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BIOLOGY

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POLLEN MORPHOLOGY OF TURKISH CENTAURIUM HILL. (GENTIANACEAE)

N. Münevver Pınar*

Received 10.8.1998

Abstract

Pollen grains of 9 taxa the genus *Centaurium* Hill. (*Gentianaceae*), have been examined in detial comparatively by using light microscopy (LM) and scanning electron microscopy (SEM). Pollen description of each taxon has been given. *C. erythraea* Rafn., *C. tenuiflorum* (Hoffmanns & Link) Fritsch., and *C. pulchellum* (Swartz) Druce are similar in pollen morphology. *C. spiratum* (L.) Fritschen and *C. maritimum* (L.) Fritsch with pollen morphology can be differentiated from the other species.

Key Words : *Centaurium, Gentianaceae,* Pollen morphology.

Introduction

The genus *Centaurium* Hill (*Gentianaceae*) is represented by 5 species and 6 subspecies in Flora of Turkey [1]. The taxa are classified only on the basis of corolla colour and inflorescens structure. According to Jacobsen [1] there are difficulties in the separation of subspecies belonging to *C. erythracea* Rafn. *and C. tenuiflorum* (Hoffmanns & Link) Fritsch.

There are few studies in pollen morphology of *Centaurium*. Punt and Nienhuis [2] give the pollen descriptions of the European members of the family *Gentianaceae* and place them into 8 pollen types (*Gentianella detonsa* type, *Gentiana pneumonanthe* type, *Centaurium pulchellum* type, *Lomatogonium rotatum* type, *Gentianella campestris* type, *Cicendia filiformis* type, *Blackstonia perfoliata* type and *Gentianella tenella* type).

In this study, pollen morphology of all Anatolian *Centaurium* species is examined by LM and SEM and then compared with the pollen types defined by Punt and Nienhuis. It is also aimed to provide some palynological help in the taxonomy of the genus.

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Materials and Methods

Plant materials were received from the herbaria of ANK (Ankara University) and HUB (Hacettepe University).

Pollen grains were prepared according to the acetolysis method as described by Erdtman [3].

The light microscopical work was done with a Nicon microscope (100x). Data on size have been based on the measurements of 20 pollen grains for each taxon. A Leitz-Wetzlar microscope was employed for photographing.

The air-dried material for SEM was coated with gold. Scanning electron micrographs were taken with a Jeol 100 CXII microscope.

Terminology mainly follows Erdtman [4] with some addional terms from Punt and Nienhuis [2].

Specimens investigated
[in the order given by Jacobsen (1)]

Centaurium erythraea Rafn subsp *rumelicum*	Elazığ H. Evren 359 (ANK)
C. erythraea Rafn subsp. *erythrae*	Artvin A.Düzenli 840 (ANK)
C. erythraea Rafn. subsp *turcicum*	Yozgat R. İlarslan 495 (ANK)
C. erythraea Rafn. subsp *rhodense*	Manisa H. Peşmen 1978 (HUB)
C. pulchellum (Swartz) Druce	Konya E.Yurdakulol 36 (ANK)
C. tenuiflorum (Hoffmanns & Link) Fritsch subsp. *tenuiflorum*	Antalya Davis 503 (ANK)
C. tenuiflorum (Hoffmanns & Link) Fritsch subsp. *acutiflorum*	Aydın H. Peşmen 867 (ANK)
C. spicatum (L) Fritsch	Antalya H. Peşmen 4918 (ANK)
C. maritimum (L) Fritsch	Bolu M. Aydoğdu 288 (ANK)

Results

Pollen descriptions

Centaurium erythraea* Rafn subsp. *rumelicum (Figs 1.a-d)

Pollen class: 3-Zonocolparate

P/E ratio: Prolate-spheroidal

Apertures: Ectoaperture-Colpus, long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct and granular.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate short, less dense; muri broad, often anostomosing; parallel to colpus.

Measurements: P 29.8 μm; E 28.8 μm; polar exine 3.8 μm, equatorial exine 2.7 μm; Clg 28.5 μm, Clt 5.3 μm; Plg 5.7 μm, Plt 5.3 μm; Apocolpium 6 μm.

C. erythraea* Rafn. subsp. *erythraea (Figs 1.e-i)

Pollen class: 3-Zonocolporate. Sometimes 4 pantocolporate (%3).

P/E ratio: Oblate - spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; parallel to colpus, curved near poles; perforation very small.

Measurements; P 26.4 μm; E 26.4 μm; polar exine 3 μm, eequatorial exine 3 μm; Clg 23.3 μm, Clt 5 μm; Plg 5 μm, Plt 5 μm; Apocolpium 5 μm.

C. erythraea* Rafn. subsp. *turcicum (Figs 1.j-n)

Pollen class: 3-Zonocolporate

P/E ratio: Prolate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a less distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine a little thicker than nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; perpendicular to pore and parallel to colpus at poles; perforation wide.

Measurements; P 26.6 µm; E 25.3 µm; polar exine 3.9 µm, equatorial exine 2.9 µm; Clg 26 µm, Clt 5.3 µm; Plg 4.3 µm, Plt 4.3 µm; Apocolpium 5 µm.

C. erythraea* Rafn. subsp. *rhodense (Figs 1.o-s)

Pollen class: 3-Zonocolporate

P/E ratio: Oblate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine a little thicker than nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; parallel to colpus at mesocolpia; perforation wide.

Measurements; P 34.8 µm; E 35.8 µm; polar exine 3.3 µm, equatorial exine 4.1 µm; Clg 31.2 µm, Clt 5.7 µm; Plg 6.8 µm, Plt 6.2 µm; Apocolpium 9.9 µm.

***C. pulchellum* (Swartz) Druce** (Figs 2.a-e)

Pollen class: 3-Zonocolporate

P/E ratio: Prolate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; parallel to colpus, curved near poles; perforation wide.

Measurements: P 32.5 µm; E 29.8 µm; polar exine 3.8 µm, equatorial exine 2.5 µm; Clg 30.5 µm, Clt 5.3 µm; Plg 5.3 µm, Plt 5.5 µm; Apocolpium 6 µm.

C. tenuiflorum* (Hoffmanns & Link) Fritsch subsp. *tenuiflorum (Figs 2.f-k)

Pollen class: 3-Zonocolporate

P/E ratio: Prolate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct and less granular.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Muri thin, running parallel to colpi, frequently anastomosing; perforation wide.

Measurements: P 30.4 µm; E 27.4 µm; polar exine 3.5 µm, equatorial exine 2.4 µm; Clg 27.8 µm, Clt 5.6 µm; Plg 3.8 µm, Plt 4.1 µm; Apocolpium 5.5 µm.

C. tenuiflorum* (Hoffmanns & Link) Fritsch subsp. *acutiflorum (Figs 2.l-r)

Pollen class: 3-Zonocolporate

P/E ratio: Prolate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a distinct H-endoaperture, legs short, central part circular, margins distinct and granular.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; perpendicular to pore and parallel to colpus, curved near poles; perforation wide.

Measurements: P 28.4 µm; E 27.4 µm; polar exine 2.9 µm, equatorial exine 2.3 µm; Clg 26.3 µm, Clt 5.8 µm; Plg 5.5 µm, Plt 6 µm; Apocolpium 5.8 µm.

***C. spicatum* (L) Fritsch** (Figs 3.a-d)

Pollen class: 3-Zonocolporate

P/E ratio: Oblate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a less distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; perpendicular to pore and parallel to colpus, curved near poles; perforation wide.

Measurements: P 26.4 µm; E 26.4 µm; polar exine 3.9 µm, equatorial exine 2.5 µm; Clg 25.3 µm, Clt 6.3 µm; Plg 5.4 µm, Plt 6.8 µm; Apocolpium 5 µm.

***C. maritimum* (L) Fritsch** (Figs 3.e-j)

Pollen class: 3-Zonocolporate. Sometimes 4-pantocolporate (%2).

P/E ratio: Oblate-spheroidal

Apertures: Ectoaperture-Colpus long, broad and deeply sunken; margins distinct, slightly irregular, ends acute; colpus membrane smooth. Endoaperture-There is a less distinct H-endoaperture, legs short, central part circular, margins distinct.

Exine: Thick. Sexine about as thick as nexine.

Ornamentation: Tectate, supra-striate. Striate fine; muri narrow, often anastomosing; perpendicular to pore and parallel to colpus, curved near poles; perforation wide.

Measurements: P 29.2 µm; E 29.5 µm; polar exine 3.1 µm, equatorial exine 2.5 µm; Clg 27.2 µm, Clt 4.4 µm; Plg 4.2 µm, Plt 5.3 µm; Apocolpium 5.5 µm.

Discussion and Conclusion

All *Centaurium* species studied are radially symmetrical, isopolar, prolate-spheroidal or oblate-spheroidal and usually tricolporate. It is difficult to separate the species from each other on palynological grounds under LM since they appear to be homogenous. However, there are, though small, differences in endoaperture features and the sexine/nexine ratio (Table 1). The H-endoaperture is distinct in *C. erythraea* subsp. *erythraea*, *C. erythraea*

subsp. *rhodense*, *C. erythraea* subsp. *rumelicum*, *C. pulchellum*, *C. tenuiflorum* subsp. *tenuiflorum*, *C. tenuiflorum* subsp. *acutiflorum* whereas it is less distinct in *C. erythraea* subsp. *turcium*, *C. spicatum* and *C. maritimum*. Punt and Neinhuis [2] also note that there is a distinct H-endoaperture in the European *C. erythraea* and *C. pulchellum*. With respect to the sexine/nexine ratio, the sexine is thicker than the nexine only in *C. erythraea* subsp. *turcium* *C. erythraea* subsp. *rhodense* and *C. maritimum* but the ratio is almost 1 in all other taxa.

SEM micrograph of all the taxa examined show that the surface of pollen grains is characterized by striate sculpturing. In *C. erythraea* subsp. *erythraea* (Figs 1.h-i), *C. tenuiflorum* subsp. *tenuiflorum* (Figs 2.j-k), *C. tenuiflorum* subsp. *acutiflorum* (Figs 2.p-r), *C. pulchellum* (Figs 2.d-e) and *C. erythraea* subsp. *rhodense* (Figs 1.p) the striae are parallel to the colpi. In *C. erythraea* subsp. *rumelicum* (Figs 1.c-d), on the other hand the striate are parallel to colpi but the striate are shorter than in other taxa. The direction of the striae, however, changes over pollen grains in *C. erythraea* subsp. *turcium* (Figs 1.j-n), *C. spicatum* (Figs 3.c-d) and *C. maritimum* (Figs 3.i-j), perpendicular to the pores at mesocolpium and parallel to the colpi towards the poles.

In this study, 4 pantocolparate pollen grains and great variations in pollen size have been observed in *C. erythraea* subsp. *erythraea* (20.1×20.2 µm – 35.6-35.1 µm) and *C. maritumum* (22.4×21.9 µm – 38.5-39.1 µm), suggesting pollen heteromorphism.

Jacobsen [1] points out that more detailed works should be carried out on *C. erythraea* and *C. tenuiflorum*. In conclusion, this results reveals that *C. erythraea* subspecies (with the exception *C. erythraea* subsp. *turcicum*) and *C. tenuiflorum* subsps., of which have systematic problems, can be difficult to separate palynologically. In addition, *C. erythraea*, *C. tenuiflorum* and *C. pulchellum* are similar in pollen morphology. But *C. spicatum* and *C. maritimum* with pollen morphology can be differentiated from the other species. In addition, *C. erythraea* subsp. *turcicum* is similar to *C. spicatum* and *C. maritimum* in pollen morphology.

This study has revealed that all of *Centaurium* species should be placed in. *C. pulchellum* type of Punt and Nienhuis (2) on the basis of H-endoaperture structure and, characterised by the presence of supra-striate ornemantation.

References

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Table 1. Dimensions and morphological variation in pollen of *Centaurium* Hill.

TAXON	Size PXE	Shape	Exine thickness (μm)	Sexine/ nexine	Sculpture	Ridge orientation	% tricolporate	% tetracolparatae	Ectoaperture	H. Endoaperture
C. erythraea subsp. *rumelicum*	29.8×28.8	Prolate-spheroidal	2.7	Sexine about as thick as nexine	Supra-striate	Short, less dense	100	-	Long, broad	Distinct
C. erythraea subsp. *erythraea*	26.4×26.4	Oblate-spheroidal	3	Sexine about as thick as nexine	Supra-striate	Parallel to colpus curved near poles	97	3	Long, broad	Distinct
C. erythraea subsp. *turcium*	26.6×25.3	Prolate-spheroidal	2.9	Sexine a little thicker than nexine	Supra-striate	Perpendicular to pore and parallel to colpus at poles	100	-	Long, broad	Less-distinct
C. erythraea subsp.. *rhodense*	34.8×35.8	Oblate-spheroidal	4.1	Sexine a little thicker than nexine	Supra-striate	Paralel to colpus at mesocolpia	100	-	Long, broad	Distinct
C. pulchellum	32.5×29.8	Prolate-spheroidal	2.5	Sexine about as thick as nexine	Supra-striate	Paralel to colpus curved near poles	100	-	Long, broad	Distinct
C. tenuiflorum subsp. *tenuiflorum*	30.4×27.4	Prolate-spheroidal	2.4	Sexine about as thick as nexine	Supra-striate	Running parallel to colpi	100	-	Long, broad	Distinct
C. tenuiflorum subsp. *acutiflorum*	28.4×27.4	Prolate-spheroidal	2.3	Sexine about as thick as nexine	Supra-striate	Perpendicular to pore and parallel to colpus near poles	100	-	Long, broad	Distinct
C. spicatum	26.4×26.4	Oblate-spheroidal	2.5	Sexine about as thick as nexine	Supra-striate	Perpendicular to pore and parallel to colpus near poles	100	-	Long, broad	Less-distinct
C. maritimum	29.2×29.5	Oblate-spheroidal	2.5	Sexine a little thicker than nexine	Supra-striate	Perpendicular to pore and parallel to colpus near poles	98	2	Long, broad	Less-distinct

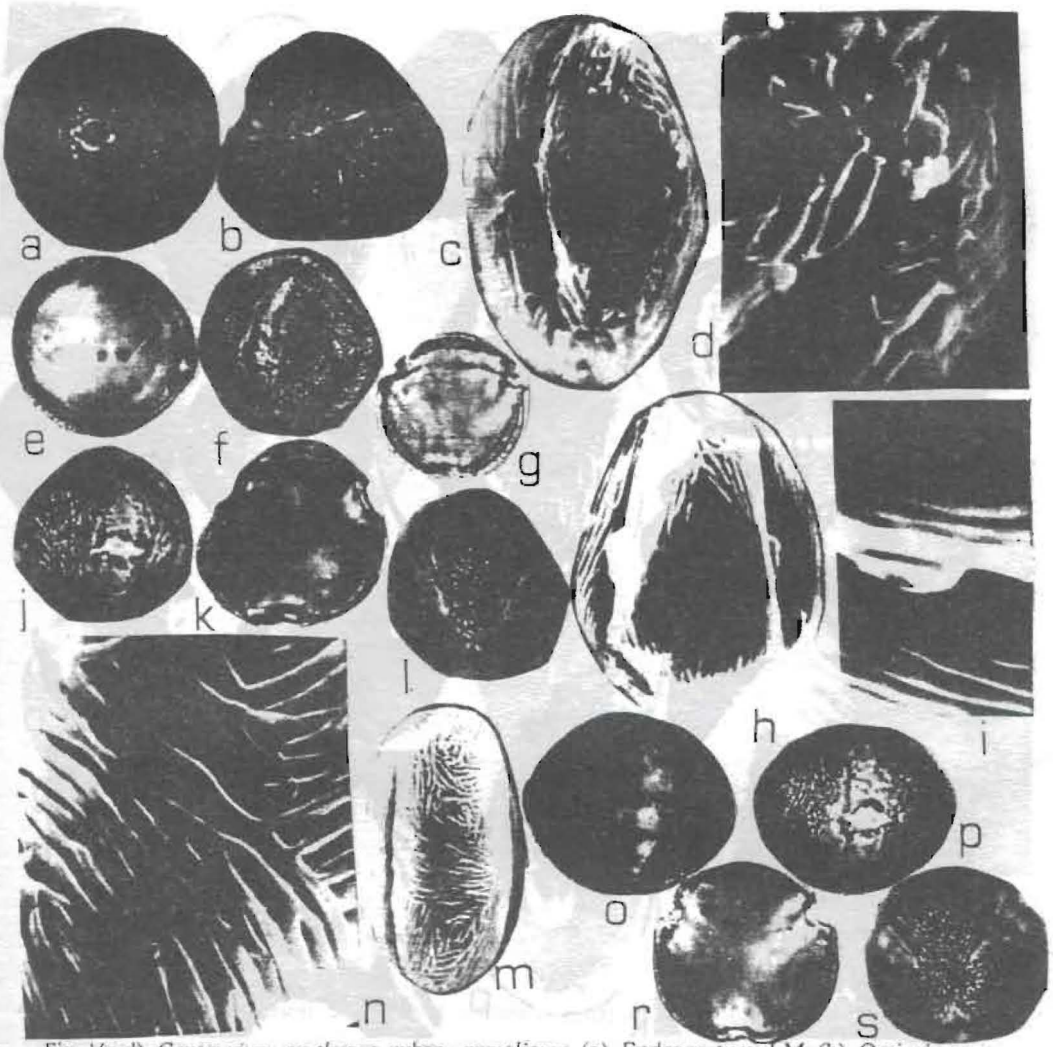

Fig 1(a-d) *Centaurium erythraea* subsp. *rumelicum* (a) Endoaperture LM (b) Optical cross-section; outline in polar view LM (c) Ornamentation in equatorial view SEMX3000 (d) Ornamentation in polar view SEMX10.000.
(e-i) *C. erythraea* subsp. *erythraea* (e) optical cross-section; outline in equatorial wiew LM (f) Endoaperture LM (g) Optical cross-section; outline in polar view LM (h) Ornementation in equatorial view SEMX3000 (i) Ornamentation in aperture SEMX10.000.
(j-n) *C. erythraea* subsp. *turcicum* (j) Optical cross-section; outline in equatorial view and endoaperture LM (k) Optical cross-section; outline in polar view LM (l) Ornamentation in apocolpium LM (m) Ornamentation in equatorial view SEMX2000 (m) Ornamentation in mesocolpium SEMX10.000.
(o-s) *C. erythraea* subsp. *rhodense* (o) Optical cross-section; outline in equatorial view LM (p) Endoaperture LM (r) Optical cross-section; outline in polar view LM (s) Ornamentation in apocolpium LM.

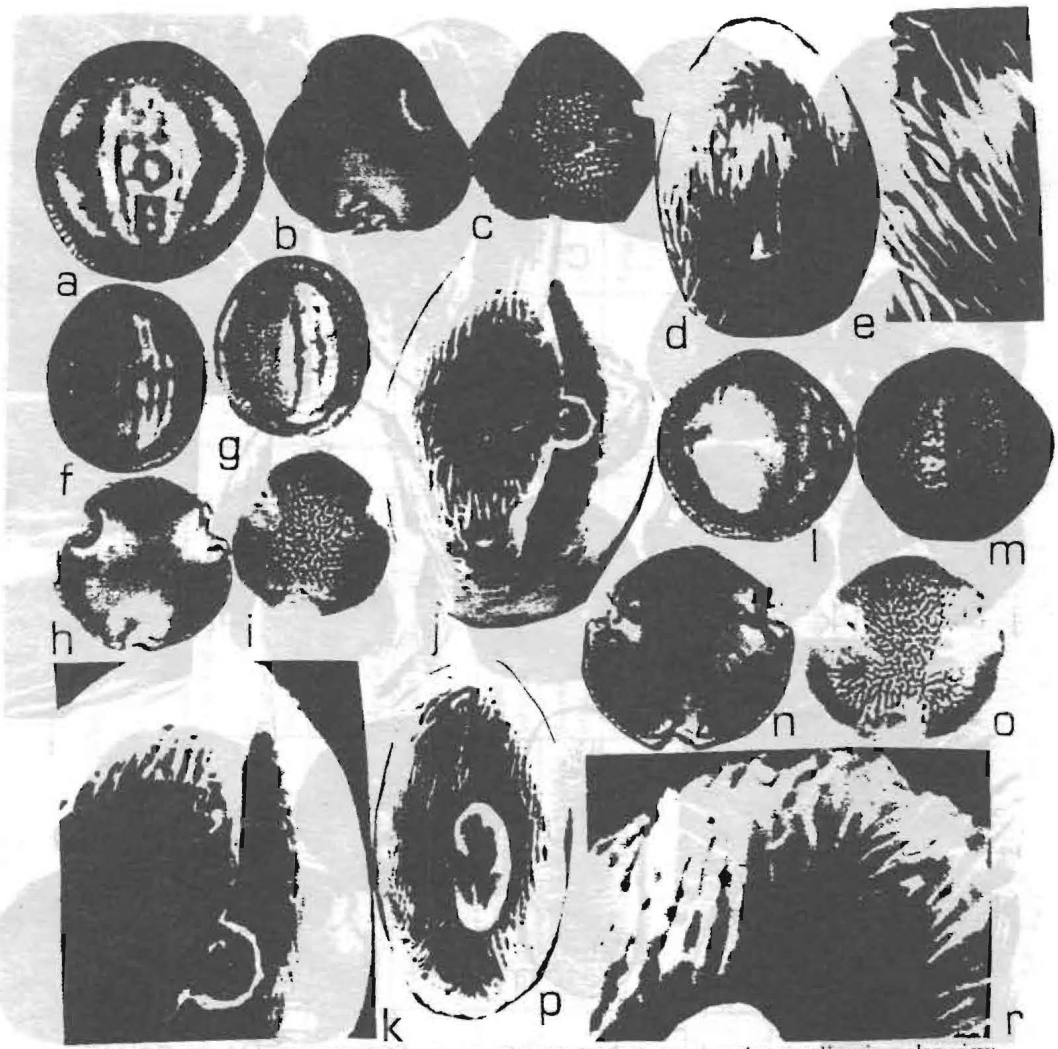

Fig 2 (a-e) *C. pulchellum* (a) Endoaperture LM (b) Optical cross-section; outline in polar view LM (c) Ornamentation in apocolpium LM (d) Ornamental in equatorial view SEMX3000 (e) Ornamentation in mesocolpium SEMX6000.

(f-k) *C. tenuiflorum* subsp. *tenuiflorum* (f) Optical cross-section; outline in equatorial view LM (g) Endoaperture LM (h) Optical cross-section; outline in polar view LM (i) Ornamentation in apocolpium LM (j) Ornamentation in equatorial view SEMX3000 (k) Ornamentation in mesocolpium SEMX5000.

(l-r) *C. tenuiflorum* subsp. *acutiflorum* (l) Optical cross-section; outline in equatorial view LM (m) Endoaperture LM (n) Optical cross-section; in polar view LM (o) Ornamentation in apocolpium LM (p) Ornamentation in equatorial view SEMX3000 (r) Ornamentation in polar view SEMX10.000.

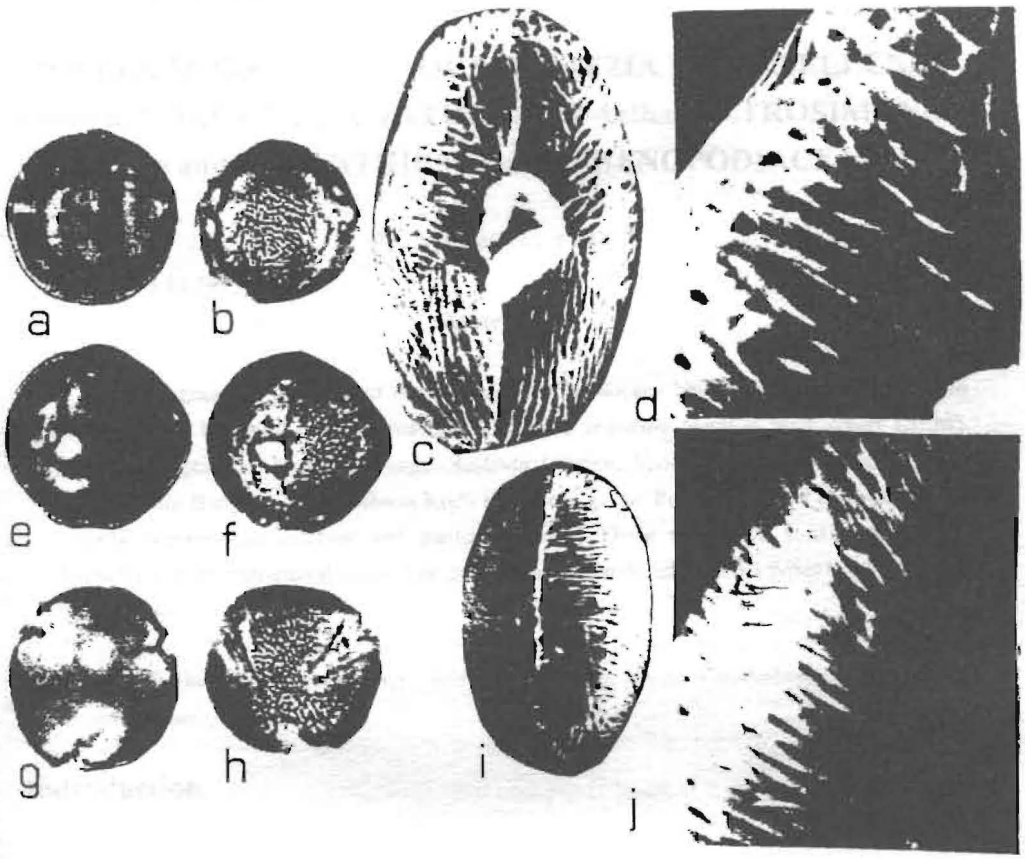

Fig 3 (a-d) *C. spicatum* (a) Optical cross-section; outline in equatorial view LM (b) Ornamentation in mesocolpium LM (c) Ornamentation in equatorial view SEMX3000 (d) Ornamentation in mesocolpium SEMX10.000.
(e-j) *C. maritimum* (e) Optical cross-section; outline in equatorial view LM (f) Endoaperture LM (g) Optical cross-section; outline in polar view LM (h) Ornamentation in apocolpium LM (i) Ornamentation in equatorial view SEMX2000 (j) Ornamentation in mesocolpium SEMX10.000.

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POLLEN MORPHOLOGY OF SEIDLITZIA Bunge, AELLENIA Ulbrich, NOAEA Moq., CYATHOBASIS Aellen, PETROSIMONIA Bunge and HALANTHIUM Koch (CHENOPODIACEAE)

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Received 3.11.1998

Abstract

Pollen grains of 6 genera of the family *Chenopodiaceae* have been examined in detail comparatively by using light microscopy (LM) and scanning electron microscopy (SEM). Pollen description of *Seidlitzia* Bunge, *Aellenia* Ulbrich, *Noaea* Moq, *Cyathobasis* Aellen, *Petrosimonia* Bunge and *Halanthium* Koch have been given. Pollen grains of each genera are radially symmetrical, isopolar and pantopolyporate. These taxa have sunken pores and distinctly convex mesaporial exine. The genera have been diveded into 3 types on the basis of pore number.

Key Words: Pollen, Pollen morphology, *Seidlitzia, Aellenia, Noaea, Cyathobasis, Petrosimonia, Halanthium, Chenopodiaceae.*

Indroduction

Seidlitzia Bunge, *Aellenia* Ulbrich, *Noaea* Moq, *Cyathobasis* Aellen, *Petrosimonia* Bunge and *Halanthium* Koch belonging to the family have been revised by Aellen [1] in Flora of Turkey. The genera have been differentiated only on the basis of plants hairy or glabrous. *Seidlitzia* Bunge, *Aellenia* Ulbrich, *Cyathobasis* Aellen are represented by one species; *Noaea* Moq. and *Petrosimonia* Bunge are represented by two species and *Halanthium* Koch is represented by three species in Turkey. *Cyathobasis fruticulosa* (Bunge) Aellen and *Petrosimonia nigdeensis* Allen are endemic species in Turkey.

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Pollen morphology of these genera have received little attention from investigators. *Aellenia glauca* (M. Beib.) Aellen was examined by Nowicke [4] through scanning electron microscope (SEM). Ultrastructure of pollen exine of *Aellenia glauca* was descripted by Skarvarla and Nowicke [8].

The objective of our research is to shed some light on the pollen morphology of these genera, under both light (LM) and scanning electron microscopes and provide help in the seperation of the genera.

Materials and methods

Polliniferus materials were taken from Ankara University Herbarium (ANK), Gazi University Herbarium (GAZİ) and Hacettepe University Herbarium (HUB). The collections are listed under "Specimens investigated", following the sequence of Aellen [1].

For LM study, the pollen slides were prepared according to the tecnique of Wodehouse (W) [9]. A Leitz-Wetzlar microscope was used for examination (Ocular x 16, objective x 100). Measurements were taken statistically. In order to estimate the pore number, the method by Mc Andrews and Swanson [3], based on the ratio of distance between centers of adjancent pores (C) and the diameter of the grain (D) was followed. Photographs were taken with a Leitz Phan-photo microscope.

For SEM study, unacetolysed pollen grains were transferred to stubs and covered with gold. Jeol 100 CXII electron microscope was employed for SEM studies.

Terminology follows that of Faegri and Iversen [2].

Specimen Investigated

Seidlitzia florida (Bieb.) Bunge	Ağrı	Motila	ANK
Aellenia glauca (Bieb.) Aellen	Erzurum	Gassner	ANK
Noaea mucronata (Forssk.) Aschers & Schweinf	Bitlis	H.Peşmen	GAZİ
		M.Öztekin,	
Cyathobasis fruticulosa (Bunge) Aellen	Kayseri	Ş, Yıldırımlı	HUB
		S. Erik	

Petrosimonia branchiata (Pallas) Bunge	Muğla	A. Güner	GAZİ
P. nigdeensis Aellen	Ankara	E. Yurdakulol	ANK
Hallanthium roseum (Trautv.) Iljin	Kars	Demirkuş	HUB
H. kulpianum (Koch) Bunge	Ankara	Aellen	ANK

Results

Pollen descriptions

SEIDLIZIA Bunge

S. florida (Bieb.) Bunge (Fig. 1a-c).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 16.6 µm (15.6-17.7 µm). Pores 4.2 µm in diameter and circular. Operculum 55-57 conical spinules. Distance between the centers of the adjancent pores (C) 8 µm. C/D 0.4819. Pore number 14.

Ornamentation scabrate. 105 spinules per 100 μm^2.

Exine 1.3 µm thick. Ektexine thick than endexine. Intine 0.5 µm thick.

AELLENIA Ulbrich

A. glauca (Bieb.) Aellen (Fig. 1d-g)

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 24.4 µm (20.8-22.9 µm). Pores 6 µm in diameter and circular. Operculum 10-11 conical spinules. Distance between the centers of the adjancent pores (C) 9.4 µm. C/D 0.4196. Pore number 19.

Ornamentation scabrate. 60 spinules per 100 μm^2.

Exine 1.6 µm thick. Ektexine thick than endexine. Intine 0.5 µm thick.

NOAEA Moq.

N. mucronata (Forssk.) Aschers & Schweinf. (Fig. 1h-k).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 19.2 µm (15.6-17.7 µm). Pores 3.5 µm in diameter and circular. Operculum 65-68 conical spinules. Distance between the centers of the adjancent pores (C) 9.4 µm. C/D 0.4896. Pore number 14.

Ornamentation scabrate. 109 spinules per 100 μm^2.

Exine 1 μm thick. Ektexine thick than endexine. Intine 0.5 μm thick.

CYATHOBASIS Aellen

C. fruticulosa (Bunge) Aellen (Fig. 1 l-n).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 19.6 μm (17.7-21.8 μm). Pores 3.3 μm in diameter and circular. Operculum 47-50 conical spinules. Distance between the centers of the adjancent pores (C) 6.4 μm. C/D 0.3265. Pore number 33.

Ornamentation scabrate. 96 spinules per 100 μm^2.

Exine 1.04 μm thick. Ektexine thick than endexine. Intine 0.5 μm thick.

PETROSIMONIA Bunge

P. brachiata (Pallas) Bunge (Fig. 2a-c).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 18.7 μm (17.7-19.8 μm). Pores 1.6 μm in diameter and circular. Distance between the centers of the adjancent pores (C) 4.5 μm. C/D 0.2406. Pore number 62.

Ornamentation scabrate. 140 spinules per 100 μm^2.

Exine 1.4 μm thick. Ektexine thick than endexine. Intine 0.3 μm thick.

P. nigdeensis Aellen (Fig. 2d-f).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 15.3 μm. Pores 1.2 μm in diameter and circular. Operculum 19-20 conical spinules. Distance between the centers of the adjancent pores (C) 3.3 μm. C/D 0.2157. Pore number 77.

Ornamentation scabrate. 114 spinules per 100 μm^2.

Exine 1.8 μm thick. Ektexine thick than endexine. Intine 0.5 μm thick.

HALANTHIUM Koch

H. roseum (Trautv.) Iljin (Fig. 2g-j).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 28 μm (23.9-31.2 μm). Pores 6.6 μm in diameter and circular. Operculum 57-58 conical spinules. Distance between the centers of the adjancent pores (C) 10 μm. C/D 0.3571. Pore number 27.

Ornamentation scabrate. 65 spinules per 100 μm^2.

Exine 1.04 μm thick. Ektexine thick than endexine. Intine 0.3 μm thick.

H. kulpuanum (Koch) Bunge (Fig. 2k-n).

Pollen grains radial symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter (D) 24.7 μm (24-25 μm). Pores 5.7 μm in diameter and circular. Operculum 46-50 conical spinules. Distance between the centers of the adjancent pores (C) 7.3 μm. C/D 0.2955. Pore number 40.

Ornamentation scabrate. 80 spinules per 100 μm^2.

Exine 1 μm thick. Ektexine thick than endexine. Intine 0.5 μm thick.

Conclusion

Pollen morphological characters of 8 species of 6 genera of *Chenopodiaceae* examined are, in general, similar. Pollen grains are radial symmetrical, isopolar and pantopolyporate. Exine consist of thick ektexine and thin endexine layers (Table 1). These features have also been accounted for some other genera of *Chenopodiaceae, Atriplex* [6], *Suaeda* [7] and *Salsola* [5] studied previously.

The most diagnostic features of the family *Chenopodiaceae* used in pollen analytical and taxonomic investigations are pore numbers and the C/D ratio [3]. Pollen size and pore number have been used as diagnostic characters for Turkish *Atriplex, Suaeda* and *Salsola* genera. Fig. 3 shows the correlation between pore number and pollen size of 8 species examined for the present study. No correlation between the pollen size and the number of pores is found in the species studied. Though the majority of the species have pollen 15-23 μm in diameter, there is a tendecy of *Halanthium roseum* to have larger pollen grains (Fig 3). But correlation between the pore number and the pore diameter is found in the species studied. (Fig. 4). When the pore diameter are smaller, the pore number have increased. In genus *Petrosimonia* to have smaller pore diameter and fewer pore number than the other genera (Fig. 4). In this study, 3 pollen types have been defined on the basis of pore number:

I. pollen type: Pore number ranges from 14-20. *Seidlitzia florida*, *Aellenia glauca* and *Noaea mucronata* are included. Pollen grains of *S. florida* are smaller then the others. *A. glauca* also has fewer spinules in 100 μm^2 and bigger pollen than *N. mucronata*.

II. pollen type: Pore number varies from 25-50. *Halantium roseum, H. kulpianum* and *Cyathobasis fruticulosa* are included. Pollen grains of *C. fruticulosa* are smaller than the others. *H. roseum* also has more bigger pollen grains than *H. kulpianum*.

III. pollen type: Pore number between 55-90. Only *Petrosimonia brachiata* and *P. nigdeensis* are included. Pollen grains of *P. nigdeensis* are smaller than *P. brachiata*.

These taxa have progressive evoluation in *Chemopodiaceae* family. Interesting results of the entire study is characterized by sunken pores and distinctly convex mesoporial exine. Nowicke [4] also noted that *Aellenia* has sunken pores and distinctly convex mesoporial exine. Otherwise, these taxa have the smallest pollen diameter and fewer pore number in *Chenopodiaceae* family. But in this taxa there is increased pore diameter and in number conical spinules of operculum. Van Campo [10] also said that generally small pollens with fewer pore were more primitive. But we also found that in *Chenopodiaceae* family, more smaller pollens and fewer pore were progressive characters.

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Table 1. Dimensions and morphological variation in pollen of *Chenopodiaceae*.

Taxa	Pollen Dimension (D) (µm)	Plt* (µm)	C** (µm)	Operculum	Exine (µm)	Intine	C/D	Pore number
Seidlitzia florida	16.6	4.2	8	55-57 conical spinules	1.3	0.5	0.4819	14
Aellenia glauca	24.4	6	9.4	10-11 conical spinules	1.6	0.5	0.4196	16
Noaea mucronata	19.2	3.5	9.4	65-68 conical spinules	1.0	0.5	0.4896	14
Cyathobasis fruticulosa	19.6	3.3	6.4	47-50 conical spinules	1.04	0.5	0.3265	33
Petrosimonia branchiata	18.7	1.6	4.5	-	1.4	0.3	0.2406	62
P. nigdeensis	15.3	1.2	3.3	19-20 conical spinules	1.8	0.5	0.2157	77
Halianthium roseum	28	6.6	10	57-58 conical spinules	1.04	0.3	0.3571	27
H. kulpianum	24.7	5.7	7.3	46-50 conical spinules	1.0	0.5	0.2955	40

*Plt: Pore diameter
**C : Distance between the centers of the adjanecnt pores

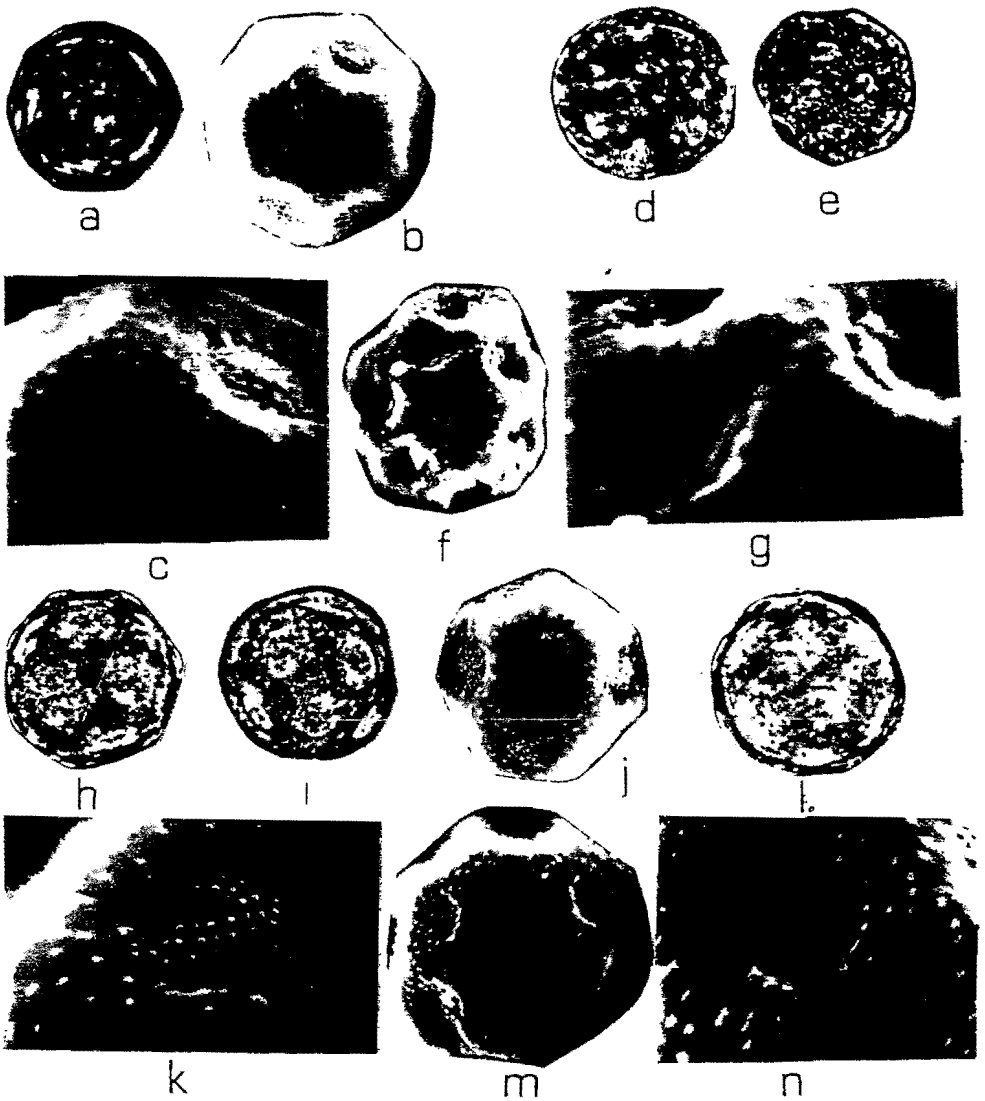

Fig 1 **(a-c)** *Seidlitzia florida* (Bieb.) Bunge (a) Pollen of *S. florida* LM x 1000 (b) Pores and ornamentation SEM x 3000 (c) Pores and opercula SEM x 10.000.

(d-g) *Aellenia glauca* (Bieb.) Aellen (d-e) Pollen of *A. glauca* LM x 1000 (f) Pores and ornamentation SEM x 3000 (g) Pores and opercula SEM x 10.000.

(h-k) *Noaea mucronata* (Forssk.) Aschers & Schweinf. (h-i) Pollen of *N. mucronata* LM x 1000 (j) Pores and ornamentation SEM x 3000 (k) Pores and opercula SEM x 10.000.

(l-n) *Cyathobasis fruticulosa* (Bunge) Aellen (l) Pollen of *C. frutirulosa* LM x 1000 (m) Pores and ornamentation SEM x 3000 (n) Pores and opercula SEM x 10.000.

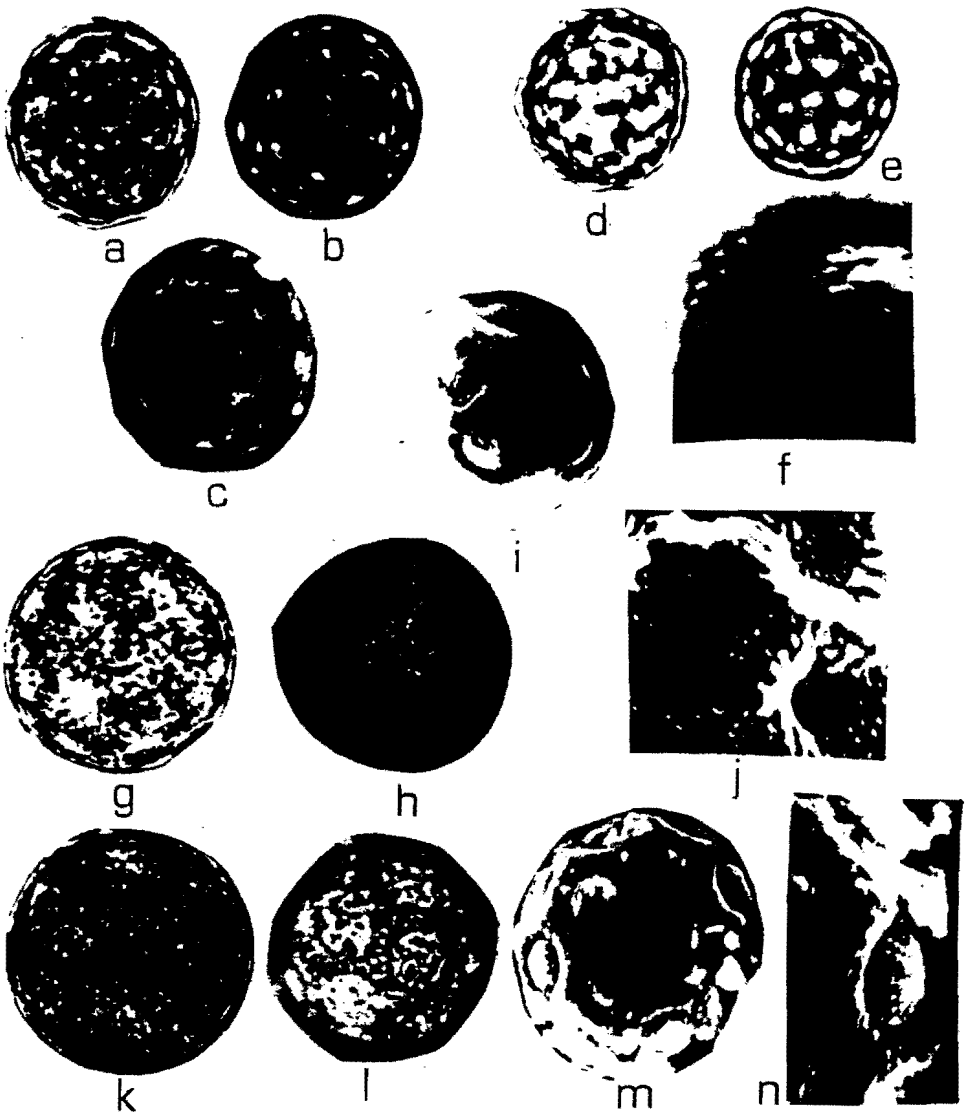

Fig 2 **(a-c)** *Petrosimonia brachiata* (Pallas) Bunge (a-b) Pollen of *P. brachiata* LM x 1000 (c) Pores and ornamentation SEM x 3000.

(d-f) *P. nigdeensis* Aellen (e) Pollen of *P. nigdeensis* LM x 1000 (f) Pores and ornamentation SEM x 10.000.

(g-j) *Halanthium roseum* (Trautv.) Iljin (g-h) Pollen of *H. roseum* LM x 1000 (i) Pores and ornamentation SEM x 3000 (j) Pores and opercula SEM x 10.000.

(k-n) *H. kulpianum* (Koch) Bunge (k-l) Pollen of *H. kulpianum* LM x 1000 (m) Pores and ornamentation SEM x 3000 (n) Pores and opercula SEM x 10.000.

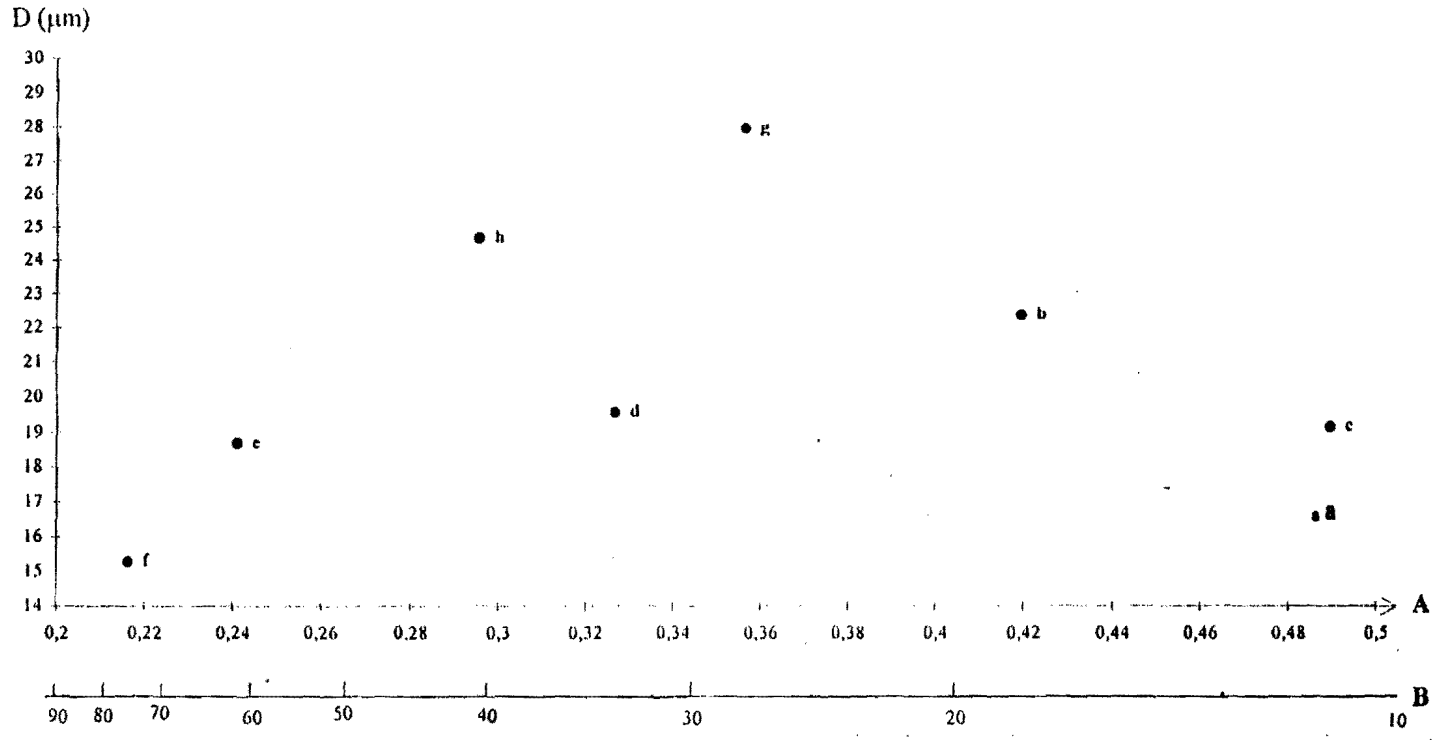

Fig. 3. Variation in polen size and C/D ratio (pore number) of *Chenopodiaceae*. Vertical axis, diameter in µm. Horizontal axis, upper (A) C/D ratio, lower (B) corresponding pore number according to Mc Andrews & Swanson a. *Seidlitzia florida*; b. *Aellenia glauca*; c. *Noaea mucronata*; d. *Cyathobasis fruticulosa*; e. *Petrosimonia brachiata*; f. *P. nigdeensis*; g. *Halanthium roseum* h. *H. kulpianum*.

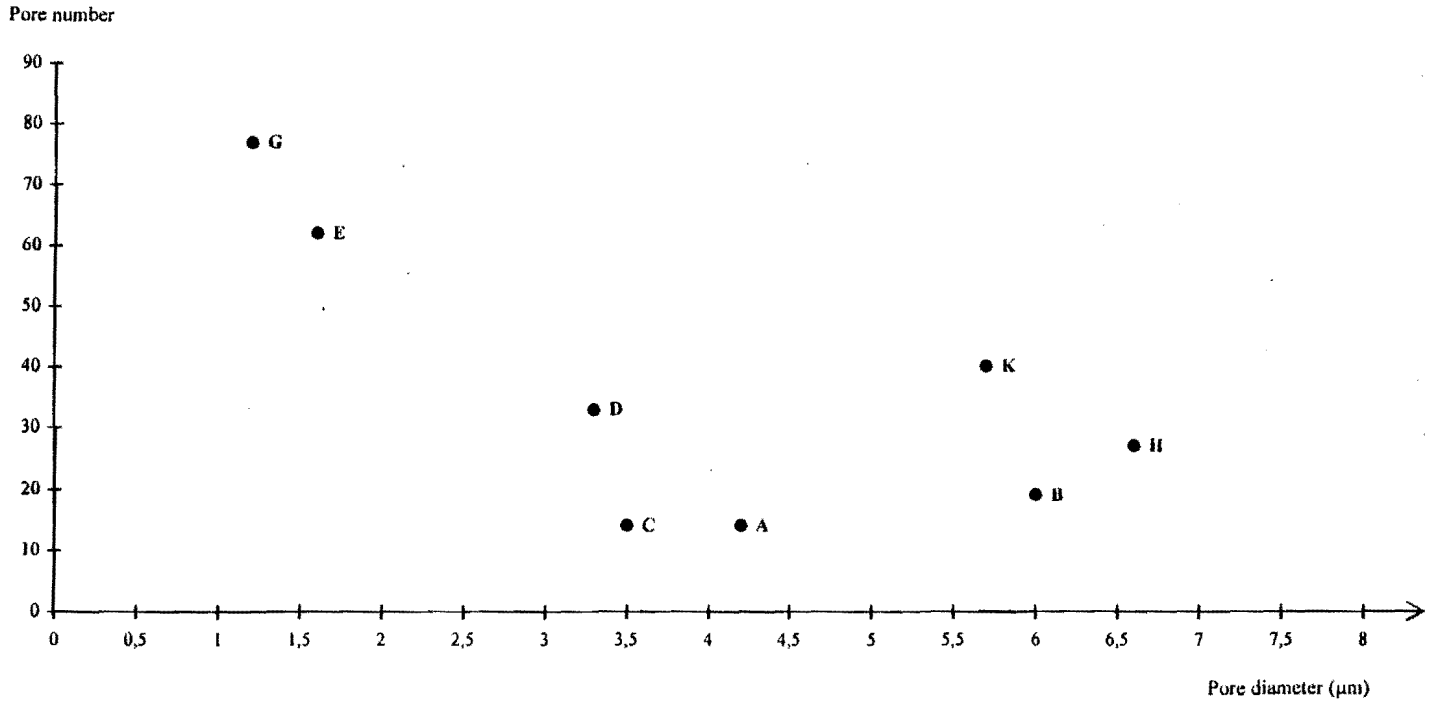

Fig. 4. The correlation between pore number and pore diameter (A) *Seidlitzia florida*, (B) *Aellenia glauca*, (C) *Noaea mucronata*, (D) *Cythobasis fruticulosa*, (E) *Petrosimonia brachiata*, (G) *P. nigdeensis*, (H) *Halanthium roseum*, (K) *H. kulpianum*

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ORNITHOFAUNA OF TURKISH-GREEK BORDER, (Ipsala -EDİRNE)

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Abstract

Ornitofaunistic researches were made between April 1995 and March 1996 in the area of Küplü and İpsala in Edirne City along the Turkish-Greek border. The purpose of this study is to find out the bird species, their populations and bio-ecological importance of military forbidden zones. Totally 139 bird species were identified in this. area. It was observed that out of 14 of these species stay permanently throughout the year and 45 species breed in the area.

Key Words: Ornithofauna, Küplü-İpsala, Edirne-Turkey.

Introduction

The River Meriç, which constitutes the border between Turkey and Greece, forms a large delta, on which two large and several small wetlands are located. The River Meriç Delta and its wetlands are of enormous importance as a breeding range and, especially, a wintering place for waterfowl and raptors during the migration season. Around 100.000 waterfowl winter in this region, which is a class A eutrophic wetland according to internationally criteria [12].

Many ornithological researches have been made in Turkey [3, 7, 8]. But there is no sufficient data on the Turkish-Greek border except Gala Lake near Küplü-İpsala area [4]. Study area (Figure 1) which stays in the north of Meriç Delta, is an ideal ecosystem for birds for feeding, breeding and settling and it is inside. For this reason, it can be considered that it be an intact ecoislet which is a very significant biological reserve.

This study was made to determine the bird species and to compare the results with the other important wetlands, like Sultan Sazlığı-KAYSERİ. in Turkey [8, 9]. This is the first study in a forbidden military zone in Turkey.

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Study Area and Methods

Study Area: Study area is located near the River Meriç (Fig 1.) and about 200 km^2 and covered with high dense vegetation. The shores of the River are covered with heavily forested area (especially consisting of *Populus sp., Salix sp and Quercus sp.*), wetlands (especially consisting of reedbeds like *Arundo sp.* and *Juncus sp)* and also southern part of the area consists of farmlands e.g. rice, sunflower and watermelon. The area between these farmlands and the river has permanently remained as a wetland and various bird species breed, visit or winter there.

Field Study : Bird observations were made between April 1995 and March 1996 in the area. Field studies were carried out at five different locations. These were Küplü Village, Adasarhanlı Village, Kuliç Forest, Sarıcaali Village and İpsala Town (Figure 1). Each location was visited monthly from dawn to twilight on foot and/or by vehicle and bird observations were recorded by the same researcher. Binoculers (Prismatic and Tasco mark, 7x50), monoculeP telescope (Marine mark, 20-60 x 80) and mechanical numerator were used during the observations [2, 8]. While carrıng out the observatıons ın order to find out the species and the population density, 1/25 000 maps were used [1]. For the systematical categorization of bird species, ıt was followed that proposed by Kiziroğlu, 1993 [6].

Climatical Data : There is not enough water running contrubiting to the rivers in the Trakya Region due to the lack of mountains. There is alluvial soil in theErgene Basin and the River Meriç. According to the records of the Edirne Meteorological Station [11], in 1995 and 1996, the region was dry and very hot in summertime, but, while rainy, windy and very cold in winter. In the region, the average temperature in 1995 was 14 °C. The maximum temperature in August was 32 °C, while minimum temperature was 2 °C in January. Generally, the weather is quite windy and rainy in winters. The average maximum wind speed in summer is 0.2 m/sec, while the average maximum wind speed in winter is 3.3 m/sec. Usually, the average minimum precipitation in summer is 45 m^3/m^2 and the maximum in winter is 125 m^3/m^2. The Meriç and Ergene Rivers overflow their banks in winter. During this time, the plains are being higly irrigated and especially in spring time they become typical swamps and are very proper for the birds ın order to find food and nest.

Results and Discusions

Bird species and their population are shown in Table 1. As consequences of the observations, 139 bird species were determined in Küplü-İpsala military zone where they have been intensively using the area for feeding, settling and breeding. It has been known that 440 bird species are currently living in Turkey. A very close area (Strandja Mountains, South East Bulgaria) was also studied and 133 bird species were determined by Milchev in 1994 [10]. Küplü-İpsala area is comparatively smaller than the other study areas mentioned above. However, the number of the bird species found in this area are relatively more than the others.

Fortheen species are observed continuously from 139 bird species in the study area. And 45 of 139 bird species are breeding in this area exactly which can be determined from nests and juvenil observations. Determined bird species of Red Data Book status are given in Table 1 and used [5]. According to this category, 5 of the bird species nearly disappaering are found in study area. This category consist of A.1.2 swans (*Cygnus cygnus*), mute swans (*Cygnus olor*) and ospreys (*Pandion haliaetus*) which are winter visitor where eagle owls (*Bubo bubo*) and kingfishers (*Alcedo atthis*) are resident species in this area. Population density of this 5 bird species are determined higly dense for these species population when compared with other important wetlands e.g. Sultan Marshes [8,9].

During this study, ornithological observations couldn't be done in the some areas (on some part of Kuliç Forest and Karaağaç covert-Adasarhanlı). Becuse of habitat destruction has been done by Military Services and Regional Directorate of Forest in these areas in autmn 1995, we could be done bird observations in these areas.In this time, we determined the nightjars *(Caprimulges europaes)* as a first time at the destructed parts of Kuliç Forest in September, October, December 1995 and Janury, February 1996 (Table 1). However this species is seen in summertime in Turkey accordin to literature. In conclusion, this species couldn't be observed in summertime in dense vegetation of Kuliç Forest and this species may choose these places as a wintering area.

Distribution of the category of these species is as follows; 33 species A.2, 26 species A.3, 25 species A.4, 3 species B.2 and 2 species B.3. hazard risk for is 94 of 139 determined bird species at different levels according to Red Data Book. Bird species under danger prefer the full protected area and this show the biological importance of the similar areas for feeding, inhabiting and breeding for bird [7]. As under the control of the military forces, this area has allegedly remained unreachable and virgin. It has been concluded that the areas where any research has not been conducted yet, like the military zones which are forbidden to enter would be very useful to

collect a lot of information for instance about flora and fauna. We strongly believe that this conclusion is likely to confirm any other observation and its results which had been performed previously in similar areas which are also restricted in other countries.

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Table 1 Population density and status of birds between April 1995 and March 1996 at Kuplü-İpsala (Edirne) along the Turkish-Greek border.

		1995								1996				
NO	SPECIES	APR	MAY	JUNE	JULY	AGU.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	R.D.B.**
1	*Podiceps cristatus*	11	0	0	0	0	0	8	21	38	43	45	28	A.2
2	*Podiceps nigricollis*	2	0	0	0	0	0	0	0	0	2	7	11	A.2
3	*Podiceps ruficollis*	31	7	0	0	0	0	0	0	58	36	15	12	A.3
4	*Pelecanus onocratalus*	0	0	0	0	0	0	0	8	17	0	3	0	A.2
5	*Pelecanus crispus*	0	0	0	0	0	0	0	8	17	0	3	0	A.2
6	*Phalacrocorax carbo*	0	0	0	0	0	0	0	0	32	147	184	69	A.2
7	*Phalacrocorax pygmeus*	9	0	0	0	0	0	0	255	397	211	162	41	A.3
8	*Phalacrocorax aristotelis*	0	0	0	0	0	0	0	110	292	239	158	180	A.2
*9	***Ardea cinerea***	***19***	***33***	***55***	***62***	***44***	***27***	***65***	***43***	***94***	***77***	***82***	***32***	***A.3***
10	*Egretta alba*	0	0	0	0	0	0	45	64	182	153	194	44	A.2
11	***Egretta garzetta***	***239***	***642***	***539***	***314***	***562***	***142***	***0***	***0***	***10***	***58***	***26***	***14***	***A.2***
12	***Ardeola ralloides***	***17***	***12***	***45***	***18***	***91***	***14***	***0***	***0***	***0***	***0***	***0***	***0***	***A.3***
13	***Nycticorax nycticorax***	***27***	***109***	***254***	***363***	***496***	***65***	***0***	***0***	***0***	***0***	***0***	***0***	***A.3***
14	***Ixobrycus minitus***	***3***	***14***	***11***	***24***	***52***	***64***	***49***	***18***	***0***	***0***	***0***	***0***	***A.3***
15	*Botaurus stellaris*	3	2	0	0	0	0	0	1	4	2	0	1	A.2
16	***Ciconia ciconia***	***226***	***1416***	***1173***	***2900***	***8500***	***53***	***0***	***0***	***0***	***0***	***0***	***6***	***A.3***
17	***Ciconia nigra***	***0***	***52***	***87***	***156***	***147***	***39***	***8***	***0***	***0***	***0***	***0***	***0***	***A.2***
18	*Plegadis falcinellus*	10	41	16	0	0	0	0	0	0	0	0	0	A.3
19	*Cygnus cygnus*	0	0	0	0	0	0	0	0	12	26	13	19	A.1.2
20	*Cygnus olor*	0	0	0	0	0	0	0	0	4	12	3	0	A.1.2
21	*Anser anser*	0	0	0	0	0	0	0	0	24	33	55	13	A.2
22	*Anser albifrons*	0	0	0	0	0	0	0	0	0	70	13	0	B.2

A.1.2.: Threatened with extinction, A.2 : Severely endangered; A.3 : Endangered; A.4 : Potantially endangered; B.2 and B.3 : Endangered migrants, winter visitors.
Breeding birds in the study areas shows bold letters (45 species).

** : Breeding birds-year birds (14 species).*
***: According to Kumerloğlu, (1989 ve 1993)*

Table 1 continue

		1995								1996				
NO	SPECIES	APR	MAY	JUNE	JULY	AGU	SEP	OCT	NOV	DEC	JAN	FEB	MAR	R.D.B **
23	*Branta ruficollis*	0	0	0	0	0	0	0	0	0	2	0	0	A.2
24	*Tadorna tadorna*	0	0	0	0	0	0	0	0	40	8	2	0	A.2
25	*Tadorna ferruginea*	0	0	0	0	0	0	0	0	14	190	25	0	A.2
26	*Anas platyrynchos*	14	42	39	0	0	11	195	215	1455	5000	5000	1235	A.4
27	*Anas crecca*	10	0	0	0	0	0	15	360	1550	426	390	84	A.4
28	*Anas strepera*	0	0	0	0	0	0	0	0	0	8	0	0	A.3
29	*Anas acuta*	0	0	0	0	0	0	0	0	0	16	24	0	A.4
30	*Netta rufina*	0	0	0	0	0	0	0	0	0	5	14	0	A.4
31	*Aythya ferina*	45	0	0	0	0	0	0	18	255	1250	1645	365	A.4
32	*Aythya fuligula*	0	0	0	0	0	0	0	0	0	4	9	0	A.4
33	*Aythya nyroca*	0	0	0	0	0	0	0	0	3	14	0	0	A.4
34	*Milvus milvus*	2	4	4	0	0	0	0	0	0	0	0	0	B.3
35	*Milvus migrans*	0	3	5	2		0	0	0	0	0	0	0	A.4
36	*Accipiter nisus*	0	0	2	1	0	0	1	1	0	0	0	0	A.4
37	*Accipitor gentilis*	0	0	1	3	1	8	12	6	1	0	0	0	A.3
38	*Circus aeruginosus*	2	6	9	2	0	0	0	0	0	2	5	7	A.3
39	*Circus cyaneus*	0	3	2	0	0	0	0	0	0	4	3	1	A.3
40	*Buteo rufinus*	0	2	2	0	1	0	0	0	0	3	6	2	A.2
41	*Buteo buteo*	3	11	19	3	2	4	1	8	10	25	42	19	A.3
42	*Buteo lagopus*	0	0	0	0	0	0	0	0	1	1	0	0	A.3
43	*Gyps fulvus*	0	2	4	0	0	0	0	0	0	0	0	0	A.2
44	*Aegypius monachus*	0	5	1	0	0	0	0	0	0	0	0	0	A.2
45	*Pandion haliaetus*	0	3	9	2	0	0	0	0	0	0	0	0	A.1.2
46	*Falco tinnunculus*	49	61	72	84	19	0	0	0	3	12	10	14	A.4
47	*Falco naumanni*	8	12	14	6	0	0	0	0	3	2	2	1	A.3
48	*Falco peregrinus*	0	0	1	5	2	0	0	0	0	0	0	0	A.2
49	*Falco vaspertinus*	0	0	0	4	0	0	0	0	0	0	0	0	A.2
50	*Rallus aquaticus*	3	8	2	0	0	0	4	5	11	24	19	2	A.4
*51	*Gallinula chloropus*	29	65	92	74	55	164	86	104	55	41	36	19	A.4
52	*Fulica atra*	124	0	0	11	463	1250	5000	5000	5000	5000	5000	1250	-
53	*Himantopus himantopus*	7	5	2	2	0	0	0	0	0	17	22	4	A.3
54	*Recurvirostra avosetta*	0	4	2	2	0	0	0	0	0	0	0	0	A.4
55	*Charadrius dubius*	3	0	0	0	0	0	0	0	2	1	11	8	A.2
56	*Vanellus vanellus*	12	18	0	0	0	0	0	0	0	0	0	0	A.4

Table 1. continue

		1995								1996				
NO	SPECIES	APR	MAY	JUNE	JULY	AGU.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	R.D.B.**
57	*Tringa totanus*	0	6	17	14	0	0	0	0	0	0	0	0	A.3
58	*Tringa hypoleucos*	3	6	18	8	0	0	0	0	44	171	29	14	
59	*Tringa ochropus*	2	7	9	3	0	0	0	0	0	0	0	3	B.2
60	*Philomachus pugnax*	2	15	8	13	0	0	0	0	0	10	18	19	B.2
61	*Larus ridibundus*	43	19	87	161	61	0	0	15	73	88	126	140	B.3
62	*Larus argentatus*	15	89	75	92	9	3	17	45	124	253	197	212	
63	*Chlidonias niger*	0	0	0	0	0	0	0	0	0	3	2	7	A.2
64	*Chlidonias leucopterus*	0	6	3	0	0	0	0	0	0	7	4	5	A.2
65	*Sterna hirundo*	0	0	0	0	0	0	0	0	0	6	9	0	A.4
66	*Sterna albifrons*	0	0	0	0	0	0	0	0	0	11	19	2	A.4
67	*Columba livia*	8	12	8	0	0	0	0	0	15	38	56	18	-
68	*Columba palumbus*	40	0	0	0	0	0	0	74	235	745	62	14	A.4
*69	*Streptopelia decaocto*	58	74	116	42	14	21	9	13	22	15	4	2	-
70	*Streptopelia turtur*	63	116	144	264	0	0	0	0	0	0	0	0	A.2
71	*Streptopelia senegalensis*	13	119	265	39	0	0	0	0	0	0	0	0	A.2
72	*Cuculus canorus*	3	2	4	1	0	0	0	0	0	0	0	6	
73	*Bubo bubo*	0	2	1	1	8	1	2	0	0	2	0	0	A.1.2
74	*Asio otus*	0	1	1	0	0	0	0	0	0	0	0	0	A.2
*75	*Athena noctua*	15	18	21	13	6	9	11	12	8	14	7	3	A.3
76	*Tyto alba*	0	5	3	3	1	2	0	0	1	0	0	0	A.2
77	*Caprimulgus europaus*	0	0	0	0	0	2	1	0	2	2	1	0	A.2
78	*Apus apus*	0	8	55	144	16	0	0	0	0	0	0	0	A.4
79	*Apus melba*	0	0	120	0	0	0	0	0	0	0	0	0	A.4
*80	*Alcedo atthis*	7	19	26	34	13	8	16	21	9	15	3	6	A.1.2
81	*Merops apiaster*	62	216	462	612	43	0	0	0	0	0	0	0	A.4
82	*Corracias garrulus*	0	0	14	36	0	0	0	0	0	0	0	0	A.2
83	*Upupa epops*	15	42	54	162	19	0	0	0	0	0	0	0	A.2

Table 1. continue

		1995								1996				
NO	SPECIES	APR.	MAY	JUNE	JULY	AGU.	SEP.	OCT.	NOV.	DEC.	JAN	FEB	MAR.	R.D.B **
*84	*Picus viridis*	3	9	26	14	8	23	17	15	13	19	26	18	A.2
*85	*Picus canus*	2	2	3	1	9	4	6	2	9	14	3	0	A.2
86	*Dryocopus martius*	0	0	1	3	1	0	1	1	2	2	0	0	A.3
*87	*Dendrocopus major*	3	9	16	11	18	6	4	9	9	8	16	5	A.3
*88	*Dendrocopus syriacus*	1	2	4	3	4	7	5	2	6	10	5	3	A.3
89	*Dendrocopus medius*	0	0	2	1	1	0	4	0	0	3	1	2	A.3
90	*Dendrocopus minor*	0	3	0	1	2	1	1	0	0	0	0	0	A.4
91	*Melanocorypha calandra*	0	0	13	16	19	0	0	0	0	0	0	0	-
92	*Galerida cristata*	10	19	21	120	93	124	136	141	74	18	21	34	-
93	*Alauda arvensis*	5	34	41	55	14	0	0	0	0	0	0	0	-
94	*Hirundo rustica*	66	650	1300	850	0	0	0	0	0	0	0	0	-
95	*Riparia riparia*	0	0	0	0	125	0	0	0	0	0	0	0	-
96	*Delichon urbica*	46	121	645	750	0	0	0	0	0	0	0	0	A.4
97	*Anthus cervinus*	0	3	11	4	0	0	0	0	0	0	0	0	-
98	*Motacilla flava feldeg*	13	200	550	0	0	0	0	0	0	0	0	0	-
99	*Cinclus cinclus*	0	0	0	0	0	0	0	0	0	4	2	0	A.3
100	*Troglodytes troglodytes*	0	0	0	0	0	0	0	0	6	11	18	2	A.3
101	*Turdus merula*	3	0	0	0	0	0	0	0	7	19	35	46	-
102	*Cetia cetti*	0	4	15	18	6	0	0	0	0	0	0	0	A.4
103	*Erithacus rubecula*	7	0	0	0	0	0	0	15	19	27	12	24	-
104	*Luscinia megarhynchos*	16	64	192	65	19	3	0	0	0	0	0	0	A.3
105	*Phoenicurus ochruros*	0	0	0	0	0	0	16	14	0	0	0	0	-
106	*Saxicola torquata*	0	0	0	0	0	0	2	5	0	0	0	0	-
107	*Acrocephalus arundinaceus*	3	11	4	14	0	0	0	0	0	0	0	2	-
108	*Hippolais icterina*													A.3
109	*Sylvia atricapilla*	14	35	42	13	8	0	0	0	0	0	0	0	-
110	*Phylloscopus collybita*	0	0	0	0	0	0	0	0	5	7	2	9	-
111	*Regulus regulus*	0	4	5	11	0	0	0	0	0	0	0	0	-

Table 1. continue

		1995								1996				
NO	SPECIES	APR.	MAY	JUNE	JULY	AGU.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	R.D.B.**
112	*Regulus ignicapillus*	1	2	1	0	1	0	0	0	0	0	0	0	
113	*Alsecicapa striata*	0	0	0	0	0	6	12	11	0	0	0	0	
114	*Ficedula albicollis*	0	4	15	18	6	0	0	0	0	0	0	0	
115	***Panurus biarmicus***	***1***	***2***	***1***	***0***	***0***	***6***	***3***	***1***	***0***	***1***	***2***	***0***	***A.2***
116	***Parus ater***	***3***	***2***	***0***	***0***	***0***	***0***	***0***	***10***	***12***	***21***	***6***	***15***	_
117	*Parus caeruleus*	0	3	7	12	0	0	0	0	0	0	10	5	_
118	***Parus major***	***14***	***13***	***26***	***62***	***21***	***0***	***0***	***0***	***0***	***23***	***17***	***32***	_
119	***Remiz pendilinus***	***0***	***4***	***9***	***16***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***A.2***
120	***Oriolus oriolus***	***18***	***25***	***61***	***44***	***95***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	_
121	*Lanius collurio*	3	36	96	135	44	0	0	0	0	0	0	0	_
122	*Lanius senator*	0	0	2	11	24	0	0	0	0	0	0	0	
123	*Lanius minor*	0	2	0	6	0		0	0	0	0	0	0	
124	***Garrulus glandarius***	***3***	***14***	***48***	***16***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	_
*125	***Pica pica***	***113***	***150***	***124***	***122***	***142***	***47***	***54***	***41***	***58***	***84***	***44***	***54***	_
*126	***Corvus monedula***	***323***	***516***	***487***	***695***	***703***	***654***	***512***	***332***	***228***	***197***	***286***	***94***	_
*127	***Corvus corone cornix***	***45***	***68***	***126***	***165***	***50***	***42***	***87***	***121***	***136***	***154***	***168***	***19***	_
128	*Corvus corax*	0	3	5	0	0	0	0	0	0	0	0	0	_
129	*Sturnus vulgaris*	1214	125	0	0	0	0	0	242	>10000	>10000	>10000	>10000	_
130	*Sturnus roseus*	0	0	0	0	0	0	0	0	41	0	0	0	_
*131	***Passer domesticus***	***524***	***1200***	***854***	***325***	***3200***	***3500***	***1500***	***1150***	***540***	***320***	***0***	***0***	_
*132	***Passer montanus***	***127***	***210***	***362***	***414***	***42***	***29***	***21***	***14***	***39***	***36***	***48***	***41***	_
133	***Passer hispaniolensis***	***19***	***47***	***165***	***49***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	_
134	*Fringilla coelebs*	13	17	0	0	0	0	125	1250	525	1200	1500	3000	_
135	*Serinus serinus*	0	0	0	0	0	17	25	9	10	0	0	0	_
136	***Carduelis chloris***	***10***	***22***	***14***	***12***	***0***	***0***	***0***	***212***	***>1000***	***>1000***	***>1000***	***>1000***	***A.4***
137	***Carduelis carduelis***	***13***	***11***	***0***	***0***	***0***	***0***	***150***	***1400***	***2500***	***3000***	***2000***	***1500***	***A.4***
138	*Loxia curvirostra*	0	0	0	0	0	0	0	10	0	0	0	0	
139	*Coccothraustes coccothraustes*	0	0	0	0	0	0	0	0	0	2	1	0	

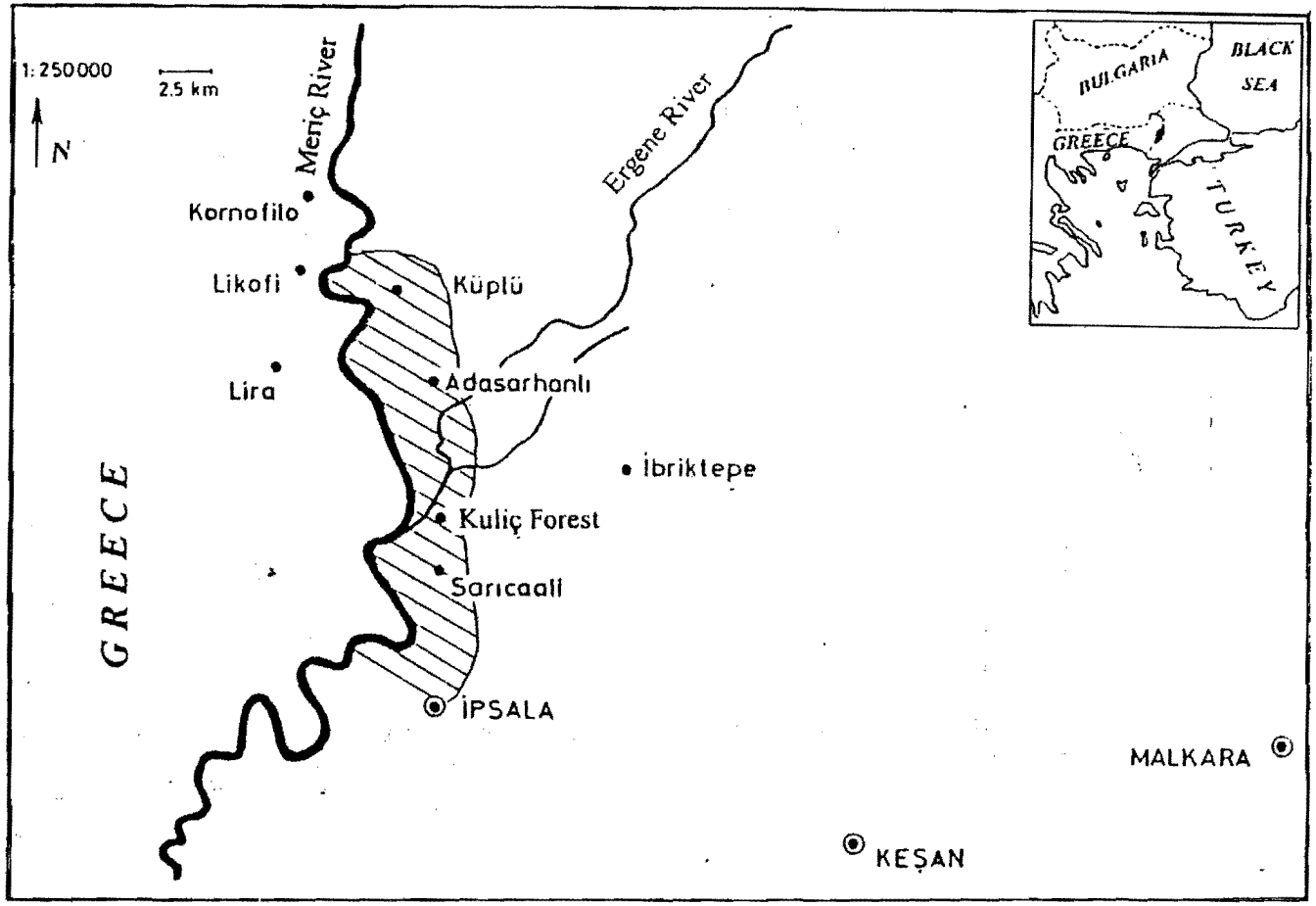

Figure 1. Location of Küplü-İpsala in Turkiye.

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POLLEN ANALYSIS OF HONEYS FROM CENTRAL, EASTERN AND SOUTHEASTERN ANATOLIA IN TURKEY

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Abstract

This study presents the pollen analysis of 53 floral honeys, 20 samples from Central Anatolia, 28 samples from Eastern Anatolia, and 5 samples from Southeastern Anatolia in Turkey. The pollen analysis has revealed 1 unifloral honey and 52 multifloral honeys. Pollens have been identified pertaining in 80 taxa, 64 of which were at genus level, and 16 were at species level.

The pollen grains of *Astragalus, Centaurea, Eryngium campestre* and *Trifolium* have been found to be the dominant group while the pollen grains of *Achillea, Astragalus, Centaurea, Cephalaria, Eryngium campestre, Helianthus annuus, Lamium, Lotus corniculatus, Marrubium vulgare, Medicago, Onobrychis viciifolia, Pimpinella anisum, Solidago, Sophora japonica, Teucrium orientalis,* and *Trifolium* identified as the secondary group, and the remaining 64 taxa pollens are defined as the minor and rare groups.

Keywords: Pollen, Honey, Melissopalynology, Unifloral Honey, Multifloral Honey.

Introduction

The plant taxa contributing to honey are revealed through pollen analysis of floral honeys [1]. A large amount of literature concerning the melissopalynologic studies shows that this subject is of great importance. Nectar containing flowering plants have been identified through pollen analysis in honey samples from various countries, e. g. 54 samples from Louisiana in USA [1], 54 samples from Switzerland [2], 36 samples from Alberta [3], and 42 samples from Saskatchevan [4] in Canada, 530 samples from Galicia [5], 115 samples from Basque [6] in Spain, 119 samples from New Zealand [7], 150 samples from Sardinian in Italy [8], 112 samples from Corsican in France [9], 20 samples from Biala Podlaska in Poland [10], 174 samples from Greek [11], and 93 samples from Los Lagos in Southern Chile [12].

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Nectar containing flowering plants have also been identified through pollen analysis in honey samples from Turkey, e. g. 94 samples from Central Anatolia [13-15], 26 samples from Rize [16], 20 samples from different regions [17], and 28 samples from Rize-Anzer [18].

The aim of the present research was the identification of nectar containing flowering plants of Central, Eastern, and Southeastern Anatolia in Turkey that mediate the formation of honey.

Materials and Methods

The study was conducted within a two year period from 1995 to 1996. The regions and districts where the samples originate from have been shown in Figure 1. Central, Eastern and Southeastern Regions of Turkey were selected, representing the Irano-Turan phytogeographical regional characteristics which permit steppe flora. The samples used in the study were donated by the Ministry of Agriculture and Rural Affairs.

The preparation and pollen analysis of the honey samples were done using the method defined by the International Bee Research Association [19].

During the pollen analysis, source books [20-25] and reference pollen preparations were used. Identification of pollen grains was done using a Leitz-Wetzlar light microscope.

The amount of pollen ranging between 1% and 5% was considered as the rare group, the one ranging between 6% and 20% was considered as the minor group, the one ranging between 21% and 50% was considered as the secondary group, and the amount of pollen exceeding 50% was called as the dominant group.

Results

As a result of the pollen analysis conducted on 53 honey samples collected from central, eastern and southeastern Anatolia, pollens from 80 taxa of 33 families were identified (Table 1). Of these taxa, 64 were at genus level while 16 were at species level (Table 1).

Of the honey samples whose pollen spectra were constructed, only one sample (28) collected from eastern Anatolia region were identified as unifloral. In this sample, *Trifolium* (Fabaceae) pollens were found to be dominant and *Heracleum* (Apicaceae) pollens were found to be rare (Table 3). The remaining honey samples were identified as multifloral due to the existence of pollens of numerous different taxa. (Tables 2 and 4).

As shown by the pollen analysis, the samples exhibiting the richest taxonal variety and pollen amount were members of the families Asteraceae, Fabaceae, Boraginaceae, Lamiaceae, Rosaceae, and Apicaceae (Tables 1 and 4).

The pollen analysis of the honey samples collected from central Anatolia have shown pollens of *Centaurea* of the Asteraceae family to be dominant in samples 3 and 4 while of the Fabaceae family *Astralagus* pollens were found to be dominant in sample 2, and *Trifolium* pollens were identified as dominant in samples 14, 16, 18 and 20. In the samples taken from the same region, pollens of *Astralagus* of the Fabaceae family were found to be secondary in sample 1 while *Lotus corniculatus* pollens were identified as secondary in samples 3, 8, 9, and 10, *Onobrychis viciifolia* pollens in sample 11, *Sophora japonica* pollens in sample 12, and *Trifolium* pollens in samples 13, 15, 17, and 19. Of the Asteraceae family, *Centaurea* pollens were identified as secondary in samples 5, 10, 15 and 19, *Helianthus annuus* pollens in sample 7 while of the Dipsacaceae family *Cephalaria* pollens were found to be secondary in sample 9, and of the Lamiaceae family *Teucrium orientalis* pollens were secondary in samples 12 and 13 (Table 2).

Regarding the pollen analysis of the honey samples taken from eastern Anatolia, pollens of *Astralagus* of the Fabaceae family were identified as the dominant group in sample 2, *Trifolium* pollens in samples 26 and 28 while of the Apiaceae family *Eryngium campestre* pollens were found to be dominant in sample 7. Among the same group of samples pollens of *Achillea* of the Asteraceae family were found to be secondary in sample 1, and *Centaurea* pollens in samples 6, 13, and 15 while of the Fabaceae family *Astralagus* pollens were secondary in samples 3-5, and 27, *Lotus corniculatus* pollens in samples 10-12, and 22, *Trifolium* pollens in samples 8, 11, 15 - 24. Of the Apiaceae family pollens of *Eryngium campestre* in sample 8, *Pimpinella anisum* pollens in sample 14 were determined. In addition, Of the Lamiaceae family *Lamium* pollens were secondary in sample 9, and *Marrubium vulgare* pollens in sample 13 (Table 3).

Among the honey samples taken from the southeastern Anatolia, pollen analysis has shown the pollens of *Trifolium* of the Fabaceae family to be dominant in samples 1-3, and 5 while of the Asteraceae family *Centaurea* pollens were dominant in sample 1, and *Solidago* pollens in sample 4. On the other hand, of the Fabaceae family *Medicago* pollens were secondary in sample 2, and *Trifolium* pollens in sample 4 (Table 4).

Pollens of other families except the ones cited above have been classified as minor and rare. Of the 53 honey samples studied, minor and rare pollens were identified in 52 samples. (Tables 2 and 4)

Discussion

As a result of the pollen analysis conducted on 53 honey samples, the identified taxa have pollens of rare, minor, secondary and dominant groups, respectively (Tables 2 and 4). The variability of the taxa with dominant pollens are usually in a smaller number while the reverse is true for the rare and minor groups [1]. In the study conducted, related previous findings were confirmed.

The plants that constitute a source of nectar for the formation of honey are those whose pollens belong to the dominant and secondary groups [26].

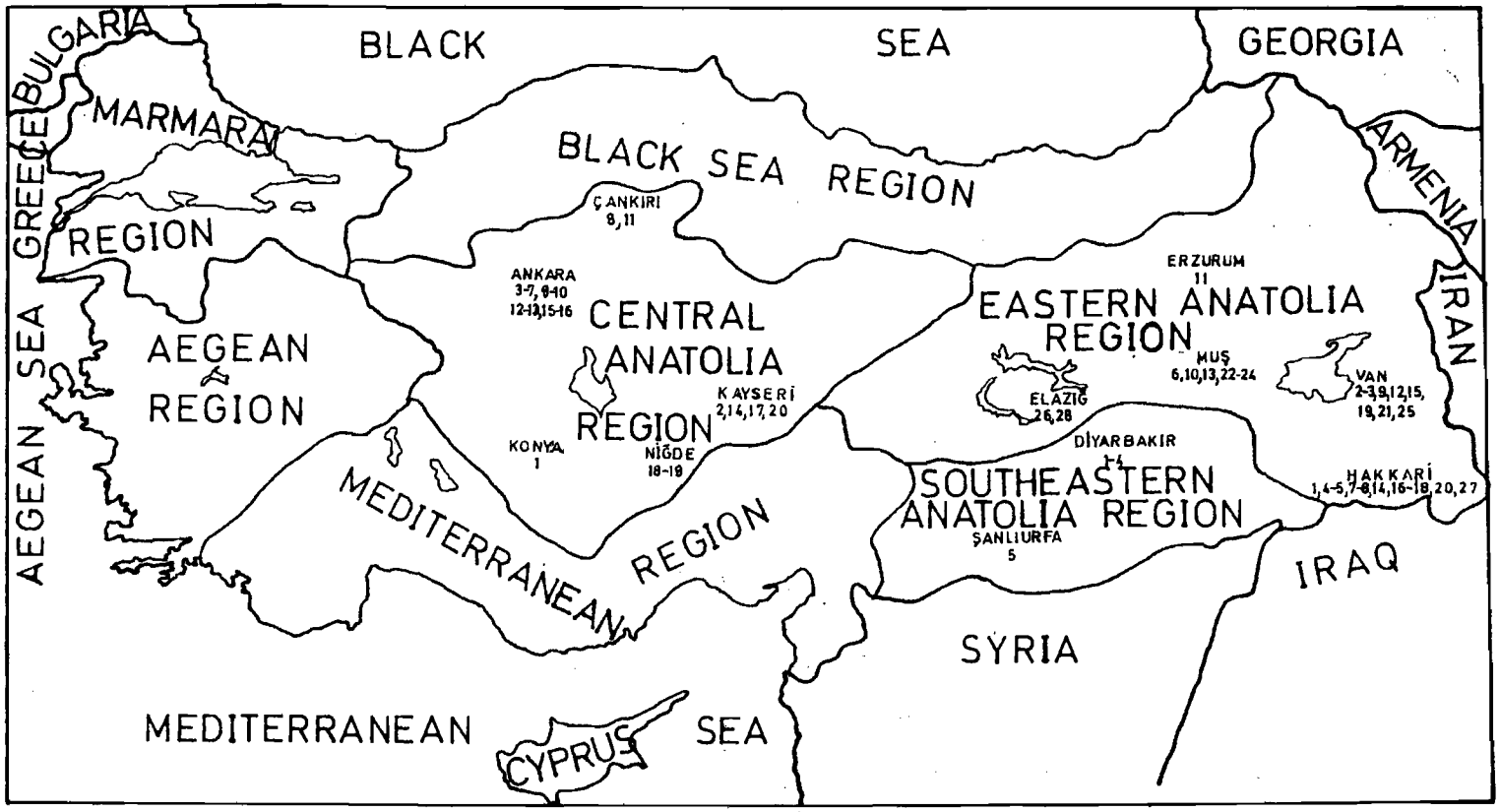

Figure 1: Regions from where samples were collected places names and sample numbers.

Table 1. Taxa whose pollens were identified in the honeys samples and the families they belong to.

Number	Family	Taxa
1	Asteraceae	*Achillea, Anthemis, Aster, Carduus, Centaurea, Cirsium, Crepis, Helianthus annuus, Lapsana, Solidago, Taraxacum, Xanthium, Xeranthemum.*
2	Fabaceae	*Astragalus, Cicer, Hedysarum varium, Lathyrus, Lotus corniculatus, Medicago, Melilotus, Onobrychis viciifolia, Sophora japonica, Trifolium, Vicia cracca.*
3	Boraginaceae	*Anchusa, Borago, Cerinthe, Cynoglossum, Echium, Heliotropium, Symphytum.*
4	Lamiaceae	*Lamium, Marrubium vulgare, Mentha, Origanum, Salvia verticillata, Teucrium orientalis, Thymus.*
5	Rosaceae	*Cerasus, Crateagus, Pyrus, Rosa, Sanguisorbe minor, Sorbus.*
6	Apiaceae	*Daucus, Eryngium campestre, Ferula, Heracleum, Pimpinella anisum.*
7	Cistaceae	*Cistus, Helianthemum.*
8	Dipsacaceae	*Cephalaria, Scabiosa.*
9	Salicaceae	*Salix vulgaris, Populus.*
10	Scrophulariaceae	*Linaria arvensis, Scrophularia.*
11	Berberidaceae	*Berberis.*
12	Brassicaceae	*Brassica.*
13	Caesalpiniaceae	*Cercis.*
14	Campanulaceae	*Campanula.*
15	Caprifoliaceae	*Lonicera.*
16	Chenopodiaceae	*Chenopodium.*
17	Convolvulaceae	*Convolvulus.*
18	Cyperaceae	*Carex.*
19	Elaeagnaceae	*Elaeagnus.*
20	Euphorbiaceae	*Euphorbia.*
21	Geraniaceae	*Geranium.*
22	Globulariaceae	*Globularia.*
23	Hippocastanaceae	*Aesculus hippocastanum.*
24	Liliaceae	*Allium.*
25	Oleaceae	*Ligustrum.*
26	Plantaginaceae	*Plantago.*
27	Poaceae	*Triticum vulgare.*
28	Polygonaceae	*Rumex.*
29	Primulaceae	*Primula.*
30	Rhamnaceae	*Rhamnus.*
31	Rubiaceae	*Galium.*
32	Tiliaceae	*Tilia.*
33	Verbenaceae	*Verbena.*

Table 2- Honey sample number, Central Anatolia region, and pollen spectrum.
* Dominant pollen, ** Secondary pollen, ***Minor pollen and ****Rare pollen.

Honey Sample Number	Regional Name	Pollen Spectrum
1	Konya	*- **Astragalus.* ***Achillea, Brassica, Crateagus, Lamium, Salix vulgaris, Trifolium.* ****Centaurea, Onobrychis vicilfolia, Sanguisorbe minor, Salvia verticillata, Taraxacum, Thymus, Triticum vulgare.*
2	Kayseri	**Astragalus.* **- ***Centaurea, Vicia cracca.* ****Achillea, Brassica, Carex, Hedysarum varium, Lathyrus, Linaria arvensis, Lotus corniculatus, Melilotus, Salix vulgaris, Salvia verticillata,* Sorbus, *Taraxacum, Triticum vulgare .*
3	Ankara	**Centaurea.* ***Lotus corniculatus.* ****Achillea.* *****Anthemis, Brassica, Chenopodium, Cistus, Linaria arvensis, Trifolium.*
4	Ankara	**Centaurea.* **- ***Lotus corniculatus.* ****Allium, Aster, Chenopodium, Daucus, Helianthus annuus, Plantago, Salix vulgaris, Solidago, Sophora japonica, Taraxacum, Teucrium orientalis, Trifolium, Triticum vulgare.*
5	Ankara	*- ***Centaurea.* ****Lotus corniculatus, Marrubium vulgare, Trifolium.* *****Aesculus hippocastanum, Brassica, Cistus, Elaeagnus, Eryngium campestre, Euphorbia, Hedysarum varium, Onobrychis vicilfolia, Rumex, Sophora japonica, Triticum vulgare.*
6	Ankara	*- **- ****Astragalus, Brassica, Centaurea, Elaeagnus, Hedysarum varium, Lotus corniculatus, Onobrychis vicilfolia, Salix vulgaris, Trifolium.* *****Achillea, Aster, Cistus, Daucus, Echium, Galium, Helianthemum, Linaria arvensis, Origanum, Primula, Pyrus, Salvia verticillata, Taraxacum, Vicia cracca.*
7	Ankara Haymana	*- ***Helianthus annuus.* ****Centaurea, Eryngium campestre, Trifolium.* *****Aster, Brassica, Chenopodium, Cistus, Crepis, Daucus, Lathyrus, Linaria arvensis,Lotus corniculatus, Medicago, Mentha, Salix vulgaris, Taraxacum, Teucrium orientalis.*

Table 2- Honey sample number, Central Anatolia region, and pollen spectrum (Continued).

8	Çankırı Kurşunlu	*- **_Lotus corniculatus._ ***_Achillea, Centaurea, Globularia, Ligustrum._ ****_Astragalus, Cerinthe, Cistus, Echium, Eryngium campestre, Galium, Hedysarum varium, Marrubium vulgare, Mentha, Onobrychis vicilfolia, Populus, Pyrus, Salix vulgaris, Sorbus, Taraxacum, Teucrium orientalis, Trifolium, Vicia cracca._
9	Ankara	*- **_Cephalaria, Lotus corniculatus._ ***_Hedysarum varium, Trifolium._ ****_Achillea, Brassica, Chenopodium, Heliathus annuus, Salix vulgaris, Triticum vulgare._
10	Ankara	*- **_Cephalaria, Lotus corniculatus._ ***_Trifolium._ ****_Achillea, Brassica, Chenopodium, Heliathus annuus, Salix vulgaris, Triticum vulgare._
11	Çankırı Ilgaz	*- **_Onobrychis vicilfolia._ ***_Centaurea, Echium, Hedysarum varium, Marrubium vulgare, Salvia verticillata, Trifolium, Vicia cracca._ ****_Anchusa, Anthemis, Brassica, Crateagus, Helianthemum, Sanguisorbe minor, Salix vulgaris, Teucrium orientalis._
12	Ankara	*- **_Sophora japonica, Teucrium orientalis._ ***_Astragalus, Centaurea, Lotus corniculatus, Trifolium._ ****_Brassica, Globularia, Hedysarum varium, Plantago, Salix vulgaris._
13	Ankara Kazan	*- **_Teucrium orientalis, Trifolium._ ***_Centaurea, Cirsium, Crateagus._ ****_Borago, Daucus, Hedysarum varium, Linaria arvensis, Salix vulgaris, Taraxacum, Triticum vulgare, Xanthium, Vicia cracca._
14	Kayseri Toroslar	*_Trifolium._ **- ***_Astragalus, Globularia._ ****_Achillea, Carduus, Centaurea, Daucus, Hedysarum varium, Helianthus annuus, Linaria arvensis, Melilotus, Plantago, Salvia verticillata, Scrophularia._
15	Ankara	*- **_Centaurea, Trifolium_ ***- ****_Brassica, Carduus, Cistus, Crateagus, Echium, Helianthus annuus, Linaria arvensis, Onobrychis vicilfolia, Sophora japonica._

Table 2- Honey sample number, Central Anatolia region, and pollen spectrum (Continued).

16	Ankara Polatlı	**Trifolium.* **- ****Achillea, Marrubium vulgare.* *****Centaurea, Chenopodium, Crepis, Heliotropium, Plantago, Salix vulgaris, Triticum vulgare.*
17	Kayseri Bünyan	*- ***Trifolium.* ****Achillea, Vicia cracca.* *****Achillea, Anthemis, Aster, Centaurea, Cirsium, Convolvulus, Eryngium campestre, Lamium, Marrubium vulgare, Melilotus, Mentha, Plantago, Salvia verticillata.*
18	Niğde	**Trifolium.* **- ****Centaurea.* *****Achillea, Astragalus, Chenopodium, Daucus, Hedysarum varium, Lotus corniculatus, Melilotus, Onobrychis vicilfolia, Plantago, Salix vulgaris, Symphytum, Triticum vulgare.*
19	Niğde	*- ***Centaurea, Trifolium.* ****Allium, Astragalus, Daucus, Melilotus.* *****Achillea, Aster, Brassica, Chenopodium, Cistus, Echium, Hedysarum varium, Lotus corniculatus, Onobrychis vicilfolia, Origanum, Plantago, Salix vulgaris, Symphytum, Taraxacum,Tilia.*
20	Kayseri	**Trifolium.* **- ****Anthemis, Astragalus.* *****Achillea, Aster, Brassica, Centaurea, Cerasus, Chenopodium, Cistus, Lamium, Mentha, Onobrychis vicilfolia, Primula, Salix vulgaris, Triticum vulgare.*

Table 3- Honey sample number, Eastern Anatolia region, and pollen spectrum.
* Dominant pollen, **Secondary pollen, ***Minör pollen and ****Rare pollen.

Honey Sample Number	Regional Name	Pollen Spectrum
1	Hakkari Yüksekova	*- **- *Achillea* ****Astragalus, Daucus, Eryngium campestre, Marrubium vulgare, Trifolium.* *****Centaurea, Hedysarum varium, Ligustrum, Plantago, Salvia verticillata, Teucrium orientalis.*
2	Van Erciş	**Astragalus* **- ****Linaria arvensis, Trifolium.* *****Centaurea, Ligustrum, Lotus corniculatus, Onobrychis vicilfolia.*
3	Van Erciş	*- ***Astragalus.* ****Chenopodium, Lonicera, Lotus corniculatus, Solidago, Trifolium.* *****Achillea, Centaurea, Cerinthe, Cistus, Galium, Hedysarum varium, Helianthus annuus, Melilotus, Salvia verticillata, Sorbus, Teucrium orientalis, Triticum vulgare.*
4	Hakkari	*- ***Astragalus.* ****Mentha, Onobrychis vicilfolia, Rosa, Salvia verticillata, Teucrium orientalis, Trifolium, Triticum vulgare.* *****Brassica, Cistus, Daucus, Eryngium campestre, Euphorbia, Hedysarum varium, Marrubium vulgare, Symphytum, Taraxacum.*
5	Hakkari	*- ***Astragalus.* ****Anthemis, Lotus corniculatus, Plantago, Trifolium.* *****Aster, Brassica, Carduus, Centaurea, Chenopodium, Cistus, Daucus, Eryngium campestre, Helianthus annuus, Lathyrus, Mentha, Salix vulgaris, Scabiosa, Taraxacum, Thymus, Vicia cracca.*
6	Muş Bulanık	*- ***Centaurea.* ****Lotus corniculatus, Trifolium, Vicia cracca.* *****Achillea, Astragalus, Brassica, Campanula, Echium, Galium, Heracleum, Lamium, Ligustrum, Linaria arvensis, Marrubium vulgare, Melilotus, Onobrychis vicilfolia, Plantago, Sorbus, Teucrium orientalis.*
7	Hakkari Yüksekova	**Eryngium campestre.* **- ****Astragalus, Lamium.* *****Carex, Cirsium, Cistus, Helianthus annuus, Mentha, Trifolium.*

Table 3- Honey sample number, Eastern Anatolia region, and pollen spectrum (Continued).

8	Hakkari Yüksekova	*- ***Eryngium campestre, Trifollum.* ****Astragalus, Solidago.* *****Aster, Carduus, Centaurea, Cirsium, Daucus, Lotus corniculatus, Onobrychis vicilfolia, Plantago, Rosa, Taraxacum, Thymus, Vicia cracca.*
9	Van Özalp	*- ***Lamium.* ****Astragalus, Centaurea, Chenopodium, Heracleum, Onobrychis vicilfolia.* *****Brassica, Ferula, Geranium, Ligustrum, Lotus corniculatus, Rosa, Taraxacum, Vicia cracca.*
10	Muş	*- ***Lotus corniculatus.* ****Astragalus, Daucus, Hedysarum varium, Linaria arvensis, Trifolium.* *****Berberis, Cercis, Galium, Heracleum, Onobrychis viciifolia, Plantago, Thymus.*
11	Erzurum Aşkale	*- ***Lotus corniculatus, Trifolium.* ****Mentha.* *****Brassica, Carex, Daucus, Onobrychis vicilfolia, Thymus, Vicia cracca.*
12	Van Özalp	*- ***Lotus corniculatus.* ****Helianthemum, Rosa, Trifolium.* *****Brassica, Centaurea, Eryngium campestre, Hedysarum varium, Lamium, Melilotus, Rumex, Taraxacum, Teucrium orientalis, Thymus.*
13	Muş Hasköy	*- ***Centaurea, Marrubium vulgare.* ****Daucus, Sanguisorbe minor, Trifolium.* *****Globularia, Lamium, Melilotus, Plantago, Scrophularia, Triticum vulgare.*
14	Hakkari Yüksekova	*- ***Pimpinella anisum.* ****Heracleum, Thymus, Trifolium.* *****Achillea, Anchusa, Aster, Astragalus, Centaurea, Chenopodium, Ligustrum, Linaria arvensis, Marrubium vulgare, Scabiosa, Solidago, Triticum vulgare.*
15	Van	*- ***Centaurea, Trifolium.* ****Marrubium vulgare, Onobrychis vicilfolia, Thymus.* *****Anthemis, Daucus, Galium, Hedysarum varium, Linaria arvensis, Salix vulgaris, Sorbus, Teucrium orientalis.*

Table 3- Honey sample number, Eastern Anatolia region, and pollen spectrum (Continued).

16	Hakkari Yüksekova	*- ***Trifolium.* ****Astragalus, Centaurea, Daucus, Echium, Linaria arvensis.* *****Achillea, Brassica, Cicer, Cynoglossum, Eryngium campestre, Galium, Hedysarum varium, Heracleum, Lapsana, Ligustrum, Marrubium vulgare, Mentha, Onobrychis vicilfolia, Primula, Salvia verticillata, Sorbus, Teucrium orientalis.*
17	Hakkari Yüksekova	*- ***Trifolium* ****Daucus, Heracleum, Linaria arvensis, Marrubium vulgare, Sorbus.* *****Achillea, Aster, Centaurea, Hedysarum varium, Ligustrum, Lotus corniculatus, Melilotus, Onobrychis vicilfolia, Plantago, Solidago, Taraxacum, Tecrium orientalis, Thymus.*
18	Hakkari Yüksekova	*- ***Trifolium.* ****Daucus, Hedysarum varium, Marrubium vulgare, Thymus.* *****Achillea, Aster, Carex, Centaurea, Cephalaria, Eryngium campestre, Lamium, Ligustrum, Lotus corniculatus, Melilotus, Onobrychis vicilfolia, Plantago, Teucrium orientalis, Triticum vulgare.*
19	Van Başkale	*- ***Trifolium* ****Achillea, Hedysarum varium, Marrubium vulgare, Salvia verticillata.* *****Carduus, Centaurea, Cerinthe, Crateagus, Daucus, Eryngium campestre, Ligustrum, Lotus corniculatus, Melilotus, Onobrychis vicilfolia, Plantago, Solidago, Taraxacum, Teucrium orientalis, Triticum vulgare, Vicia cracca.*
20	Hakkari Yüksekova	*- ***Trifolium.* ****Daucus, Eryngium campestre, Salvia verticillata.* *****Achillea, Astragalus, Centaurea, Cerinthe, Hedysarum varium, Heracleum, Linaria arvensis, Lotus corniculatus, Melilotus, Onobrychis vicilfolia, Origanum, Plantago, Rumex.*
21	Van	*- ***Trifolium.* ****Achillea, Centaurea, Daucus, Hedysarum varium, Lotus corniculatus, Thymus.* *****Achillea, Centaurea, Daucus, Cerinthe, Crepis, Eryngium campestre, Marrubium vulgare, Melilotus, Sanguisorbe minor. Primula, Rumex, Salix vulgaris, Solidago, Sorbus, Teucrium orientalis.*
22	Muş	*- ***Lotus corniculatus, Trifolium.* ****Astragalus, Centaurea, Chenopodium, Lamium, Marrubium vulgare, Scrophularia, Sorbus.* *****Echium, Eryngium campestre, Galium, Globularia, Hedysarum varium, Heracleum, Melilotus, Primula, Salvia verticillata, Teucrium orientalis.*

Table 3- Honey sample number, Eastern Anatolia region, and pollen spectrum (Continued).

23	Muş	*- **_Trifolium._ ***_Astragalus, Centaurea, Geranium, Mentha._ ****_Daucus, Hedysarum varium, Helianthemum, Lamium, Marrubium vulgare, Melilotus, Thymus._
24	Muş Ziyaret	*- **_Trifolium._ ***_Brassica, Daucus, Echium, Lamium, Plantago._ ****_Centaurea, Chenopodium, Cistus, Marrubium vulgare, Rumex, Taraxacum, Thymus, Triticum, vulgare, Vicia cracca._
25	Van Başkale	*- **- ***_Chenopodium, Hedysarum varium, Lamium, Mentha, Onobrychis viciifolia, Rosa, Trifolium, Vicia cracca._ ****_Brassica, Centaurea, Cercis, Cistus, Crateagus, Daucus, Echium, Globularia, Lotus corniculatus, Plantago, Rumex, Thymus._
26	Elazığ	*_Trifolium._ **- ***_Astragalus._ ****_Allium, Aster, Brassica, Centaurea, Cistus, Echium, Lotus corniculatus, Onobrychis viciifolia, Plantago, Primula, Rhamnus, Salix vulgaris, Taraxacum, Tilia, Triticum vulgare, Verbena, Vicia cracca, Zea mays._
27	Hakkari	* ** _Astragalus, Trifolium._ ***_Centaurea, Cistus, Lotus corniculatus, Onobrychis viciifolia._ ****_Achillea, Allium, Aster, Carduus, Daucus, Eryngium campestre, Helianthus annuus, Plantago, Taraxacum, Thymus, Triticum vulgare, Xeranthemum._
28	Elazığ Hazar Gölü	*_Trifolium._ **- ***- ****_Heracleum._

Tablo 4- Honey sample number, Southeastern Anatolia region, and pollen spectrum.
* Dominant pollen, **Secondary pollen, ***Minör pollen and, ****Rare pollen.

Honey Sample Number	Regional Name	Pollen Spectrum
1	Diyarbakır	*Trifolium. **Centaurea. ***- ****Aster, Cirsium, Globularia, Hedysarum varium, Ligustrum, Marrubium vulgare, Primula, Salvia verticillata, Teucrium orientalis, Triticum vulgare.
2	Diyarbakır	*Trifolium. **Medicago. ***- ****Anchusa, Echium, Lathyrus, Lotus corniculatus, Marrubium vulgare, Mentha, Salix vulgaris,Teucrium orientalis.
3	Diyarbakır	*Trifolium. **- ***Salix vulgaris. ****Astragalus, Brassica, Chenopodium, Lathyrus, Marrubium vulgare.
4	Diyarbakır	*- **Solidago, Trifolium. ***Astragalus, Brassica. ****Aster, Cistus, Daucus, Echium, Eryngium campestre, Helianthus annuus, Lamium, lotus corniculatus, Mentha, Plantago, Primula, Salix vulgaris, Salvia verticillata, Triticum vulgare, Xeranthemum, Vicia cracca.
5	Şanlıurfa Viranşehir	*Trifolium. **- ***Vicia cracca. ****Achillea, Anthemis, Brassica, Centaurea, Crateagus, Daucus, Hedysarum varium, Lotus corniculatus, Plantago, Primula, Salix vulgaris, Salvia verticillata, Teucrium orientalis.

In the pollen analysis of 94 honey samples collected from central Anatolia, Sorkun and İnceoğlu have identified pollens of 15 taxa as dominant, namely *Achillea, Centaurea triumfetti, Lapsana communis* and *Xeranthemum* of the Asteraceae family, *Astragalus, Hedysarum, Lotus* and *Vicia cracca* of the Fabaceae family, *Teucrium orientalis* and *Lamium amplexicaule* of the Lamiaceae family, *Rubus* of the Rosaceae family, *Heliotropium suaveolens* of the Boraginaceae family, *Brassica oleracea* of the Brassicaceae family, *Peganum harmala* of the Zygophyllaceae family and *Consolida raveyi* of the Ranunculaceae family [14]. The taxa whose pollens were identified as the dominant group in the honey samples examined in the present study were *Astralagus* and *Trifolium* of the Fabaceae family, *Centaurea* of the Asteraceae family, and *Eryngium campestre* of the Apiaceae family. Only 4 taxa had pollens of the dominant group. In both of the said studies, *Astralagus* (Fabaceae) and *Centaurea* (Asteraceae) pollens were identified as dominant groups.

In the study conducted by Sorkun and İnceoğlu pollens of 18 taxa were identified as secondary, namely *Carthamus tinctorius, Centaurea drabifolia, C. pichleri, C. solstitialis, C. virgata* and *Crepis foetida* of the Asteraceae family, *Hedysarum varium, Melilotus, Onobrychis argyrea, O. cornuta* and *O. oxydonta* of the Fabaceae family, *Myosotis, Cerinthe* and *Heliotropium lasiocarpum* of the Boraginaceae family, *Marrubium* of the Lamiaceae family, *Pyrus eleagnifolia* of the Rosaceae family, *Salix* of the Salicaceae family and *Linaria* of the Scrophulariaceae family [15]. In the present study the taxa whose pollens were observed to belong to the secondary group are *Achillea, Centaurea, Helianthus annuus* and *Solidago* of the Asteraceae family, *Astralagus, Lotus corniculatus, Medicago, Onobrychis viciifolia, Sophora japonica* and *Trifolium* of the Fabaceae family, *Lamium, Marrubium vulgare* and *Teucrium orientalis* of the Lamiaceae family, *Eryngium campestre* and *Pimpinella anisum* of the Apiaceae family, and *Cephalaria* of the Dipsacaceae family. In either study cited, *Centaurea* (Asteraceae), *Onobrychis viciifolia* and *Marrubium vulgare* (Lamiaceae) were taxa with pollens identified as secondary groups.

In the pollen analysis made on honey samples collected from various regions of Turkey, it has been observed that the pollens of taxa of the families Asteraceae, Fabaceae, Lamiaceae, Rosaceae, Boraginaceae, Apiaceae, and Brassicaceae constitute the majority in Turkish honey samples and play an important role in that respect [13-18].

The present study has once more revealed that an important part of the taxa contributing to the honey production in central, eastern and southeastern regions of Turkey belong to the families Fabaceae, Asteraceae, Apiaceae, Lamiaceae, and Dipsacaceae.

Some of the plants whose pollens belong to the minor group are insignificant as a source of nectar. It can be said that those pollens of minor and rare groups have been mixed in the honey in random fashion [27].

The central, eastern, and southeastern regions of Turkey belong to the Irano-Turanian pythogeographical zone [28] characterized by the steppe vegetation. Among the main sources of

this kind of vegetation are taxa such as *Astralagus* and *Trifolium* of the Fabaceae family, *Centaurea* of the Asteraceae family, and *Eryngium campestre* of the Apicaceae family [29]. As a result of the present study, it has been verified that the honey of central, eastern, and southeastern Turkey are of multifloral origin. The results indicate a direct parallelism with the pythogeographical characteristics of the regions.

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