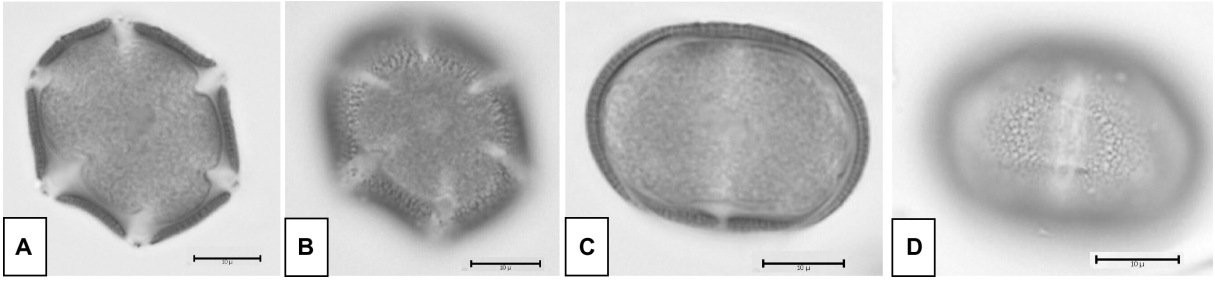


***Figure 1. T. longicaulis subsp. longicalis var. subisophyllus A and B. polar view; C and D. Equatorial view.***

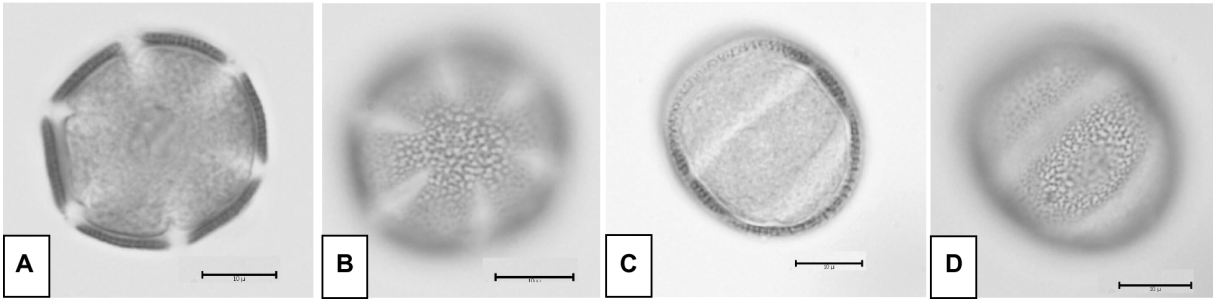


*Figure 2. T. sipyleus subsp. sipyleus var. sipyleus A and B. polar view; C and D. equatorial view.*

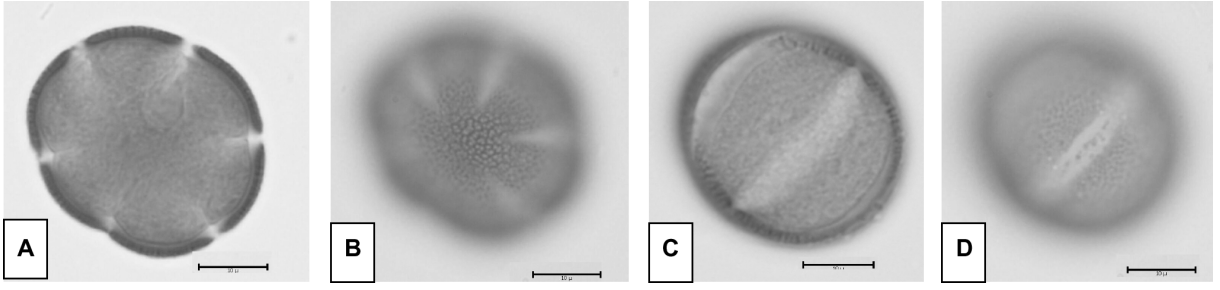


*Figure 3. T. sipleyus subsp. rosulans A and B polar view; C and D. equatorial view.*

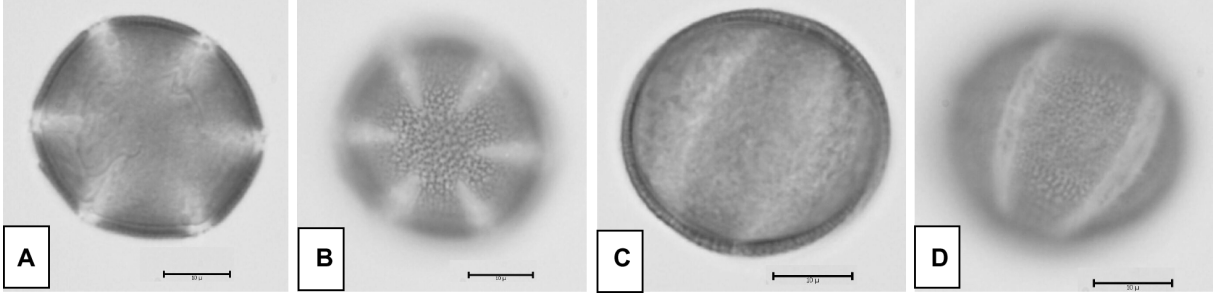


*Figure 4. T. leuchotricus var. leuchotricus A and B. polar view; C and D. equatorial view.*

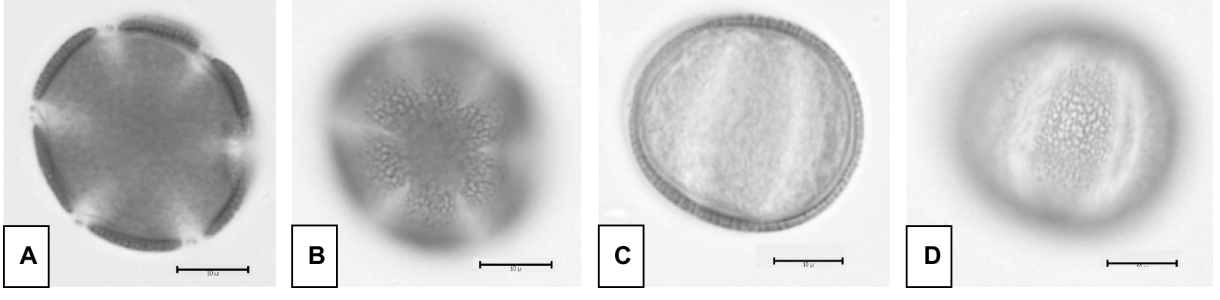


*Figure 5. T. cappadocicus var. globifer A and B. polar view; C and D. Equatorial view*

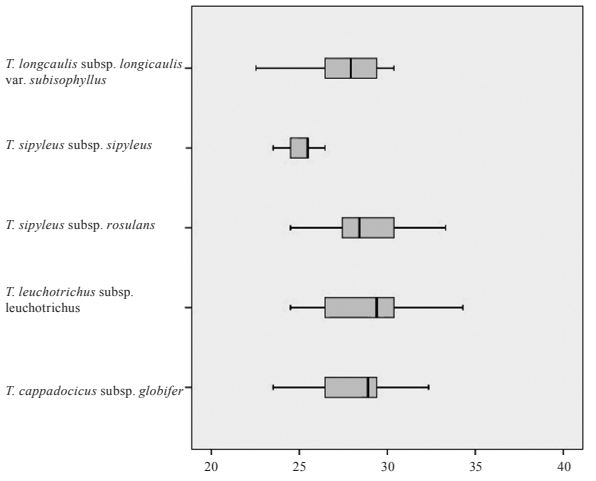


***Figure 6.1 AMB diameters (µm) in the Thymus species examined in this study.***

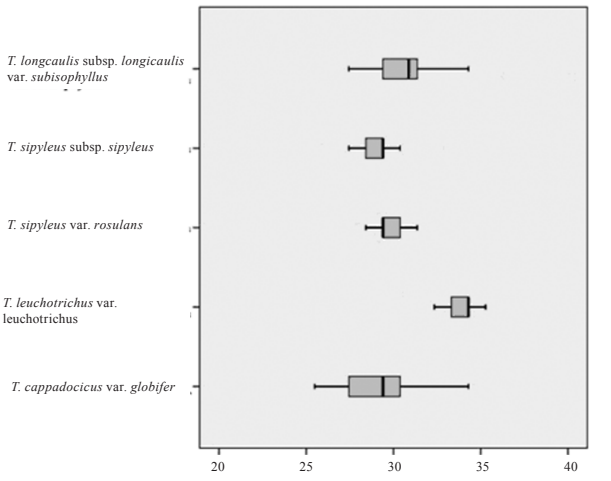


***Figure 6.2 Polar axis lengths (µm) in the Thymus species examined in this study.***

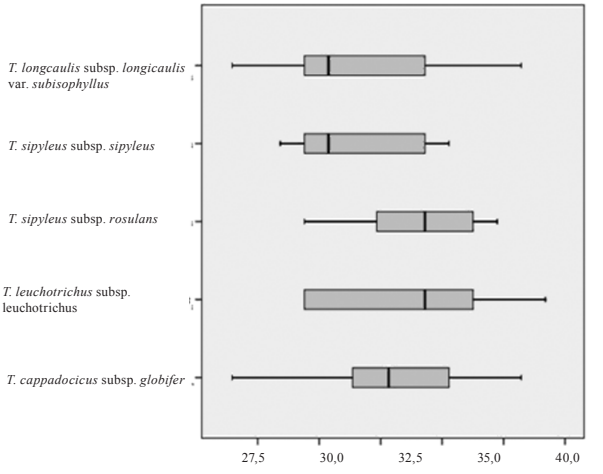


***Figure 6.3 Equatorial axis lengths (µm) in the Thymus species examined in this study.***

***Table1. Voucher specimens*** (locality, dates and voucher numbers)

| | | |
|---|---|---|
| *T. longicaulis* subsp. *longicaulis* var. *subisophyllus* | A4 Ankara: Yeşilöz, Kirmir valley, around the park, across the bridge, rocks, 40º 15'17" N, 32º 15' 56.2" E, 760 m, 02/06/2002. | B.Tarıkahya 1575 |
| *T. sipyleus* subsp. *sipyleus* var. *sipyleus* | B6 Sivas: Gemerek; Karababa Mountain, south-east slopes of Karasivri hill, open *Juniperus excelsa– Pinus sylvestris,* rocks, 39º 27'859" N, 36º 06' 918" E , 1900 – 2000 m, 04/ 07/ 2007. | B.Özüdoğru 1286 |
| *T. sipyleus* subsp. *rosulans* | B6 Sivas: Gemerek; Karababa Mountain, north-east slopes of Karasivri hill, rocks, 39º 28'729" N, 36º 05' 505" E , 1900 m, 04/ 07/ 2007. | B.Özüdoğru 1370 |
| *T. leuchotricus* var. *leuchotricus* | B6 Sivas: Gemerek; Karababa Mountain, east slopes of Karasivri hill, *Astragalus – Festuca* steppe, 39º 28'23.4" N, 36º 06' 30.7" E, 1900 – 2000 m, 09/06/2007. | B.Özüdoğru 1190 |
| *T.cappadocicus* var. *globifer* | B6 Sivas: Şarkışla; Karababa Mountain, Kazıkgeçmez, calcerous rocks, 39º 30'882" N, 36º 06' 0.52" N, 2100 – 2200 m, 09/07/2007. | B.Özüdoğru 1410 |

***Table 2. Pollen morphological features of the examined Thymus species (W).*** (Clg: colpus length, Clt: colpus width, t: apocolpium)

| Taxa | | *T. longicaulis subsp. longicaulis var. subisophyllus* | *T. sipyleus subsp. sipyleus var. sipyleus* | *Sipyleus subsp. rosulans* | *T. leuchotricus var. leuchotricus* | *T.cappadocicus var. globifer* |
|---|---|---|---|---|---|---|
| Pollen shape | | Oblate-spheriodal | spheriodal | suboblate | Prolate-spheriodal | suboblate |
| P/E | | 0.98 | 0.92 | 0.88 | 1.01 | 0.88 |
| Polar axis (µm) | M | 31.00 | 29.04 | 34.13 | 28.87 | 30.02 |
| | S | 2.43 | 1.53 | 1.78 | 2.07 | 1.57 |
| | Var. | 27.44-39.20 | 24.50-32.34 | 30.38-38.22 | 25.48-34.30 | 27.44-34.30 |
| Equatoral axis (µm) | M | 31.36 | 31.52 | 33.71 | 32.53 | 33.77 |
| | S | 3.37 | 2.16 | 3.34 | 3.07 | 2.31 |
| | Var. | 26.46-38.22 | 28.42-35.28 | 29.40-39.20 | 26.46-38.22 | 29.40-37.24 |
| AMB (µm) | M | 27.86 | 25.21 | 28.64 | 28.68 | 28.81 |
| | S | 2.03 | 1.28 | 2.5 | 3.05 | 1.90 |
| | Var. | 22.54-30.38 | 20.58-27.44 | 24.50-34.30 | 23.52-36.26 | 24.50-33.32 |
| Exine (µm) | M | 1.47 | 1.56 | 1.50 | 1.76 | 1.30 |
| | S | 0.49 | 0.48 | 0.49 | 0.39 | 0.46 |
| | Var. | 0.98-1.96 | 0.98-1.96 | 0.98-1.96 | 0.98-1.96 | 0.98-1.96 |
| Clg/Clt | | 8.71 | 8.71 | 10.80 | 6.48 | 8.15 |
| Clg (µm) | M | 25.02 | 22.14 | 28.19 | 21.98 | 23.16 |
| | S | 2.53 | 1.77 | 2.51 | 2.05 | 1.53 |
| | Var. | 19.60-29.40 | 19.60-25.48 | 23.52-33.32 | 18.62-26.46 | 20.58-26.46 |
| Celt (µm) | M | 2.87 | 2.54 | 2.61 | 3.39 | 2.84 |
| | S | 1.02 | 0.79 | 0.86 | 0.95 | 0.90 |
| | Var. | 1.96-4.90 | 0.98-3.92 | 1.96-4.90 | 1.96-5.88 | 1.96-4.90 |
| t (µm) | M | 5.58 | 6.14 | 5.74 | 7.12 | 6.07 |
| | S | 0.77 | 1.11 | 0.76 | 1.08 | 0.86 |
| | Var. | 3.92-6.86 | 3.92-8.82 | 3.92-6.86 | 5.88-9.80 | 3.92-7.84 |
| Intine | M | O.98 | 0.89 | 0.81 | 0.89 | 0.98 |
| | S | 0 | 0.18 | 0.23 | 0.18 | 0 |
| | Var. | O.98 | 0.49-0.98 | 0.49-0.98 | 0.49-0.98 | O.98 |

***Table 3. The enlarged characters of species***

| Species | Characters added | Flora of Turkey |
|---|---|---|
| *T. longicaulis* | At least basal half of cauline leaves are ciliate, Calyx 2.5-5 mm | Basal half of cauline leaves not indicated. Calyx 2.5-4 mm |
| *T. sipyleus* | Bracts green, 3-4 x c.2 mm, ovate to lanceolate, margin ciliate. | Not indicated |
| *T. leuchotrichus* | Bracts 4-6 x 1.8-3.5 mm | Bracts 1.8-3.5 mm broad |
| *Thymus cappadocicus* | - | - |

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## APPENDIX

***T. longicaulis*** C. Presl subsp**.** ***longicalis*** var. ***subisophyllus*** (Borbas) Jalas

Mat-forming, with long ± woody creeping branches, non-flowering or with a terminal inflorescence. Flowering stems commonly to 10 (-15) cm, retrorse hairy all round and cauline leaves all (except small leaves of basal fascicles) of about equal size, 5.5-13.5 x 1.5-2.5 mm, commonly 3-5 x as long as broad, linear–lanceolate to oblanceolate obtusish, often with weakly revolute margins**,** at last basal half ciliate; oil dots numerose, usually red; lateral veins seldom prominent, evanescent. Bracts similar to leaves but often suffesed with purple and outer ones usually larger. Bracteoles usually 1-2 mm, shorter than pedicels. Calyx 2.5-5 mm, suffused with purple, upper lip equaling lower teeth, upper teeth (0.5-) 0.7-1 mm, not pungent, lower teeth 2.5-3 mm, ciliate; corolla lilac to purple, bilabiate, upper lip emarginate, lower lip 3 lobed, outer surfaces pubescent and densely oil dots. Stamen 4, exserted. Nutlets glabrous.

**Flowering time:** 5-8

**Habitat:** Stony and rocky mountain slopes, 1000-3600 m.

**Distribition:** North and central Anatolia.

***T. sipyleus*** Boiss.

Low woody and freely branching subshrub forming dense cushions. Flowering stems 1-7 (-10) cm, erect, hairy all round with mainly short reflexed hairs; internodes shorter than or ± as long as leaves; axillary clusters of small, ovate, tightly imbricate decussate leaves present. Cauline leaves 3-6(-9) mm, ovate to lanceolate, obtuse, ± carnose; both surfaces covered sparsely eglandular hairs long ciliate at the base, oil dots usually absent, or few above; lateral veins 3 pairs, joining to form a marginal thickening, prominent, best developed in leaf-like bracts. Inflorescence a compact

head or only weakly differentiated from vegetative shoot, usually with 2-flowered verticillasters. Bracts leaf-like, green, 3-4 x c.2 mm, ovate to lanceolate, margin ciliate. Bracteoles usually 1-1.5 mm, ciliate, longer than pedicels. Calyx 3.2-3.8(-4.5) mm, usually green, sometimes purple on veins and upper part of tube, ± campanulate,10 veined, oil dots present; lips of ± equal length and equaling tube, upper teeth 0.5-0.9(-1.2) mm ciliate, lower teeth to 2 mm, long ciliate, hairs to 0.5 mm, especially at base of teeth. Corolla 5-6 mm. white, sometimes pink in lips, exserted calyx, bilabiate, upper lip emarginate, lower lip 3 lobed, outer surfaces pubescent and oil dots. Stamen 4, exserted. Nutlets glabrous.

**Flowering time:** 5-8.

**Habitat:** Mountain steppes, rocky slopes, 400-2700 m.

Middle cauline leaves lanceolate to almost linear, more than 3x longer than wide, often ± flat; lateral veins mostly 2 pairs, not prominent; inflorescence capitate to somewhat elongated, often with many flowered verticillasters

subsp. ***rosulans***

Middle cauline leaves ovate-elliptic to ovate-lanceolate, to 3x as long as broad, often recurved and ±keeled; lateral veins 3 pairs, prominent; inflorescence a compact head or only weakly differentiated from vegetative shoot, usually with 2-flowered verticillasters

subsp. ***sipyleus***

*T. sipyleus* Boiss. subsp. *sipyleus* is endemic for Turkey and distributed west, south and inner Anatolia.

*T. sipyleus* Boiss. subsp. *rosulans* (Borbas) Jalas is mainly distributed north, central and west Anatolia and Aegean islands.

***T. leuchotricus*** Hal. **var. *leuchotricus***

Dwarf shrub forming loose cushions or mats. Primary branches procumbent, with axillary leaf fascicles or erect flowering stems 1.5-6 cm, retrorse and patent hairy all round. Leaves 4-9.5 x 0.6-1.3 mm, linear-lanceolate, velutinos-puberulent with additional longer hairs, oil dots absent or few, pale; margins slightly revolute or with a thickened pseudo-revolute margin, at least basal half ciliate. Inflorescence capitate. Bracts 4-6 x 1.8-3.5 mm, elliptic-ovate, usually with a marginal thickening and revolute margins towards apex, mostly colored towards base, with 1-2(-3) pairs of lateral veins beneath. Bracteoles 1-2.5 mm. Calyx 3.5-5 mm, usually green, oil dots absent or few, yellowish; lips longer than tube, upper teeth 0.8-1.6 mm, ciliate, lower teeth 2-2.8 mm, ciliate. Corolla mauve to purple, 6-8 mm, exserted calyx, bilabiate, upper lip emarginate, lower lip 3 lobed, outer surfaces pubescent and oil dots. Stamen 4, exserted. Nutlets glabrous.

**Flowering time:** 6-7.

**Habitat:** Mountain steppes, rocky slopes, 1200-c.3000 m.

**Distribition:** Mainly distributed inner Anatolia, mountains of S. Balkans and Crete.

E. Medit element.

***T. cappadocicus*** Boiss. **var. *globifer*** Jalas

Basal branches woody, ascending and freely branching to form dense cushions of erect flowering stems 2-3 cm; stems ± quadrangular, puberulent to hirsute. Leaves linear, acutish, 3-9 x 0,4-0,8 mm, longer than internodes, oil dots absent or sparse, yellow to orange; margins revolute, ciliate at least in lower half. Inflorescence 7-9-flowered, globose. Bracts leaf-like, ovate-lanceolate, 4-6.5 x 0.8-1.5 mm, ciliate, overtopping flowers, lateral veins obsolete, Bracteoles lanceolate-subulate, 1.5-2.5 mm, longer than pedicels. Calyx campanulate, 2.8-4 mm, tube hirsute, upper lip as long as or shorter than lower teeth; upper teeth 0.8-1.8 mm, triangular, ciliate. lower teeth c.2 mm, usually purple, ciliate. Corolla white to lilac, c. 5-6 mm, exserted calyx, bilabiate, with short hairs and sparse oil dots. Stamen 4, exserted. Nutlets glabrous.

**Flowering time:** 6-7

**Habitat:** Open calcareous ground, 1000-1800 m. Irano-Turanien element.

**Distribition:** This variety endemic of central Anatolia.