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POLLEN MORPHOLOGY OF SOME CHENOPODIACEAE: I. ATRIPLEX L.

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Abstract: Pollen grains of 11 species of the genus *Atriplex* L. (*Chenopodiaceae*), of which morphological separation is proplematical, have been examined in detail comparatively by using light microscopy (LM), scanning (SEM) and transmission electron microscopy (TEM). Pollen description of each taxon has been given. Pollen grains of *Atriplex* species examined are radially symmetrical, isopolar, pantopolyporate and spheroidal. Their exine structure are similar. Ektexine thick than endexine. The genus has been divided into three types on the basis of pollen size. It is suggested that pollen size and pore number can be regarded as diagnotistic characters, a tentative solution to taxonomic problems.

Key Words: *Atriplex*, *Chenopodiaceae*, Pollen morphology.

Introduction

The genus *Atriplex* L., revised by Aellen [1], is represented by 13 species and 3 varities in Flora of Turkey. Difficulties have been encountered in the separation of species due to their close morphological similarity [1].

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There are several palynological works on *Atriplex*, but most are not detailed. Erdtman [2] gave a short description of *A. latifolium* L. and *A. maritima*. L. Markgraf and D'antoni [6] studied *A. lampa* L. under the LM. Tsukada [8] made a comparison between fossil and recent pollen grains of *A. littoralis* L., *A. portulacoides* L. and *A. writghtii* L., using SEM. Hai-ping and Jin-Tan [5] showed scanning electron micrographs of the pollen of 50 *Chenopodiaceae* taxa, including *Atriplex* species, *A. patens* L., *A. centralasiatica* L., *A. cana* Ledeb., *A. tatarica* L., and *A. dimorphostegia* Kar et Kir.

The main aims of this study are to contribute to an understanding of the detailed pollen morphology of some *Atriplex* species by light and electron microscopes and to make an attempt to solve taxonomic problems.

Materials and Methods

Polliniferous material was taken from Ankara University Herbarium (ANK) and Royal Botanic Garden Edinburgh (E). The collections are listed under "Specimens investigated", following the sequence of Aellen [1].

For LM study, the pollen slides were prepared according to the technique of Wodehouse (W) [9] and Erdtman (E) [3]. A Leitz-Wetzlar microscope was used for examination (Ocular X16, objective X100). Measurements were taken statistically. In order to estimate the pore number, the method by Mc Andrews and Swanson [7], based on the ratio of distance between centers of adjacent pores (C) and the diameter of the grain (D) was followed. Photographs were taken with a Leitz Phan-Photo microscope.

For TEM study, acetolysed pollen grains were fixed in OsO_4 stained with uranly acetate and embedded in araldite. Ultrathin sections were post-stained with lead citrate and uranly acetate. For SEM study, unacetolysed pollen grains were transferred to stubs and covered with gold. A jeol 100 CXII electron microscope was employed for both TEM and SEM studies.

Terminology follows that of Faegri and Iversen [4].

Specimen Investigated

Atriplex halimus L.	Iran: Oskanernarkazi	P. Uothiola (E)
A. hortensis L.	Nevşehir: Göreme	Davis-Hedge 32777 (ANK)
A. nitens Schkuhr	Tilkili köy., Kızıözü muh., 650 m.	Karamanoğlu(ANK)
A. laevis C.A. Meyer	Konya: Çumra	Karamanoğlu 283 (ANK)
A. lasiantha Boiss.	Ağrı	Birand-Karamanoğlu 509 (ANK)
A. tatarica L.	Konya: Çumra	E. Yurdakulol 13 (ANK)
A. rosea L.	Ankara	Krause (ANK)
A. tornabeni Tineo	Balıkesir: Ayvalık	W. Kotte 1953 (ANK)
A. davisii Aellen	Niğde: Aksaray	Davis-Hedge 32846 (ANK)
A. hashata L.	Konya: Çumra	E. Yurdakulol 12 (ANK)
A. patula L.	Yunanistan: Kalymnos adası	Davis 67890 (E)

Results

Pollen Decriptions

Atriplex halimus L. (Fig 1 f-j)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 21 µm (W), 20.8 µm (E). Poses 1.6 µm (W) (E) in diameter and circular. Operculum 1.6 µm (E) wide; 0.4 µm high,

7-9 conical spinules on operculum. Distance between the centers of the adjacent pores 3.9 μm (E). C/D 0.1875. Por number 102.

Ornamentation scabrate; 120 spinules per 100 μm^2; tectal spinules conical, 0.3 μm high, 0.25 μm wide.

Exine 1.6 μm (W), 1.71 μm (E) thick; ektexine 1.67 μm thick; tectum subtectate, 0.65 μm thick; columellae 0.95 μm high, 0.28 μm wide; foot layer continuous, 0.063 μm thick; endexine irregular, 0.04 μm thick.

Intine 0.6 μm (W) thick (Ex/Int ≅ 4/1).

A. hortensis L.

Pollen grains radially symmetrical, isopolar, pantopolyporatec, spheroidal, pollen diameter 20 μm (W), 20.7 μm (E). Pores 2.2 μm (W), 2.3 μm (E) in diameter and circular Operculum 2.3 μm (E) wide; 0.1 μm high, 8-9 conical spinules on operculum. Distance between the centers of the adjacent pores 4.9 μm (E). C/D 0.2367. Por number 64.

Ornamentation scabrate; 70 spinules per 100 μm^2; tectal spinules conical, 0.2 μm high, 0.22 μm wide.

Exine 1.4 μm (W), 1.57 μm (E) thick; ektexine 1.49 μm thick; tectum subtectate, 0.7 μm thick; columellae 0.73 μm high, 0.22 μm wide; foot layer continuous, 0.06 μm; endexine irregular, 0.083 μm thick.

Intine 0.6 μm (W) thick (Ex/Int ≅ 3/1).

A. nitens L.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 22 μm (W), 22.9 μm (E). Pores 2.1 μm (W), 2 μm (E) in diameter and circular. Operculum 2 μm (E) wide; 0.15 μm high, 5-6 conical spinules on operculum. Distance between the centers of the adjancent pores 4.9 μm (E). C/D 0.2139. Por number 77.

Ornamentation scabrate; 85 spinules per 100 μm^2; tectal spinules conical, 0.17 μm high, 0.2 μm wide.

Exine 1.45 μm (W), 1.44 μm (E) thick; ektexine 1.35 μm thick; tectum subtectate, 0.7 μm thick; columellae 0.6 μm high, 0.17 μm wide; foot layer continuous, 0.005 μm thick; endexine irregular, 0.09 μm.

Intine 0.5 μm (W) thick (Ex/Int ≅ 3/1).

A. laevis C.A. Meyer.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 14.5 μm (W), 17.7 μm (E). Pores 1.2 μm (W), 1.3 μm (E) in diameter and circular. Operculum 1.2 μm (E) wide; 0.3 μm high, 4-5 conical spinules on operculum. Distance between the centers of the adjancent pores 3.2 μm (E). C/D 0.1808. Por number 110.

Ornamentation scabrate; 90 spinules per 100 μm^2; tectal spinules conical, 0.3 μm thick; columellae 0.8 μm high, 0.3 μm wide; foot layer continuous, 0.09 μm thick; endexine irregular, 0.05 μm thick.

Intine 0.65 μm (W) thick (Ex/Int ≅ 2/1).

A. lasianhta Bosis (Fig 1 a-e)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 13.5 μm (W), 15.2 μm (E) wide; pores 1.25 μm (W), 1.3 μm (E) in diameter and circular. Operculum 1.2 μm (E) wide; 0.4 μm high, 4-5 conical spinules on operculum. Distance between the centers of the adjancent pores 2.9 μm (E). C/D 0.1908. Por number 93.

Ornamentation scabrate; 90 spinules per 100 μm^2; tectal spinules conical, 0.3 μm high, 0.33 μm wide.

Exine 1.5 μm (W), 1.43 μm (E) thick; ektexine 1.32 μm thick; tectum subtectate, 0.56 μm thick; columellae 0.65 μm high, 0.28 μm wide; foot layer continuous, 0.11 μm thick; endexine irregular, 0.11 μm thick.

Intine 0.45 μm (W) thick (Ex/Int ≅ 3/1).

A. tatarica L.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 16.1 μm (W), 15.2 μm (E). Pores 2 μm (W), 1.9 μm (E) in diameter and circular. Operculum 1.9 μm (E) wide; 0.25 μm high, 9-10 conical spinules on operculum. Distance between the centers of the adjancent pores 3.1 μm (E). C/D 0.1824. Por number 108.

Ornamentation scabrate; 70 spinules per 100 μm^2; tectal spinules conical, 0.23 μm high, 0.28 μm wide.

Exine 1.7 μm (W), 1.93 μm (E) thick; ektexine 1.84 μm thick; tectum subtectate, 0.78 μm thick; columellae 0.98 μm high, 0.35 μm

wide; foot layer continuous, 0.078 μm thick; endexine irregular, 0.087 μm thick.

Intine 0.4 μm (W) thick (Ex/Int ≅ 4/1).

A. rosea L.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 24.2 μm (W), 25.2 μm (E). Pores 3 μm (W), 2.9 μm (E) in diameter and circular. Operculum 2.9 μm (E) wide; 0.2 μm high, 8-10 conical spinules on operculum. Distance between the centers of the adjancent pores 5.2 μm (E). C/D 0.2063. Por number 84.

Ornamentation scabrate; 80 spinules per 100 μm^2; tectal spinules conical, 0.1 μm high.

Exine 1.9 μm (W) (E) thick; ektexine 1.54 μm thick; tectum subtectate, 0.65 μm thick; columellae 0.8 μm high, 0.25 μm wide; foot layer continuous, 0.092 μm thick; endexine irregular, 0.34 μm thick.

Intine 0.6 μm (W) thick (Ex/Int ≅ 4/1).

A. tornabeni Tineo (Fig 1 k-n)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 24 μm (W), 25 μm (E). Pores 2 μm (W), 2.1 μm (E) in diameter and circular. Operculum 1.9 μm (E) wide; 0.1 μm high, 4-5 conical spinules on operculum. Distance between the centers of the adjancent pores 4.4 μm (E). C/D 0.1781. Por number 113.

Ornamentation scabrate; 80 spinules per 100 μm^2; tectal spinules conical, 0.3 μm high, 0.29 μm wide.

Exine 1.8 μm (W), 1.9 μm (E) thick; ektexine 1.81 μm thick; tectum subtectate, 0.78 μm thick; columellae 0.93 μm high, 0.37 μm wide; foot layer continuous, 0.1 μm thick; endexine irregular, 0.07 μm thick.

Intine 0.7 μm (W) thick (Ex/Int ≅ 3/1).

A. davisii Aelen

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 19.5 μm (W), 20.3 μm (E). Pores 1.3 μm (W), 1.4 μm (E) in diameter and circular. Operculum 1.2 μm (E) wide; 0.3 μm high, 6-7 conical spinules on operculum. Distance between the centers of the adjancent pores 3.64 μm (E). C/D 0.1793. Por number 112.

Ornamentation scabrate; 100 spinules per 100 μm^2; tectal spinules conical, 0.26 μm high, 0.38 μm wide.

Exine 1.2 μm (W), 1.4 μm (E); ektexine 1.27 μm thick; tectum subtectate, 0.5 μm thick; columellae 0.7 μm high, 0.3 μm wide; foot layer continuous, 0.07 μm thick; endexine irregular, 0.1 μm thick.

Intine 0.4 μm (W) thick (Ex/Int ≅ 3/1).

A. hashata L.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 19.4 μm (W), 20 μm (E). Pores 2 μm (W), 1.9 μm (E) in diameter and circular. Operculum 1.8 μm (E) wide; 0.1 μm high, 7-8 conical spinules on operculum. Distance between the centers of the adjancent pores 3.9 μm (E). C/D 0.1980. Por number 92.

Ornamentation scabrate; 70 spinules per 100 μm²; tectal spinules conical, 0.22 μm high, 0.25 μm wide.

Exine 1.5 μm (W), 1.6 μm (E) thick; ektexine 1.47 μm thick; tectum subtectate, 0.73 μm thick; columellae 0.67 μm high, 0.29 μm wide; foot layer continuous, 0.07 μm thick; endexine irregular, 0.11 μm thick.

Intine 0.45 μm (W) thick (Ex/Int ≅ 3/1).

A. patula L.

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 16 μm (W), 16.3 μm (E). Pores 1.5 μm (W), 1.6 μm (E) in diameter and circular. Operculum 1.6 μm (E) wide; 0.25 μm high, 6-7 conical spinules on operculum. Distance between the centers of the adjancent pores 3.2 μm (E). C/D 0.1963. Por number 93.

Ornamentation scabrate; 60 spinules per 100 μm²; tectal spinules conical, 0.28 μm high, 0.3 μm wide.

Exine 2 μm (W), 2.1 μm (E) thick; ektexine 1.8 μm thick; tectum subtectate, 0.7 μm thick; columellae 0.8 μm high, 0.25 μm wide; foot layer continuous, 0.3 μm thick; endexine irregular, 0.33 μm thick.

Intine 0.4 μm (W) thick (Ex/Int ≅ 5/1).

Discussion and Conclusion

Pollen grains of *Atriplex* species examined are radially symmetrical, isopolar, pantopolyporate and spheroidal. Their exine structure is similar under LM and TEM. Ektexine overlying endexine is thick. Tectum is discontinuous and it is as thick as the collumellae layer. Foot layer is very thin. Endexine is as thick as foot layer and it is discontinuous (Fig c,h,n).

The number of pores in the pollen of *Chenopodiaceae* is usually used as one of diagnostic characters in pollen analytical and taxonomic studies [7]. This research, however, suggest that pollen size as well as pore number can be used in the separation of *Atriplex* species at hand (Table 1).

Atriplex species have been divided into three pollen types, on the basis of pollen diameter, first. The species placed in these types have been then evaulated with respect to their pore number.

***A. patula* type**: Pollen grains ranging from 15-18 μm in diameter belong here, namely, *A. patula*, *A. lasiantha*, *A. tatarica* and *A. laevis*. In both *A patula* and *A. lasiantha* pore number is 93 whereas in *A. tatarica* and *A. laevis* it is 108 and 110 respectively, not so different. Therefore, pore number can not be as a useful character to separate the latter taxa. However, the former taxa, *A. patula* and *A. lasiantha*, both are characterized by 93 pores, can be distinguished from the other two. Moreover, *A. lasiantha* with smaller por diameter and thinner exine layer can be separated from *A. patula*. In addition, *A. lasiantha* has more spinules per 100 μm^2 (90) than *A. patula* (60). Again, *A. tatarica* with

larger pore diameter and thicker exine layer can be differentiated from *A. laevis*. In the light of these views, it is suggested that pore diameter and exine thickness can be regarded as diagnostic features in the separation of the taxa under this type.

***A. hashata* type**: Pollen grains ranging from 20-23 μm in diameter are placed in this type, including *A. hashata*, *A. hortensis*, *A. halimus*, *A. nitens* and *A. davisii*, with 92, 64, 102, 77 and 112 pores respectively. Since the numbers of pores are distinctively different, pollen grains of these species can be separated easily. In addition *A. halimus* has the thinest endexine (0.04 μm) in the group. Besides *A. halimus* (1230) and *A. davisii* (100) have more spinules per 100 μm^2 in *A. hashata* type.

***A. tornabeni* type**: Pollen grains which are 25 μm in diameter are belong here *A. tornabeni* and *A. roseai*. These two taxa can be distinguished from each other on the basis of pore number, being 84 in the former and 113 in the latter. In addition *A. rosea* has thicker endexine (0.34 μm) than *A. tornabeni* (0.07 μm).

This study shows that pollen morphology also provides some help in the differentation of *Atriplex* species.

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Table 1. Dimensions and morphological variation in pollen of Atriplex

Taxa	Pollen Dimension (D) (μm)		Plt * (μm)		C*** (μm)	Op** (μm)	Exine (μm)		Intine (μm)	C/D	Por number	Ornamen-tation
	E	W	E	W	E	E	E	W	W			
Atriplex halimus	20.8	21	1.6	1.6	3.9	1.6	1.71	1.6	0.6	0.1875	102	Scabrate
A. hortensis	20.7	20	2.3	2.2	4.9	2.3	1.6	1.4	0.6	0.2367	64	Scabrate
A. nitens	22	22.9	2	2.1	4.9	2	1.44	1.45	0.5	0.2139	77	Scabrate
A. laevis	17.7	14.5	1.3	1.2	3.2	1.2	1.24	1.5	0.65	0.1808	110	Scabrate
A. lasiantha	15.2	13.5	1.3	1.25	2.9	1.2	1.43	1.5	0.45	0.1908	93	Scabrate
A. tatarica	15.2	16.1	1.9	2	3.1	1.9	1.93	1.7	0.4	0.1824	108	Scabrate
A. rosea	25.2	24.2	2.9	3	5.2	2.9	1.9	1.9	0.6	0.2063	84	Scabrate
A. tornabeni	25	24	2.1	2	4.4	1.9	1.9	1.8	0.7	0.1781	113	Scabrate
A. davisii	20.3	19.5	1.4	1.3	3.64	1.2	1.4	1.2	0.4	0.1793	112	Scabrate
A. hashata	19.4	19.4	1.9	2	3.9	1.8	1.6	1.5	0.4	0.1980	92	Scabrate
A. patula	16.3	16	1.6	1.5	3.2	1.6	2.1	2	0.4	0.1963	93	Scabrate

* Plt : Pore dimension
** Op: Operculum dimension
*** Distance between of adjacent pores

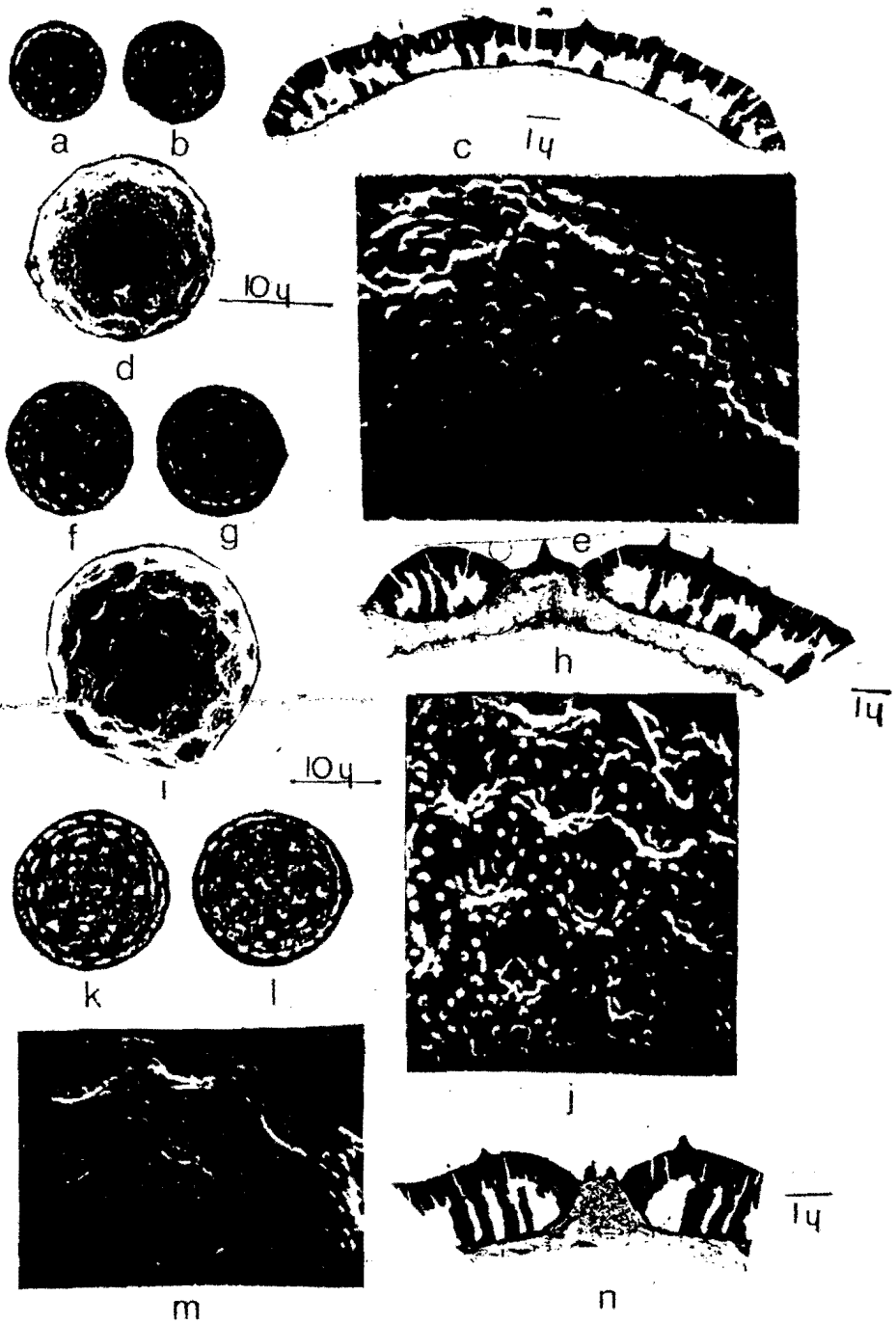

Figure 1 (a-e): *A. patula* type pollen. **a-b:** Pollen of *A. lasiantha* LM. **c:** Exine structure TEMx10.000 **d:** Pores and ornamentation SEMx2000 **e:** Pores and opercula SEMx10.000.
(f-j): *A. hashata* type pollen. **f-g:** Pollen of *A. halimus* LM. **h:** Exine structure TEMx10.000 **i:** Pores and ornamentation SEMx3000 **j:** Pores and opercula SEMx10.000.
(k-n): *A. tornabeni* type pollen. **k-l:** Pollen of *A. tornabeni* LM. **m:** Exine structure TEMx10.000 **n:** Pores and opercula SEMx10.000.

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POLLEN MORPHOLOGY OF SOME TURKISH CHENOPODIACEAE: II. SUAEDA L.

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Abstract: Pollen grains of 8 species of the genus *Suaeda* L. (*Chenopodiaceae*), of which morphological separation is proplematical, have been examined in detail comparatively by using light microscopy (LM), scanning (SEM) and transmission electron microscopy (TEM). Pollen description of each taxon has been given. Pollen grains of *Suaeda* species examined are radially symmetrical, isopolar, pantopolyporate and spheroidal. Their exine structure are similar. Ektexine thick than endexine. The genus has been divided into three types on the basis of pollen size.

Key Words: *Suaeda*, *Chenopodiaceae*, Pollen morphology.

Introduction

Suaeda L., belonging the family *Chenopodiaceae* has been revised by Aellen [1] in Flora of Turkey. The genus respresents taxonomic problems and its species have been differentiated only on the basis of leaf and seed characters [1].

Pollen morphology of *Suaeda* has received little attention from investigators. Markgraf and D'antoni [6] studied *S. divaricata* L. under light microscope. Some *Suaeda* species from the Iberian Peninsula and the

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Balearic Islands. *S. Splenders* (Pourret) Gren & Godron, *S. vera* Forsk. *S. vera* var. *brown-blanquietii* Costroviejo & Petrol, *S. genesiana* Costroviejo & Petrol, *S. albescens* Lazaro Ibýza, *S. maritima* L. (Dumort) and *S. spicata* (Willd.) Moq. were examined by Ferreras and Pedrol [4], those from China, *S. coniculata* L. and *S. glauca* L. by Hai-ping and Jin-Ton [5], using scanning electron microscopy.

Previous studies in pollen of *Suaeda* provided little help in the taxonomy of the genus. The objective of our research is to shed some light on the pollen morphology of some *Suaeda* species, under both light and electron microscopes and to provide help in the separation of the taxa.

Materials and Methods

Polliniferous material was taken from Ankara University Herbarium (ANK). The collections are listed under "Specimens investigated", following the sequence of Aellen [1].

For LM study, the pollen slides were prepared according to the technique of Wodehouse (W) [8] and Erdtman (E) [2]. A Leitz-Wetzlar microscope was used for examination (Ocular X16, objective X100). Measurements were taken statistically. In order to estimate the pore number, the method by Mc Andrews and Swanson [7], based on the ratio of distance between centers of adjacent pores (C) and the diameter of the grain (D) was followed. Photographs were taken with a Leitz Phan-Photo microscope.

For TEM study, acetolysed pollen grains were fixed in OsO_4 stained with uranly acetate and embedded in araldite. Ultrathin sections

were post-stained with lead citrate and uranly acetate. For SEM study, unacetolysed pollen grains were transferred to stubs and covered with gold. A jeol 100 CXII electron microscope was employed for both TEM and SEM studies.

Terminology follows that of Faegri and Iversen [3].

Specimen Investigated

Suaeda microphylla Pall	Kars: Iğdır	H. Derimiz (ANK)
S. altissima (L.) Pall	Konya: Cumra	E. Yurdakulol 10 (ANK)
S. prostrata Pall	Niğde: Aksaray	Davis-Hedge 32798 (ANK)
S. eltonica Pall	İzmir: İnciraltı	C. Regel 32021 (ANK)
S. confusa Iljin	Kayseri: Boğazköprü	Birand-Karamanoğlu 35 (ANK)
S. cucullata Aelen	Burdur	B. Kasapgil (ANK)
S. carnossima Past	Kayseri: Develi	Davis-Hedge 32747 (ANK)
S. linifolia Pall	Kars: Iğdır	Davis 47028 (ANK)

Results

Pollen Decriptions

***Suaeda microphylla* Pall.** (Fig 1 j-m)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 20.1 μm (W), 21 μm (E). Pores 1.9 μm (W), 1.8 μm (E) in diameter and circular. Operculum 1.8 μm (E) wide; 0.3 μm high, 5-6 conical spinules on operculum. Distance between the centers of the adjancent pores 4.1 μm (E). C/D 0.1952. Por number 93.

Ornamentation scabrate; 90 spinules per 100 μm^2; tectal spinules conical, 0.2 μm high, 0.25 μm wide.

Exine 2.1 μm (W), (E) thick; ektexine 1.64 μm thick; tectum subtectate, 0.67 μm thick; columellae 0.63 μm high, 0.22 μm wide; foot layer continuous, 0.34 μm thick; endexine irregular, 0.37 μm thick.

Intine 0.4 μm (W) (Ex/Int ≅ 4/1).

***S. altissima* (L) Pall**

Pollen grains radially symmetrical, isopolar, pantopolyporatec, spheroidal, pollen diameter 20 μm (W), 19.7 μm (E). Pores 1.4 μm (W), 1.3 μm (E) in diameter and circular Operculum 1.3 μm (E) wide; 0.1 μm high, 9-10 conical spinules on operculum. Distance between the centers of the adjancent pores 3.5 μm (E). C/D 0.1776. Por number 114.

Ornamentation scabrate; 119 spinules per 100 μm^2; tectal spinules conical, 0.2 μm high, 0.3 μm wide.

Exine 1.5 μm (W), 1.4 μm (E) thick; ektexine 1.3 μm thick; tectum subtectate, 0.65 μm thick; columellae 0.55 μm high, 0.25 μm wide; foot layer continuous, 0.06 μm; endexine irregular, 0.083 μm thick.

Intine 0.6 μm (W) (Ex/Int ≅ 3/1).

***S. prostrata* Pall** (Fig. 1 f-g)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 19.8 μm (W), (E). Pores 1.3 μm (W) (E) in diameter and circular. Operculum 1.3 μm (E) wide; 0.3 μm high, 8-9 conical spinules on operculum. Distance between the centers of the adjancent pores 3.6 μm (E). C/D 0.1818. Por number 109.

Ornamentation scabrate; 76 spinules per 100 μm²; tectal spinules conical, 0.2 μm high, 0.2 μm wide.

Exine 1.8 μm (W) (E) thick; ektexine 1.5 μm thick; tectum subtectate, 0.68 μm thick; columellae 0.73 μm high, 0.28 μm wide; foot layer continuous, 0.087 μm thick; endexine irregular, 0.09 μm thick.

Intine 0.5 μm (W) (Ex/Int ≅ 4/1).

***S. eltonica* Iljin** (Fig 1 a-e)

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 18 μm (W), 17.3 μm (E). Pores 1.5 μm (W), 1.6 μm (E) in diameter and circular. Operculum 1.6 μm (E) wide; 0.5 μm high, 7-10 conical spinules on operculum. Distance between the centers of the adjancent pores 3.6 μm (E). C/D 0.2080. Por number 83.

Ornamentation scabrate; 96 spinules per 100 μm²; tectal spinules conical, 0.15 μm high, 0.2 μm wide.

Exine 1.8 μm (W), 1.83 μm (E) thick; ektexine 1.53 μm thick; tectum subtectate, 0.71 μm thick; columellae 0.73 μm high, 0.27 μm wide; foot layer continuous, 0.087 μm thick; endexine irregular, 0.3 μm thick.

Intine 0.6 μm (W) (Ex/Int ≅ 3/1).

***S. confusa* Iljin**

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 17.4 μm (W) (E) wide; pores 1.4 μm (W), 1.3 μm (E) in diameter and circular. Operculum 1.3 μm (E) wide; 0.35 μm

high, 10-12 conical spinules on operculum. Distance between the centers of the adjancent pores 3.2 μm (E). C/D 0.1857. Por number 104.

Ornamentation scabrate; 92 spinules per 100 μm^2; tectal spinules conical, 0.15 μm high, 0.17 μm wide.

Exine 1.7 μm (W), 1.75 μm (E) thick; ektexine 1.61 μm thick; tectum subtectate, 0.7 μm thick; columellae 0.8 μm high, 0.1 μm wide; foot layer continuous, 0.11 μm thick; endexine irregular, 0.14 μm thick.

Intine 0.5 μm (W) (Ex/Int ≅ 3/1).

***S. cucullata* Aelen**

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 17 μm (W), 16.8 μm (E). Pores 1.4 μm (W), 1.3 μm (E) in diameter and circular. Operculum 1.3 μm (E) wide; 0.3 μm high, 9-10 conical spinules on operculum. Distance between the centers of the adjancent pores 3.12 μm (E). C/D 0.1857. Por number 104.

Ornamentation scabrate; 128 spinules per 100 μm^2; tectal spinules conical, 0.2 μm high, 0.2 μm wide.

Exine 1.7 μm (W) (E) thick; ektexine 1.34 μm thick; tectum subtectate, 0.8 μm thick; columellae 0.5 μm high, 0.25 μm wide; foot layer continuous, 0.035 μm thick; endexine irregular, 0.36 μm thick.

Intine 0.5 μm (W) (Ex/Int ≅ 3/1).

***S. carnossima* Past**

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 17.2 μm (W), 17.7 μm (E). Pores 1.8 μm (W) (E) in diameter and circular. Operculum 1.5 μm (E) wide; 0.1 μm high, 4-5 conical spinules on operculum. Distance between the centers of the adjancent pores 4.03 μm (E). C/D 0.2276. Por number 69.

Ornamentation scabrate; 98 spinules per 100 μm^2; tectal spinules conical, 0.3 μm high, 0.3 μm wide.

Exine 1.72 μm (W) (E) thick; ektexine 1.64 μm thick; tectum subtectate, 0.84 μm thick; columellae 0.7 μm high, 0.26 μm wide; foot layer continuous, 0.1 μm thick; endexine irregular, 0.08 μm thick.

Intine 0.6 μm (W) (Ex/Int ≅ 3/1).

***S. linifolia* Pall**

Pollen grains radially symmetrical, isopolar, pantopolyporate, spheroidal, pollen diameter 21.3 μm (W), 21.7 μm (E). Pores 1.3 μm (W) (E) in diameter and circular. Operculum 1.3 μm (E) wide; 0.2 μm high, 5-6 conical spinules on operculum. Distance between the centers of the adjancent pores 4.4 μm (E). C/D 0.2028. Por number 87.

Ornamentation scabrate; 93 spinules per 100 μm^2; tectal spinules conical, 0.1 μm high, 0.2 μm wide.

Exine 1.69 μm (W) (E) thick; ektexine 1.35 μm thick; tectum subtectate, 0.6 μm thick; columellae 0.65 μm high, 0.36 μm wide; foot layer continuous, 0.1 μm thick; endexine irregular, 0.34 μm thick.

Intine 0.5 μm (W) (Ex/Int ≅ 3/1).

Discussion and Conclusion

Pollen grains of *Suaeda* species studied are radially symmetrical, isopolar, pantopolyporate and spheroidal. Their exine structure is similar under ligh and electron microscopes. Ektexine is thick while endexine is very thin. Tectum is discontinuous and it is as thick as the collumellae layer. Foot layer is thin. Endexine is thicker than foot layer and it is discontinuous (Fig c,h,m).

In *Suaeda* species from the Iberian Peninsula and the Balearic Islands, pollen size ranges from 18 μm to 32 μm and pore number is between 70 and 140 [4]. In Turkish *Suaeda* species, on the other hand, pollen grains are smaller (18-22 μm) and pore number ranges from 69 to 114 (Table 1). The pollen grains of both regions are similar in exine structure and thickness.

The taxa of the genus Suaeda have been divided into three types on the basis of pollen diameter.

***S. cucullata* type**: Pollen grains ranging from 17 μm to 18 μm in diameter are placed in this type, including *S. cucullata*, *S. carnossima*, *S. eltonica* and *S. confusa*. *S. carnossima* pollen with 69 pores and *S. eltonica* pollen with 83 pores can be separated from each other. *S. cucullata* and *S. confusa* are the same in pore number, pore size and exine thickness. But *S. cucullata* has thicker endexine (0.36 μm) and more spinules (128) per 100 μm^2 than *S. confusa*.

***S. prostrata* type**: Diameter of pollen grains ranges betwien 19 μm and 20 μm. *S. prostrata* and *S. altissima* belong here. The pollen of the former with 109 pores can be separated from the latter with 114 pores. In

additions, *S. altissima* has the thinner endexine (0.083 μm) and more spinules (119) per 100 μm^2 than *S. prostrata*.

***S. microphylla* type**: Pollen grains which are 21-22 μm in diameter are placed in this type, namely *S. microphylla* and *S. linifolia*. The two taxa are very similar in pore number. But *S. microphylla* with thicker exine layer can be differented from *S. linifolia*. Especsiely, *S. microphylla* has thicker foot layer (0.34 μm) than *S. linifolia* (0.1 μm).

In conclusion, our research reveals that some taxa of the genus *Suaeda*, which resemble each other morphologically, show small differences in pollen morphology and only certain types can be separated palynologically.

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

Taxa	Pollen Dimension (D) (μm)		Plt * (μm)		C*** (μm)	Op** (μm)	Exine (μm)		Intine (μm)	C/D	Por number	Ornamen-tation
	E	W	E	W	E	E	E	W	W			
Sueada microphylla	21	20.1	1.8	1.9	4.1	1.8	2.1	2.1	0.4	0.1952	93	Scabrate
S. altissima	19.7	20	1.3	1.4	3.5	1.3	1.4	1.5	0.6	0.1776	114	Scabrate
S. prostrata	19.8	19.8	1.3	1.3	3.6	1.3	1.8	1.8	0.5	0.1818	109	Scabrate
S. eltonica	17.3	18	1.6	1.5	3.6	1.6	1.8	1.83	0.6	0.2080	83	Scabrate
S. confusa	17.4	17.4	1.3	1.4	3.2	1.3	1.75	1.7	0.5	0.1857	104	Scabrate
S. cucullata	16.8	17	1.3	1.4	3.12	1.3	1.7	1.7	0.5	0.1857	104	Scabrate
S. carnossima	17.7	17.2	1.8	1.8	4.03	1.5	1.72	1.7	0.8	0.2276	69	Scabrate
S. linifolia	21.7	21.3	1.3	1.3	4.4	1.3	1.69	1.8	0.5	0.2028	87	Scabrate

* Plt : Pore dimension
** Op: Operculum dimension
*** C: Distance between centers of adjacent pores

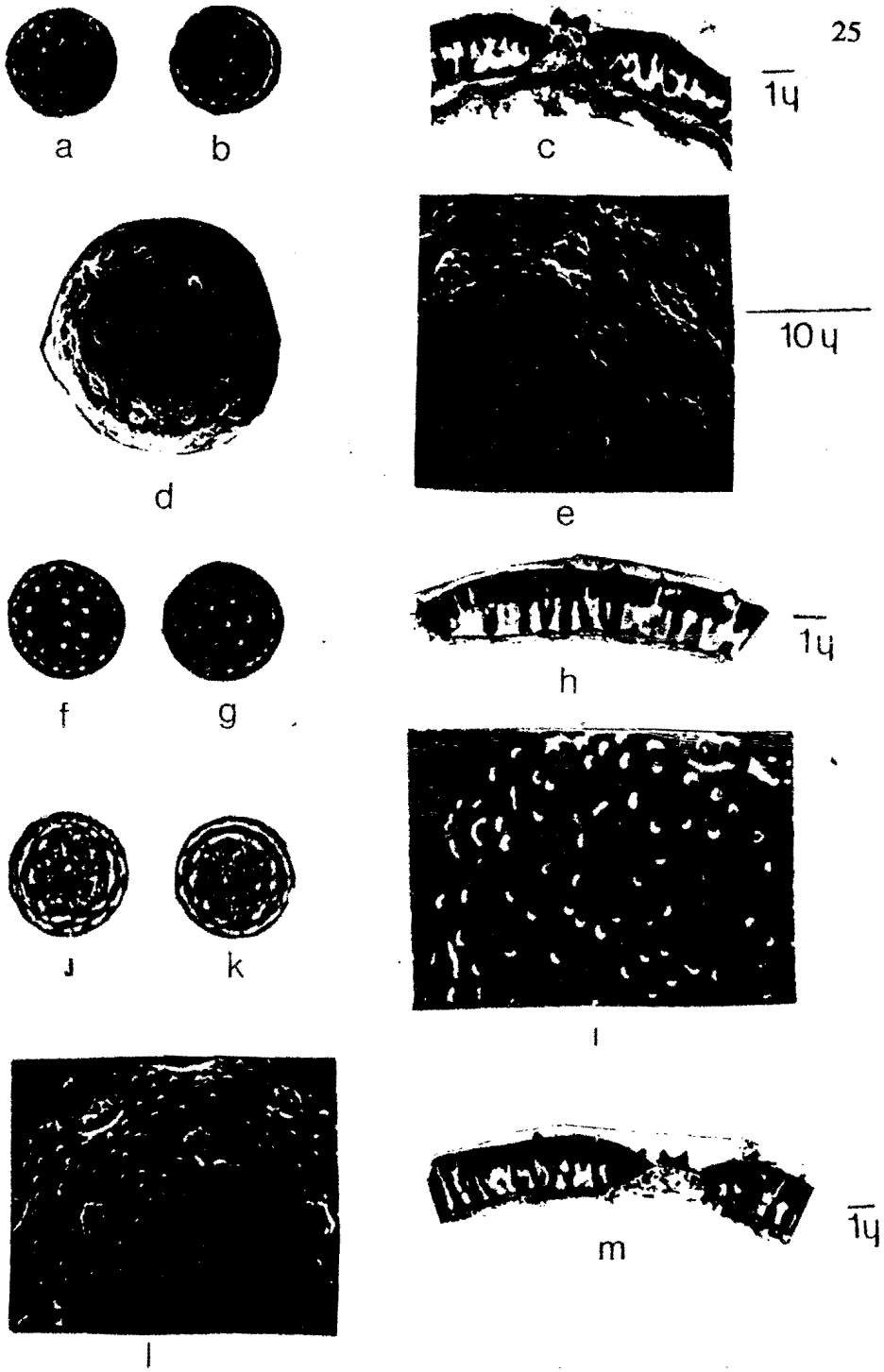

Figure 1 (a-e): *S. cucullata* type pollen. **a-b:** Pollen of *S. eltonica* LM. **c:** Exine structure with operculum TEMx10.000 **d:** Pores and ornamentation SEMx2000 **e:** Pores and opercula SEMx10.000.
(f-ı): *S. prostrata* type pollen. **f-g:** Pollen of *S. prostrata* LM. **h:** Exine structure TEMx10.000 **ı:** Pores and opercula SEMx10.000.
(j-m): *S. microphylla* type pollen. **j-k:** Pollen of *microphylla* LM. **l:** Exine structure with operculum TEMx10.000 **m:** Pores and opercula SEMx10.000.

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A RESEARCH ON THE FLORA OF UZUNDERE (KARGAPAZARI MOUNTAINS ERZURUM) AND ITS SURROUNDINGS

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Abstract: The field studies have been carried out to determine the flora of Uzundere (Kargapazarı Mountains) and its surroundings, during 1995 and 1996. 1002 plant specimen were collected in these studies. After the identification of these materials, 683 taxa, at species, subspecies and variety levels, have been established. The largest family is *Asteraceae* (96 species) and the second family is *Lamiaceae* (51 species). The largest genus is *Astragalus* (14 species) and the second genus is *Centaurea* (12 species). The research area is in the Irano-Turanian phytogeographical region. The phytogeofraphical spectrum of the species is as follows: Irano-Turanion elements 158 (25.1%); Euro-Siberian elements 116 (17.8%) and Mediterranean elements 20 (3.1%). The rate of endemism is 11.5%.

Key Words: Flora, Turkey, Kargapazarı Mountains.

Introduction

This paper is concerned with the flora of Uzundere (Kargapazarı Mountains) and its surroundings which takes place in the North-East Anatolia: in the boundaries of Erzurum Province and within A8 and A9 grid squares. The area is surrounded by Oltu stream (at south, east and north) and Tortum stream (at west) and have a surface area of about 1230 square kilometres with an altitude of 700 to 3047 metres from sea level (Fig.1).

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The area was formed during the Mesosoic and Senozoic periods, and is generally made up volcanic series and granite, andesite and dasite and the soil cover is generally composed of limestone, clay, sand and *alluvion* [1].

The research area has a semi-continential climate. According to the data obtained from Oltu Meteorology Station, seasonal rain regime was obtained as I.Y.S.K. (Fig.2) and this result is a proparty of semi-continential climate which is localized at the east part of the Northeast Anatolia [2,3].

The area is cited in between the less studied regions [4]. That's why some other floristic studies had also been carried out in Erzurum and in the surrounding cities.

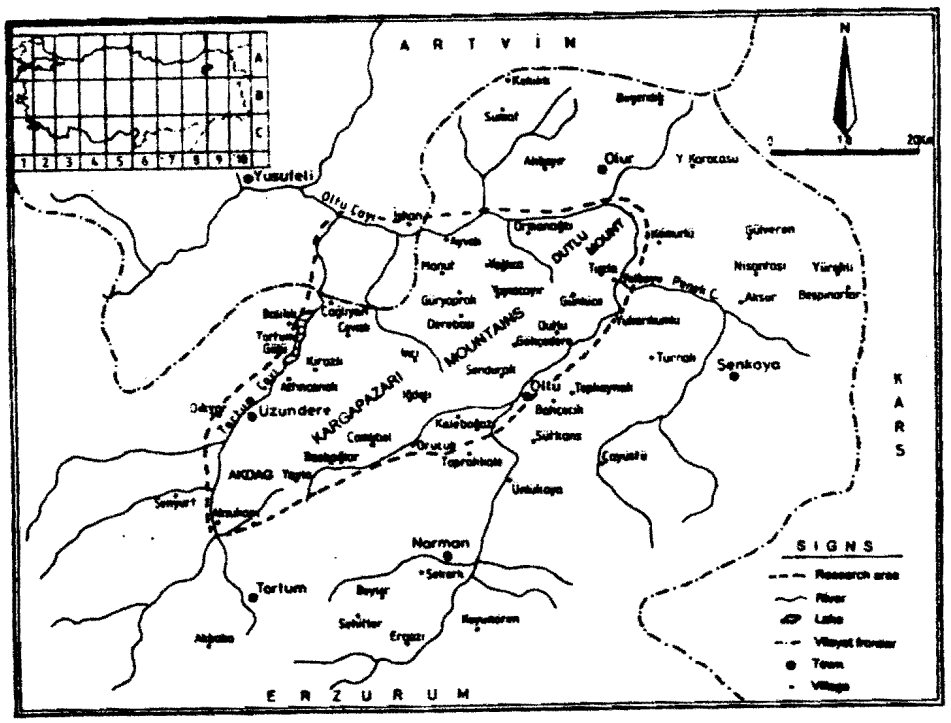

Figure 1. Map of the Research Area.

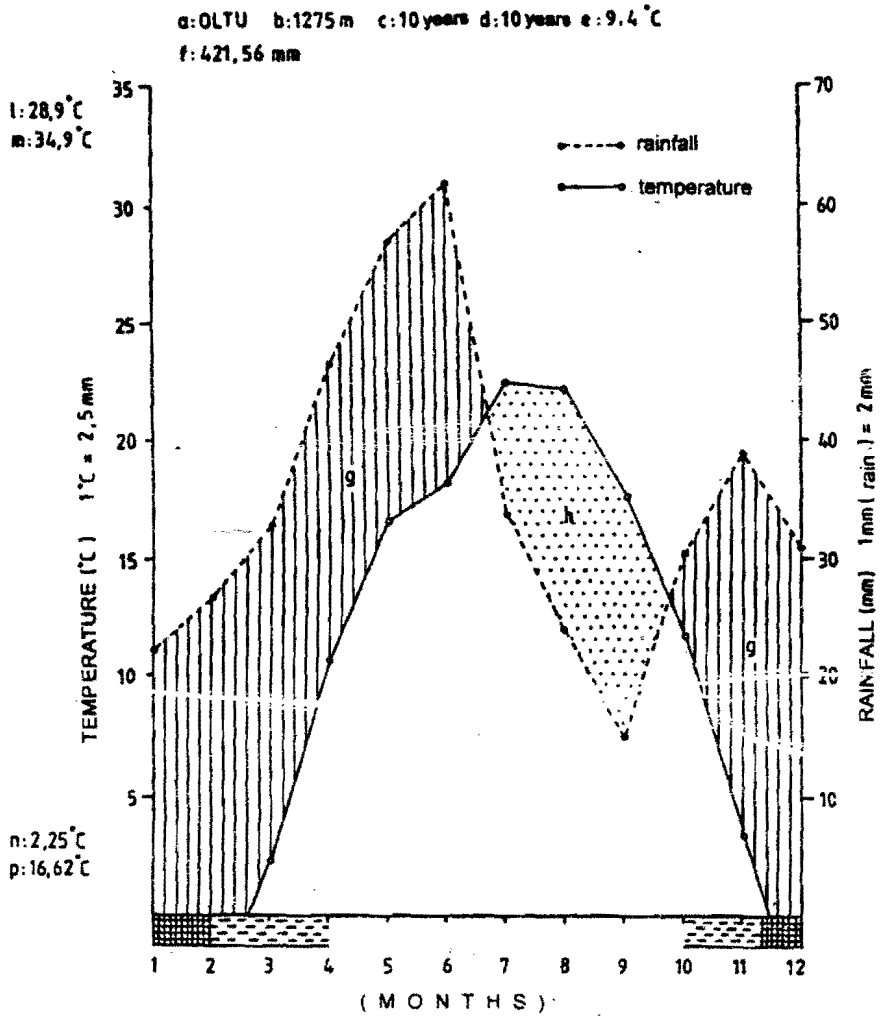

Figure 2. Climatic Diagram of Oltu.

a.Meteorology station, b. Altitude of the meteorolgy station, c. Duration of temperature measurement, d. Duration of rainfall measurement, e. Annual average temperature, f. Annual average rainfall, g. Rainy period, h. Dry period, i. Months with high freezing probability, l. Average high temperature of the hottest month, m. Average highest temperature of the hottest month, n. Average low temperature of the coldest month, p. Average lowest temperature of the coldest month.

Material and Method

The research material were obtained as a result of twelve field trips to the study area at different times in 1995 and 1996. During the identification of the plant samples, Flora of Turkey The East Agean Islands [5] was the main reference.

In the floristic list, all the families, genera and species are given in evolutionary order as cited in The Flora [5]. To avoid repetation, the localities are given in a list. Every species, in the floristic list, is represented in the following order: The name and the author of the species, the locality list number, the citation of the specimens collected from the study area, the endemism, phytogeoraphical elements and Red Data Categories [6].

During the citation of species, the red data categories, phytogeographical regions ect. are used as abbreviations. These abbreviations are: Ex-Extinct; E-Endangered; V-Vulnerable; R-Rare; nt-No risk; K-Insufficiently known; I-Indeterminate; Ir.-Tur.-Irano-Turanian; Eux.-Euxine; Medit.-Mediterranean; E.Medit.-East Mediterranean; Abd.-Abdullah.

The collected samples are kept in VANF (Herbarium of Yüzüncü Yıl University).

The life forms which are analyzed according to Raunkiaer [7] and phytogeographical distribution of each taxa are given in "Result and Discussions" section. The obtained results were also discussed by comparing with the results of other nearest floristic researches [8-13].

Localities from which plant samples were collected, and the specimen numbers

(Abd. 1001 - 2002)

1. A9, Oltu, around Oltu, around arable fields, 1300-1400 m, 5.18.1995

1001 - 1034

2. A8, Uzundere, Azort high plateau, nursery field, 2000-2300 m, 5.19.1995

1035 - 1065

3. A8, Uzundere, between Yayla and Başbağlar villages, 1800-2000 m, 5.19.1995

1066 - 1087

4. A8, Oltu, between Çamlıbel and İnanmış villages, 1600-1900 m, 5.19.1995

1088 - 1093

5. A8, Uzundere, Azort high plateau, forest area, 2000-2300 m, 5.19.1995

1094 - 1099

6. A8, Oltu, between İnanmış and Başbağlar villages, 1800-1900 m, 5.19.11995

1100 - 1101

7. A8, Oltu, İnci Village, Mağarabaşı place, woodland, 2000-2300 m, 5.20.1995

1102 - 1109

8. A8, Oltu, around İnci Village, 1600-1800 m, 5.20.1995

1110 - 1123

9. A9, Oltu, Kesik Köprü place, 1400-1600 m, 5.21.1995

1124 - 1150

10. A9, Olur, around Ormanağzı Village, 1100-1800 m, 5.21.1995

1151 - 1161

11. A9, Oltu, around Tuzla Village, 1200-1400 m, 5.22.1995

1162 - 1170

12. A9, Olur, around Ormanağzı Village, 1100-1800 m, 5.22.1995

1171 - 1178

13. A8, Uzundere, Dikyar Village, Avuşgen place, 1200-1500 m, 5.23.1995

1179 - 1183

14. A8, Uzundere, from Uzundere to Çağlayan Village, 1000-1200 m, 5.24.1995

1184 - 1202

15. A8, Uzundere, from Aksukapı to Yayla Village, 1600-2000 m, 5.25.1995

1203 - 1208

16. A8, Uzundere, Azort high plateau, 2000-2300 m, 6.18.1995

1209 - 1296

17. A8, Uzundere, Yayla Village, around arable fields, 1800-2000 m, 6.18.1995

1297 - 1341

18. A8, Oltu, around Orcuk Village, 1600-1800 m, 6.19.1995

1342 - 1369

19. A8, Oltu, around İnanmış Village, step, 1700-1900 m, 6.20.1995

1370 - 1381

20. A8, Oltu, around the road İnci Village, 1600-1800 m, 6.20.1995

1382 - 1403

21. A9, Oltu, from Tuzla Village to Olur, 1200-1400 m, 6.21.1995

1404 - 1426

22. A9, Oltu, around Dutlu Village, 1300-1500 m, 6.21.1995

1427 - 1433

23. A9, Oltu, from Günlüce Village to Ormanağzı Village, along the forest road, 1500-2000 m, 6.22.1995

1434 - 1452

24. A9, Oltu, around the Şendurak Village, around arable fields,1300-1500 m, 6.23.1995

1453 - 1472

25. A9, Oltu, around the Uzunoluk forest park, forest area, 1700-1800 m, 6.23.1995

1473 - 1490

26. A8, Uzundere, Uzundere forest, Aros place, 1600-1800 m, 6.24.1995

1491 - 1501

27. A8, Uzundere, around Kirazlı Village, step, 1200-1600 m, 6.24.1995

1502 - 1512

28. A8, Uzundere, Yayla Village, around arable fields, 1800-2000 m, 7.09.1995

1513 - 1547

29. A9, Oltu, from Günlüce Village to Ormanağzı Village, 1500-2000 m, 7.10.1995

1548 - 1585

30. A8, Oltu, around the Orcuk Village, 1600-1800 m, 7.11.1995

1586 - 1608

31. A8, Uzundere, Yayla Village, around arable fields, 1900-2100 m, 7.12.1995

1609 - 1641

32. A8, Uzundere, from Uzundere to Çağlayan Village, 1000-1200 m, 7.12.1995

1642 - 1651

33. A9, Oltu, from Dutlu Village to Dutlu Mount, 1500-2200 m, 7.13.1995

1652 - 1737

34. A8, Uzundere, Uzundere Forest, forest area, 1900-2300 m, 7.13.1995

1738 - 1765

35. A8, Uzundere, from Cevizli Village, 1200-1400 m, 7.14.1995

1766 - 1785

36. A8, Uzundere, between Cevizli and Çağlayan villages, 1000-1400 m, 7.14.1995

1786 - 1799

37. A8, Uzundere, from Aksukapı to Yayla Village, 1600-2000 m, 8.10.1995

1800 - 1817

38. A9, Oltu, from Günlüce Village to Ormanağzı Village, 1500-2000 m, 8.11.1995

1818 - 1838

39. A9, Oltu, from Gökçedere Village to Güryaprak Village, 1400-2200 m, 8.12.1995

1839 - 1863

40. A8, Oltu, around the road of İnci Village, Hanlar place, 1600-1800 m, 8.12.1995

1864 - 1879

41. A8, Olur, from Ayvalı Village to İşhan Village, along the highway, 800-1100 m, 8.13.1995

1880 - 1915

42. A8, Uzundere, Uzundere Forest, 1800-2200 m, 8.16.1995

1916 - 1932

43. A9, Oltu, from Dutlu Village to Dutlu Mount, 1500-2200 m, 9.11.1995

1933 - 1940

44. A8, Uzundere, Azort high plateau, nursery field, 1900-2200 m, 9.12.1995

1941 - 1944

45. A8, Oltu, from İnanmış Village to Orcuk Village, 1600-1900 m, 9.12.1995

1945 - 1948

46. A9, Oltu, from Tuzla Village to Günlüce Village, 1200-1600 m, 11.5.1995

1949 - 1954

47. A8, Oltu, from Orcuk Village to İnanmış Village, 1600-1900 m, 11.6.1995

1955 - 1956

48. A8, Uzundere, around Yayla Village, 1900-2100 m, 5.05.1996

1957 - 1963

49. A9, Oltu, around Günlüce Village, 1500-1800 m, 5.06.1996

1964 - 1973

50. A9, Oltu, Günlüce Village, Kırdağ, 1900-2200 m, 5.06.1996

1974 - 1979

51. A9, Oltu, Dutlu Mount, Koçaklar place, 1900-2100 m, 5.06.1996

1980 - 1983

52. A9, Oltu, from Dutlu Mount to Dutlu Village, 1500-2200 m, 5.06.1996

1984 - 1988

53. A9, Oltu, from Oltu to Olur, along the highway, 1100-1400 m, 5.07.1996

1989 - 1992

54. A8, Olur, from Ayvalı Village to İşhan Village, 800-1100 m, 5.08.1996

1993 - 1997

55. A8, Uzundere, from Balıklı Village to Altınçanak Village, 11900-1200 m, 5.08.1995

1998 - 2002

The Floristic List

I. DIVISIO: PTERIDOPHYTA

1. EQUISETACEAE

1. *Equisetum hyemale* L., 42, Abd. 1929
2. *E. ramosissimum* Desf., 36, Abd. 1790

II. DIVISIO: SPERMATOPHYTA

GYMNOSPERMAE

2. PINACEAE

1. *Pinus sylvestris* L., 16, Abd. 1250, Euro-Sib.

3. CUPRESSACEAE

1. *Juniperus communis* L. subsp. *nana* Syme, 16, Abd. 1251
2. *J. oxycedrus* L. subsp. *oxycedrus*, 17, Abd. 1340
3. *J. foetidissima* Willd., 16, Abd. 1251.

4. EPHEDRACEAE

1. *Ephedra major* Host, 46, Abd. 1952.

ANGIOSPERMAE

DICOTYLEDONES

5. RANUNCULACEAE

1. *Nigella arvensis* L., 24, Abd. 1459.
2. *Calta polypetala* Hochst. ex Lorent, 5, Abd. 1098.
3. *Delphinium albiflorum* DC., 20, Abd. 1400.
4. *Consolida hohenackeri* (Boiss.) Grossh., 38, Abd. 1827, Ir.-Tur.

5. *C. orientalis* (Gay) Schröd., 14, Abd. 1196
6. *Anemone albana* Stev., 16, Abd. 1239, Ir.-Tur.
7. *Clematis orientalis* L., 33, Abd. 1701.
8. *Adonis aestivalis* L. subsp. *parviflora* (Fisch ex DC.) Busch, 1, Abd. 1024.
9. *Ranunculus brachylobus* Boiss.&Hoh. subsp. *brachylobus*, 2, Abd. 1081.
10. *R. dissectus* Bieb. subsp. *napelliflorus* (DC.) Davis, 7, Abd. 1102.
11. *R. repens* L., 4, Abd. 1091.
12. *R. kotschii* Boiss., 1, Abd. 1026.
13. *R. constantinopolitanus* (DC.) d.'Urv., 4, Abd. 1090.
14. *R. arvensis* L., 8, Abd. 1110.
15. *Ceratocephalus falcatus* (L.) Pers., 50, Abd. 1974.
16. *Thalictrum isopyroides* C.A. Meyer, 30, Abd. 1608.
17. *T. minus* L. var. *minus*, 23, Abd. 1434.

6. BERBERIDACEAE

1. *Berberis vulgaris* L., 9, Abd. 1148.

7. PAPAVERACEAE

1. *Chelidonium majus* L., 23, Abd. 1441, Euro-Sib.
2. *Glaucium grandiflorium* Boiss.&Huet var. *grandiflorum*, 49, Abd. 1965, Ir.-Tur.
3. *G. grandiflorum* Boiss.&Huet var. *torquatum* Gullen, 22, Abd. 1433, Ir.-Tur., "**V**".
4. *G. cappadocicum* Boiss., 12, Abd. 1171, End., Ir.-Tur., "**R**"
5. *Papaver orientale* L. var. *parviflorum* Busch., 23, Abd. 1435, Ir.-Tur., "**R**"
6. *P. paucifoliatum* (Trautv.) Fedde, 17, Abd. 1330, Ir.-Tur.
7. *P. tauricola* Boiss., 31, Abd. 1627.
8. *P. fugax* Poiret var. *fugax*, 26, Abd. 1495, End., Ir.-Tur.
9. *P. macrostomum* Boiss. et Huet ex Boiss., 9, Abd. 1137, Ir.-Tur.
10. *Fumana microcarpa* Boiss., 2, Abd. 1055.

8. BRASSICACEAE (CRUCIFERAE)

1. *Rhapnus raphanistrum* L., 10, Abd. 1160.
2. *Crambe orientalis* L. var. *orientalis*, 14, Abd. 1192, Ir.-Tur.
3. *Conringia orientalis* (L.) Andrz., 30, Abd. 1604.
4. *C. planisiliqua* Fisch & Mey., 8, Abd. 1015.
5. *C. persica* Boiss., 9, Abd. 1124.
6. *C. perfoliata* (C. A. Meyer) Busch, 52, Abd. 1986.
7. *Lepidium sativum* L. subsp. *sativum*, 35, Abd. 1782.
8. *Cardaria draba* (L.) Desv. subsp. *draba*, 1, Abd. 1022.
9. C. *draba* (L.) Desv. subsp. *chalepensis* (L.) O.E. Schultz, 28, Abd. 1540.
10. *Isatis cappadocica* Desv. subsp. *cappadocica*, 9, Abd. 1141, Ir.-Tur.
11. *I. aucheri* Boiss., 3, Abd. 1082, End., Ir.-Tur.
12. *I. glauca* Aucher ex Boiss. subsp. *glauca*, 3, Abd. 1085, Ir.-Tur.
13. *Coluteocarpus vesicaria* (L.) Holmoe subsp. *vesicaria*, 48, Abd. 1960, Ir.-Tur.
14. *Aethionema arabicum* (L.) Andrz. ex DC., 8, Abd. 1112.
15. *A. cordatum* (Desf.) Boiss., 30, Abd.1601, Ir.-Tur.
16. *A. speciosum* Boiss. & Huet, 2, Abd. 1036, Ir.-Tur.
17. *A. trinervium* (DC.) Boiss., 7, Abd. 1105.
18. *A. diastrophis* Bunge, 9, Abd. 1133, "**K**".
19. *Thlaspi perfoliatum* L., 48, Abd. 1962.
20. *T. oxyceras* (Boiss.) Hedge, 49, Abd. 1971.
21. *Capsella bursa-pastoris* (L.) Medik, 19, Abd. 1271.
22. *Alyssum linifolium* Steph. ex Willd. var. *linifolium*, 1, Abd. 1012.
23. *A. alyssoides* (L.) L., 1, Abd. 1013.
24. *A. strigosum* Banks & Sol. subsp. *strigosum*, 9, Abd. 1127.
25. *A. ochroleucum* Boiss. & Huet, 16, Abd. 1229, End.
26. *A. artvinense* Busch, 4, Abd. 1093, End., "**R**".
27. *A. praecox* Boiss. & Bal. var. *praecox*, 16, Abd. 1282, End.
28. *A. pateri* Nyar. subsp. *prostratum* (Nyar.) Dudley, 9, abd. 1133, End.
29. *A. murale* Waldst. & Kit. var. *alpinum* Boiss. ex Nyar., 16, Abd.

1288.

30. *Draba bruniifolia* Stev. subsp. *bruniifolia*, 2, Abd. 1040.
31. *D. bruniifolia* Stev. subsp. *armeniaca* Coode & Cullen, 16, Abd. 1212, End., "**R**".
32. *D. nemorosa* L., 1, Abd. 1030.
33. *Erophila verna* (L.) Chevall subsp. *verna*, 49, Abd. 1973.
34. *Arabis caucasica* Willd. subsp. *caucasica*, 52, Abd. 1985.
35. *A. sagittata* (Bertol.) DC., 34, Abd. 1748.
36. *A. nova* Vill., 13, Abd. 1180.
37. *Cardamine lazica* Boiss. & Bal., 4, Abd. 1089, Eux.
38. *C. impatiens* L. var. *impatiens*, 16, Abd. 1268, Euro-Sib.
39. *Matthiola longipetala* (Vent.) DC. subsp. *bicornis* (Sibth.&Smith) P.W. Ball, 20, Abd. 1397.
40. *Chorispora tanella* (Pall.) DC., 50, Abd. 1975.
41. *Hesperis schischkinii* Tzvelev, 3, Abd. 1080, End.
42. *H. buschhiana* Tzvelev, 8, Abd. 1122, End.
43. *H. matronalis* L. subsp. *matronalis*, 25, Abd. 1479.
44. *Sterigmostemum incanum* Bieb., 1, Abd. 1028, Ir.-Tur.
45. *Erysimum leucanthemum* (Steph.) Fedtsch., 36, Abd. 1792.
46. *E. pulchellum* (Willd.) Gay., 15, Abd. 1208.
47. *E. gelidum* Bunge, 2. Abd. 1038, Ir.-Tur.
48. *E. leptophyllum* (Bieb.) Andrz., 1, Abd. 1019, "**K**".
49. *E. unicifoliatum* Boss., 3, Abd. 1084, End.
50. *E. erginense* Hausskn., 9, Abd. 1125, End.
51. *Sobolewskia clavata* (Boiss.) Fenzl, 53, Abd. 1990.
52. *Descuriana sophia* (L.) Webb. ex Prantl., 1, Abd. 1011.
53. *Camelina rumelica* Vell, 1, Abd. 1008.

9. CAPPARACEAE

1. *Capparis ovata* Desf. var. *herbacea* (Willd.) Zoh., 32, Abd. 1650.
2. *Cleome ornithopodioides* L., 29, Abd. 1550.

10. RESEDACEA

1. *Reseda lutea* L. var. *lutea*, 1, Abd. 1032.

11. CISTASEAE

1. *Helianthemum nummularium* (L.) Miller, subsp. *nummularium*, 11, Abd. 1164.
2. *H. nummularium* (L.) Miller, subsp. *tomentosum* (Scop.) Schintz & Amanus, 16, Abd. 1290.
3. *H. nummularium* (L.) Miller, subsp. *ovatum* (Viv.) Schnitz et Thellang, 24, Abd. 1469.
4. *H. canum* (L.) Baumgl, 17, Abd. 1297.
5. *Fumana procumbens* (Dun.) Gren. & Godr., 29, Abd. 1548.

12. VIOLACEAE

1. *Viola alba* Besser subsp. *dehnhardtii* (Ten.) Becker, 52, Abd. 1984.
2. *V. occulta* Lehm., 48, Abd. 1963.
3. *V. modesta* Fenzl, 50, Abd. 1977.
4. *V. gracilis* Sibth. & Sm., 26, Abd. 1501.

13. POLYGALACEAE

1. *Polygala supina* Schreb., 16, Abd. 1231.
2. *P. anatolica* Boiss. & Heldr, 12, Abd. 1175.
3. *P. transcaucasica* Tamamschian, 8, 13, Abd. 1117, Abd. 1182, "**R**".
4. *P. vulgaris* L., 6, Abd. 1101, Euro-Sib.
5. *P. alpestris* Reichb., 2, Abd. 1037, Euro-Sib.

14. CARYOPHYLLACEAE

1. *Arenaria. tremula* Boiss., 49, Abd. 1972, Medit.
2. *Minuartia. glandulosa* (Boiss. & Huet) Bornm., 16, Abd. 1260, End., Ir.-Tur.
3. *M. verna* (L.) Hiern., 16, Abd. 1285.
4. *M. erythrocephala* (Boiss.) Hand. var. *erythrocephala*, 31, Abd. 1610, End.
5. *M. corymbulosa* (Boiss. & Bal.) McNeil var. *corymbulosa*, 16, Abd. 1281, End., Ir.-Tur.
6. *M. urumiensis* (Bornm.) Bornm., 53, Abd. 1991, Ir.-Tur.
7. *Cerastium dahuricum* Fisch., 25, Abd. 1476, Euro-Sib.
8. *C. lazicum* Boiss. 8, Abd. 1114, End., Eux. mt., "K".

9. *C. armeniacum* Gren., 9, Abd. 1126.
10. *C. chloriflorum* Fisch. & Mey., 10. Abd. 1159.
11. *C. fragillimum* Boiss., 10, Abd. 1152.
12. *Dianthus crinitus* Sm. var. *crinitus*, 24, Abd. 1464.
13. *D. erytrocoleus* Boiss., 33, Abd. 1709, 37, Abd. 1815, End., Ir.-Tur.
14. *D. calocephalus* Boiss., 33, Abd. 1671.
15. *Saponaria prostrata* Willd. subsp. *calvertii* (Boiss.) Hedge, 3, Abd. 1071.
16. *Gypsophila elegans* Bieb., 17, Abd. 1303, Ir.-Tur.
17. *G. bitlisensis* Bark., 33, Abd. 1723, End., Ir.-Tur., "**R**".
18. *Vaccaria pyramidata* Medik. var. *grandiflora* (Fisch ex DC.) Gullen, 14, Abd. 1193.
19. *Silene saxatilis* Sims, 33, Abd. 1712.
20. *S. marschalli* C. A. Mayer, 23, Abd. 1407, Ir.-Tur.
21. *S. laxa* Boiss. & Kotschy, 34, Abd. 1752, Ir.-Tur.
22. *S. spergulifolia* (Desf.) Bieb., 16, Abd. 1245, Ir.-Tur.
23. *S. montbretiana* Boiss., 3, Abd. 1085, Ir.-Tur.
24. *S. dianthoides* Pers., 16, Abd. 1234, Ir.-Tur.
25. *S. vulgaris* (Moench) Garcke var. *vulgaris*, 1, Abd. 1017.
26. *S. alba* (Miller) Krause subsp. *divaricata* (Reich.) Walthus, 16, Abd. 1272.
27. *S. dichotoma* Ehrh. subsp. *dichotoma*, 42, Abd. 1928.

15. ILLECEBRACEAE

1. *Paronychia kurdica* Boiss. subsp. *kurdica* var. *kurdica*, 21, Abd. 1404, Ir.-Tur.

16. POLYGONACEAE

1. *Atraphaxis billardieri* Jaub & Spach var. *billadieri*, 14, Abd. 1190, Ir.-Tur.
2. *A. billardieri* Jaub & Spach. var. *tournefortii* (Jaub. & Spach) Gullen, 24, Abd. 1470, Ir.-Tur.
3. *Polygonum persicaria* L., 37, Abd. 1808.
4. *P. avicularia* L., 43, 1938.

5. *P.dumetorum* L., 34, Abd. 1647.
6. *Rumex scutatus* L., 23, Abd. 1451.
7. *R. tuberosus* L. subsp. *creticus* (Boiss.) Rech., 10, Abd. 1154.
8. *R. tuberosus* L. subspl *horizontalis* (Koch) Rech., 23, Abd. 1440.

17. CHENOPODIACEAE

1. *Chenopodium foliosum* (Moench) Aschers, 29, Abd. 1584.
2. C. *album* L. subsp. *album* var. *album*, 41, Abd. 1883.
3. *Krascheninnikovia ceratoides* (L.) Guldenst., 37, Abd. 1810.

18. AMARANTHACEAE

1. *Amaranhtus retroflexus* L., 41, Abd. 1886.

19. TAMARICACEAE

1. *Tamarix symrensis* Bunge, 14, Abd. 1199.
2. *Myricaria germaniaca* (L.) Desv., 37, Abd. 1811.

20. HYPERICACEAE (GUTTIFERAE)

1. *Hypericum scabrum* L., 17, Abd. 1309.
2. *H. venustum* Fenzl., 15, Abd. 1204.
3. *H. linarioides* Bosse, 17, Abd. 1300.
4. *H. armenum* Jaub.& Spach, 17, Abd. 1310.
5. *H. perforatum* L., 29, Abd. 1551.
6. *H. lydium* Boiss., 14. Abd. 1197.

21. MALVACEAE

1. *Malva neglecta* Wallr., 17, Abd. 1336.
2. *Alcea striata* (DC.) Alef. subsp. *striata*, 21, Abd. 1424.
3. *A. calvertii* (Boiss.) Boiss., 33, Abd. 1669, End., Ir.-Tur.
4. *A. lavateriflora* (DC.) Boiss., 39, Abd. 1854, "**R**".
5. *Althea cannabina* L., 41, Abd. 1889.

22. TILIACEAE

1. *Tili rubra* DC: subsp. *caucasica* (Rpr.) V. Engler, 53, Abd. 19489, Eux.

23. LINACEAE

1. *Linum mucronatum* Bertol subsp. *armenum* (Bordz.) Davis, 11, Abd. 1162.

2. *L. nervosum* Waldst. & Kit., 17, Abd. 1306.
3. *L. tenuifolium* L., 29, Abd. 1559.
4. *L. austriacum* L. subsp. *austriacum*, 7, Abd. 1205.
5. *L. catharticum* L., 42, Abd. 1916, Euro-Sib.

24. GERONIACEAE

1. *Geranium tuberosum* L. subsp. *tuberosum*, 9, Abd. 1131.
2. *G. macrostylum* Boiss., 1, Abd. 1021.
3. *G. collinum* Steph. ex Willd., 45, Abd. 1946.
4. *G. polypetalum* Fisch. & Mey., 25, Abd. 1447.
5. *G. ibericum* Cav. subsp. *ibericum*, 25, Abd. 1478.
6. *Erodium moschatum* (L.) L'Herit, 49, Abd. 1964, Medit.
7. *Pelargonium endlicherianum* Fenzl, 27, Abd.1507.

25. ZYGOPHYLLACEAE

1. *Peganum harmala* L., 21, Abd. 1426.

26. RUTACEAE

1. *Haplophyllum armenum* Spach, 33, Abd. 1720, End.

27. ACERACEAE

1. *Acer divergens* Pax var. *divergens*, 21, 36, Abd. 1423, Abd. 1796, End.
2. *A. divergens* Pax var. *trilobum* Yalt., 23, Abd. 1445, End., Ir.-Tur.

28. VITACEAE

1. *Vitis sylvestris* Gmelin, 41, Abd. 1880.

29. RHAMNACEAE

1. *Paliurus spina-christi* Miller, 14, Abd. 1189.
2. *Rhamnus pallasii* Fisch. & Mey., 33, Abd. 1665.

30.ANACARDIACEAE

1. *Cotinus coggyria* Scop., 14, Abd. 1201.

31. CELASTRACEAE

1. *Euonymus latifolius* (L.) Miller subsp. *latifolius*, 43, Abd. 1934, Euro-Sib.
2. *E. europaeus* L., 41, Abd. 1913, Euro-Sib.

32. FABACEAE (LEGUMINOSAE)

1. *Acasia longifolia* Willd., 25, Abd. 1473.
2. *Colutea armena* Boiss. & Huet., 14, Abd. 1198.
3. *Chesneya elegans* Fomin, 6, Abd.1100, End., Ir.-Tur., "**R**".
4. *Astragalus coadunatus* Hub-Mor. & Chamb., 29, Abd. 1570, End., Ir.-Tur., "**R**".
5. *A. galegiformis* L., 18, Abd. 1359, Euro-Sib.
6. *A. aureus* Willd., 33, Abd. 1667, Ir.-Tur.
7. *A. eriocephalus* Willd. subsp. *eriocephalus*, 32, Abd. 1651, "**R**".
8. *A. lagurus* Willd. 33, Abd. 1666, Ir.-Tur.
9. *A. cancellatus* Bunge, 34, Abd. 1743, Ir.-Tur.
10. *A. atrocarpus* Chamb. & Matthews, 1, Abd. 1006, End., Ir.-Tur., "**R**".
11. *A. fumosus* Boiss., 3, Abd. 1068, End.
12. *A. onobrychioides* Bieb., 28, Abd. 1518.
13. *A. bicolor* Lam., 16, Abd. 1215, End., Ir.-Tur.
14. *A. cylindraceus* DC., 18, Abd. 1263, End., Ir.-Tur.
15. *A. czorochensis* Charadze, 26, Abd. 1500, Eux. mt., "**R**".
16. *A. campylosema* Boiss. subsp. *campylosema*, 17, Abd. 1308, End., Ir.-Tur.
17. *A. kastamonuensis* Chamb. & Matthews, 24, Abd. 1467, End., Ir.-Tur.
18. *Oxytropis albana* Stev., 43, Abd. 1935.
19. *O. lazica* Boiss., 5, Abd. 1094.
20. *Cicer anatolicum* Alef., 26, Abd. 1498, Euro-Sib.
21. *Vicia cracca* L. subsp. *cracca*, 17, Abd. 1302, Euro-Sib.
22. *V. cracca* L. subsp. *tenuifolia* (Roth.) Gaudin, 33, Abd. 1736.
23. *V. cracca* L. subsp. *stenophylla* Vel., 31, Abd. 1623.
24. *V. villosa* Roth. subsp. *villosa*, 42, Abd. 1930.
25. *V. trunculata* Fischer ex Bieb., 17, Abd. 1305, Euro-Sib.
26. *V. erzurumica* Demirkuş ex Erik (yayına hazırlanmakta), 26, Abd. 1492, End., "**E**".

27. *Lathyrus pratensis* L., 39, Abd. 1849.
28. *L. tuberosus* L., 24, Abd. 1461, Euro-Sib.
29. *L. rotundifolius* Willd. subsp. *miniatus* (Bieb. ex Stev.) Davis, 10, Abd. 1153.
30. *Pisum sativum* subsp. *elatius* (Bieb.) Asches&Graebn var. *elatius*, 17, Abd. 1319, Medit.
31. *Trifolium ambiguum* Bieb., 16, Abd. 1258.
32. *T. pratense* L. var. *pratense*, 1, Abd. 1007.
33. *T. trichhocephalum* Bieb., 17, Abd. 1321.
34. *Melilotus officinalis* (L.) Desr., 20, Abd. 1394.
35. *Trigonella arcuata* C. A. Meyer, 3, Abd. 1070.
36. *Medicago lupulina* L., 3, Abd. 1074.
37. *Lotus corniculatus* L. var. *corniculatus*, 30, Abd. 1599.
38. *L. corniculatus* L. var. *tenuifolius* L., 31, Abd. 1639.
39. *L. corniculatus* L. var *alpinus* Ser., 3, Abd. 1073.
40. *Anthyllis vulneraria* L. subsp. *polyphylla* (DC.) Nyman, 29, Abd. 1561, Euro-Sib.
41. *A. vulneraria* L. subsp. *boissieri* (Sag.) Bornm., 16, Abd.1291.
42. *Coronilla orientalis* Miller var. *orientalis*, 18, Abd. 1351.
43. *C. varia* L. subsp. *varia*, 39, Abd. 1850.
44. *Hedysarum varium* Willd., 27, Abd. 1504, Ir.-Tur.
45. *H. nitidum* Willd., 18, Abd. 1356, End., Ir.-Tur.
46. *H. huetii* Boiss., 27, Abd. 1512, Ir.-Tur., "**K**".
47. *H. cappadocicum* Boiss., 14, Abd. 1188, End., Ir.-Tur.
48. *H. elegans* Boiss. & Huet., 19, Abd. 1372, Ir.-Tur.
49. *H. Onobrychis cornuta* (L.) Desv., 27, Abd. 1510, Ir.-Tur.
50. *H. stenostachya* Freyn subsp. *sosnowskyi* (Grossh.) Hedge, 20, Abd. 1392, End., Ir.-Tur., "**R**".
51. *H. oxyodonta* Boiss. var. *oxyodonta*, 31, Abd. 1624.
52. *H. huetiana* Boiss., 20, Abd. 1389, End., Ir.-Tur., "**R**".
53. *H. tournefortii* (Willd.) Desv., 18, Abd. 1361, End.
54. *H. oltense* B. Yıldız et Aktoklu, 27, Abd. 1504.

33. ROSACEAE

1. *Prunus domestica* L. 41, Abd. 1905.
2. *P. divaricata* Ledeb. subsp. *divaricata*, 38, Abd. 1838.
3. *Cerasus angustifolia* (Spach) Browicz. var. *angustifolia*, 20, Abd. 1403, Ir.-Tur.
4. *C. avium* (L.) Moench, 35, Abd. 1775.
5. *C. vulgaris* Miller, 35, Abd. 1776.
6. *C. mahaleb* (L.) Miller var. *mahaleb*, 38, Abd. 1821.
7. *Persica vulgaris* Miller, 35, Abd. 1774.
8. *Flipendula vulgaris* Moench. 23, Abd. 1436, Euro-Sib.
9. *Rubus saxatalis* L. 39, Abd. 1842.
10. *R. caesius* L. 35, Abd. 1783.
11. *R. discolar* Weihe & Nees, 41, Abd. 1911.
12. *Potentilla anatolica* Peşmen, 25, Abd. 1489, End., Ir.-Tur.
13. *P. crantzii* (Crantz.) G. Beck ex Fritsch var. *crantzii*, 16, Abd. 1216, Euro-Sib.
14. *P. geranoides* Willd. 2, Abd. 1059, Ir.-Tur.
15. *Fragaria vesca* L. 25, Abd. 1480.
16. *Geum urbanum* L. 42, Abd. 1919.
17. *Agrimonia eupatoria* L. 30, Abd. 1591.
18. *Sanguisorba minor* Scop. subsp. *minor*, 33, Abd. 1655.
19. *Alchemilla caucasica* Buser, 16, Abd. 1236, Eux. mt.
20. *A. stricta* Rothm. 31, Abd. 1631.
21. *Rosa pimpinellifolia* L. 23, Abd. 1444, Euro-Sib.
22. *R. elymaitica* Boiss & Hauskn. 33, Abd. 1656, Ir.-Tur., "**R**".
23. *R. gallica* L, 24, Abd. 1368.
24. *R. iberica* Stev. 39, Abd. 1844.
25. *Cotoneaster nummularia* Fisch. & Mey. 33, 39, Abd. 1673, Abd. 1869.
26. *Crataegus oriantalis* Pallas ex Bieb. var. *orientalis*, 38, Abd. 1820.
27. *C. pseudohetorophylla* Pojark, 9, Abd. 1147, Ir.-Tur.
28. *Sorbus umbellata* (Desf.) Fritsch var. *umbellata*, 33, Abd. 1707.

29. *Cydonia oblonga* Miller, 36, Abd. 1799.
30. *Pyrus communis* L. subsp. *sativa* (DC.) Hedge, 38, Abd. 1818.
31. *P. communis* L. subsp. *caucasica* (Fed.) Browicz, 38, Abd. 1819.
32. *P. salicifolia* Pallas var. *salicifolia*, 13, Abd. 1183, "**R**".

34. PUNICACEAE

1. *Punica granatum* L. 41, Abd. 1898.

35. LYTHRACEAE

1. *Lythrum salicaria* L. 36, Abd. 1876, Euro-Sib.

36. ONAGRACEAE

1. *Epilobium anfgustifolium* L. 39, Abd. 1841.
2. *E. hirsutum* L. 41, Abd. 1885.
3. *E. confusum* Hausskn. 36, Abd. 1789, Ir.-Tur.

37. CUCURBITACEAE

1. *Bryonia alba* L. 41, Abd. 1892, Euro-Sib.

38. CRASSULACEAE

1. *Sedum telephium* L. subsp. *maximum* (L.) Krocker, 40, Abd. 1878, Euro-Sib.
2. *S. spurium* Bieb. 30, Abd. 1603.
3. *S. album* L. 24, Abd. 1463.
4. *S. subulatum* (C. A. Meyer) Boiss. 33, Abd. 1713.
5. *S. magellense* Ten. 33, Abd. 1715.
6. *S. gracile* C. A. Meyer, 16, Abd. 1280, Eux. mt.
7. *S. sempervivoides* Bieb. 24, Abd. 1472.
8. *S. pilosum* Bieb. 16, Abd. 1261.
9. *S. pallidum* Bieb. var. *bithynicum* (Boiss.) Chamberlain, 33, Abd. 1714, Eux.
10. *Sempervivum transcaucasicum* Muirhead, 41, Abd. 1897, "**R**".

39. SAXIFRAGACEAE

1. *Saxifraga paniculata* Miller subsp. *paniculata*, 16, Abd. 1262.
2. *S. adcendens* L. subsp. *adcendens*, 33, Abd. 1716.

40. APIACEAE (UMBELLIFERAE)

1. *Eryngium billardieri* Delar., 37, Abd. 1817, Ir.-Tur.

2. *Chaerophyllum macrospermum* (Sprengel) Fisch. & Mey., 39, Abd. 1858, Ir.-Tur.
3. *Anthriscus nemorasa* (Bieb.) Sprengel, 25, Abd. 1483.
4. *Bunium microcarpum* (Boiss.) Freyn. subsp. *bourgeri* (Boiss.) Hedge & Lamond, 31, Abd. 1611.
5. *Carum meifolium* (Bieb.) Boiss., 19, Abd. 1370.
6. *Physospermum cornubiense* (L.) DC., 39, Abd. 1848.
7. *Eleutherospermum cicutarium* (Bieb.) Boiss., 39, Abd. 1894.
8. *Prangos pabularia* Lindl., 9, Abd. 1145, Ir.-Tur.
9. *P. ferulacea* (L.) Lindl., 27, Abd. 1511.
10. *Bupleurum schistosum* Woronw, 21, Abd. 1416, End., Ir.-Tur.
11. *B. falcatum* L. subsp. *cernuum* (Ten.) Arc., 38, Abd. 1828.
12. *Cicuta virosa* L., 33, Abd. 1700, "K".
13. Cnidium silaifolium (Jacq.) Simonkai, 20, Abd. 1397.
14. *Malabalia secacul* Banks & Sol., 30, Abd. 1597.
15. *Heracleum platytaenium* Boiss., 23, Abd. 1452, End., Eux.
16. *H. pastinacifolium* C. Koch subsp. *incanum* (Boiss. & Huet) Davis., 33, Abd. 1701. End.
17. *Laser tribolum* (L.) Barkh., 25, Abd. 1542, Ir.-Tur.
18. *Astrodaucus orientalis* (L.) Drude, 28, Abd. 1542, Ir.-Tur.
19. *Caucalis platycarpuos* L., 40, Abd. 1867.

41. CORNACEAE

1. *Cornus sanguinea* L. subsp. *australis* (J.A. Meer) Jav., 36, Abd. 1797, Euro-Sib.
2. *C. mas* L., 35, Abd. 1773, Euro-Sib.

42. CAPRIFOLIACEAE

1. *Lonicera caucasica* Pallas subsp. *caucasica*, 23, Abd. 1446.
2. *L. caprifolium* L., 39, Abd. 1859.

43. VALERIANACEAE

1. *Valeriana alliarifolia* Adams., 25, Abd. 1482.
2. *Centranthus longiflorus* Stev., 9, Abd. 1144, Ir.-Tur.

44. MORINACEAE

1. *Morina persica* L., 20, Abd. 1402, Ir.-Tur.

45. DISPACACEAE

1. *Knautia montana* (Bieb.) DC., 28, Abd. 1545, Euro-Sib., "R".
2. *K. involucrata* Somm & Lev., 40, Abd. 1871, Eux. mt.
3. *Scabiosa crinita* Katschy & Boiss., 21, Abd. 1410, Ir.-Tur.
4. *S. argentea* L., 17, Abd. 1323.

46. ASTERACEAE (COMPOSITAE)

1. *Telekia speciosa* (Shreber) Baumg., 35, Abd. 1780, Euro-Sib.
2. *Inula helenium* L. subsp. *orygalis* (Boiss.) Grierson, 39, Abd. 1862, End., Eux.
3. *I. salicina* L., 21, Abd. 1413, Euro-Sib., "**R**".
4. *I. mariae* Bordz.. 30, Abd. 1602, Eux. mt.
5. *I. oculus-christi* L., 36, Abd. 1689, Euro-Sib.
6. *I. montbretiana* DC., 33, Abd. 1717, Ir.-Tur.
7. *Pulicaria dysenterica* (L.) Bernth., 41, Abd. 1884.
8. *Antennaria dioica* (L.) Gaertner, 16, Abd. 1284, Euro-Sib.
9. *Helicrhysum plicatum* DC. subsp. *plicatum*, 29, Abd. 1563.
10. *H. arenarium* (L.) Moench subsp. *aucheri* (Boiss.) Davis & Kupicha, 18, Abd. 1350.
11. *H. arenarium* (L.) Moench subsp. *erzincanicum* Davis & Kupicha, 33, Abd. 1722, End., Ir.-Tur.
12. *Solidago virgurea* L. subsp. *alpestris* (Waldst. & Kit.) Gaudin, 39, Abd. 1839, Euro-Sib.
13. *Aster amellus* L. subsp. *ibericus* (Stev.) Avetisian, 28, Abd. 1527.
14. *A. alpinus* L., 34, Abd. 1760.
15. *A. tripolium* L., 28, Abd. 1532, "**V**".
16. *Erigeron caucasicus* Stev. subsp. *caucasicus*, 30, Abd. 1590, Eux. mt.
17. *E. caucasicus* Stev. subsp. *venustus* (Batsch.) Girerson, 34, Abd. 1760.
18. *E. acer* L. subsp. *pycnotrichus* (Vierh.) Girerson, 16, Abd. 1255.
19. *Conyza canadensis* (L.) Cronquist, 41, Abd. 1907.

20. *Senecio integrifolius* (L.) Clairv. subsp. *karsianus* Matthews, 16, Abd. 1273, End., Eux. mt., "**R**".
21. *S. vernalis* Walldst. & Kit., 10, Abd. 1161.
22. *Tussilago farfara* L., 51, Abd. 1983, Euro-Sib.
23. *Eupatorium cannabium* L., 41, Abd. 1912, Euro-Sib.
24. *Anthemis cretica* L. subsp. *umbliciata* (Boiss. & Huet.) Grierson, 11, Abd. 1170.
25. *A. tinctoria* L. var. *tinctoria*, 26, Abd. 1497.
26. *A. tinctoria* L. var. *pallida* DC., 16, Abd. 1219.
27. *A.triumfettii* (L.) All., 29, Abd. 1569.
28. *Achillea millefolium* L. subsp. *millefolium*, 33, Abd. 1690, Euro-Sib.
29. *A. setacea* Waldst. & Kit., 28., Abd. 1535, Euro-Sib.
30. *A. biebersteinii* Afan., 1, Abd. 1003, Ir.-Tur.
31. *Leucanthemum vulgare* Lam., 44, Abd. 1941, Euro-Sib.
32. *Tanacetum balsamita* L. subsp. *balsamitoides* (Schultz Bip.) Grierson, 34, Abd. 1754.
33. *T. sericeum* (Adams) Schultz, 28, Abd. 1529, "**R**".
34. *T. oltense* (Sosn.) Grierson, 29, Abd. 1577, End., "**R**".
35. *T. chiliophyllum* (Fisch & Mey.) Schultz var. *chiliophyllum*, 33, Abd. 1686.
36. *T. abrotanifolium* (L.) Druce, 33, Abd. 1663, Ir.-Tur.
37. *T. argenteum* (Lam.) Willd. subsp. *canum* (C. Koch) Griersan var. *canum*, 33, Abd. 1653.
38. *Tripleurospermum melanolepsis* (Boiss. & Bushe) Pebed., 16, Abd. 1220.
39. *Artemisia absinthum* L., 24, Abd. 1454.
40. *Arctium tomentosum* Miller var. *glabrum* (Körnicke) Arenes, 28, Abd. 1546.
41. *Onopordum acanthium* L., 33, Abd. 1704.
42. *Circium adjaricum* Somm. & Lev., 40, Abd. 1874, Eux. mt.,"**K**".
43. *C. macrobotrys* (C. Koch.) Boiss., 42, Abd. 1932.
44. *C. lappaceum* (Bieb.) Fischer subsp. *tenuilobum*. (C. Koch.) Davis &

Parris, 42, Abd. 1931, End., Ir.-Tur.

45. C. *arvense* (L.) Scop subsp. *vesticum* (Wimmer et Graph.) Petrak, 37, Abd. 1813, Eux.
46. *C. pseudopersonata* Boiss & Ball. subsp. *pseudopersonata*, 44, Abd. 1942, End., Eux.
47. *C. pseudopersonata* Boiss & Ball. subsp. *kuznezowianum* (Somm & Lev.) Pertak, 33, Abd. 1967, Status: "K".
48. *C. simplex* C. A. Meyer subsp. *armenum* (DC.) Petrak, 31, Abd. 1628.
49. *C. libanoticum* DC. subsp. (Boiss. & Heldr.) Davis & Parris, 12, Abd. 1173, End., E. Medit mt.
50. *Carduus lanugunosus* Willd., 28, Abd. 1547, End.
51. *C. hamulosus* Ehrh. subsp. *hamulosus*, 18, Abd. 1362, Euro-Sib.
52. *Jurinea pontica* Hausskn. & Freyn ex Hausskn., 21, Abd. 1412, End., Ir.-Tur.
53. *Jurinella moschus* (Habl.) Bobrov subsp. *pinnatisecta* (Boiss.) Danin & Davis, 28, Abd. 1524, Ir.-Tur.
54. *Serratula coriacea* Fisch. & Mey ex DC., 37, Abd. 1806, Ir.-Tur. "**R**".
55. *Centaurea virgata* Lam., 37, Abd. 1803, Ir.-Tur.
56. *C. sessilis* Willd., 33, Abd. 1706, End., Ir.-Tur.
57. *C. rhizanta* C.A. Meyer., 30, Abd. 1586, Ir.-Tur.
58. *C. glastifolia* L., 28, Abd. 1530, Ir.-Tur.
59. *C. carduiformis* DC. subsp. *carduiformis*, 32, Abd. 1634.
60. *C. carduiformis* DC. subsp. *orientalis* Wagenitz, 18, Abd. 1363, Ir.-Tur.
61. *C. pseudascabiosa* Boiss. & Buhse subsp. *pseudascabiosa*, 27, Abd. 1509.
62. *C. simplicicaulis* Boiss. & Huet., 17, Abd. 1307, Eux.
63. *C. hedgei* Wagenitz, 18, Abd. 1357, End., Ir.-Tur.
64. *C. pulcherrima* Willd. var. *pulcherrima*, 39, Abd. 1861.
65. *C. cheiranthifolia* Willd. var. *cheiranthifolia*, 16, Abd. 1237, Eux. mt.
66. *C. tirumfettii* All, 34, Abd.1759.

67. *C. depressa* Bieb., 28, Abd. 1538.
68. *Carthamus lanatus* L. 39, Abd. 1845.
69. *C. glaucus* Bieb. subsp. *glaucus*, 43, Abd. 1936.
70. *Xeranthemum annuum* L., 37, Abd. 1800.
71. *Echinops sphaerocephalus* L. subsp. *sphaerocephalus*, 33, Abd. 1703, Euro-Sib.
72. *Uechtritzia armena* Freyn & Sint., 38, Abd. 1835, End., Ir.-Tur., "**R**".
73. *Cichorium intybus* L., 28, Abd. 1514.
74. *Scorzonera cana* (C. A. Meyer) Hoffm. var. *jacquiniana* (W. Koch) Chamberlain, 29, Abd. 1565.
75. *S. cana* (C.A. Meyer) Hoffm. var. *alpina* (Boiss.) Chamberlain, 34, Abd. 1762.
76. *S. cana* (C.A. Meyer) Hoffm. var. *radicosa* (Boiss.) Chamberlain, 16, Abd. 1222.
77. *S. parviflora* Jacq., 11, Abd. 1167.
78. *S. pseudolanata* Grossh., 48, Abd. 1967, Ir.-Tur.
79. *S. latifolia* (Fisch & Mey.) DC. var. *angustifolia* Prilipko, 29, Abd. 1574, Ir.-Tur., Status: "**R**".
80. *S. woronowii* Krasch, 29, Abd. 1575, Euro-Sib.
81. *Tragopogon longirostris* Bisch ex Schultz var. *abbreviatus* Boiss., 39, Abd. 1853.
82. *T. reticulatus* Boiss. & Huet., 15, Abd. 1206.
83. *T. fibrosus* Freyn & Sint ex Freyn, 17, Abd. 1332, End.
84. *Leontodon hispidus* L. var. *glabratus* (W. Koch) Bisch., 29, Abd. 1572.
85. *S. crispus* Vill. subsp. *asper* (Waldst & Kit.) Rohl. var. *asper*, 28, Abd. 1521.
86. *Picris hieracioides* L., 44, Abd. 1943, Euro-Sib.
87. *P. strigosa* Bieb., 29, Abd. 1563, Ir.-Tur.
88. *Reichardia glauca* Matthews, 28, Abd. 1533, Ir.-Tur.
89. *Hieracium lasiochaetum* (Bornm. & Zahn) Sell & West, 29, Abd.

1573. End.

90. *Pilosella hoppeana* (Schultes) C.H. & F.W. Schultz subsp. *pilisquama* (NP.) Sell & West, 26, Abd. 1494.
91. *P. x ruprechtii* (Boiss.) Sell & West, 29, Abd. 1571.
92. *P. piloselloides* (Vill.) Sojak subsp. *megalomastix* (NP.) Sell & West, 17, Abd. 1325.
93. *P. echioides* (Lumn.) C.H. & F. W. Schultz subsp. *procera* (Fries) Sell & West, 38, Abd. 1836.
94. *P. x macrotricha* (Boiss.) C.H. & F. W. Schultz, 38, Abd. 1837.
95. *P. maschukensis* (Litw. & Zahn.) Sojak, 33, Abd. 1724.
96. *P. verruculata* (Link) Sojak, 42, Abd. 1920.
97. *Prenanthes purpurea* L., 17, Abd. 1308, "**R**".
98. *Lactuca saligna* L., 41, Abd. 1910.
99. *Lapsana communis* L. subsp. *alpina* (Boiss. & Bal) Sell, 41, Abd. 1890, Eux.
100. *L. communis* L. subsp. *intermedia* (Bieb.) Hayek, 18, Abd. 1354.
101. *L. communis* L. subsp. *grandiflora* (Bieb.) Sell, 43, Abd. 1940, Eux. mt.
102. *Taraxacum ceratinum* (Waldst. & Kit.) Poiret, 11, Abd. 1168.
103. *T. crepidiforme* DC. subsp. *crepidiforme*, 16, Abd. 1221, Ir.-Tur.
104. *Crepis sancta* (L.) Babcock, 29, Abd. 1549.

47. CAMPANULACEAE

1. *Campanula rapunculoides* L. subsp. *rapunculoides*, 18, Abd. 1345.
2. *C. rapunculoides* L subsp. *cordifolia* (C. Koch) Damboldt, 43, Abd. 1937.
3. *C. trachelium* L., 33, Abd. 1661.
4. *C. sibirica* L., subsp. *hohenachkeri* (Fisch. & Mey.) Damboldt, 11, Abd. 1165, Eux.
5. *C. glomerata* L. subsp. *hispida* (Witasek) Hayek, 18, Abd. 1346.
6. *C. macrochlamys* Boiss. & Huet, 3, Abd. 1078.
7. *C. allifaifolia* Willd., 29, Abd. 1578, Eux.
8. *C. betulifolia* C. Koch., 33, Abd. 1652, Eux., "**R**".

9. *C. tridentata* Schreber, 16, Abd. 1209, Eux.
10. *C. stevenii* Bieb. subspl *stevenii*, 34, Abd. 1764, Eux.
11. *Asyneuma rigidum* (Willd. Grossh. subsp. *rigidum*, 42, Abd. 1831, Ir.-Tur.
12. *A. amplexicaula* (Willd.) Hand-Maz. subsp. *amplexicaula* var. *amplexicaula*, 29, Abd. 1562.
13. *A. amplexicaula* (Willd.) Hand. Maz. subsp. *amplexicaula* var. *angustifolium* (Boiss.) Bornm., 31, Abd. 1616, Ir.-Tur.
14. *A. virgatum* (Labill) Bornm, subsp. *virgatum*, 27, Abd. 1505, Ir.-Tur.

48. ERICACEAE

1. *Pyrola media* Swartz, 39, Abd. 1851, Euro-Sib.

49. PRIMULACEAE

1. *Primula veris* L. subsp. *columnae* L., 25, Abd. 1481, Euro-Sib.
2. *P. veris* L. subsp. *macrocalyx* (Bunge) Lüdi, 2, Abd. 1050, Euro-Sib.
3. *P. elatior* (L.) Hill subsp. *pseudoelatior* (L.) Hill, 33, Abd. 1688, Euro-Sib.
4. *P. longipes* Freyn & Sint., 5, Abd. 1099, End., Eux., "R".
5. *P. auriculata* Lam., 3, Abd. 1066, Ir.-Tur.
6. *P. algida* Adams, 5, Abd. 1097.
7. *Androsace armeniaca* Duby var. *macrantha* (Boiss. & Huet.) Martelli, 16, Abd. 1225, End., Ir.-Tur.
8. *A. villosa* L., 2, Abd. 1057, Euro-Sib.
9. *Lysimachia vulgaris* L., 32, Abd. 1649.

50. EBENACEAE

1. *Diospyros lotus* L., 39, Abd. 1843.
2. *D. kaki* L., 41, Abd. 1906.

51. OLEACEAE

1. *Jusminum fructicans* L., 9, Abd. 1149, Medit.
2. *Olea europea* L. var. *sylvestris* (Miller) Lehr., 41, Abd. 1909, Medit.

52. APOCYNACEAE

1. *Trachomitum venetum* (L.) Woodson, 41, Abd. 1899, Medit.
2. *Vinca minor* L., 41, Abd. 1891.

53. ASCLEPIADACEAE

1. *Cynanchum acutum* L. subsp. *acutum*, 36, Abd. 1788.
2. *Vincetoxicum tmoleum* Boiss., 21, Abd. 1425, Ir.-Tur.

54. GENTIANACEAE

1. *Gentiana gelida* Bieb., 33, Abd. 1730, Eux.
2. *Gentianella ciliata* (L.) Morkh. subsp. *blepharophora* (E. Bordz.) Pritchard, 43, Abd. 1934, Eux. mt.

55. CONVOLVULACEAE

1. *Convolvulus lineatus* L., 20, Abd. 1383, Ir.-Tur.
2. *C. arversis* L., 31, Abd. 1637.

56. CUSCUTACEAE

1. *Cuscuta campestris* Yuncker, 41, Abd. 1914.
2. *C. europaea* L., 34, Abd. 1744.

57. BORGINACEAE

1. *Heliotropium europaeum* L., 41, Abd. 1908, Medit.
2. *Asperugo procumbens* Ledeb., 1, Abd. 1010, Euro-Sib.
3. *Myosotis stricta* Link ex Roemer et Schultes, 16, Abd. 1228, Euro-Sib.
4. *M. arvensis* (L.) Hill subsp. *arvensis*, 2, Abd. 1045, Euro-Sib.
5. *L. lazica* M. Popov, 8, Abd. 1116, Euro-Sib.
6. *M. alpestris* F.W. Schmidt subsp. *alpestris*, 48, Abd. 1961.
7. *M. litospermifoila* (Willd) Hornem., 12, Abd. 1176.
8. *M. laxa* Lehm. subsp. *caespitosa* (C.F. Schultz) Hyl ex Nordh., 1, Abd. 1002.
9. *M. sicula* Guss., 53, Abd. 1991.
10. *Arnebia pulchra* (Roemer & Schultes) Edmonsdson, 7, Abd. 1108, Eux. mt.
11. *Buglossoides arvensis* (L.) Johnston, 8, Abd. 1111.
12. *Echium rusicum* J.F. Gmelin, 15, Abd. 1203, Euro-Sib.
13. *E. italicum* L., 28, Abd. 1515, Medit.
14. *E. vulgare* L., 17, Abd. 1320, Euro-Sib.
15. *Moltkia coerulea* (Willd.) Lehm., 14, Abd. 1197, Ir.-Tur.
16. *Onosma sericeum* Willd., 11, Abd. 1163, Ir.-Tur.

17. *O. nigricaule* H. Riedl, 9, Abd. 1134, End., Eux., "**R**".
18. *O. tauricum* Pallas ex Willd. var. *tauricum*, 16, Abd. 1292.
19. *Symphytum armeniacum* Bucknall, 32, Abd. 1643, End., Eux., "**K**".
20. *Anchusa leptophylla* Roemer & Schlutes subsp. *leptoplylla*, 19, Abd. 1277.
21. *A. leptophylla* Roemer & Schultes subsp. *incana* (Ledeb.) Chamb., 10, Abd. 1153, End., Ir.-Tur.
22. *Nonea anchusoides* Boiss. & Buhse, 2, Abd. 1039, Ir.-Tur.
23. *N. intermedia* Ledeb., 16, 1266, Eux., "**K**".
24. *N. pulla* (L.) DC. subsp. *scabrisquamata* A. Baytop, 2, Abd. 1048, Ir.-Tur.
25. *Caccinia macranthera* (Banks & Sol.) Brand var. *crassifolia* (Vent) Brand, 1, Abd. 1020, Ir.-Tur.

58. SOLANACEAE

1. *Solanum nigrum* L. subsp. *nigrum*, 40, Abd. 1868.
2. *S. dulcamara* L.. 22, Abd. 1428, Euro-Sib.
3. *S. tuberosum* L., 28, Abd. 1517.
4. *Physalis alkegengi* L., 41, Abd. 1430.
5. *Datura stramonium* L., 22, Abd. 1430.
6. *Hyoscyamus niger* L., 9, Abd. 1146.

59. SCROPHULARIACEAE

1. *Verbascum flavidum* (Boiss.) Freyn & Bornm., 14, Abd. 1185, Euro-Sib.
2. *V. georgicum* Bentham, 31, Abd. 1632, Ir.-Tur.
3. *V. asperuloides* Hub.-Mor., 14, Abd. 1184, End., Ir.-Tur.
4. *V. speciosum* Schrader, 31, Abd. 1633.
5. *Scrophularia ilwensis* C. Koch., 17, Abd. 1324, Ir.-Tur.
6. *Linaria genistifolia* (L) Miller subsp. *linifolia* (Boiss) Davis, 32, Abd. 1751.
7. *L. corifolia* Chav.,19, Abd. 1738, End., Ir.-Tur.
8. *L. armaniaca* Chav., 19, Abd. 1381, Ir.-Tur.
9. *L. kurdica* Boiss. & Hohen. subsp. *kurdica*, 37, Abd. 1816, Ir.-Tur.

10. *Digitalis ferruginea* L. subsp. *schisckinii* (Ivan.) Werner, 42, Abd. 1863, Eux.
11. *Veronica gentianoides* Vahl. subsp. *gentianoides*, 8, Abd. 1211, Eux. mt.
12. *V. anagallis-aquatica* L. subsp. *oxycarpa* (Boiss.) A. Jelem, 33, Abd. 1695.
13. V. *beccabunga* L. subsp. *beccabunga*, 25, Abd. 1488.
14. *V. beccabunga* L. subsp. *abscantia* M.A.F., 16, Abd. 1269.
15. *V. oltensis* Woron., 3, Abd. 1072, End., Ir.-Tur. "**R**".
16. *V. orientalis* Miller subsp. *orientalis*, 3, Abd. 1086.
17. *V. multifida* L., 1, Abd. 1023, End., Ir.-Tur.
18. *V. armena* Boiss. et Huet, 2, Abd. 1035, Ir.-Tur.
19. *Melampyrum arvense* L. var. *arvense*, 31, Abd. 1622, Euro-Sib.
20. *Euphrasia pectinata* Ten., 30, Abd. 1606, Euro-Sib.
21. *Odontites glutinosa* (Bieb.) Bentham, 30, Abd. 1593.
22. *Pedicularis wilhemsiana* Fischer ex Bieb., 8, Abd. 1121, Eux. mt.
23. *P. comosa* L. var. *sibthorpii* (Boiss.) Boiss., 13, Abd. 1181.
24. *Rhinanthus angustifolis* C. C. Gmelin subsp. *grandiflorus* (Wallr.) D. A. Webb., 18, Abd. 1344.
25. *Bungea trifida* (Vahl) C. A. Meyer, 20, Abd. 1385, Ir.-Tur.

60. OROBANCHACEAE

1. *Orobanche purpurea* Jacq., 24, Abd. 1466.
2. *O. elatior* Sutton, 33, Abd. 1723.

61. GLOBULARIACEAE

1. *Globularia trichosanctha* Fisch. & Mey., 46, Abd. 1953, "**R**".

62. LAMIACEAE (LABIATEAE)

1. Ajuga orentalis L., 8, Abd. 1120.
2. *A. chamaepitys* (L.) Schreber subsp. *cuneatifolia* (Stapf.) P.H. Davis, 1, Abd. 1031.
3. *Teucrium orientale* L. var. *orientale*, 24, Abd. 1456, Ir.-Tur.
4. *T. orientale* L. var. *puberulens* T. Ekim, 45, Abd. 1947, Ir.-Tur.
5. *T. chamaedrys* L. subsp. chamaedrys, 29, Abd. 1554, Euro-Sib.

6. *T. polium* L., 21, Abd. 1405.
7. *Scutellaria orientalis* A. Ham. subsp. *sosnowskyi* (Takht.) Fed., 4, Abd. 1092, Ir.-Tur. "**R**".
8. *Eremostachys laciniata* (L.) Bunge, 12, Abd. 1178, Ir.-Tur.
9. *Phlomis tuberosa* L., 30, Abd. 1587.
10. *P. armeniaca* Willd., 20, Abd. 1399, Ir.-Tur.
11. *Lamium garganicum* L. subsp. *reniforme* (Montbret & Aucher ex Bentham) R. Mill, 10, Abd. 1156.
12. *L. tomentosum* Willd. var *tomentosum*, 16, Abd. 1267, Ir.-Tur.
13. *L. galactophyllum* Boiss. & Reuter, 2, Abd. 1054, End. Ir.-Tur.
14. *Marrubium anisodon* C. Koch., 41, Abd. 1912.
15. *M. parviflorum* Fisch. & Mey. subsp. *parviflorum*, 28, Abd. 1525, Ir.-Tur.
16. *Sideritis montana* L. subsp. *montana*, 23, Abd. 1450, Medit.
17. *Stachys setifera* C. A. Meyer subsp. *setifera*, 23, Abd. 1439, Ir.-Tur.
18. *S. lavandulifolia* Vahl. var. *lavandulifolia*, 33, Abd. 1687, Ir.-Tur.
19. *S. lavandulifolia* Vahl. var. *brachyodon* Boiss., 19, Abd. 1373, Ir.-Tur.
20. *S. atherocalyx* C. Koch., 28, Abd. 1523, Euro-Sib.
21. *S. iberica* Bieb. subsp. *iberica* var. *iberica*, 17, Abd. 1313, Ir.-Tur.
22. *S. iberica* Bieb. subsp. *stenostacyha* (Boiss.) Rech., 30, Abd. 1592, Ir.-Tur.
23. *S. annua* (L.) L. subsp. *annua* var. *annua*, 17, Abd. 1301.
24. *Nepeta cataria* L., 23, Abd. 1437, Euro-Sib.
25. *N. nuda* L. subsp. *albiflora* (Boiss.) Germs., 33, Abd. 1694.
26. *N. transcaucasica* Grossh., 9, Abd. 1139, Ir.-Tur.
27. *N. fissa* C. A. Meyer, 38, Abd. 1829, Ir.-Tur.
28. *Lallemantia peltata* (L.) Fisch. & Mey., 17, Abd. 1329.
29. *L. canescens* (L.) Fisch. & Mey., 28, Abd. 1526, Ir.-Tur.
30. *Prunella vulgaris* L., 33, Abd. 1683, 23, Abd. 1448, Euro-Sib.
31. *P. laciniata* (L.) L., 23, Abd. 1448, Euro-Sib.
32. *Origanum vulgare* L. subsp. *vulgare*, 38, Abd. 1832, Euro-Sib.

33. *Satureja hortensis* L., 42, Abd. 1917.
34. *Clinopodium vulgare* L. subsp. *vulgare*, 39, Abd. 1840.
35. *Micromeria fruticosa* (L.) Druce subsp. *serpyllifolia* (Bieb.) P.H. Davis, 40, Abd. 1865.
36. *Thymus canoviridis* Jalas, 20, Abd. 1390, End., "**R**".
37. *T. transcaucasicus* Ronniger, 38, Abd. 1828, "**R**".
38. *T. pubescens* Boiss. & Kosthy ex Celak var. *pubescens*, 38, Abd. 1828B.
39. *T. migricus* Kokov & Shost., 20, Abd. 1391, Ir.-Tur.
40. *T. bornmuelleri* Velen., 33, Abd. 1681, Medit., "**R**".
41. *T. praecox* Opiz subsp. *grossheimi* (Ronniger) Jalas var. *grossheimi*, 31, Abd. 1640.
42. *T. longicaulis* C. Presl. subsp. *longicaulis* var. *subisophyllus* (Borbas) Jalas, 33, Abd. 1662.
43. *Mentha longifolia* (L.) Hudson subsp. *longifolia*, 36, Abd. 1787, Eux. element.
44. *M. longifolia* (L.) Hudson subsp. *typhoides* (Briq.) Harley var. *typhoides*, 32, Abd. 1644.
45. *M. spicata* L. subsp. *spicata*, 37, Abd. 1802.
46. *Salvia pinnata* L., 17, Abd. 1312, Medit.
47. *S. bracteata* Banks & Sol., 9, Abd. 1140, Ir.-Tur.
48. *S. rosifolia* Sm., 29, Abd. 1550, End., Ir.-Tur.
49. *S. huberi* Hedge, 14, Abd. 1194, End., Ir.-Tur., "**R**".
50. *S. sclarea* L., 18, Abd. 1364.
51. *S. aethiopis* L., 29, Abd. 1585.
52. *S. candidissima* Vahl. subsp. *oxcidentalis* Hedge, 28, abd. 1543, Ir.-Tur.
53. *S. staminea* Montbret & Aucher ex Bentham, 7, Abd. 1109, Ir.-Tur.
54. *S. nemorosa* L., 29, Abd. 1582.
55. *S. verticillata* L. subsp. *verticillata*, 28, Abd. 1524.

63. PLUMBAGINACEAE

1. *Plumbago europea* L., 38, Abd. 1830, Euro-Sib.
2. *Acantholimon acerosum* (Willd.) Boiss. var. *brachystachyum* Boiss., 33, Abd. 1668, End., Ir.-Tur.
3. *A. armenum* Boiss. & Huet var. *balansae* Boiss. & Huet, 21, Abd. 1418, Ir.-Tur.

64. PLANTAGINACEAE

1. *Plantago matirima* L., 16, Abd. 1296.
2. *P. media* L., 31, Abd. 1617.
3. *P. lanceolata* L., 35, Abd. 1769.

65. TYMELAEACEAE

1. *Daphne glomerata* Lam., 16, Abd. 1249, Eux.
2. *D. oleoides* Schreber subsp. *oleoides*, 21, Abd. 1414.
3. *D. oleoides* Schreber subsp. *kurdica* (Bornm.) Bornm., 46, Abd. 1951, Ir.-Tur.

66. ELEAGNACEAE

1. *Hippophae rhamnoides* L., 35, Abd. 1778.
2. *Eleagnus angustifolia* L., 14, Abd. 1200.

67. EUPHORBIACEAE

1. *Euphorbia paralias* L., 33, Abd. 1705, Medit.
2. *E. cheiradenia* Boiss. & Hohen., 24, Abd. 1453, Ir.-Tur.
3. *E. virgata* Waldst. Kit., 49, Abd. 1973.
4. *E. iberica* Boiss., 3, Abd. 1088, Ir.-Tur.

68. URTIACAEAE

1. *Urtica dioica* L., 19. Abd. 1278, Euro-Sib.

69. MORACEAE

1. *Morus alba* L., 22, Abd. 1429.
2. *Ficus carica* L. subsp. *carica*, 41, Abd. 1904.

70. ULMACEAE

1. *Celtis australis* L., 41, Abd. 1902.

71. JUGLANDACEAE

1. *Juglans regia* L., 35, Abd. 1770.

72. FAGACEAE

1. *Quercus macranthera* Fisch. & Mey. ex Hoben. subsp. *syspirensis* (C. Koch) Menitsky, 42, Abd. 1926.

73. CORYLACEAE

1. *Carpinus betulus* L., 23, Abd. 1442, Euro-Sib.
2. *Ostrya carpinifolia* Scop., 25, Abd. 1484, Medit.
3. *Corylus maxima* Miller, 35, Abd. 1772, Euro-Sib.

74. SALICACEAE

1. *Salix triandra* L. subsp. *bornmuelleri* L., 35, Abd. 1777, Ir.-Tur.
2. *S. babylonica* L., 35, Abd. 1779.
3. *Populus tremula* L., 25, Abd. 1486.
4. *P. nigra* L. subsp. *nigra*, 22, Abd. 1431.

75. RUBIACEAE

1. *Asperula glomerata* (Bieb.) Griseb. subsp. *glomerata*, 17, Abd. 1326.
2. *A. glomerata* (Bieb.) Griseb. subsp. *condensata* (Ehrend.) Ehrend. var. *condensata*, 19, Abd. 1378.
3. *A. virgata* Hub.-Mor. ex Ehrend & Schnöb.-Ten., 27, Abd. 1502, End., Ir.-Tur. "**R**".
4. *A. pestalozzae* Boiss., 47, Abd. 1955, End., Eux.
5. *A. woronwii* Krecz., 31, Abd. 1641, End., Eux., "**R**".
6. *A. orientalis* Boiss. & Hohen., 9, Abd. 1128, Ir.-Tur.
7. *Galium articulatum* Lam., 35, Abd. 1784, Eux. mt., "**R**".
8. *G. humifusum* Bieb.,34, Abd. 1739.
9. *G. verum* L. subsp. *verum*, 24, Abd. 1460, Euro-Sib.
10. *G. margaceum* Ehrend. & Schönb.-Ten., 18, Abd. 1348.
11. *Cruciata taurica* (Pallas ex Willd.) Ehrend., 3, Abd. 1075, Ir.-Tur.
12. *C. articulata* (L.) Ehrend., 9, Abd. 1141, Ir.-Tur.
13. *Rubia tinctorum* L., 41, Abd. 1888, Ir.-Tur.

MONOCOTYLEDONES

76. LILIACEIAE

1. *Allium stamineum* Boiss., 27, Abd. 1503.
2. *A. kunthianum* Vved., 39, Abd. 1857, Ir.-Tur.

3. *A. flavum* L. subsp. *taucricum* (Besser ex Reichb.) Stearn var. *tauricum*, 24, Abd. 1426B, Medit, "**R**".
4. *A. armenum* Boiss. & Kotschy, 24, Abd. 1462, End., Ir.-Tur., "**R**".
5. *A. atroviolaceum* Boiss., 28, Abd. 1541.
6. *A. scorodoprasum* L. subsp. *rotundum* (L.) Stearn, 20, Abd. 1396.
7. *A. sosnowskyanum* Miscz., 19, Abd. 1380, End., Eux., "**R**".
8. *Scilla siberica* Haw. subsp. *armena* (Grossh.) Mordak, 51, Abd. 1980, Ir.-Tur.
9. *Ornitgogalum oligophyllum* E.D. Clarke, 11, Abd. 1166.
10. *O. sigmoideum* Freyn & Sint., 50, Abd. 1978.
11. *Muscari caucasicum* (Griseb.) Baker, 1, Abd. 1005, Ir.-Tur.
12. *M. tenuiflorum* Tausch, 10, Abd. 1152.
13. *M. armeniacum* Leichtlin ex Baker, 2, Abd. 1042.
14. *M. neglectum* Guss., 49, Abd. 1971.
15. *Bellevalia gracilis* Feinbrun, 1, Abd. 1009, End., Ir.-Tur.
16. *Fritillaria pinardii* Boiss., 49, Abd. 1969, Ir.-Tur.
17. *Tulipa julia* C. Koch, 7, Abd. 1107, Ir.-Tur.
18. *Gagea bulbifera* (Pallas) H Schultes & Schultes fil., 49, Abd. 1970, Euro-Sib.
19. *G. chanae* Grossh., 2, Abd. 1047, Ir.-Tur., "**K**".
20. *G. villosa* (Bieb.) Duby var. *villosa*, 51, Abd. 1981, Medit.
21. *Narthecium balansae* Briq., 20, Abd. 1388, Eux., "**R**".
22. *Colchicum szovitsii* Fisch. & Mey., 48, Abd. 1957, Ir.-Tur.

77. IRIDACEAE

1. *Iris taochia* Woronow ex Grossh., 8, Abd. 1118, End., Ir.-Tur., "**R**".
2. *I. iberica* Hoffm. subsp. *elegantissima* (Sosn.) Takht. & Fedorov, 1, Abd. 1034, Ir.-Tur.
3. *I. caucasica* Hoffm. subsp. *caucasia*, 49, Abd. 1966, Euro-Sib., "**R**".
4. *Crocus biflorus* Miller subsp. *tauri* (Maw.) Matthew, 51, Abd. 1982, Ir.-Tur.
5. *C. vallicola* Herbert, 44, Abd. 1944, Eux.
6. *Gladiolus kotschyanus* Boiss., 31, Abd. 1612, Ir.-Tur.

7. *G. atroviolaceus* Boiss., 1, Abd. 1001, Ir.-Tur.

78. ORCHIDACEAE

1. *Platanthera bifolia* (L.) L. C. M. Richard, 26, Abd. 1496, Euro-Sib.
2. *P. chlorantha* (Custer) Reichb., 12, 1274.
3. *Ophrys oestrifera* Bieb. subsp. *oestrifera*, 34, Abd. 1749.
4. *Orchis tridentata* Scop., 3, Abd. 1067.
5. *Dactylorhiza iberica* (Bieb. ex Willd.) Soo, 33, Abd. 1671.

79. TYPHACEAE

1. *Typha latifolia* L., 40, Abd. 1877.

80. POACEAE

1. *Amblylopyrum muticum* (Boiss.) Eig var. *loliaceum* (Jaub. & Spach) Eig, 21, Abd. 1420.
2. *Aegilops triuncialis* L. subsp. *triuncialis*, 33, Abd. 1704.
3. *Psathyrostachys fragilis* (Boiss.) Nevski, 9, Abd. 1143, 23, Abd. 1449.
4. *Hordeum violaceum* Boiss. & Huet, 31, Abd. 1619.
5. *Bromus squarrosus* L., 33, Abd. 1727.
6. *B. danthoniae* Trin., 33, Abd. 1702.
7. *B. sterilis* L., 18, Abd. 1367.
8. *B.tomentellus* Boiss., 16, Abd. 1257, Ir.-Tur.
9. *B. erectus* Hudson, 33, Abd. 1691.
10. *Avena sterilis* L. subsp. *sterilis*, 37, Abd. 1814.
11. *Helictotrichon argaeum* (Boiss.) Parsa, 16, Abd. 1246.
12. *Trisetum rigidum* (Bieb.) Roemer & Schultes, 30, Abd. 1605, Ir.-Tur.
13. *T. flavescens* (L.) P. Beauv., 33, Abd. 1729, Euro-Sib.
14. *Koeleria eriostachya* Pancic, 16, Abd. 1276.
15. *K. cristata* (L.) Pers., 18, Abd. 1366, 20, Abd. 1384.
16. *Calamagrotis epigejos* (L.) Roth, 33, Abd. 1674, Euro-Sib.
17. *C. arundinacea* (L.) Roth, 39, Abd. 1852, Euro-Sib.
18. *Agrostis stolonifera* L., 39, Abd. 1855.
19. *Phleum pratense* L., 31, Abd. 1621.
20. *P. exaratum* Hachst. ex Griseb, subsp. *exaratum*, 21, Abd. 1408.

21. *Festuca arundinacea* Schreber subsp. *arundinacea*, 33, Abd. 1676.
22. *F. woronowii* Hackel subsp. *caucasica* (St.-Yves) Markgr-Dannenb., 42, Abd. 1927, Ir.-Tur.
23. *F. chalcophaea* V. Krecz. & Bobrov subsp. *chalcophea*, 31, Abd. 1620, Ir.-Tur.
24. *Poa trivialis* L., 16, Abd. 1275.
25. *P. longifolia* Trin., 18, Abd. 1244, Eux.
26. *P. bulbosa* L. var. *vivipara*, 16, Abd. 1238.
27. *Dactylis glomerata* L. subsp. *glomerata*, 31, Abd. 1618, 33, Abd. 1658.
28. *Sesleria phleoides* Steven ex Roemer & Schultes, 16, Abd. 1247.
29. *Glyceria plicata* (Fries) Fries, 34, Abd. 1758.
30. *Stipa hohenackeriana* Trin. & Rupr. var. *hohenackreiana*, 20, Abd. 1382, Ir.-Tur.
31. *Piptatherum coerulescens* (Desf.) P. Beauv., 33, Abd. 1657.
32. *Arundo donax* L., 24, Abd. 1468.
33. *Setaria viridis* (L.) P. Beauv., 35, Abd. 1766.
34. *Pennisetum orientale* L. C. M. Richard. 21, Abd. 1409.
35. *Sorghum halepense* (L.) Pers. var. halepense, 51, Abd. 1983.
36. *Bothriochloa ischaemum* (L.) Keng., 21, Abd. 1421, 35, Abd. 1768.
37. *Zea mays* L., 24, Abd. 1459.

Results and Discussion

At the end of the identification of the collected samples, 303 genera, 651 species, 20 subspecies and 11 varieties, as total 683 taxa have been established. Among the 683 taxa, two of them belong to Pteridophyta division and 681 of them belong to Spermatophyta division. In this division, Gymnospermae and Agiospremae have 5 and 676 taxa respectively. In Angiospermae, Dicotyledones include 517 taxa and Monocotyledones include 59 taxa.

Table 1. Life-forms in Uzundere (Kargapazarı Mountains) and its surroundings.

Life-form	Number of species	Percentage (%)
Hemicryptphyte	362	53.1
Therophyte	117	17.1
Cryphophyte	89	13.1
Phanerophyte	78	11.4
Chamephyte	36	5.3
Total	683	100

Life-forms in the study area are given in Table 1. It appears that hemicryptophytes (%3.1 %) have the largest proportion in the total flora. The proportions of Therophytes, Cryptophytes, Phanerophytes and Chamaephytes are 17.1 %, 13.1 %, 11.4 % and 5.3 % respectively.

Table 2. Comparison of the distribution of the phytogeographical elements and the endemism with the result of the other nearest floristic studies.

RESEARCHES	1	2	3	4	5	6
TOTAL NUMBER OF SPECIES	683	476	1407	592	726	728
EURO-SIBERIAN (%)	17.8	10.95	8.0	12.9	29.6	15.1
IRANO-TURANIAN (%)	25.2	46.11	45.7	20.7	12.6	24.4
MEDITERRANEAN (%)	3.1	2.95	4.4	1.2	1.0	--
UNKNOWN (%)	53.3	39.99	41.9	55.5	56.8	60.2
ENDEMISMS (%)	11.5	13.65	19.9	5.3	2.7	4.4

RESEARCHES:

1. FLORA OF UZUNDERE (KARGAPAZARI MOUNTAINS) AND ITS SURROUNDINGS
2. FLORA OF TORTUM
3. FLORA OF MUNZUR MOUNTAINS (TUNCELİ/ERZİNCAN)
4. FLORA OF ALADAĞ
5. FLORA OF ÇİÇEK MOUNTAIN (ULGAR) AND ITS ENVIRONS
6. FLORA OF AKYAYA-ARPAÇAY (KARS)

Distribution of the phytogeographical elements in Kargapazarı Mountain and the comparison with other nearest studies are given in Table 2. Except the 5th study which is carried out in an area closer to Black Sea Region, the distribution of phytogeographical elements show correlation with all the studies. This is due to existence of the study area in East Anatolia which is under the effect of continental climate.

The rate of endemism in our research area is 11.5 % 43 of 78 endemic species are Irano-Turanian elements, 9 of them are Euxine elements, 1 of them is East-Mediterranean element and the other 25 are endemic to Turkey.

Table 3. Comparison of the largest 10 families with other neraset floristic studies.

RESEARCHES	Uzundere and its surrounding(Erz)	Tortum (Erzurum)	Munzur Dağları (Erzincan)	Aladağ Florası (Kars)	Çiçek Dağı (Posof/Kars)	Akyaka-Arpaçay (Kars)
	1	2	3	4	5	6
TOTAL TAXA	683	476	1407	592	734	728
FAMILY NAME RATIO (%)	Asteraceae 15.2	Asteraceae 15.54	Asteraceae 12.1	Asteraceae 17.0	Asteraceae 15.7	Asteraceae 17.2
" " " "	Lamiaceae 8.05	Fabaceae 9.24	Brassicaceae 9.2	Brassicaceae 8.34	Fabaceae 6.3	Poaceae 8.9
" " " "	Fabaceae 7.9	Lamiaceae 8.32	Fabaceae 8.7	Fabaceae 8.03	Lamiaceae 5.7	Fabaceae 7.4
" " " "	Brassicaceae 7.8	Caryophyllaceae 6.3	Lamiaceae 7.2	Lamiaceae 6.77	Rosaceae 5.3	Caryophyllaceae 7.3
" " " "	Poaceae 5.4	Poaceae 6.3	Caryophyllaceae 5.7	Caryophyllaceae 6.45	Scrophulariaceae 5.1	Lamiaceae 6.2
" " " "	Rosaceae 4.7	Brassicaceae 6.09	Poaceae 5.0	Liliaceae 4.72	Brassicaceae 4.7	Scrophulariaceae 4.9
" " " "	Caryophyllaceae 3.95	Boraginaceae 3.78	Boraginaceae 4.7	Rosaceae 4.56	Caryophyllaceae 4.7	Brassicaceae 4.7
" " " "	Borginaceae 3.66	Apiaceae 3.57	Liliaceae 4.3	Poaceae 4.09	Poaceae 4.5	Rosaceae 3.7
" " " "	Scrophulariace 3.66	Rusaceae 2.94	Apiaceae 4.2	Apiaceae 3.93	Apiaceae 4.2	Boraginaceae 3.7
" " " "	Liliaceae 3.2	Scrophulariaceae 2.52	Scrophulariaceae 4.0	Boraginaceae 3.93	Ranunculaceae 3.0	Liliaceae 3.6

The largest 10 families are listed and compared with other studies in Table 3. As it can also be seen from the table, *Asteraceae* is the largest family. It is also the largest family in Turkey and the members of this have a wide range of ecological toleranca. *Laimaceae* is the second and the *Fabaceae* is the third family. They are also the third and second largest families of Turkey. *Brassicaceae*, which is another larger family of

Turkey, is the fourth one in our study area. *Poaceae* and *Rosaceae* which are the fifth and sixth largest families in the area, show a wide distribution in the tropical region of north hemisphere. *Caryophyllaceae, Boraginaceae, Scrophulariaceae* and *Liliaceae*, which are the seventh, eight, ninenth and tenth families in the area, more or less have the same ranks in other studies.

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THE OBSERVATION OF AQUATIC PARAMETERS OF ÇILDIR LAKE

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Abstract: Samples and measuring were taken from the determined stations on the lake for the determination of the limnological parameters of Çıldır Lake during 1991-93 period. Samples were collected monthly interval in order to obtain water quality and seasonal distribution of the phytoplanktonic and zooplanktonic organisms. Bacillariophyta, Chlorophyta, Cyanophyta, Dinophyta and Euglenophyta were found in the plankton. The most common species were *Cymatopleura* and *Cyclotella* that belongs to Bacillariophyta and Anabaena that belongs to Cyanophyta.

Key Words: Pytoplankton, Zooplankton, Water quality, Fish, Çıldır Lake.

Introduction

Çıldır Lake, is a lava barrier lake studied between volcanic areas Kısırdağı (Mountain of Kısır) and Akbaba Mountain. The lake situated between the Provinces of Ardahan and Kars took place on the 41 degree 00 minute North Latitude and 43 degree 12 minute East Longitude. Its width is 15 km on the North, its length is nearly 18 km, its surface is 124 km square and its maximum depth is 30 m. The stream Yandere coming from the Village of Gölebakan and the streams coming from the Village of Doğruyol, secures water continuously to the lake. Waters of the lake, reachs to the Arpaçay River by the way of Çara stream.

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Segers et al [1], determined 25 species of Rotifers on the research realized on the 20 August 1992. Species determined as extra by this research, are evaluated with the phytoplanktonic organisms.

Materials and Method

Three stations determined on the whole lake area to determine the important limnological parts of the Çıldır Lake (Figure 1). The First Station choosen on the part, where the excess water, outlow the lake, the Second Station, chosen from the part represent the general water quality of the lake, the Third Station, were chosen from the part of the seasonal sources feeding the lake.

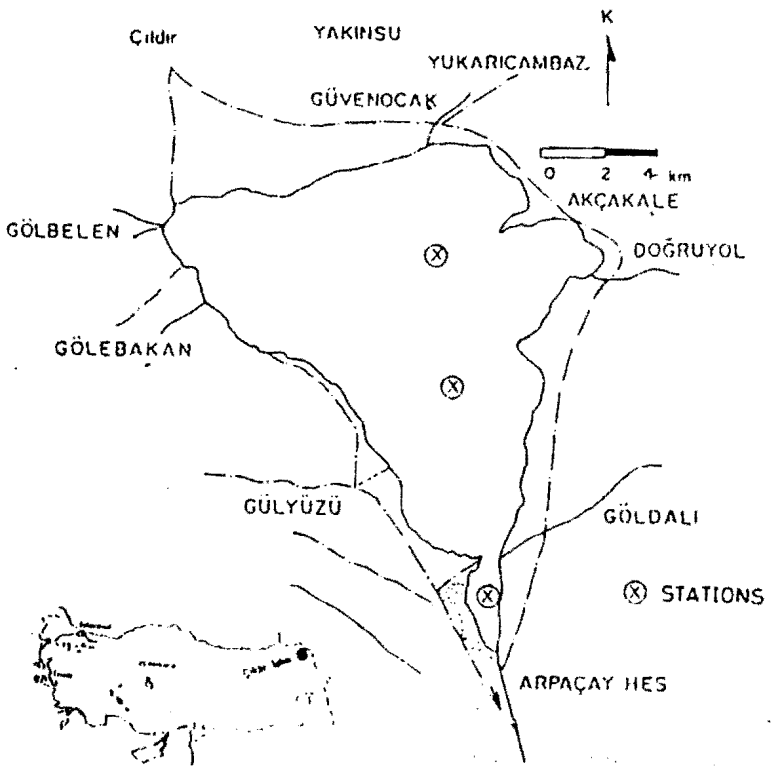

Figure 1. Study area and stations.

Water temperature, electrical conductivity and salinity determined by a YSI S.C.T meter, marked YSI, oxygen measured by a YSI 5515; pH recorded by a Chemitrix 400 pH meter. The water depth and Sechhi depth were taken as cm.

Amounts of NH_3-N, NO_3-N, NO_2-N, O-PO_4, Ca_2, Mg_2, SO_4, Cl and organic matters having direct effects to the tropic level, determined to determine the chemical parts of the water of the lake. The sampling and the determination and analysis operations of the determined parameters, realized by the methods proposed on the research named "Standart Methods for the Examination of Water and Waste water Analysis" [2].

Phytoplankton samples taken by Lamotte Water Sampling Instrument having 1 liter of volume, their counting realized upon Lund [3] and their number found as individual/ml. Furthermore, a sampling realized, using a sampling spoon and their determination realized under the microscope to determine their general abundance. Zooplanktonic organisms collected vertically from the stations determined on the lake, by the plankton spoons having pore opening 55 μ, their counting and identification operations realized [4-6].

Results and Discussion

Upon the results of the examinations and analysis done, Çıldır Lake has an oligothropic character. But, it is possible to find some vegatative life on the costs of the lake. The oxygen concentration is high, pH is neutral and other anions and cations values are considerably low in the lake. So the turbidity and electrical conductivity measured low (Table 1).

Table 1: Physical Paremeters Measured on the Çıldır Lake

		1. STATION (GULYUZU)							2. STATION (ÇANAKSU)							3. STATION (AKÇAKALE)						
		MONTHS																				
	Years	5	6	7	8	9	10	11	5	6	7	8	9	10	11	5	6	7	8	9	10	11
TEMPERATURE (°C, S)	1991	12	11.2	18.8	20	17.3	10.5	27	9	18.4	18.5	23.3	17.7	9.2	3	9	16.1	19.1	21.2	17	11.5	4
	1992	9	13.5	18.2	-	-	-	3.4	6	12	17	-	-	-	4.5	11.5	12	17	-	-	-	4.9
	1993	-	11.4	18.5	18.5	16.5	-	-	-	12.5	19.8	19	18.1	-	-	-	12.5	19.8	18.3	17	-	-
TEMPERATURE (°C, D)	1991	12	11.2	16.8	19.1	-	-	-	9	18.4	18.3	21.2	-	-	-	9	16.1	18.5	20.2	-	-	-
	1992	-	11.3	18	-	-	-	-	-	11	16	-	-	-	-	-	11.5	16	-	-	-	-
	1993	-	13.5	17	18.3	16	-	-	-	11.6	19.3	18.2	16.2	-	-	-	11.6	18	18.2	16.8	-	-
DEPTH (cm.)	1991	110	110	200	200	200	150	150	400	200	200	200	200	200	450	500	200	200	200	200	600	700
	1992	200	300	200	-	-	-	-	400	450	500	-	-	-	-	700	500	600	-	-	-	-
	1993	-	500	700	750	750	-	-	-	500	500	500	500	-	-	-	250	750	750	750	-	-
SECCHI DEPTH (Secchi D., cm.)	1991	60	60	25	30	50	80	80	400	100	55.	70	75	100	95	90	90	70	80	110	70	100
	1992	40	60	70	-	-	-	100	90	70	93	-	-	-	100	115	65	95	-	-	-	100
	1993	-	45	30	80	90	-	-	-	75	30	80	90	-	-	-	80	50	100	90	-	-
DISS. OXYGEN (ppm, S)	1991	9.2	11.5	9.1	7.2	6.2	8.4	10.6	10.4	9.5	9	6	6.8	9.2	10.6	10.2	9.5	10.5	9.5	6.2	8.8	10.5
	1992	10.2	9.2	8.5	-	-	-	12	11	10	8.9	-	-	-	12	9.8	10.6	10.2	-	-	-	12.6
	1993	-	10.3	7.2	7.7	6.9	-	-	-	11	7.1	7.5	6.7	-	-	-	10.7	7.6	7.3	7.4	-	-
DISS. OXYGEN (ppm, D)	1991	8.9	11.5	7.7	6.8	-	-	-	10.4	9.5	9	5.7	-	-	-	9.8	-	9.2	8.9	-	-	-
	1992	-	9.4	8.4	-	-	-	-	-	10.2	8.9	-	-	-	-	-	10.8	9.8	-	-	-	-
	1993	-	10.3	6.7	7.5	6.7	-	-	-		7	6.6	6.9	-	-	-	10	6.7	6.9	7.3	-	-
pH (S)	1991	6.3	8.4	8.8	9	8.2	7.3	7.3	7.6	7.6	8.7	8.8	8	6.6	7.5	7.3	7.4	8.6	9	7.7	7	7.6
	1992	7.35	7.18	7.45	-	-	-	8.4	7.7	7.7	7.9	-	-	-	8.4	7.23	7.72	7.8	-	-	-	8.3
	1993	-	8.07	7.83	8.11	8.07	-	-	-	8.02	7.86	8.2	8.15	-	-	-	7.93	7.8	8.1	8.1	-	-
pH (D)	1991	6.3	8.4	9	8.7	7.9	-	-	7.6	7.6	8.7	8.7	7.9	-	-	7.3	7.4	8.5	8.8	-	-	-
	1992	-	-	7.45	-	-	-	-	-	-	7.9	-	-	-	-	-	-	7.9	-	-	-	-
	1993	-	8.07	7.8	7.24	8.11	-	-	-	8.07	7.63	8.13	8.12	-	-	-	7.9	7.8	8.16	7.96	-	-
E.C. (μmhos/cm.,S.)	1991	240	110	70	60	60	60	-	210	120	80	80	55	40	-	220	120	80	90	60	50	-
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1993	-	155	142	141	122	-	-	-	155	128	125	119	-	-	-	152	132	128	118		-
Depth Condition		Muddy							Silt-Sand							Muddy						

S= SURFACE, D= DEPHT

Water quality parameters (Table 2) are between the values of oligothropic lakes and the environments without contamination [7,8]. All of these parameters result indicate that Çıldır Lake is not contaminated and it is oligothropic level yet.

Phytoplankton and Rotifers species (Table 3) found intensively in the lake given as a list.

It is determined that, phytyolankton samples examined in the lake, are from the groupies of Bacillariophyta, Chlorophyta, Cyanophyta, Dinophyta and Euglenophyta. *Cymatopleura* and *Cyclotella* are the largest groups, between them. Especially, the presence of, *Cymatopleura solea*, *Amphora* and *Pediastrum* saw on the spring months, could be in corelation with the pH of the lake near to the neutral values. Round [9], declared that, these species are abundant in the neutral or slightly alkali waters.

Molesira and *Cyclotella* species from the Bacillariophyta, also are largely saw in the lake. The 37,38% of the phytoplankton intensity of 1940 organisms / individual was *Cyclotella* on the date of September 1993. Upon the evaluation of Hutchinson [10], *Cyclotella* species is the indication of the oligotropic lakes, upon the classification for the phytoplanktonic organisms.

It is seen that, the organism from the Cyanophyta increases on the summer months and represents by the maximum individual number on the August 1993. On this date, it is seen date, blue-green algae consist 95,7% of the total phytoplanktonic organism number. Specially, *Anabaena* reaches to its maximum number of individual. It is possible to relate this

Table 2: Chemical Parameters Measured on Çıldır Lake

		1. STATION (GULYUZU)							2. STATION (ÇANAKSU)							3. STATION (AKÇAKALE)						
		MONTHS																				
	Years	5	6	7	8	9	10	11	5	6	7	8	9	10	11	5	6	7	8	9	10	11
NO2-N (mg/lt)	1991	0.01	0.02	0.001	0.002	0.003	0.003	0.001	0.004	0.003	0.004	0.005	0.004	0.002	0.004	0.003	0.02	0.001	0.004	0.003	0.003	0.004
	1992	0.001	0.003	0.005				0.001	0.002	0.003	0.002				0.002	0.001	0.002	0.001				0.002
	1993				0.47	0.47						0.47	0.47						0.47	0.47		
NO3-N (mg/lt)	1991	0	0.4	0.8	1.7	0.1	0.8	1.5	0	0	0.8	2.1	0	0	2.1	0	0	1.1	1.1	0	0.8	0.4
	1992																					
	1993				0.02							0.02							0.02			
O-PO4-P (mg/lt)	1991		0.034					0.082	0.052	0.027	0.08				0.068	0.09	0.09		0.087			0.11
	1992																					
	1993		0.007	0.006	0.006					0.007	0.006	0.006					0.007	0.006	0.006			
Ca+2 (mg/lt)	1991	48.1	12.3	11.02	18.04	16	16.03	14	30.04	22.04	8.02	20.04	18	15.03	11	24.05	20.04	14.03	12.03	16	12.02	9
	1992	7		5				5.4	4		36				22	8		18				26
	1993		4.01	18.04	18.03	14.03				4.01	18.04	18.03	14.03				4.01	18.04	18.03	14.03		
Mg+2 (mg/lt)	1991	18.24	7.3	8.51	8.51	4	9.7	6	11.79	6.08	12.77	10.35	11.5	7.9	7	7.3	12.16	9.73	7.9	20	9.73	6
	1992			2.3				12.2	6		7.3				19.4	7		17				12.2
	1993		12.16	3.65	3.6	17.02				12.16	3.65	3.6	17.02				12.16	3.65	3.6	17.02		
SO-4 (mg/lt)	1991			20.5	19.5	5.5	7	2	4	8	23	25	8	7.5	8	20	90	40	32	8	8.5	7
	1992	3	1	0				14	7	0	8.8				5.8	6	2.8	9				8
	1993		10.14	6	7.6	8.87				10.14	6	7.6	8.87				10.14	6	7.6	8.87		
BOI 5 (mg/lt)	1993		30	88	32	28				30	88	32	28				30	88	32	28		
Depht Condition		Muddy							Silt-Sand							Muddy						

P.S.: Results belongs to surface

Table 3. Phytoplanktonic organisms in the Çıldır Lake and their abundance

DIVISIO	Genus	Abundance
BACILLAROPHYTA	*Amphora*	XX
	Anomoneis	
	Caloneis	
	Campylodiscus	
	Caretoneis	
	Cocconeis	*
	Coscinodiscus	
	Cyclotella	XX
	Cymatopleura	XXX
	Cymbella	XX
	Diatoma	X
	Didymosphenia	
	Diploneis	X
	Epithemia	X
	Fragilaria	X
	Gomphonema	X
	Gyrosigma	XX
	Hantzschia	X
	Mastogloia	
	Melosira	XX
	Meridion	
	Navicula	XX
	Neidium	
	Nitzschia	X
	Pinnularia	X
	Rhoicosphenia	
	Rhoipalodia	X
	Stauroneis	
	Stephanodiscus	XX
	Surirella	XX
	Synedra	X
CHLOROPHYTA	*Cosmarium*	
	Chroococcus	
	Closterium	
	Oocystis	
	Pediastrum	XX
	Scenedesmus	
	Staurastrum	X
CYANOPHYTA	*Anabaena*	XX
	Microcystis	
	Oscillatoria	X
	Spirulina	X
DINOPHYTA	*Ceratium*	XXX
EUGLENOPHYTA	*Euglena*	X
	Phacus	
	Trachelomonas	X

There is no asterix on the very rare species
x rare species
xx frequent species
xxx common species

aspect to the increase of the water temperature and the feeding matters. Euglenophyta groups found largely in the waters reach by the organic matters [11]. In the Çıldır Lake, not so rich by organic matter, the species from these groups are seen scarcely.

When the evaluation realized for the zooplankton, the Cladocera and Copepoda fauna of Çıldır Lake are convenient for a oligotrophic lake describe definition. *Daphina galeate*, *Biapertura affinis*, from Cladocera, *Acanthodaptomus denticornis* and *Cyclops asbyssorum* from Copepoda [12], *Kellicottia longispina*, *Synchaetapectinata*, *Polyartradolichoptera* and *Brachionusangularis* from Rotifera are seen intensively among zooplanktonic organisms. *Kellicottia longispina* used as indicator of oligotrophic lakes, is dominant species. In this research, *Synchaeta pectinata*, *Kellicottia longispina*, *Notholca acuminata*, *Brachionus calyciflorus*, *Ascomorpha saltans* found largely, additionally to the species determined by Segers et al [1].

On the examinations dated September 1993, 20025 individual / m^3 found in the first station, 918 and 2806 individual found respectively in the second and third stations.

On the works aiming the examination and the determination of the zooplankton samples taken from the Çıldır Lake during the research period, it is seen that the members of the Copepoda are mostly dominant [12]. And it is determined that the species of Rotifers are increasing in the spring and fall months in correlation of increase of phytoplanktonic organisms.

The Rotifers species determined in the Çıldır Lake is given below.

Brachionus angularis GOSSE, 1851

Brachionus calyciflorus PALLAS, 1766

Keratella quadrata (O.F.M, 1786)

Keratella tropica (APSTEIN, 1907)

Keratella cochlearis (GOSSE, 1851)

Notholca acuminata (EHRB., 1832)

Kellicottia longisipina (KELLICOTT, 1879)

Euchlanis dilatata EHRB., 11832

Lecane luna (O.F.M, 1776)

Lecane lunaris (EHRB., 1832)

Lecane closterocerca (SCHMARDA, 1859)

Synchaeta pectinata EHR., 1832

Polyarthra dolichoptera IDELSON, 1925

Ascomorpha sp. PERTY, 1850

Trichocerca weberi JENNINGS, 1903

Trichocerca tenuior (GOSSE, 1886)

Asplancha sp. GOSSE, 1850

Filinia longiseta (EHRB., 1834)

The classification realized upon Koste [6].

It can be considered that Çıldır Lake was rich in terms fish fauna [13,14]. The plankton flora and fauna and the fish fauna determined by the water quality medium, can be considered as a sample of oligotrophicmedium.

Table 4: The Fish Species of Çıldır Lake and Surroundings

FAMILY	SPECIES	TURKISH NAME
Salmonidae	*Salmo trutta*	Alabalık
Cyprinidae	*Acanthalburnus microlepis**	Dumışka
	*Alburnoides bipunctatus fasciatus**	Tahta balığı
	Alburnus filippii	İnci balığı
	*Aspius aspius taeniatus**	Şafak balığı=Akbalık
	*Barbus capito capito**	Bıyıklı balık
	*Barbus mursa**	Murza balığı
	*Barbus plebejus lacerta**	Murza balığı=Bıyıklı balık
	*Capoeta capoeta capoeta**	Karabalık=Sirazbalığı
	*Chondrostoma cyri**	Karaburun
	*Cyprinus carpio**	Sazan balığı
	Gobio persa	Kababurun
	*Leuciscus cephalus**	Gümüşlü balık=Tatlısu kefali
	Leucalburnus satunini	
Cobitidae	*Cobitis aurata**	Taş yiyen balığı
	Orthrias angorae	Çöpçü balığı
	Orthrias panthera	Çöpçü balığı
	Gobius cephalarges constructor	Küçük kaya balığı

* Species are often seen in the lake

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POSTNATAL GROWTH OF MUSCLES PECTORALIS MAJOR FIBRES OF *GUINEA PIG*

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Abstract: In order to investigate changes in diameters of muscle fibres in relation to age, pectoral muscles of 20 day, four-month and eight-month old *Guinea pigs* were removed and were stained with Haematoxylen-eosin. The diameters of muscle fibres showed a large increase from the 20 day to four-month *Guinea pigs* but showed a decline in eight-month old individuals. Increases and decreases in the diameter of fibres became insignificant for small-scale fibres and inconsistent for medium or big-diameter fibres. Thus, the small-diameter fibres would be able to sustain oxidative capacities whereas medium and big-diameter fibres would show advanced plasticity depending on muscle functions.

Key Words: *Guinea pig*, Skeletal muscle, Fibre diameter, Aging, Pectoral muscles.

Introduction

As a result of noticable plasticities of skeletal muscle fibres [1], there was loss of muscle mass depending on denervation and reinnervation with advancing age [2-5] and reduction of performance dealing with the motor

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tasks [6]. In all mammals, including humans, it was seen that there was an increase in fibre diameters as a result of hypertrophy [7] or a reduction in diameter [8-10] due to muscle fibre atrophy [11] and increased variation [12,13] in the percentage and the dimensions of muscle fibres with age [14]. Although hindlimb muscles used in the movement have been examined well, there are few studies about the forearm muscles [7,8,14]. This study investigated the pectoral muscles in *Guinea pigs* supporting forearm instrumental for feeding and movements in order to elucidate changes in fibre diameter with age.

Materials and Method

Pectoral muscle starts from clavicula-sternum to the upper end point of humerus [15-18], and causes the front limb to make flexion movement [16] and adduction [15].

Pectoral muscles of nine *Guinea pigs*, of 20 day, four-month and eight-month old were removed under a dissection microscope and the first five sections were retained from the pectoral muscles from each group. The latter 20 sections were omitted and then five sections were retained again. This process was repeated until the parts of muscle finished. One of each five sections was selected randomly for Haematoxylen-eosin staining [19]. Preparates were examined under a light microscope and the diameters of 20 fibres selected randomly were measured using ocular-micrometer [20]. Mean fibre diameter, standard deviation and standard error were calculated and means in fiber diameters between the age groups were separated using 'Student's t-test.'

Results and Discussion

Pectoral muscle diameters of twenty fibres of *Guinea pigs* of 20 day, four and eight-month old were measured after staining with Haematoxylen-eosin. Mean diameters, standard deviation and standard errors are shown in Table 1.

Table 1. Means, standard deviation (STDEV) and standard error (SEMEAN) of the fibres with small-diameter (C_1, C_2, C_3), at medium-diameter (C_4, C_5, C_6) and big-diameter (C_7, C_8, C_9) in pectoral muscles of 20 day, four and eight-month old *Guinea pigs*.

	MEAN	STDEV	SEMEAN
C_1	15.675	2.595	0.580
C_2	16.170	2.812	0.629
C_3	16.500	2.394	0.535
C_4	19.305	2.459	0.550
C_5	32.670	2.650	1.040
C_6	23.100	3.386	0.757
C_7	22.770	2.601	0.582
C_8	37.290	4.800	1.070
C_9	26.235	4.212	0.942

'Student's t-test' among the muscle fibres of pectoral muscles of *Guinea pigs* and 'P' values are given in Table 2.

Table 2. 'Student's t-test' and 'P' values among muscle fibres of three groups. C_{21}; (C_1- C_2), C_{22}; (C_1 - C_3), C_{23}; (C_2 - C_3), C_{24}; (C_4 - C_5), C_{25}; (C_4 - C_6), C_{26}; (C_5 - C_6), C_{27}; (C_7 - C_8), C_{28}; (C_7 - C_9), C_{29}; (C_8 - C_9).

	MEAN	STDEV	SEMEAN	t	P VALUE
C_{21}	0.495	4.045	0.905	0.55	0.59
C_{22}	0.825	4.398	0.983	0.84	0.41
C_{23}	0.330	3.693	0.826	0.40	0.69
C_{24}	13.365	5.297	1.184	11.28	0.0000
C_{25}	3.795	4.045	0.905	4.20	0.0005
C_{26}	9.570	4.895	1.094	8.74	0.0000
C_{27}	14.520	5.706	1.276	11.38	0.0000
C_{28}	3.465	4.602	1.029	3.37	0.0032
C_{29}	11.055	6.359	1.422	7.77	0.0000

Except for fibres of small-diameters (C1, C2; Means of the fibres with small-diameter in pectoral muscles of 20 day and four-month old *Guinea pigs*, respectively) muscles fibre diameters (C4, C5; Means of the fibres with medium-diameter and C7, C8; Means of fibres with big-diameter in pectoral muscles of 20 day and four-month old *Guinea pigs*, respectively) in *Guinea pigs* from twenty day to four-month old considerably increased (Table 1). Our data show that fiber diameters may increase depending on the increasing function of pectoral muscle for adaptation to the enlarged transversal section area. Similar findings were also observed by others [21,22]. Although the diameter changes in fibres with small diameter were not significant (C21; 'P' value between C1 and C2) in

our studies (Table 2), Dall Pai V et al (1982) recorded diameter changes in both fibres with small and medium-diameter and reported that these fibres completed their diameter changes before fibres with big-diameter did. Medium (C24; 'P' value between C4 and C5) and big-diameter fibres (C27; 'P' value between C7 and C8) showed large scale in our findings.

When pectoral muscle fibers of *Guinea pigs* of four to eight-month were compared, a decrease in diameter was relatively low among fibres with small-diameter (C23; 'P' value between C2 and C3) but that decreases in diameter among medium (C26; 'P' value between C5 and C6) and big-diameter fibres (C29; 'P' value between C8 and C9) were inconsistent. Thus, the small-diameter fibres would be able to sustain oxidative capacities whereas medium and big-diameter fibres would be able to show advencedly depending on muscle functions. So our findings were in parallel with the findings some of researchers [8-10]. However, an another study reported that there was an increase in fibre diameters with age [20]. When the pectoral muscles fibers of *Guinea pigs* from 20 days to eight-month old (C22; 'P' value C1 and C3), (C25; 'P' value between C4 and C6), (C28; 'P' value between C7 and C9) were compared findings were similar to Hooper's results (1981). It is probable that this was caused by comparing two extreme values. In this case, as Poggi et al., (1987) recorded, whether a decrease in fibre diameters occurred as a result of atrophy is a matter of speculation.

In conclusion, there was a variation in the diameters of skeleton muscle fibres whose plasticty was high. Similar results were obtained by various researches [1,14]. According to our results, the loss of mass [2-5] depending on decrease of denervation and reinnervation could occur as

result of decreasing diameter. As Schaumburg et al., (1983) recorded, there was also a loss of performance in motor functions depending on the loss of muscle mass.

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BIOCTIVE CHEMICALS FROM CELL SUSPENSION CULTURES OF *HYPERICUM CAPITATUM* VAR. *CAPITATUM*

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Abstract: Cell suspension cultures of *Hypericum capitatum* var. *capitatum* were established. Bioassay-guided fractionation of the extract prepared from the cell material yielded three compounds and two of them were active against three bacteria and a yeast. No activity was observed against herpes simplex viruses, but a fraction was found to be slightly active against HIV-I. The UV, IR and MASS spectra of isolated compounds suggest that compounds **II** and **III** are xanthones with 258 and 288 molecular weights respectively, but little can be deduced for compound **I**.

Key Words: Bioassay, Cell suspension cultures, *Hypericum capitatum* var. *capitatum*, Antimicrobial activity, Xanthone.

Introduction

The genus *Hypericum* (Guttiferae) comprises more than 400 species [1]. Some of these species are well known folk medicines used in several countries, where they are employed in various curative treatments [2-7].

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Antiretroviral and antiviral activities of the aromatic polycyclic diones, e.g. hypericin and pseudohypericin, which are prominent constituents of the genus *Hypericum*, have been reported before [9-10]. As minor plant phenolics, xanthones are also important constituents of *Hypericum* species and they are generally found in just two families of higher plants- the Guttiferae and Gentianaceae [11-12]. There are relatively few publications on the cell culture of *Hypericum* species to be found in the literature [13-16], but no information is given about bioactive chemicals produced by the cell cultures of these species.

This paper reports on the establishment of cell suspension cultures of *H. capitatum* var. *capitatum*, an endemic species in the Turkish flora [17]. Also, isolation and structural elucidation of the bioactive compounds from the cell cultures of *Hypericum* species are first described in this paper.

Biossay-guided fractionation was carried out using flash chromatography which was monitored by thin layer chromatography (TLC) and antimicrobial activity tests were assessed against five bacteria, a yeast, herpes simplex virus type I and II (HSV-I and HSV-II) and human immunodeficiency virus (HIV-I) strain MN.

Materials and Methods

Collection of plant material. H. capitatum var. *capitatum* was collected from the south of Malatya province and identified by Bayram Yıldız, Department of Biology, Balıkesir University, Balıkesir-TURKIYE.

Culture conditions. Hypocotyl sections of the seeds of *H. capitatum* var. *capitatum* were induced to form callus on solid Gamborg B5 [18], supplemented with 2.5 % sucrose(w/v), kinetin (0.1 ppm) and 2,4-

dichlorophenoxyacetic acid (2,4-D) (1.0 ppm). The pH was adjusted to 5.8 before adding 0.9 % agar (w/v). The newly initiated calli were then transferred to fresh media containing the same medium components and subcultured at 21 days intervals.

Cell suspension cultures of *Hypericum capitatum* var. *capitatum* were established from callus cultures by transferring friable callus material (4.0-5.0 g) to liquid medium (15 ml) in 100-ml Erlenmeyer flasks containing the same media components as used for callus cultures, but without agar. The callus pieces were agitated in liquid medium by shaking them at 140 rpm in the dark at 24 ±2 ^{0}C for 21 days. For subculture, 20 ml of seed cultures were inoculated to fresh liquid medium (80 ml) contained in the 250-ml Erlenmeyer flasks at three week intervals.

Harvesting of cultured cells. Twenty-one-day-old batch cultures were harvested at 21-day intervals. The harvested cell suspension cultures were aseptically filtered on a tape miracloth. The resulting cell mass was then lyophilized.

Extraction and chromatography. The powdered material (458 g) from cell suspension cultures was first extracted with dichloromethane (CH_2Cl_2) for 3 hours at room temperature. The CH_2Cl_2 was then filtered and evaporated. The remaining residue was extracted with methanol (MeOH) (96 %, 1 L) in a Soxhlet apparatus at ≤ 60 °C for 6 h. The MeOH was evaporated *in vacuo* to give a crude extract (56.8 g), which was suspended in a minimum volume of water. The suspension was then partitioned with diethyl ether (Et_2O) and ethyl acetate (EtOAc). The diethyl ether and ethyl acetate fractions showed similar bioactivity against

test microorganisms. These fractions were therefore combined (11.25 g) and subjected to flash chromatography.

A portion of the combined fractions (5 g)was dissolved in CH_2Cl_2 (40 ml) and fractionated by flash chromatography on silica gel (40-63 μm, 5x25 cm i.d.) with CH_2Cl_2 and then a gradient of CH_2Cl_2/MeOH (flow rate 50 ml/min) to produce six fractions. Each fraction was monitored by TLC (0.2 mm thick Silica Gel $G60F_{254}$ A1 sheets; Merck) with CH_2Cl_2/MeOH (19:1) solvent system (system I). TLC spots were detected under short-wave UV light. Since the *in vitro* antibacterial activity was mainly found in Fraction II, this fraction was subjected to second flash chromatography using the same silica gel (flow rate 40 ml/min) with C_6H_6/EtOAc gradients, monitored by TLC with C_6H_6/EtOAc (4:1) solvent system (system II). Repetitive flash chromatography of this antibacterial fraction gave eight fractions (II-A to II-H). Fraction II-C and, in particular II-D were found to have antibacterial activity. A third flash chromatography was carried out with the combination of these fractions using a gradient of petroleum ether/EtOAc, monitored by TLC using petroleum ether/EtOAc (6:4) as solvent system (system III). Repeated flash chromatography with this solvent system gave 6 fractions including Compound **I** (19 mg) and **II** (9 mg) and **III** (11 mg) respectively.

HPLC of isolated compounds was individually performed using a JASCO model PU 980 HPLC apparatus as follows: injection volume: 50 μL; column type: Shandon Hypersil Elite C-18; column i.d.: 25 cm x 3.9 mm; equipped precolumn: 4 μm, detector: Philips Pye Unicam LC-UV detector; flow rate: 1.2 ml min^{-1} at 40 °C; wavelength: 254 nm; mobil

phase: gradient A (acetonitrile-water, 5:95), gradient B (acetonitrile-water, 70:30).

HPLC analysis was started with 100 % of Gradient A or Pump-A, acetonitrile-water (5:95) (0 min.). Gradient A was reduced while Gradient B or Pump B, acetonitrile-water (70:30) was gradually increased. Elution was finished with of % B (50 min.). HPLC traces of fraction II showed the existence of three main peaks. To avoid the peak tailing of phenolic compounds, 0.05 % of trifluoroacetic acid was added to the solvents, leading to a pH of 3.0. Compounds were prepared by dissolving in acetonitrile to make a final concentration.

UV spectra of each compound were recorded on an ATI-UNICAM UV/VIS Spectrometer using MeOH as solvent. For IR spectroscopy, Spectra-Tech IR-Plan Advanced Analytical Microscope which was coupled to a Mattson 4020 Galaxy Seies FT-IR instrument was used.

VG TRIO-1 mass spectrometer was employed for EI-MS while VG ProSpec mass spectrometer (NOBA as reference solvent) was for FAB-MS (for Compound 1).

In vitro biological activity tests

1. *Antibacterial activity* tests. The microorganisms tested against were representatives of Gram-positive cocci and bacilli, Gram-negative cocci and bacilli, anaerobic bacilli and a yeast; they comprised *Staphylococcus aureus*, *Bacillus cereus*, *Branhamella catarrhalis*, *Escherichia coli*, *Clostridium perfringens* and *Candida albicans*; all had been obtained and identified from clinical specimens and were

subsequently maintained as stock strains by storage in liquid nitrogen, vapour phase at -135 °C.

Simple susceptibility screening test using agar-well diffusion method. The extracts or fractions were weighed and dissolved in phosphate buffer saline (PBS) (pH=7.0-7.2) and dimethylsulphoxide (DMSO) at a 1:1 ratio to prepare extract solution of 5000 µg/ml. Each microorganism was suspended in sterile saline and diluted at ca. 10^6 colony forming unit (cfu) per ml. They were "flood-inoculated" onto the surface of Columbia blood agar plates (Unipath Ltd., UK) which were then dried. Eight mm diameter wells were cut from the agar using a sterile cork-borer, and 0.1 ml of the plant extract solutions were delivered into the wells. After incubation at 37°C overnight, plates were examined for any zones of growth inhibition.

For comparison, none of the microorganisms showed resistance to antibiotics.

Minimal Inhibitory Concentration (MIC) Test. Dilutions of compounds to be tested were prepared in 1.0 ml volumes of sterile nutrient broth to give a range of concentrations from 5 mg/ml to 1.0 µg/ml. Suspensions of test microorganisms were prepared (ca. 10^6 organisms per ml) and one drop of these (0.02 ml) was added to the extract/broth dilutions. After 18 hours incubation at 37°C, the tubes were then examined for growth. The MIC of compounds was taken as the lowest concentration that showed no growth.

2. *Antiviral activity tests against herpes simplex viruses (type I and II).* Vero cells were obtained from Gibco Biocult Ltd., Paisley, Scotland. at

passage level 145; the cells were used for the preparation of stock virus and for antiviral activity tests and stock suspensions of herpes simplex viruses (HSV-I and II) were prepared and titrated as previously reported [19,20]. The procedure used was based on the plaque formation method described before [19,21].

3. *Antiretroviral activity tests against HIV-I (strain MN).* Anti-HIV activity was determined by the method of inhibition syncytia formation [19,22].

Results and Discussion

Bioasssay-guided fractionation of the methanol extracts of *H. capitatum* var. *capitatum* cell suspension cultures showed that fraction II was active against three bacteria and a yeast. Fraction VI showed a slight activity against HIV-I with an IC_{50} dose at 500 μg/ml. None of the fractions showed activity against herpes viruses, but fraction I was found to be toxic to host cells (both vero and MT-2 cells) at ca. 400 μg/ml.

Subsequent bioassay-guided fractionation yielded in turn three compounds. Each compound was tested against 5 bacteria and a yeast and the antibacterial activity was found to be mostly associated with compound I. The second compound isolated (compound II) was also found to possess some activity, but not as strong as compound I. Compound III was not found to be active against test microorganisms. The MIC test results of isolated compounds are given in Table 1. Antimicrobial activity of the extracts from *Hypericum* species has been reported earlier [23,24], but not from their cell cultures.

Table 1. The *in vitro* MIC test results of compounds isolated from cell suspension cultures of *H. capitatum* var. *capitatum**

Compounds	Test Microorganisms					
	B. cereus	*E. coli*	*S. aureus*	*B. catarrhalis*	*C. perfringens*	*C. albicans*
I	125 [1]	xxx	xxx	500	1000	500
II	500	xxx	xxx	2000	2000	2000
III	xxx	xxx	xxx	xxx	xxx	xxx

[1] values are given as μg/ml
xxx no activity

HPLC analyses of both the active fraction and, subsequently, isolated compounds were performed. The HPLC peaks of active fraction indicated the traces of active principles. The retention times of Compund **I**, **II** and **III** were 43.58, 40.49 and 36.39 min. respectively.

UV, IR and MASS spectra of each compound are presented in Table 2. The UV spectra of compound **II** and **III** gave four main peaks that are typical of xanthones whereas compound **I** is totally different. Therefore, compound **II** and **III** are possibly xanthones with *m/z* 258 and *m/z* 288 molecular weight respectively. The in vitro antimicrobial activity of xanthones has also been reported before [25]. Only molecular weight can be deduced for compound **I** with *m/z* 414, but nothing can be proposed about its chemical nature. Consequently, further chemical analyses (NMR, X-ray etc.) are required for the structural elucidation of isolated compounds.

The results of present study provide further evidence of the importance of plant cell cultures as an alternative system for the production of bioactive chemicals [126,27]. Apart from being potential tools for the production of commercially important chemicals, plant cell cultures may also produce novel ones [27]. These chemicals may be used in various treatments, such as antimicrobial agents or the leads of synthetic antibiotics for the treatment of several diseases.

Table 2. MASS, UV and IR spectral data of the isolated compounds.

Compounds	I	II	III
EI-MS (*m/z*)	414, 396, 329, 303, 273, 255, 228, 213	258, 243, 228, 213, 185, 149	288, 273, 256, 243, 227
FAB-MS (*m/z*)	414, 397, 329, 307, 289, 273, 255	Not available	Not available
UV (λ_{max}) (MeOH)	236, 264	238, 270, 330, 400	210, 260sh, 334, 403
IR (ν_{max} cm^{-1})	3300, 2962, 2931, 2850, 1731, 1639	3369, 3061, 3006, 2952, 2937, 2850, 1643, 1606	3229, 3108, 3078, 3009, 2973, 2954, 2931, 2852, 1650

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FENTON AND RELATED OXIDATION REACTIONS OF METHYLTHIOPHENES

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Abstract: The oxidation of 2- and 3- methylhiophene under aqueous conditions in the presence of Fenton and related reagents is reported. The principal products from 2-methlyhiophene are the 3H- and 5H-thiophen-2-one tautomers of 2-hydroxy-5-methylhiophene, isolated in 10% yields, together with dihydroxylated products, and 2-methyl-5-(2-thienylmethyl)thiophene. These products were not formed when the reactions were conducted in the presence of the radical trap TEMPO. A similar range of products was isolated from the related oxidation reactions of 3-methylhiophene.

Key Words: Methylhiophenes, Fenton's reagent, Oxidation, Radicals.

Introduction

In recent papers we have described an investigation of the products of oxidation of methylpyridines [1] and thiophene [2] under aqueous conditions in the presence of Fenton's reagent (Fe^{2+}-H_2O_2) or a series of related reagents which involve a transition metal ion other than iron (II), e.g. iron (III), copper (II), vanadium (IV), which are assumed to behave

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like Fenton's reagent in providing a source of the hydroxyl radical [3], although this has been the focus of considerable recent debate [4,5]. The significant finding in our earlier studies was that compounds apparently derived from free radical intermediates predominated among the products. Thus, from the methylpyridines, a range of dipyridylmethanes, and bipyridyls was formed [1]. Such products derived from the appropriate pyridylmethyl radical were not found when the reactions were carried out in the presence of the radical trap TEMPO [6]. We have also found that oxidation of thiophene in the presence of a copper (II)-hydrogen peroxide reagent gave 2-hydroxythiophene (and its thiolactone tautomers), isolated in 60% yield in a single step reaction, providing a clean route to this system [2]. We now report a related study of the oxidation of 2-and 3-methylthiophenes under aqueous conditions in the presence of Fenton and related reagents.

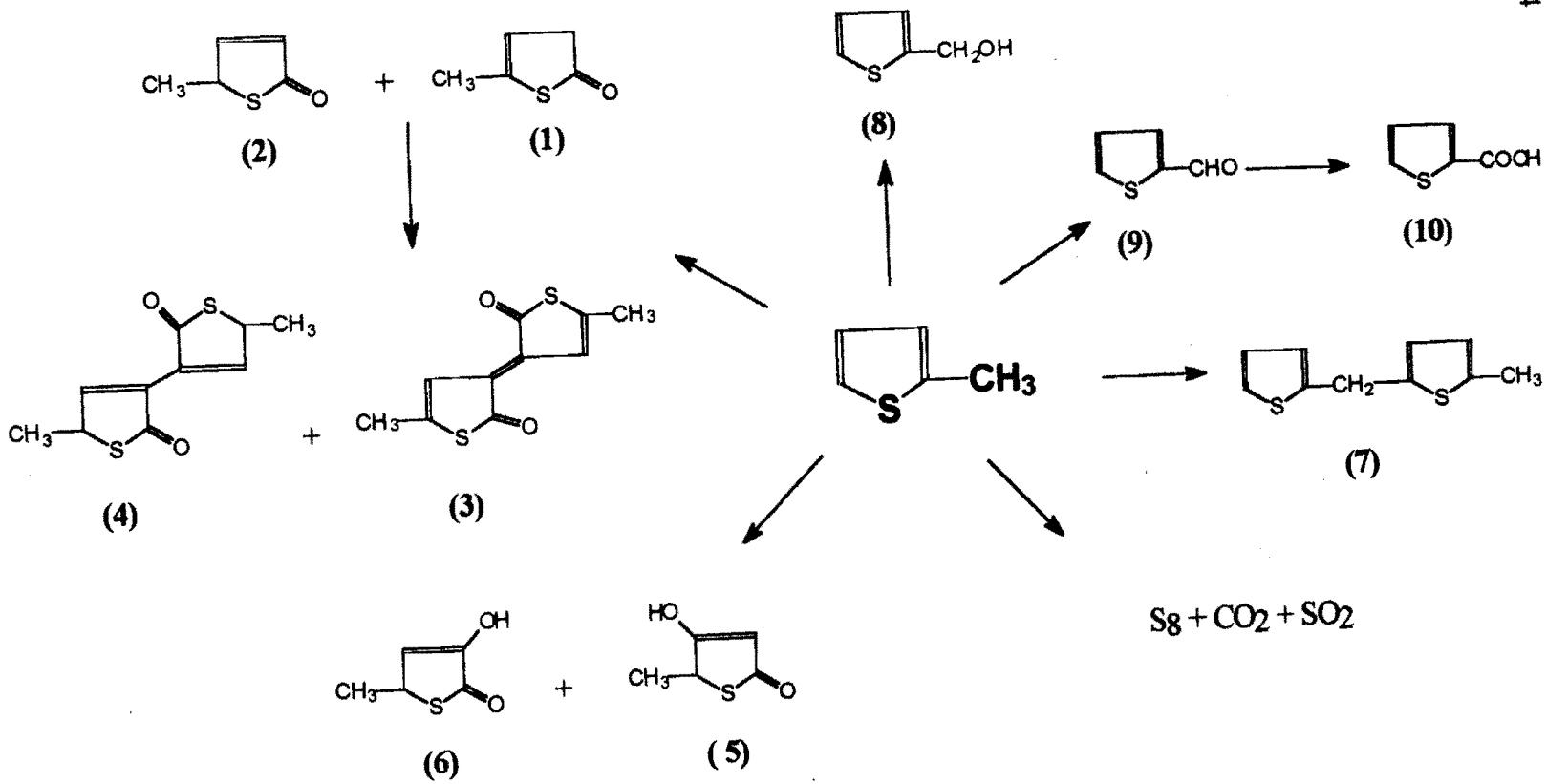
Results and Discussion

The methylhiophenes was treated as a suspension under acidified aqueous conditions with hydrogen peroxide in the presence of the appropriate transition metal salts, and the resulting two phase system stirred for periods of up to twenty four hours. The products were than isolated by solvent extraction into dichloramethane, and the extract analysed by GCMS and LCMS techniques. In each case, a complex mixture of products was formed. Components of the mixture were identified by comparison with commercially available standarts or with synthetic standards. Some of the products were subsequently isolated by chromatography and fully characterised. In general, variation in the nature of the metal ion had very little effect on the range of substances formed,

although there were differences in the relative amounts of individual substances, and in the overall extent of oxidation of the methylthiophene as judged by GC analysis. Oxidation of 2-methylthiophene under the above conditions gave the range of products displayed in Scheme 1. The principal products were the respective 3H- and 5H-thiophene-2-one tautomers (1) and (2), of 2-hydroxy-5-methylthiophene isolated in *ca* 10% yield. This reaction therefore parallels the related oxidation of the parent thiophene system, from which 2-hydroxythiophene is a principal product [2]. The above thiophene-2-one tautomers are known [7,8] to undergo oxidative conversion to the dimeric systems (3) and (4), (*m/z*, 224 and 226, respectively M^+) also detect in the Fenton and related oxidations. As shown before, alkyl thiolactones undergo oxidative dimerization in the presence of iron (III) to form such indigoidal structures [7].

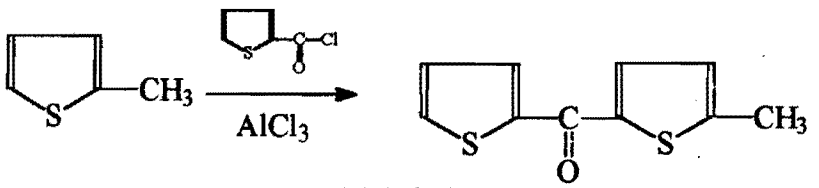
Also characterised were the isomeric hydroxythiophene-ones, (5) and (6), which presumably arise by attack of a second hydroxyl radical at the ring system of (1) and (2). Multiple hydroxylation is common in Fenton-type oxidations of aromatic systems and dihydroxylated products have been identified in several cases [9-13]. Compounds (5) and (6) are known in the literature [14].

Another significant product was the dithienylmethane (7), the origin of which is presumably attack of the initially formed 2-thienylmethyl radical at the 5-position of another 2-methylthiophene unit. It is well known that thiophenes readily undergo substitution at a free *alpha*-position of the ring under free radical conditions [15]. The formation of 2- and 3-thienylmethyl radicals by hydrogen abstraction from the related methylthiophenes by the *t*-butoxyl radical has been documented [16]. The

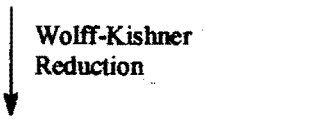


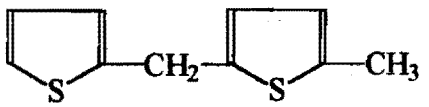
Scheme 1

dithienylmethane (7) was not formed when the oxidation reactions were carried out in the presence of the free radical trop TEMPO. As (7) does not appear to have been characterised previously, it was synthhesised by the route shown in Scheme 2. Friedel-Crafts aroylation of 2-methythiophene with 2-thienylcarbonyl chloride proceeded smoothly to give the expected ketone. Attempted Clemmenson reduction (Zn-Hg, Hcl) of this gave the desired dithienylmethane (7), but only as a minor component in a disappointingly complex mixture of products. However, Wolff-Kishner reduction (hydrazine hydrate, NaOH, diethylene glycol) gave the desired compound in good yield. This product was identical to that isolated from the Fenton and related oxidations.



5-Methyl-2-(2-thienoyl)thiophene (**23**)





(7)

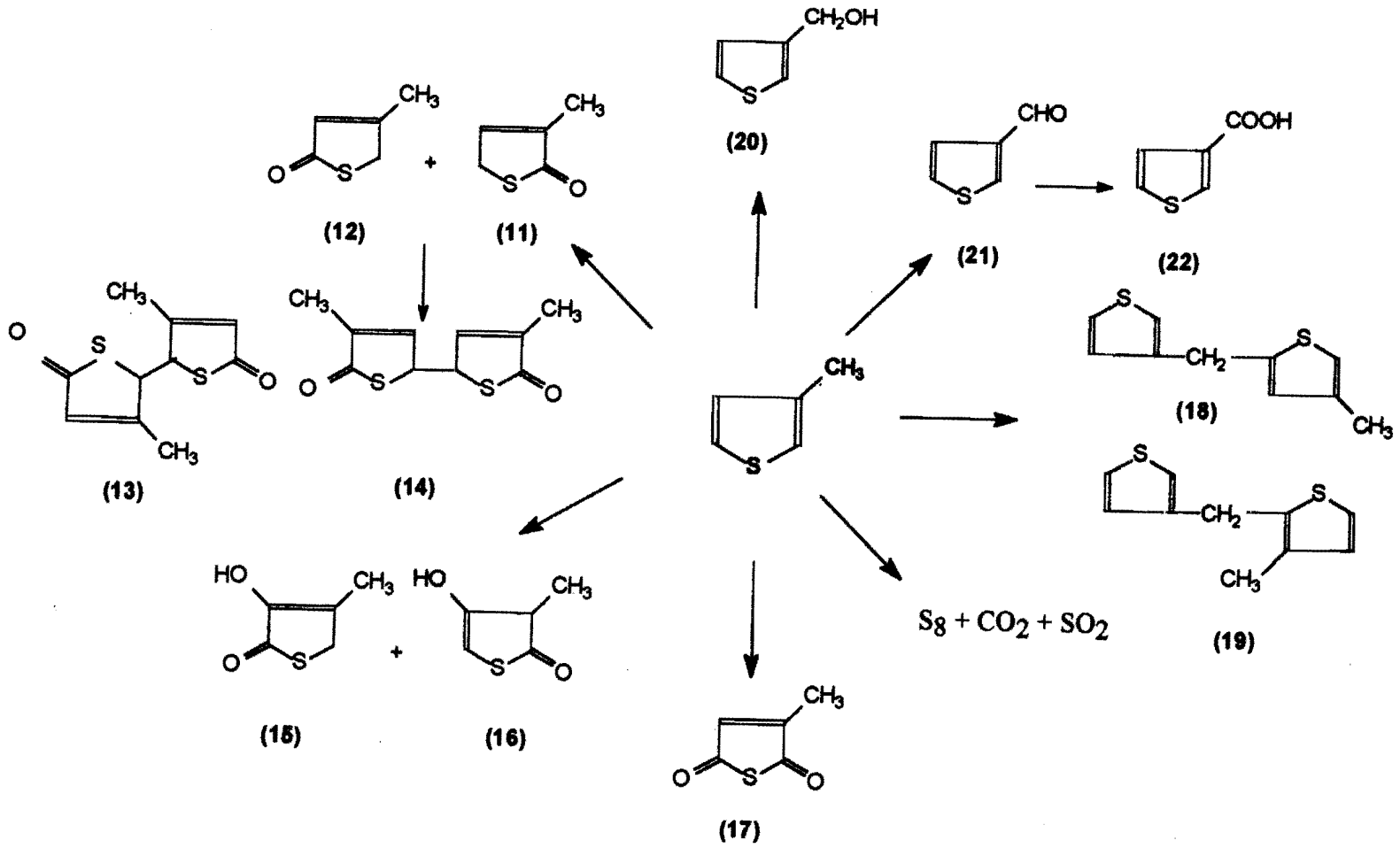
Scheme 2

Also detected among the oxidation products of 2-methylthiophene were the simple alcohol (8), aldehyde (9) and carboxylic acid (10). Significantly, these were also formed when the oxidation reactions were

conducted in the presence of the radical trap TEMPO, suggesting that their formation is non-radical in origin.

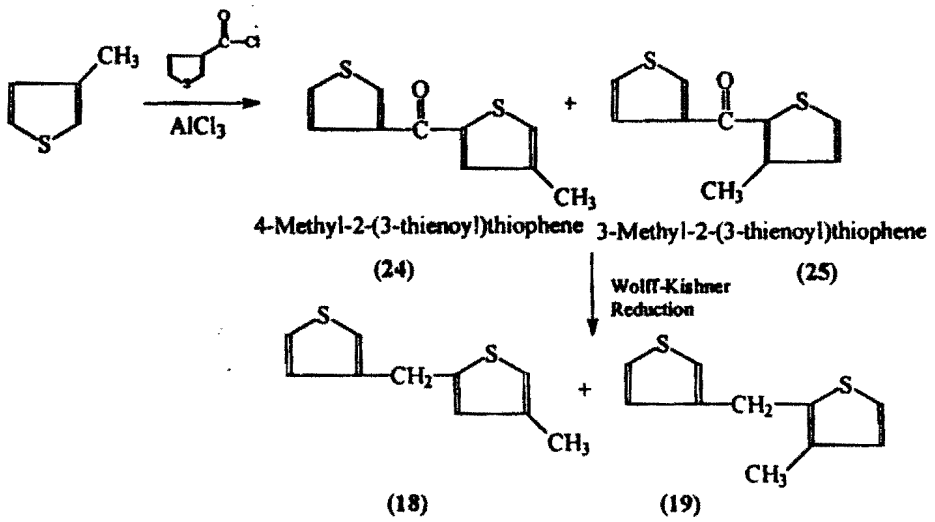
The course of Fenton and related oxidations of 3-methylthiophene followed a similar pattern (Scheme 3). As with the 2-isomer, the tautomers (11) and (12), from the related isomeric 2-hydroxy- and 2-hydroxy-3-methylthiophenes, isolated in *ca* 10% yield, were characterised, together with their related dimeric oxidation products (13) and (14). The dihydroxylated products (15, 16) and (17) were also detected. 2,3-Dihyroxy-4-methylthiophene (Compound 15) was prepared by a literature method [4], and both GC retention time and mass spectral fragmentation data were identical with those of the related component detected in the products of oxidation of 3-methylthiophene. However, we were unable to repeat the related preparation [12] of the isomer (16), and therefore our identification of (16) rests on the similarities in GC-MS data to those of (15). A third dihydroxylated product, assumed to be 3-methylthiomaleic anhydride (17), was also detected as a minor product. This compound was also detected as a by product in the synthesis of 3- and 4-methyl-3-thiolene-2-ones.

A dithienylmethane system was also formed in the Fenton and related oxidations of 3-methylthiophene. Although almost certainly (18), (on the basis of unhindered attack by the 3-thienylmethyl radical at the free 5-position of 3-methylthiophene), it was not possible to rule out structure (19) for this product. A synthetic approach to these systems (Scheme 4) gave the expected mixture of isomeric ketones, which we were unable to separate. Wolff-Kishner reduction of the mixture gave a mixture of the isomeric dithienylmethanes (18) and (19), which again could not be separated on a preparative scale. GC-MS analysis revealed the presence of



Scheme 3

the two isomers, having virtually identical retention times and mass spectral fragmentation patterns, again making an unequivocal distinction between the alternative structures impossible.



Scheme 4

As in the oxidation of 2-methylthiophene, the formation of the dithienylmethane derived from 3-methylthiophene was inhibited in the presence of TEMPO. Furthermore, the related alcohol (20), aldehyde (21) and carboxylic acid (22) were also formed, both in the presence and absence of the radical trap.

Experimental

GC-MS analyses were carried out using the VG-Trio-1 system previously described [1]. NMR spectra were recorded in deuteriochloroform using a Bruker AC250 FTNMR spectrometer. Mass spectra were recorded an a VC Micromass 7070F instrument. Accurate mass determinations were carried out using perfluorokerosen as internal standard, with a resolution of 5000.

Fenton and Related Oxidation Reactions: To a solution of the appropriate metal sulphate (10^{-2} mole) dissolved in dilute sulphuric acid (1 $mol.dm^{-3}$, 25 cm^3) was added the methylthiophene (0.1 mole), and the resulting solution stirred and cooled in ice. To this was added a solution of hydrogen peroxide (0.2 mole, 30% w/v aqueous solution) in dilute sulphuric acid (1 $mol.dm^{-3}$, 25 cm^3), and the resulting system allowed to warm to room temperature. Stirring was continued for up to 24 hrs. The organic products were then extracted into dichloromethane, and the organic layer separated, dried ($MgSO_4$) and evaporated to give a residue which was analysed by GC-MS techniques and then subjected to flash column chromatography for the preparative separation of individual components.

The following known compounds, detected in or isolated from the Fenton oxidation reactions, were prepared for purposes of comparison, by literature procedures:

5-methyl-4-thiolene-2-one (1) [18], 5-methyl-3-thiolene-2-one (2) [18], 3-methyl-3-thiolene-2-one (11) [18], 4-methyl-3-thiolene-2-one (12) [18], the dimeric systems and (3) and (4) [8], 4-hydroxy-5-methyl-3-thiolene-2-one (5) [14], 3-hyrdoxy-5-methyl-3-thiolene-2-one (6) [14] and 3-hydroxy-4-methyl-3-thiolene-2-one (15) [17] and 4-hydroxy-3-methyl-4-thiolene-2-one (16) [17].

Synthesis of Dithienylmethanes (7), (18) and (19)

General procedure: Anhydrous aluminium chloride (10g) was added to dichloromethane (50 cm^3) and treated with the appropriate thiophen carboxylic acid chloride (0.1. mole), with cooling in an ice-bath.

To the stirred, cooled solution was added dropwise the appropriate methylthiophene (0.1 mole), dissolved in dichloromethane (20 cm^3). On completion of the addition, the reaction mixture was then stirred for 2 h at room temperature. Aqueous hydrochloric acid (2 $mole.dm^{-3}$, 50 cm^3) was then added dropwise, and the organic layer separated, dried over anhydrous magnesium sulphate, and evaporated. The crude residue was purified by flash column chromatography to give the appropriate dithienylketone. The following compounds were isolated:

5-methyl-2-(2-thienoyl)-thiophene (23): colourless crystals, m.p. 48°C, δ^1H ($CDCl_3$): 2.6 (s, CH_3); 6.85 (m, 1H); 7.16 (dd, 1H, J=5,4 Hz); 7.66 (dd, 1H, J=5,1 Hz); 7.72 (d, 1H, J=4 Hz) and 7.85 (dd, 1H, J=4,1 Hz) ppm. Found *m/z* 208.00183 (M+, 89%); $C_{10}H_8OS_2$ requires *m/z* 208.00166 (M^+).

3-Methyl-2-(3-thienoyl)thiophene (25) and/or 4-methyl-2-(3-thienoyl) thiophene (24): colourless crystals, m.p. 45°C, δ^1H ($CDCl_3$): 2.6 (s, CH_3); 6.83 (d, 1H, J=5 Hz); 7.15 (m, 1H); 7.7 (m, 2H) and 7.85 (m, 1H) ppm. Found *m/z* 208.00124 (M+, 55%). $C_{10}H_8OS_2$ requires *m/z* 208.00166 (M^+).

The above ketones were then reduced to the respective dithienylmethanes by the Wolff-Kishner method: The ketone (2 x 10^{-2} mole), hydrazine hydrate (6 x 10^{-2} mole), sodium hydroxide (0.1 mole) and diethylene glycol (0.5 mole) were heated together under reflux for 2 h, with stirring. The reflux condenser was then replaced by a distillation adaptor and condenser, and the temperature then slowly raised to 195-200°C and held for 6 hr, during which time a mixture of hydrazine and water distilled over. The residue was then cooled, diluted with water (30

cm^3), the acidity adjusted to pH 1-2 with concentrated hydrochloric acid, and the products extracted into dichloromethane. The organic phase was washed with water and saturated sodium chloride solution, dried over anhydrous magnesium sulphate, and evaporated. The crude residue was purified by flash column chromatography on silica using a petroleum ether-dichloromethane gradient solvent system. The following compounds were isolated:

2-methyl-5-(2-thienylmethyl)thiophene (7): brown oil, δ^1H ($CDCl_3$): 2.7 (s, 3H); 4.5 (s, 2H); 6.68 (d, 1H, J=3.2 Hz); 6.77 (d, 1H, J=3.25 Hz); 6.98 (d, 1H, J=3.5 Hz); 7.04 (dd, 1H, J=3.5, 5.05 Hz) and 7.25 (dd, 1H, J=5,1 Hz) ppm. Found *m/z* 194.0026 (M+, 80.4%). $C_{10}H_{10}S_2$ requires *m/z* 194.0020 (M^+).

3-methyl-2-(3-thienylmethyl)thiophene (18) and/or 4-methyl-2-(3-thienymethyl)thiophene (19): isolated as a yellow oil, (37%). δ^1H ($CDCl_3$): 2.45 (s, 3H); 2.45 (s, 3H); 4.3 (s, 2H); 6.85 (m, 1H); 6.66 (m, 1H); 6.85-7.00 (m, 2H) and 7.15 (m, 1H) ppm. Found *m/z* 194.0034 (M+, 70%). $C_{10}H_{10}S_2$ requires *m/z* 194.0020 (M^+).

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