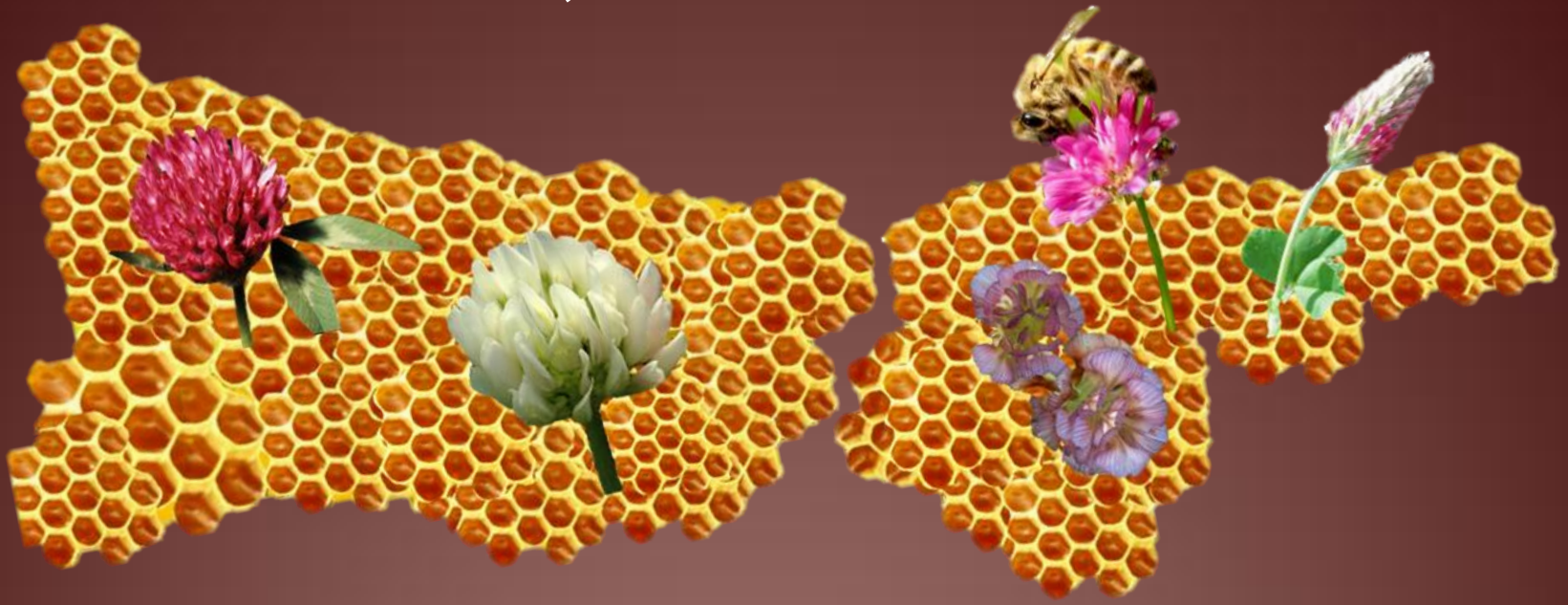
The Favorite Plants of Honey Bees in Istanbul; *Trifolium* Species



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The Genus *Trifolium* L. in the World

- The Fabaceae (Leguminosae) is the third largest family of flowering plants (727 genera and ca. 19,325 species (Lewis et al., 2005)
- The clover genus, *Trifolium* L., is one of the largest genera in the family, with ca. 255 species (Gillett and Taylor, 2001; Keskin 2004; Zohary and Heller, 1984).
- Clovers are widely grown as livestock forage and green manure crops, many native species are also utilized by grazing animals (Crampton, 1985).
- At least 16 species of *Trifolium* are actively cultivated (Gillett and Taylor, 2001)

Trifolium montanum subsp. *humboldtianum*

The Native Distribution

- The native distribution of *Trifolium* encompasses the temperate and, to a lesser extent, subtropical regions of the Northern and Southern Hemispheres.
- Native clovers are absent from southeast Asia and Australia.
- The greatest species diversity is found in three geographic regions:

(1) the Mediterranean basin,

(2) western North America

(3) the highlands of eastern Africa.

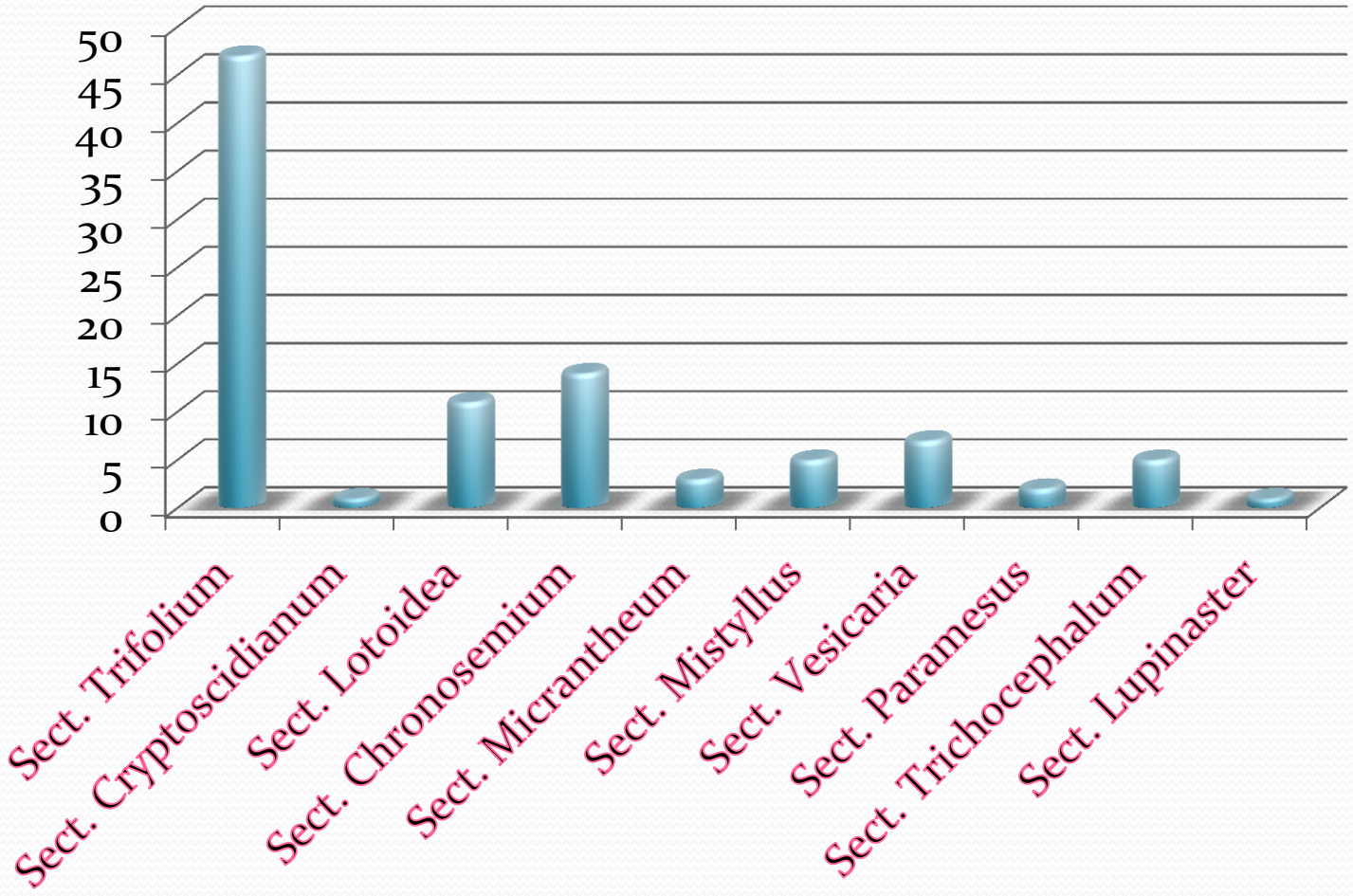
(Ellison et al. 2006)

The Habitat

- *Trifolium* species occur in a wide range of habitats, including meadows and prairies, open woodlands, semi-deserts, mountains, and alpine peaks.
- A common feature of these diverse habitats is high solar radiation; few clover species tolerate shade.

The Genus *Trifolium* L. in Turkey

- The genus *Trifolium* is represented by 104 species in Turkey of which 16 are endemics and it is grouped into 10 sections (Keskin 2001).



The Genus *Trifolium* L. in Istanbul

The genus *Trifolium* is represented by 71 taxa (55 species with 1 subspecies and 15 varietes) in Istanbul and it is grouped into 9 sections.

The Trifolium species of Istanbul

Sect. Trifolium

T. pratense var. *pratense*
T. pratense var. *americanum*
T. pratense var. *sativum*
T. pallidum
T. medium var. *medium*
T. medium var. *eriocalycinum*
T. ochroleucum
T. pannonicum subsp. *elongatum* (end)
T. rubens (doubtful)
T. stellatum var. *stellatum*
T. stellatum var. *longiflorum*
T. stellatum var. *xanthium*
T. incarnatum var. *incarnatum*
T. incarnatum var. *molinieri*
T. sylvaticum
T. striatum
T. bocconei
T. scabrum

T. lucanicum
T. hirtum
T. ligusticum
T. lappaceum
T. cherleri
T. arvense var. *arvense*
T. affine
T. angustifolium
T. purpureum var. *purpureum*
T. purpureum var.laxiusculum
T. apertum var. *kilaeum* (end.)
T. apertum var. *apertum*
T. bertyheum (doubtful)
T. squamosum
T. obscurum
T. constantinopolitanum
T. leucanthum
T. echinatum var. *echicanum*

Sect. Cryptoscidianum

T. uniflorum

Sect. Lotoidea

T. repens var. *repens*
T. repens var.*biasolettii*
T. repens var.giganteum
T. repens var.orphanideum (rare)
T. hybridum var. hybridum
T. hybridum var. *anatolicum*
T. nigrescens subsp. *petrisavii*
T. nigrescens subsp.*nigrescens*
T. michelianum var. *michelianum*
T. michelianum var. *balansae*
T. retusum

Sect. Chronosemium

T. mesogitanum
T. sebastiani (doubtful)
T. campestre
T. patens
T. dubium
T. micranthum

Sect. Micrantheum

T. glomeratum
T. suffocatum
T. pachycalyx (end.)

T. glomeratum

Sect. Mistyllus

T. spumosum
T. mutabile (doubtful)
T. vesiculosum var. *rumelicum*

T. spumosum

Sect. Vesicaria

T. fragiferum var. *fragiferum*
T. fragiferum var. *pulchellum*
T. resupinatum var. *resupinatum*
T. tomentosum var. *tomentosum*
T. tomentosum var. *lanatum*

T. fragiferum

Sect. Paramesus

T. strictum

T. glanduliferum var. *glanduliferum*

Sect. Trichocephalum

T. pauciflorum

T. pilulare

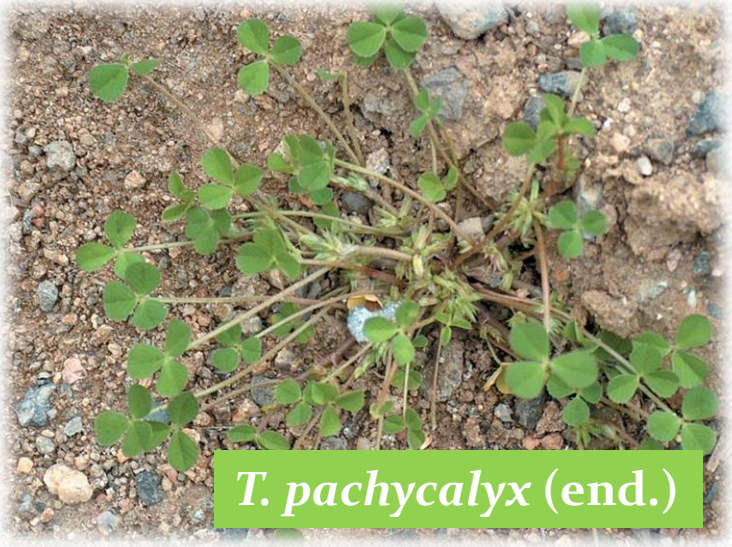
T. globosum

T. subterraneum

The Morphology of *Trifolium* Species

- Annual or perennial herbs, often prostrate and rarely more than 50 cm tall.

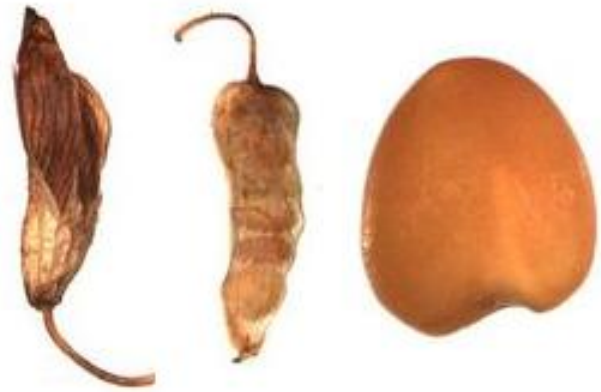
- The genus name refers to the distinctive leaves usually composed of three leaflets (trifoliolate).
- Leaflets; stipules obviously, usually entire, adnate to the petiole.



- The small to medium-sized flowers (ca. 0.3–2.5 cm) are usually arranged in capitate to spicate heads.
- Corolla pink, red to purple, white or yellow, usually persistent.
- Calyx variable, sometimes accrescent, indurated or inflated, throat open or closed by a 2-lipped callosity; teeth equal or unequal.

- Stamens diadelphous.
- Legume usually included in the calyx, often indehiscent, l-2(-10)-seeded.

Trifolium repens



Trifolium arvense

Trifolium resupinatum

Why the Favorite Plants of Honey Bees?

The question has 5 answers…

1.) *Trifolium* species have long flowering time, so they can used during four seasons by honey bees.

2.) Their inflorescence have many flowers, so when honey bees visited a specimen, they could reach many flowers and many pollen grains.

3.) *Trifolium* species live as densely populations.

4.) Honey bees can take both pollen grains and nectars from *Trifolium* species.

5.) Many *Trifolium* species can live at the same habitats, for example 54 taxa distributes between Alemdağ to Nişantepe (Istanbul), so pollen diversity is provided by bees.

Trifolium angustifolium

Trifolium constantinopolitanum

Trifolium incarnatum var. *incarnatum*

Trifolium argutum

Trifolium dubium

Trifolium incarnatum var. *molinierii*

The Honey Plants of Istanbul Project

- **Infrastructures of the Project**
  - ISTE, has 85% of Istanbul's Flora
  - Important Plant Areas of Turkey by N. Özhatay, Istanbul has 7 IPA's: Terkos/Kasatura Kıyıları, Ağaçlı Kumulları, Kilyos Kumulları, Batı İstanbul Meraları, Kuzey Boğaziçi, Sahilköy-Şile Kıyıları, Ömerli Havzası.
  - Ömerli Havzasının «İstanbul» Doğal Bitkileri by N. Özhatay, M. Keskin
  - Wild Plants of Şile by N.&E. Özhatay, A. Ö. Erdem

- The project named as ‘’The Platform of Bees’’

is funded by Istanbul Development Agency and coordinated of BalDer (It is a national society on honey products). Honey plants of Istanbul is a part of this project and carried out by Istanbul University Faculty of Pharmacy and The Herbarium of ISTE .

- The major objectives of this project are to identify the plant sources used for the production of wildflower honey in Istanbul (Turkey).

Material and Methods

- In the study, 6 districts have been chosen where honey is produced by beekeepers in Istanbul.
- Field trips have been started on June 2011, 8 field trips have been done during 2011, and approximately 300 flowered plants have been collected.

1. Silivri 2. Şile	3. Sarıyer 4. Beykoz	5. Çekmeköy 6. Çatalca

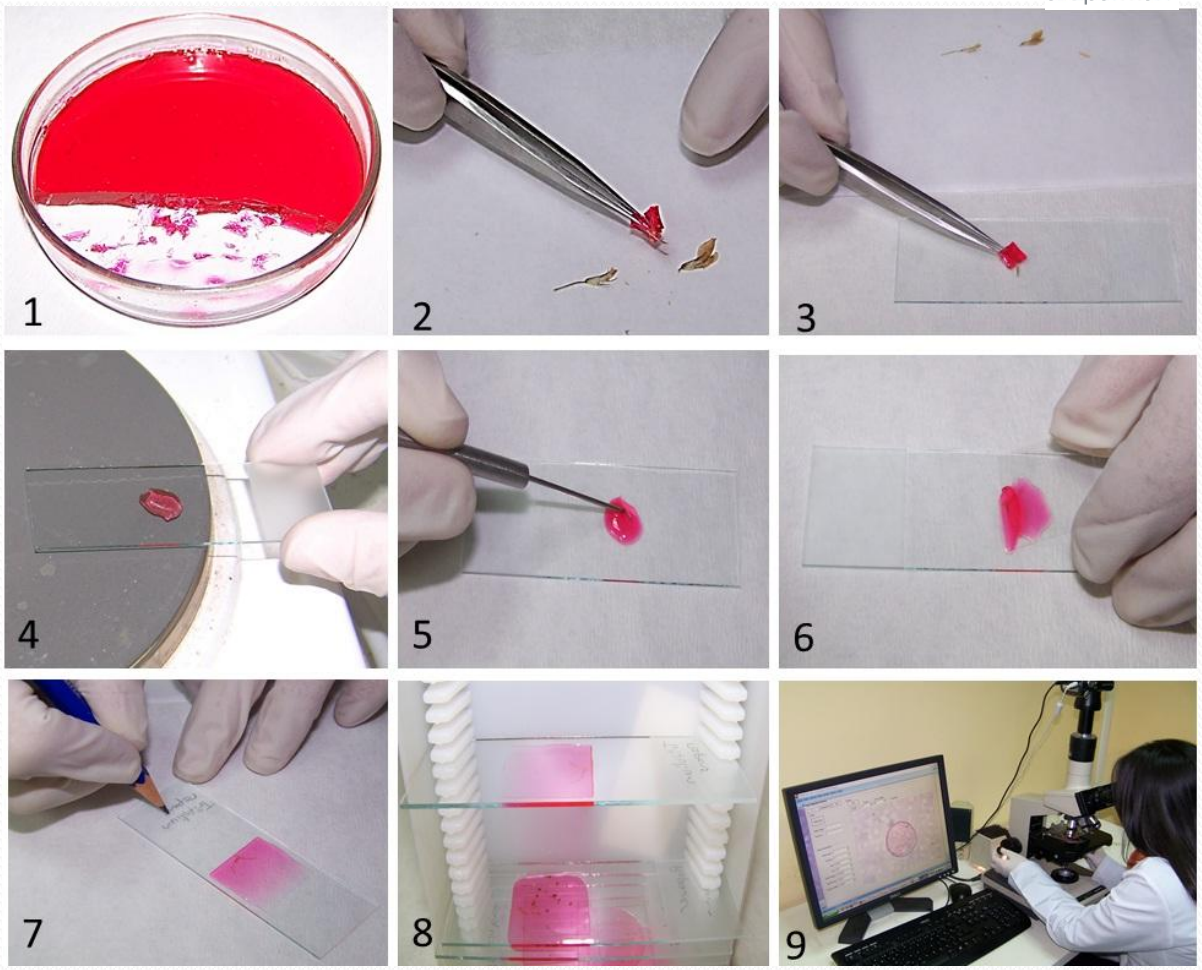
- They have been kept in ISTE (Herbarium of Istanbul University, Faculty of Pharmacy). The plant sources were identified used for the production of wildflower honey in Istanbul.

- As a result of field studies, *Trifolium* species which are mostly visited by honey bees in Istanbul around were collected during field trips.

Taxon	Pollen/ Nectar	Traditional Medicine	Pharmacological Activity
Trifolium angustifolium *Trifolium arvense* var. *arvense* *Trifolium campestre* *Trifolium constantinopolitanum* *Trifolium echinatum* *Trifolium ligusticum* *Trifolium michelianum* var. *balansae* *Trifolium nigrescens* subsp. *petrisavii* *Trifolium pallidum* *Trifolium pannonicum* subsp. *elongatum* *Trifolium patens* *Trifolium pratense* var. *pratense* *Trifolium purpureum* *Trifolium repens* var. *repens* *Trifolium resupinatum* var. *resupinatum* *Trifolium striatum* *Trifolium subterraneum*	   	for wound healing	estrogenic, chemoprotective, cardiotonic, against prostate cancer 

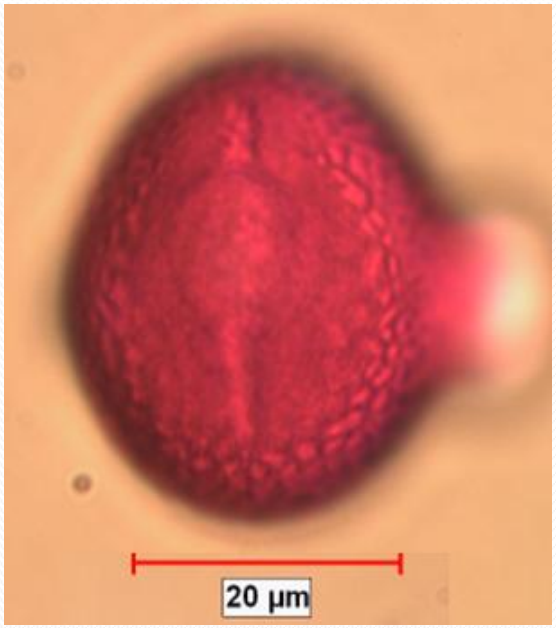
- Our object was to examine the pollen morphology of 17 of *Trifolium* taxa by using the data obtained from LM observations.
- Pollen grains of specimens for LM investigations were prepared according to the methods of Wodehouse (1935), and they were compared with the pollen grains into honey in Altıparmak Laboratory.

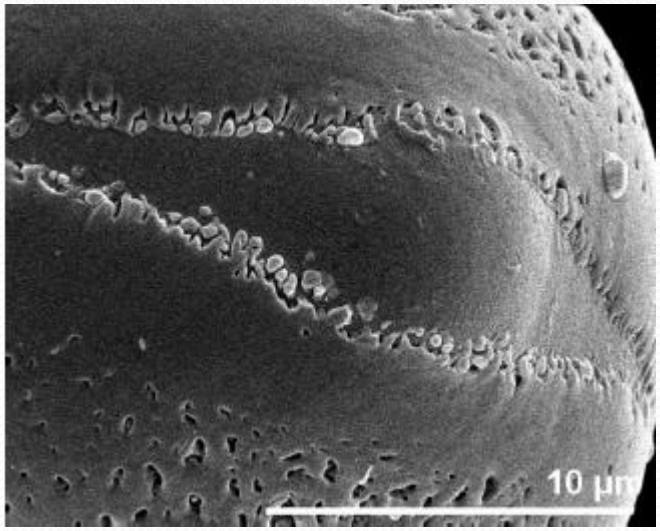
altıparmak



Pollen Grains of *Trifolium* species

- The *Trifolium* pollen grains are almost globular 31.05 x 26.96 µ when turgid, with a little flattening around the germ pores, and have an average size of 44.5 x 43 µ
- They are usually 3-colporate.
- The colpus generally extends not fully to the end of the grain, it may be very wide or may have an operculum, which may be ornamented (e.g. reticulate), or thin and scabrate.
- Aperture peculiarities: Smooth aperture membrane, aperture surface without an exine elements
- Pollen grain with elongated apertures situated at the equator.





Aperture peculiarities

17 taxa were treated using Woodhause Methods for examination by LM, pollen was mounted in glycerine jelly. Measurements were taken from at least 15 grains of each sample.

	Area µm²	FilledArea µm²	Perimeter µm	ConvPerim µm	Length µm	Width µm	OuterDiam µm	Sphericity	Roundness	AspRatio	Compactness	Roughness	SpherDiam µm
T. repens var. repens	474,55	474,55	100,12	79,85	26,65	24,00	29,02	0,61	0,85	1,11	0,93	0,80	30,08
T. angustifolium	673,57	673,57	131,54	99,01	35,15	27,94	36,98	0,51	0,69	1,26	0,86	0,76	35,78
T. patens	342,74	342,74	79,87	68,77	23,21	20,41	24,81	0,68	0,81	1,14	0,91	0,86	25,57
T. striatum	510,20	510,20	99,79	83,95	29,24	24,11	31,12	0,65	0,76	1,22	0,91	0,84	31,18
T. lingusticum	393,16	393,16	99,08	75,51	25,89	22,04	28,08	0,53	0,74	1,18	0,86	0,78	27,31
T. pratense var. pratanse	1176,80	1176,80	149,93	124,28	41,25	37,83	44,31	0,66	0,88	1,09	0,95	0,83	47,32
T. nigrescens subsp. petrisavii	439,78	439,78	87,28	76,42	25,46	23,09	27,07	0,73	0,86	1,10	0,95	0,88	28,96
T. subterraneum	798,73	798,73	128,88	105,04	35,91	30,83	38,45	0,62	0,79	1,17	0,91	0,82	38,98
T.constantinopolitanum	658,78	658,78	114,88	94,11	32,17	27,70	34,41	0,64	0,81	1,17	0,93	0,83	35,39
T. pallidum	697,93	697,93	127,72	97,65	32,70	29,37	36,08	0,55	0,83	1,11	0,92	0,77	36,48
T. purpureum	973,24	973,24	160,38	115,23	39,28	34,22	41,61	0,48	0,80	1,15	0,92	0,73	42,94
T.echinatum	793,06	793,06	137,23	103,11	34,81	30,72	36,53	0,55	0,83	1,13	0,93	0,76	38,81
T. arvense	398,84	398,84	87,35	74,51	25,62	21,58	26,92	0,66	0,77	1,19	0,90	0,86	27,54
T. campestre	314,30	314,30	76,60	65,14	22,10	19,30	23,44	0,68	0,81	1,15	0,92	0,86	24,41
T. pannonicum subsp.elongatum	1002,18	1002,18	152,95	116,74	39,69	34,64	42,21	0,57	0,81	1,15	0,92	0,78	43,72
T. resupinatum var. resupinatum	727,09	727,09	128,93	100,68	34,68	29,14	36,89	0,56	0,77	1,19	0,90	0,78	37,21
T. michelianum var. balansae	385,26	385,26	81,91	71,75	24,11	21,34	25,93	0,73	0,84	1,13	0,94	0,88	27,11

According to shape

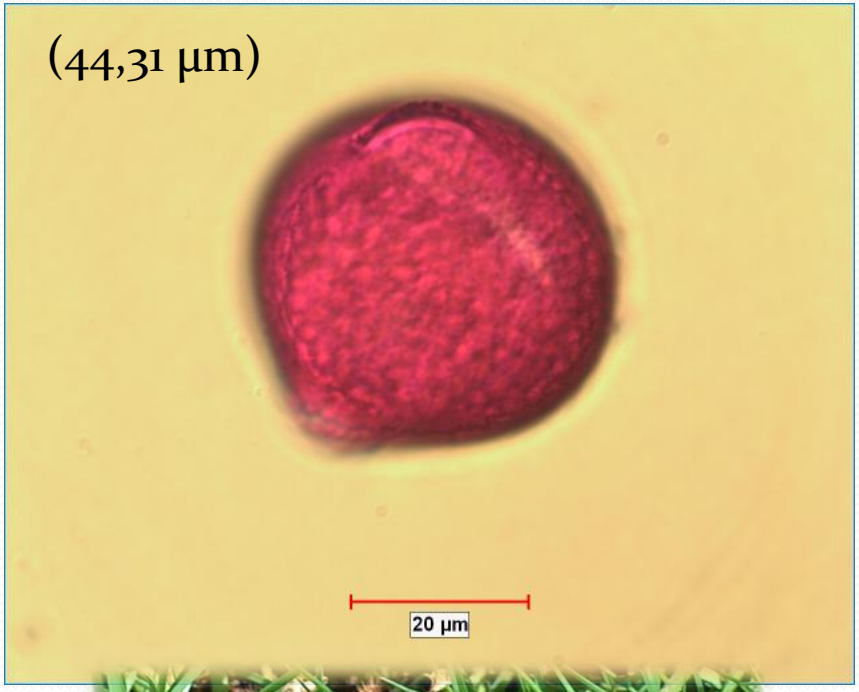
subspheroidal

Prolate

T. nigrescens subsp. petrisavii

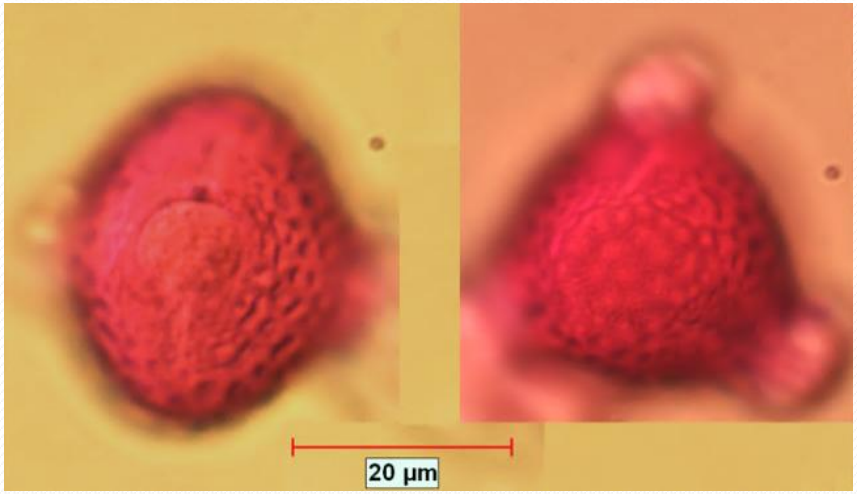
T. subterraneum

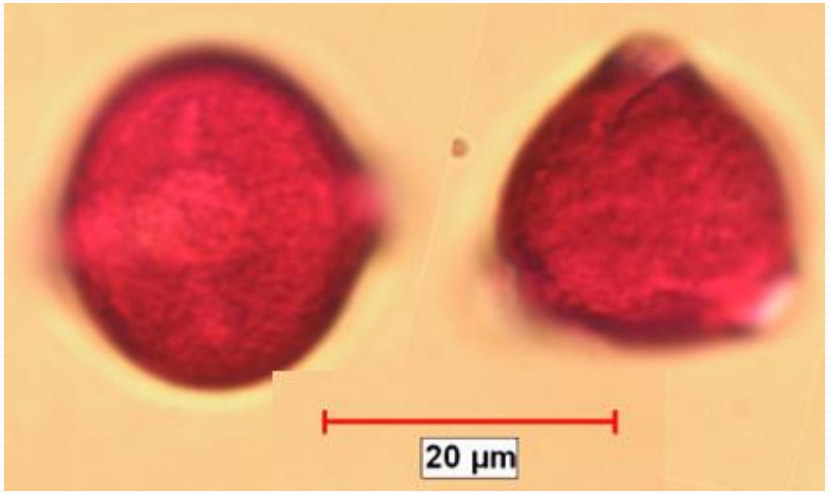
According to and size



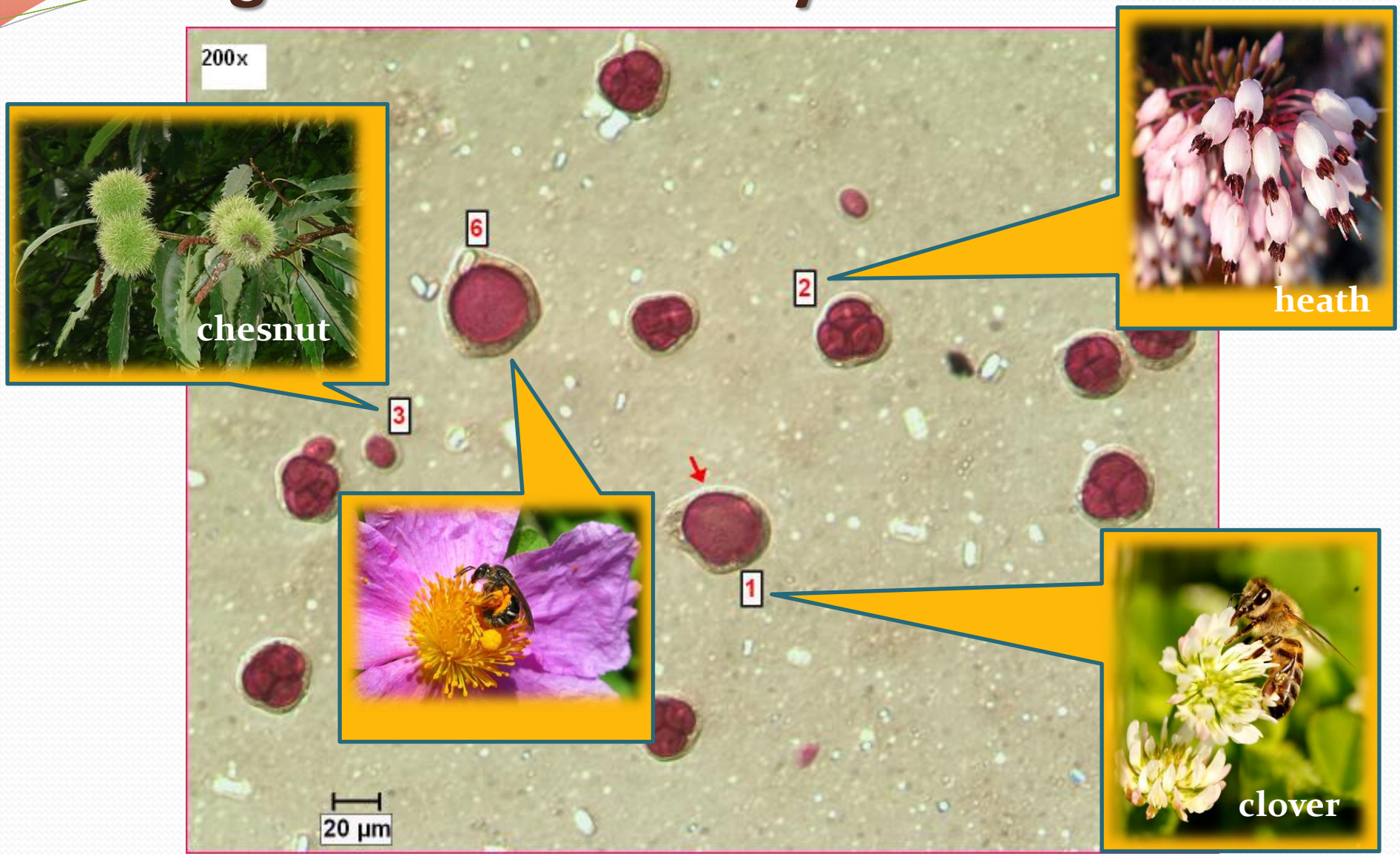
The use of the following size categories: very small (< 10 µm), small (10–25 µm), medium (26–50 µm), large (51–100 µm) and very large (>100 µm).

According to surface

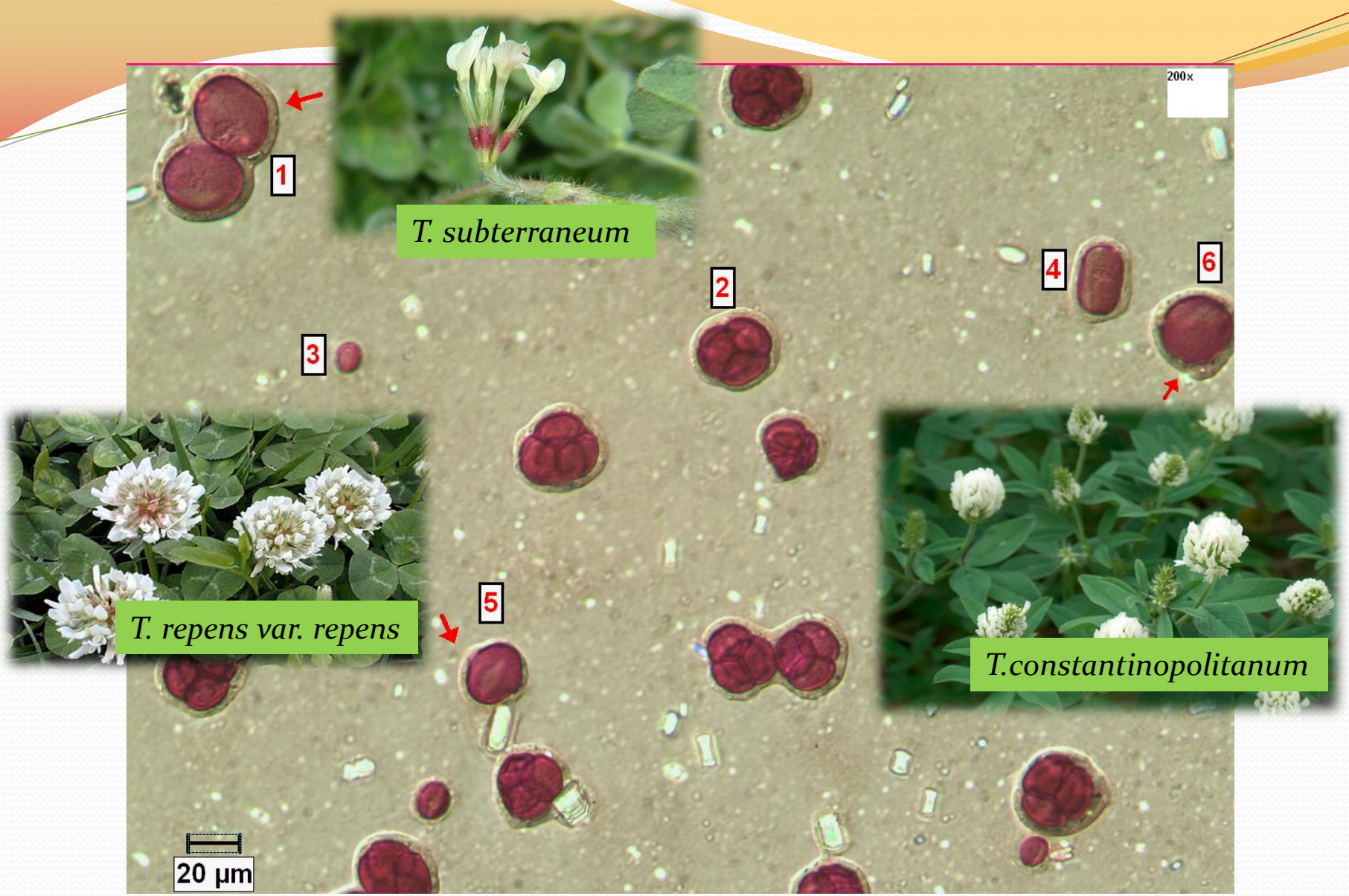




Pollen grains from honey of Istanbul

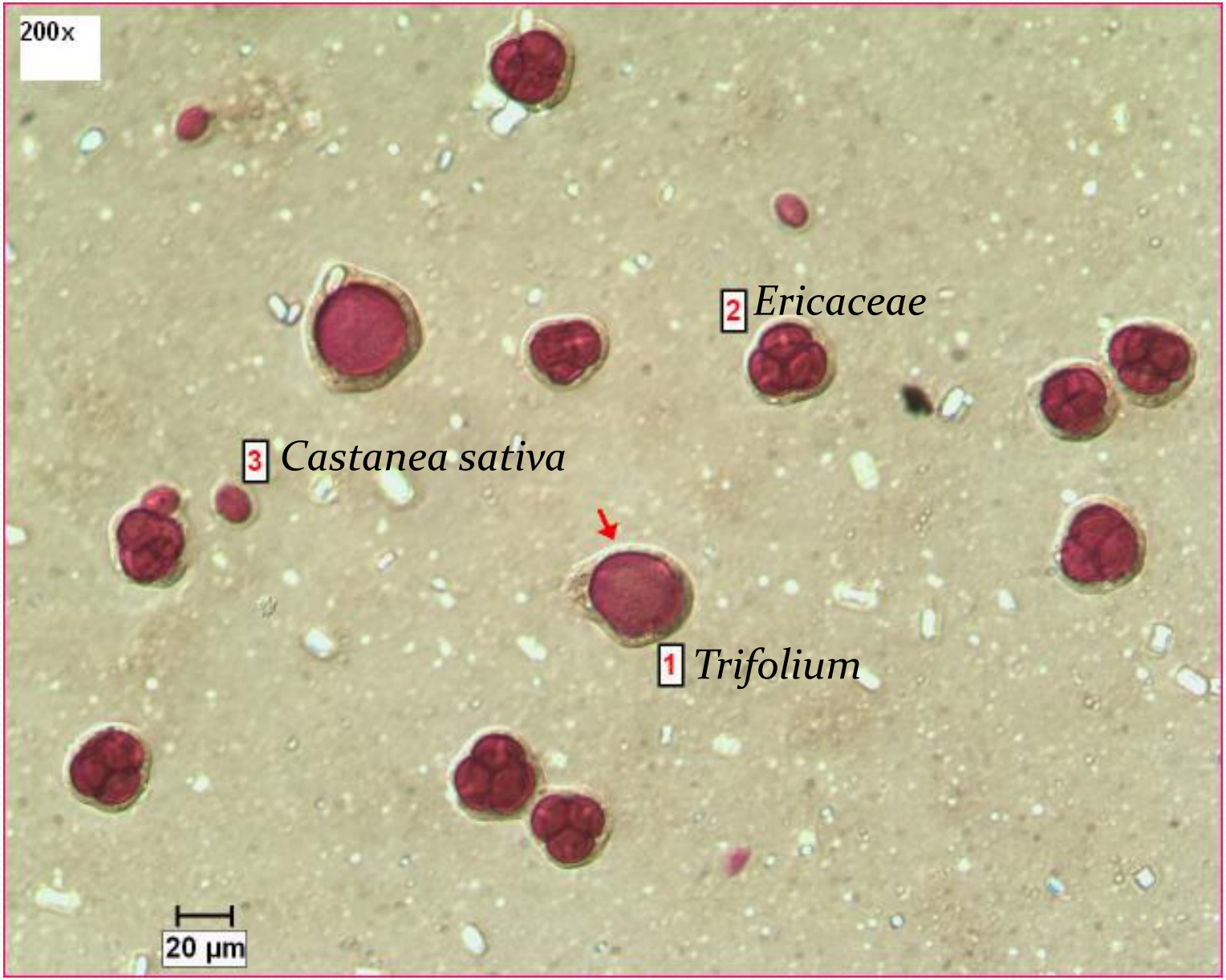


1; Trifolium, 2; Ericaceae, 3; Castanea sativa, 6; Cistus



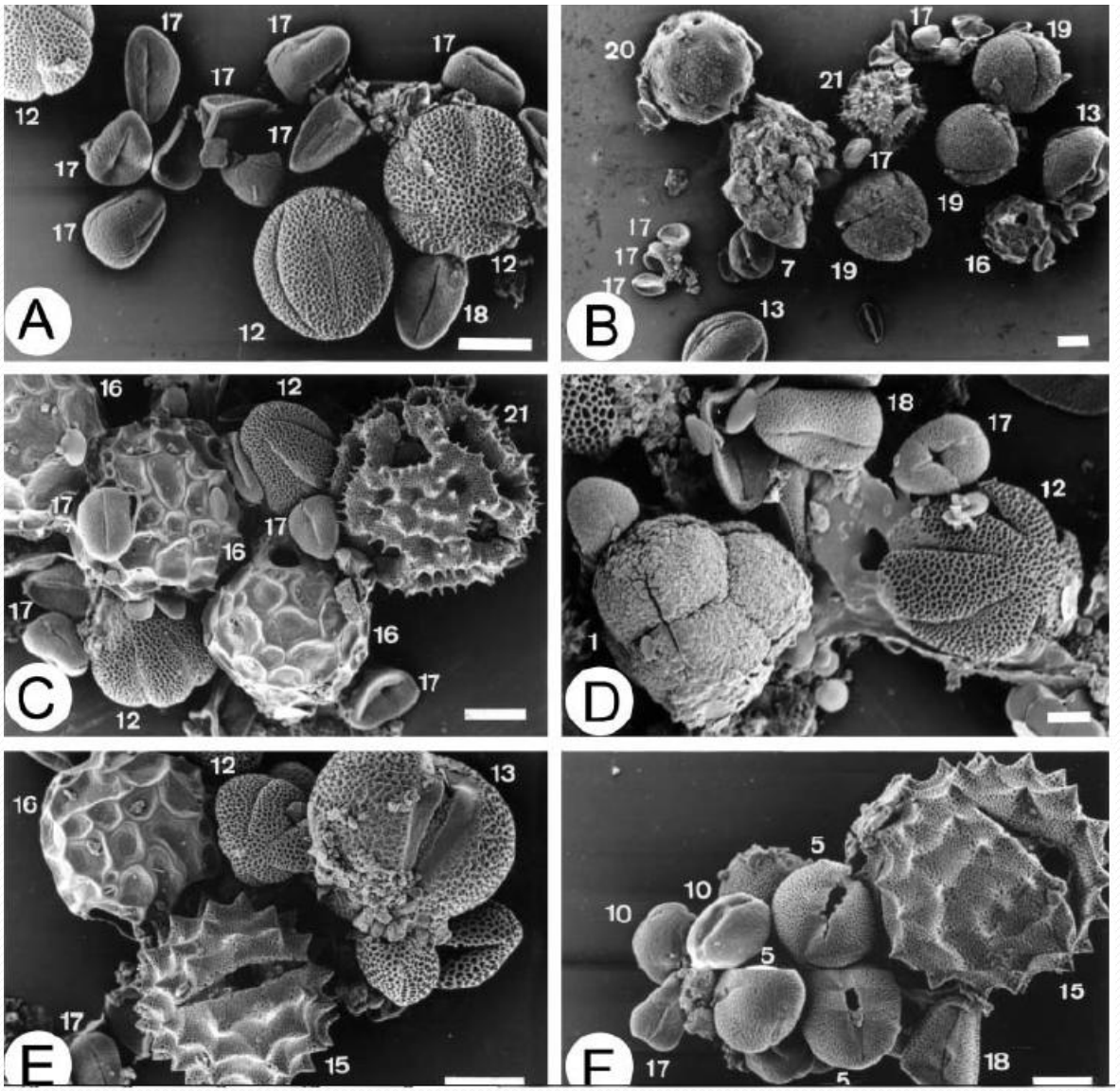
1; Trifolium subterraneum, 2; Calluna vulgaris, 3; Castanea sativa, 4; Onobrychis viciifolia, 5; Trifolium repens, 6; Trifolium constantinopolitanum.

A Puzzle of Pollen Grains for you…



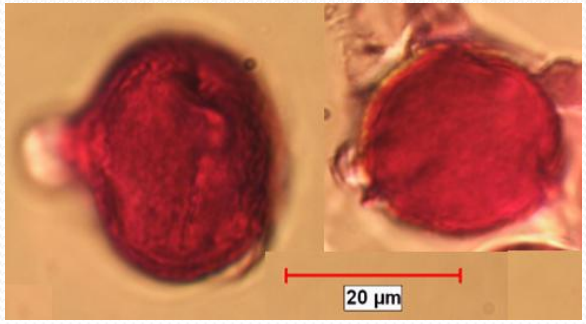
Grana, 2006; 45: 146–159

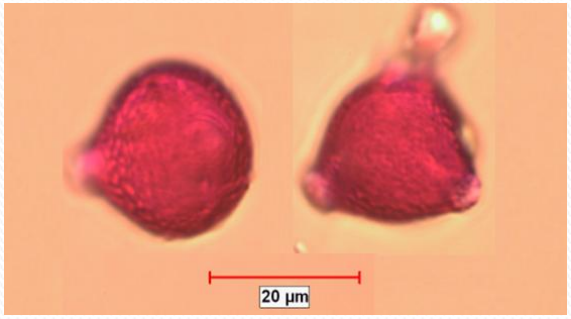
Pollen and sensorial characterization of different honeys from El Hierro (Canary Islands)

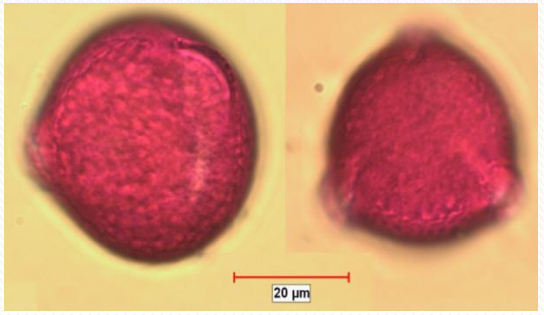


Conclusions

- The information may be used to develop analytical standards among honey and medicinal plants.
- General principles outlined by the International Commission for Bee Botany have been used as a guide, although in practice these are considerably modified.
- An analytical study of honey provides a basis for identifying the origins of a honey in terms of locality and floral source.







Thank you for your attentions...

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