

A STATISTICAL COMPARISON OF ANATOMICAL FEATURES IN SOME *Ornithogalum* SP. SPECIES¹

Comparação Estatística das Características Anatômicas em Espécies de Ornithogalum sp.

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ABSTRACT - In the present study, *Ornithogalum narbonense*, *O. montanum*, *O. wiedemannii*, *O. sigmoideum* and *O. lanceolatum* species were compared statistically with respect to anatomical characters. Some differences were found in root, stem and leaf anatomy of the species. These differences and similarities were indicated in this study. A big metaxylem was present in all root cross sections, except for *O. lanceolatum*, which has three metaxylema. 2-3 layered annular type collenchyma were present in all species. Aerenchyma is present in all mesophiles.

Keywords: statistic, *Ornithogalum*, anatomy.

RESUMO - No presente estudo, as espécies *Ornithogalum narbonense*, *O. montanum*, *O. wiedemannii*, *O. sigmoideum* e *O. lanceolatum*, foram comparadas estatisticamente com relação às suas características anatômicas. Foram observadas diferenças na anatomia da raiz, caule e folhas das espécies. Estas diferenças e semelhanças foram indicadas no presente estudo. Foi observado um grande metaxilema em todas as seções da raiz, com exceção de *O. lanceolatum*, que possui três metaxilemas. Duas a três camadas de colênquima foram encontradas em todas as espécies. Todas as espécies mesófilas continham aerenquima.

Palavras-chave: estatística, *Ornithogalum*, anatomia.

INTRODUCTION

The genus *Ornithogalum* belonging to Hyacinthaceae family contains over 140 species widespread around the world. The genus is mostly spread in South Africa and around the Mediterranean (Uysal et al., 2005). *Ornithogalum* is represented by 45 species in the flora of Turkey and 17 of these species are endemic (Cullen, 1984; Davis et al., 1988; Ozhatay, 2000; Uysal et al., 2005; Varol, 2008; Dalgıç et al., 2009). *Ornithogalum* is a taxonomically difficult genus, while its morphology is poorly correlated with the variation in chromosome number and karyotype (Dalgıç and Özhatay, 1997). Since several decades, this taxonomically extremely

difficult genus was the object of several studies on bulb structure and germination-type (Zahariadi, 1962, 1965; Speta, 1990, 1990a), classical cytotaxonomy (Peruzzi and Passalacqua, 2002; Garbari et al., 2003; Tornadore et al., 2003; Aquaro and Peruzzi, 2006), karyotype evolution (van Raamsdonk, 1986), chemotaxonomy (Øvstedal, 1991), morphometry (Moret et al., 1991; Øvstedal, 1991; Raamsdonk and Heringa, 1987; Moret, 1992; Moret and Galland, 1992; Coskuncelebi et al., 2002), seed micromorphology (Coskuncelebi, et al., 2000). In this study, *Ornithogalum narbonense*, *O. montanum*, *O. wiedemannii*, *O. sigmoideum* and *O. lanceolatum* species were compared statistically regarding their anatomical characters.

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MATERIAL AND METHODS

Materials were collected from B1 Manisa Spil Mountain. Specimens were kept in the herbarium at Celal Bayar University. A morphological illustration of the plant taxon was made from fresh and dry specimens followed "Flora of Turkey" volume 8 (Davis, 1984). For anatomical studies, the plant specimens were fixed in 70% ethanol. Hand cuts were stained with safranin and fast green. Preparates were photographed with a motorized Leica DM 3000 microscope. Measurements were taken using ocular-micrometer of root, stem and leaf cell sizes of the species. Minimum, maximum, mean and standard deviations were determined.

For the numerical analysis, 16 anatomical characters were selected. This selection was based on the variations of the anatomical data. Characters were coded as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and the taxa were coded as A, B, C, D, E. Significance of the differences between the taxa and characters were evaluated by Analysis of variance (Regression Analysis) and Pearson's correlation. The differences were assessed by the one-way ANOVA test. Pearson's correlation coefficients were also calculated. Statistical analysis were performed using the MINITAB software package.

RESULTS AND DISCUSSION

Anatomical findings

Roots

O. narbonense and *O. lanceolatum* species have two layered epidermis. Other species have one layered epidermis. Cortex is 3-5, 3-4, 7-11, 6-8, 4-5 layered in *O. narbonense*, *O. montanum*, *O. wiedemannii*, *O. sigmoedeum* and *O. lanceolatum*, respectively. Four-sided endodermis wall thickening was present in *O. narbonense*, *O. montanum* and *O. sigmoedeum*. A big metaxylem was present in all root cross sections except for *O. lanceolatum*, which has three metaxylema. 4-5 xylem strands were present in all roots.

Stems

A thick cuticle surrounds the one layered epidermis in all stem cross sections. The

cortex consists of circle shaped cells in all species and 4-5, 5-6, 2-3, 5-6, 4-5 layered in *O. narbonense*, *O. montanum*, *O. wiedemannii*, *O. sigmoedeum*, and *O. lanceolatum*, respectively. 2-3 layered annular type collenchyma were present in all species. Vascular bundles are arranged in two rows in *O. narbonense* and *O. montanum*, three rings in *O. wiedemannii*, *O. sigmoedeum*, and *O. lanceolatum*. Raphide crystals were present in the stem cortex of *O. sigmoedeum*.

Leaves

In all species, the cuticle is present on both sides of the leaf. *O. narbonense*, *O. wiedemannii* and *O. lanceolatum* leaves have 1-2 layered palisade parenchyma under adaxial and abaxial epidermis and 2-3 layered spongy parenchyma. Palisade spongy separation was absent in *O. montanum* and *O. sigmoedeum* species. Mesophiles of all species have aerenchyma. *O. lanceolatum* mesophyll have bigger aerenchyma than others.

Statistical analysis

The anatomical measurements of the investigated taxa are shown in Table 1. Significance of the differences between the *Ornithogalum* taxa was evaluated by analysis of variance (Regression Analysis) and Pearson's correlation (Correlation). The statistical analysis of the results are shown in Tables 2, 3, 4, 5 and 6.

The differences among the investigated taxa are shown as A-C, A-D, A-E, B-C, B-D, D-E and C-D in Table 3 and Table 5, and they are significant at level of 0.01P and 0.05P. According to Table 4 and Table 6, based on the Pearson's correlation method (Correlation), there are important correlations among the anatomical characters of the investigated taxa, shown as (Table 2) 1-3, 1-5, 1-7, 1-16, 2-15, 3-4, 3-7, 3-12, 3-14, 3-16, 4-16, 6-10, 7-12, 8-12, 8-14, 9-15, 11-13 and 14-15 at levels of 0.01P and 0.05P.

The results of the statistical analysis are shown in Tables 4 and 6. It was found that there were statistically important differences at levels of 0.01P and 0.05P.

Table 1 - Anatomical measurements of the species

<i>O. narbonense</i>	Min.-Max .	Ort±S.D	<i>O. lanceolatum</i>	Min.-Max.	Ort±S.D
Root			Root		
Epidermis Width	20-50	35±13	Epidermis Width	38-52	47.5±6.4
Epidermis Length	15-50	30±12	Epidermis Length	30-50	42±8
Cortex (diameter)	70-23	140±62	Cortex (diameter)	30-170	100±99
Endodermis Width	18-23	21±1.8	Endodermis Width	12-22	17.8±3.7
Endodermis Length	10-15	12±1.8	Endodermis Length	7-12	10±1.7
Pericycle Width	15-18	17±1.2	Pericycle Width	15-26	21±4.6
Metaxylem (diameter)	25-63	38±13	Metaxylem (diameter)	15-26	21±4.6
Stem			Stem		
Epidermis Width	13-25	17±2.5	Epidermis Width	18-22	20±1.6
Epidermis Length	30-43	35±4.3	Epidermis Length	18-23	20.6±2
Cortex (diameter)	3-50	48±9.7	Cortex (diameter)	20-70	45±14.5
Trachea (diameter)	8-23	19±2.5	Trachea (diameter)	10-15	12±2.7
Leaf			Leaf		
Abaxial epidermis Width	38-50	44±5.6	Abaxial epidermis Width	10-22	20±0.8
Abaxial epidermis Length	20-28	26±3.3	Abaxial epidermis Length	25-30	29±2.2
Palisade Length	28-40	34±4.7	Palisade Length	20-25	22.8±2.16
Adaxial epidermis Width	18-25	22±2.5	Adaxial epidermis Width	12-25	18.8± 4.5
Adaxial epidermis Length	30-38	34±2.5	Adaxial epidermis Length	12-20	16±4
<i>O. sigmoideum</i>	Min.-Max .	Ort±S.D	<i>O. wiedemannii</i> var. <i>wiedemannii</i>	Min.-Max.	Ort±S.D
Root			Root		
Epidermis Width	15-38	24.5±9.8	Epidermis Width	10-20	15±5
Epidermis Length	20-50	32±13.8	Epidermis Length	20-40	30±10
Cortex (diameter)	10-35	25±10	Cortex (diameter)	22-10	16±6
Endodermis Width	18-23	20.6±2	Endodermis Width	5-15	9.6±5
Endodermis Length	11-18	14.6±3.5	Endodermis Length	10-18	13±3
Pericycle Width	10-18	15±3.4	Pericycle Width	15-25	20±5
Metaxylem (diameter)	35-40	38±2.1	Metaxylem (diameter)		
Stem			Stem	30-38	34±3
Epidermis Width	20-35	26±6.5	Epidermis Width	25-30	26.5±2
Epidermis Length	30-40	37±4.4	Epidermis Length	28-88	72±22
Cortex (diameter)	35-110	64±31	Cortex (diameter)	25-38	33.5±5
Trachea (diameter)	15-30	23±6.7	Trachea (diameter)		
Leaf			Leaf	15-23	20±5.1
Abaxial epidermis Width	25-40	32.5±6.4	Abaxial epidermis Width	15-20	17.5±2
Abaxial epidermis Length	20-25	23±2.4	Abaxial epidermis Length	63-70	66±2.8
Palisade Length	40-170	83.5±59	Palisade Length	12-25	19±4.8
Adaxial epidermis Width	13-20	16.3±3	Adaxial epidermis Width	15-22.5	17±3.2
Adaxial epidermis Length	20-27	23±2.6	Adaxial epidermis Length	10-20	15±5
<i>O. montanum</i>	Min.-Max .	Ort±S.D			
Root	20-45	37±9.7			
Epidermis Width	10-30	24±9			
Epidermis Length	40-60	53±8.3			
Cortex (diameter)	13-15	14±0.9			
Endodermis Width	7-10	8.5±1.2			
Endodermis Length	9-11	10±0.8			
Pericycle Width	20-32	27±0.4			
Metaxylem (diameter)					
Stem	15-20	17±2.5			
Epidermis Width	10-25	19±6.2			
Epidermis Length	15-40	33.6±16			
Cortex (diameter)	3-15	7.6±4.8			
Trachea (diameter)					
Leaf	10-28	20±7.5			
Abaxial epidermis Width	20-40	27.5±8.6			
Abaxial epidermis Length	38-15	33±3			
Palisade Length	15-28	22±5			
Adaxial epidermis Width	30-42	38±4.5			
Adaxial epidermis Length	20-45	37±9.7			



Table 2 - Pearson's correlation (Correlation) based on anatomical characters of the investigated taxa

Features	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0.607														
	0.278														
2	0.962	0.744													
	0.009**	0.150													
3	0.948	0.691	0.947												
	0.014	0.196	0.015*												
4	0.041*	0.798	0.204	0.220											
	0.948	0.106	0.742	0.722											
5	0.343	0.244	-0.138	0.055	0.565										
	0.572	0.692	0.825	0.930	0.320										
6	0.962	0.396	0.894	0.851	0.222	0.492									
	0.009**	0.510	0.041*	0.068	0.720	0.400									
7	0.874	0.721	0.872	0.745	0.221	0.456	0.819								
	0.053	0.169	0.054	0.149	0.721	0.441	0.090								
8	0.649	0.858	0.693	0.808	0.703	0.249	0.421	0.564							
	0.236	0.063	0.194	0.098	0.186	0.686	0.480	0.322							
9	0.751	0.415	0.667	0.869	0.118	0.011*	0.649	0.414	0.773						
	0.144	0.487	0.219	0.056	0.850	0.985	0.236	0.488	0.126						
10	0.873	0.622	0.778	0.857	0.241	0.371	0.762	0.795	0.797	0.820					
	0.053	0.262	0.121	0.064	0.696	0.539	0.134	0.108	0.107	0.089					
11	0.975	0.542	0.917	0.856	0.045	0.517	0.970	0.927	0.525	0.620	0.847				
	0.005	0.345	0.028*	0.064	0.942	0.372	0.006**	0.023*	0.363	0.264	0.070				
12	0.791	0.173	0.610	0.755	0.237	0.496	0.791	0.527	0.500	0.870	0.854	0.760			
	0.111	0.781	0.274	0.140	0.701	0.395	0.111	0.362	0.391	0.055	0.066	0.136			
13	0.910	0.730	0.928	0.800	0.194	0.382	0.863	0.988	0.570	0.451	0.770	0.944	0.528		
	0.032	0.162	0.023*	0.104	0.755	0.526	0.060	0.002**	0.316	0.446	0.128	0.016*	0.361		
14	0.737	0.959	0.804	0.809	0.700	0.082	0.533	0.785	0.937	0.614	0.814	0.672	0.429	0.781	
	0.155	0.010*	0.101	0.097	0.188	0.896	0.355	0.116	0.019*	0.270	0.094	0.214	0.471	0.119	
15	0.932	0.848	0.976	0.953	0.385	0.066	0.811	0.873	0.825	0.707	0.843	0.874	0.600	0.910	0.913
	0.021*	0.070	0.005**	0.012*	0.522	0.915	0.096	0.053	0.085	0.182	0.073	0.053	0.285	0.032*	0.030*

* Significant at the level of 0.05. ** Significant at the level of 0.01.

Table 3 - Pearson correlation (Correlation) based on 8 anatomical characters of the leaves of the investigated taxa

Characters	A	B	C	D
B	0.362			
	0.140			
C	0.006**	0.573		
	0.979	0.013*		
D	0.007**	0.483	0.749	
	0.978	0.042*	0.008**	
E	0.029*	0.194	0.430	0.030*
	0.910	0.441	0.075	0.906

O. narbonense (A), *O. lanceolatum* (B), *O. sigmoideum* (C), *O. wiedemannii* (D), *O. montanum* (E), *O. wiedemannii* (D), *O. montanum* (E).

In the present study, five *Ornithogalum* taxa were compared statistically regarding anatomical characters. We aimed to find statistical and anatomical differences in addition to morphological characters to distinguish these species. Anatomical features of the root of the five species are similar. *O. lanceolatum* have three metaxylema in the root while others have one metaxylem. Scape has a single layered epidermis with a thin cuticle in all taxa. In most species of the subfamily Ornithogaloideae, vascular bundles are in two rows and large bundles alternate with small bundles (Lynch et al., 2006). In our study, vascular bundles are in two rows in

Table 4 - Comparison anatomical features of the investigated taxa with Minitab

Takson	1	2	3	4	5	6	7	8
1	0.582							
	0.303							
2	0.546	0.998						
	0.341	0.010**						
3	0.957	0.768	0.736					
	0.010**	0.130	0.156					
4	0.873	0.516	0.472	0.841				
	0.053	0.373	0.422	0.074				
5	0.759	0.932	0.925	0.852	0.688			
	0.136	0.021*	0.024*	0.067	0.199			
6	-0.057	0.458	0.447	0.202	0.028	0.136		
	0.927	0.438	0.450	0.744	0.965	0.827		
7	0.996	0.613	0.576	0.967	0.909	0.780	-0.007	
	0.020*	0.272	0.310	0.007**	0.032	0.120	0.991	
8	0.865	0.547	0.537	0.787	0.619	0.778	-0.382	0.833
	0.058	0.340	0.351	0.114	0.265	0.121	0.526	0.080

Table 5 - Comparison anatomical features of the investigated taxa with Pearson's correlation analysis

Taxa	C1	C2	C3	C4
C2	0.631			
	0.009			
C3	0.211	0.503		
	0.433	0.047*		
C4	0.125	0.192	0.177	
	0.644	0.476	0.511	
C5	0.621	0.730	0.143	0.103
	0.010*	0.001**	0.597	0.705

O. narbonense and *O. montanum* are in three rows in *O. wiedemannii* var *wiedemannii*, *O. sigmoedeum*, and *O. lanceolatum*. Lynch et al. (2006) reported that Hyacinthaceae has a wide range of variation in the crystal types. There are raphide, styloid and druse crystals in this family (Lynch et al., 2006). Raphide crystals are present in the stem cortex of *O. sigmoedeum*. The presence, morphology and distribution of crystals within a species are very important, because it is under genetic control (Franceschi and Nakata, 2005). Thus, the constancy of crystal type and distribution can be viewed as a taxonomic character for classification of species. Leaf anatomy of the taxa shows some

Table 6 - Comparison anatomical features of the investigated taxa with Minitab

One – way ANOVA: C1 versus C2					
Source	DF	SS	MS	F	P
C2	12	9651	804	0.52	0.817
Error	3	4597	1532		
Total	15	14247			
S=39.14 R-Sq=67.74 % R-Sq(adj) = 0.00%					
Level	N	Mean	StDev		
12	1	19.00	^		
13	1	17.00	^		
16	1	34.00	^		
17	1	21.00	^		
18	1	25.00	^		
20	2	30.00	19.09		
21	1	38.00	^		
22	1	34.00	^		
25	1	40.00	^		
45	2	94.00	65.05		
47	2	35.00	0.00		
51	1	70.00	^		
55	1	75.00	^		

Pooled StDev = 39.14.

To be continued...



Table 6, cont...

One – way ANOVA: C1 versus C3					
Source	DF	SS	MS	F	P
C3	12	8920	743	0.42	0.880
Error	3	5327	1762		
Total	15	14247			
S=42.14 R-Sq=62.61 % R-Sq(adj) = 0.00%					
Level	N	Mean	StDev		
15	1	17.00	^		
16	1	25.00	^		
20	1	21.00	^		
23	1	26.00	10.61		
24	1	35.00	^		
25	2	89.00	72.12		
26	1	17.00	^		
32	1	44.00	^		
50	2	37.00	3.54		
55	1	75.00	^		
64	1	48.00	^		
68	1	70.00	^		
82	1	34.00	^		

Pooled StDev = 42.14.

Table 6, cont...

One – way ANOVA: C2 versus C3					
Source	DF	SS	MS	F	P
C3	12	3046	254	1.42	0.434
Error	3	538	179		
Total	15	3584			
S=13.39 R-Sq=84.99 % R-Sq(adj) = 24.94%					
Level	N	Mean	StDev		
15	1	13.00	^		
16	1	18.00	^		
20	1	17.00	^		
22	2	14.00	2.82		
24	1	47.00	^		
25	1	33.00	16.97		
26	1	20.00	^		
32	1	20.00	^		
50	2	36.00	15.56		
55	1	55.00	^		
64	1	45.00	^		
68	1	51.00	^		
82	1	22.00	^		

Pooled StDev = 13.39.

One – way ANOVA: C1 versus C5					
Source	DF	SS	MS	F	P
C5	12	8732	728	0.40	0.893
Error	3	5515	1838		
Total	15	14247			
S=42.88 R-Sq=62.29 % R-Sq(adj) = 0.00%					
Level	N	Mean	StDev		
7	1	17.00	^		
10	1	25.00	^		
11	1	21.00	^		
14	1	26.00	^		
15	2	35.00	1.41		
17	1	89.00	72.12		
20	1	17.00	^		
22	1	44.00	^		
25	2	37.00	^		
33	1	75.00	^		
37	2	48.00	0.71		
40	1	70.00	^		
53	2	34.00	74.25		

Pooled StDev = 42.88.

To be continued...

One – way ANOVA: C2 versus C4					
Source	DF	SS	MS	F	P
C4	12	3542	295	21.6	0.014
Error	3	41	13		
Total	15	3582			
S=3.697 R-Sq=98.86 % R-Sq(adj) = 94.28%					
Level	N	Mean	StDev		
12	1	12.00	^		
15	2	47.00	0.000		
16	1	17.00	^		
19	2	22.00	^		
20	2	20.00	0.707		
25	2	20.00	6.364		
30	1	45.00	^		
33	1	12.00	^		
34	1	20.00	^		
35	1	55.00	^		
40	1	51.00	^		
66	1	18.00	^		
72	1	45.00	^		

Pooled StDev = 3.697.

To be continued...

Table 6, cont...

One – way ANOVA: C2 versus C5					
Source	DF	SS	MS	F	P
C5	12	3092	258	1.58	0.392
Error	3	491	164		
Total	15	3584			
S=12.79 R-Sq=56.21 % R-Sq(adj) = 31.57%					
Level	N	Mean	StDev		
7	1	12.00	^		
10	1	13.00	^		
11	1	22.00	^		
14	1	17.00	^		
15	2	23.00	2.83		
17	1	20.00	^		
20	1	20.00	^		
22	1	18.00	^		
25	1	55.00	^		
33	1	45.00	^		
37	2	31.00	21.92		
40	1	51.00	^		
53	2	46.00	1.14		

Pooled StDev = 12.79.

Table 6, cont...

One – way ANOVA: C3 versus C5					
Source	DF	SS	MS	F	P
C5	12	6048	504	2.42	0.254
Error	3	626	209		
Total	15	6674			
S=14.44 R-Sq=90.63 % R-Sq(adj) = 53.14%					
Level	N	Mean	StDev		
7	1	23.00	^		
10	1	15.00	^		
11	1	83.00	^		
14	1	20.00	^		
15	2	37.50	17.68		
17	1	26.00	^		
20	1	32.00	^		
22	1	16.00	^		
25	1	55.00	^		
33	1	64.00	^		
37	2	23.00	0.71		
40	1	68.00	^		
53	1	37.00	17.68		

Pooled StDev = 14.44.

One – way ANOVA: C3 versus C4					
Source	DF	SS	MS	F	P
C4	12	5947	496	2.05	0.304
Error	3	727	242		
Total	15	6674			
S=12.79 R-Sq=56.21 % R-Sq(adj) = 31.57%					
Level	N	Mean	StDev		
12	1	15.00	^		
15	2	37.00	18.38		
16	1	20.00	^		
19	1	83.00	^		
20	2	28.50	4.95		
25	2	36.50	19.09		
30	1	25.00	^		
33	1	23.00	^		
34	1	26.00	^		
35	1	55.00	^		
40	1	68.00	^		
66	1	16.00	^		
72	1	64.00	^		

Pooled StDev = 15.57.

To be continued...

One – way ANOVA: C4 versus C5					
Source	DF	SS	MS	F	P
C5	12	4340	361	6.20	0.080
Error	3	175	58		
Total	15	4515			
S=7.638 R-Sq=96.12 % R-Sq(adj) = 80.62%					
Level	N	Mean	StDev		
7	1	33.00	^		
10	1	13.00	^		
11	1	19.00	^		
14	1	16.00	^		
15	2	22.50	3.536		
17	1	34.00	^		
20	1	20.00	^		
22	1	66.00	^		
25	1	35.00	^		
33	1	72.00	^		
37	2	20.00	7.071		
40	1	40.00	^		
53	1	22.00	10.607		

Pooled StDev = 7.638.



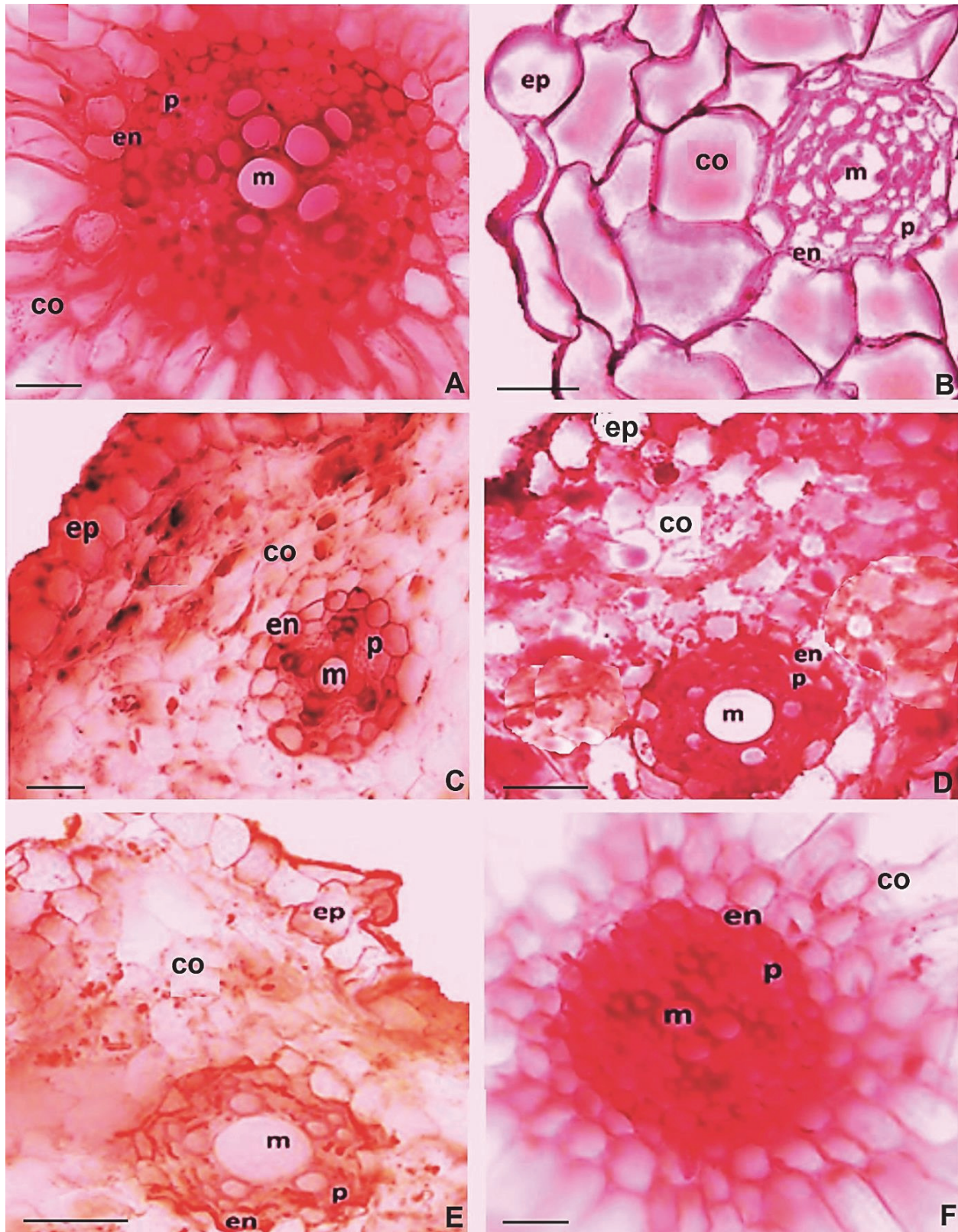


Figure 1 - Root cross sections; A:*O. narbonense*, B:*O. montanum*, C:*O. wiedemannii*, D,E: *O. sigmoedeum*, F:*O. lanceolatum*; co: cortex, en: endodermis, ep:epidermis, m:metaxylem, p:pericycle; scale bar 50 μ m.

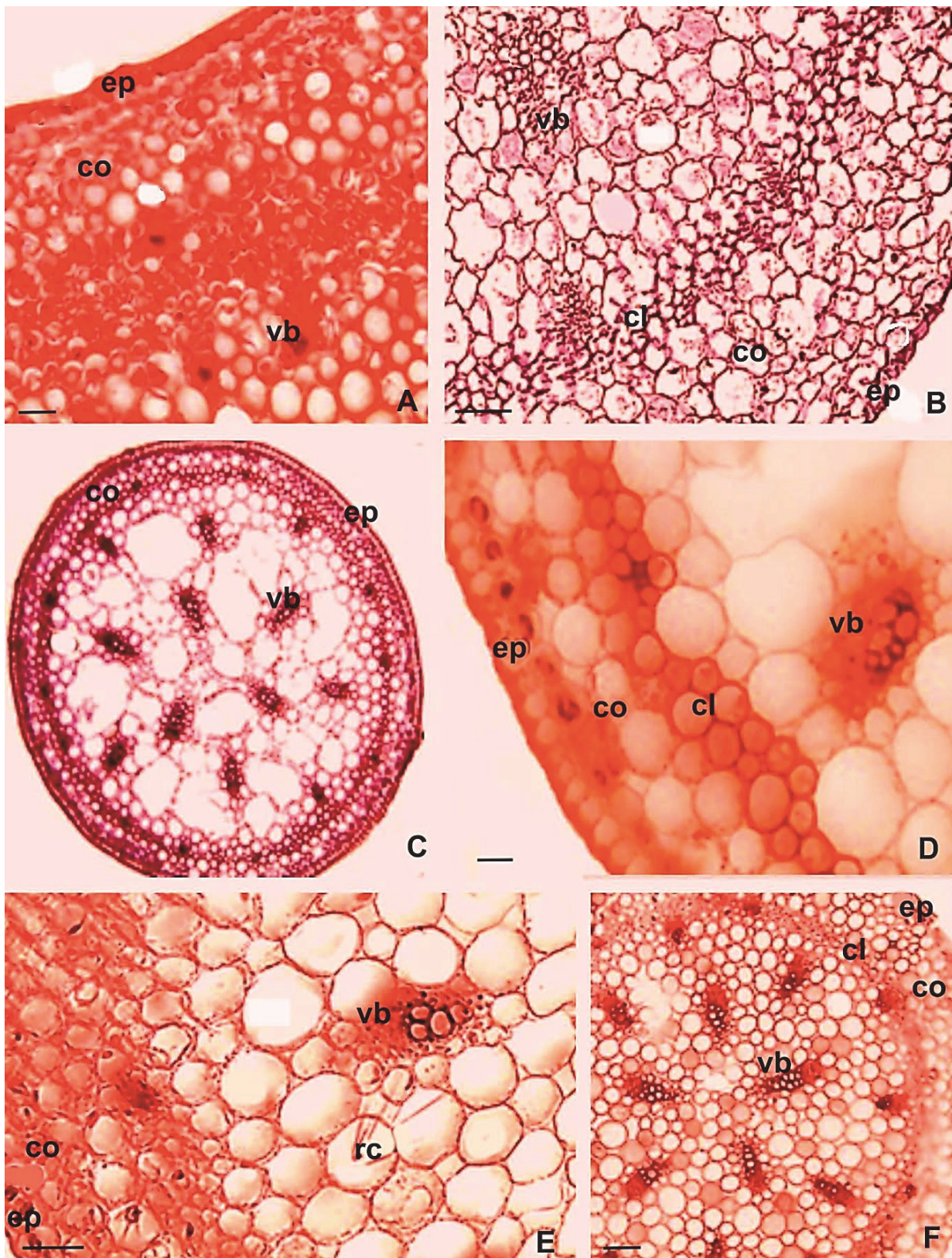


Figure 2 - Stem cross sections; A:*O. narbonense*, B:*O. montanum*, C,D:*O. wiedemannii*, E: *O. sigmoedeum*, F:*O. lanceolatum*; co: cortex, cl:collenchyma, ep:epidermis, rc:raphide crystals, vb:vascular bundle; scale bar 50 μ m.

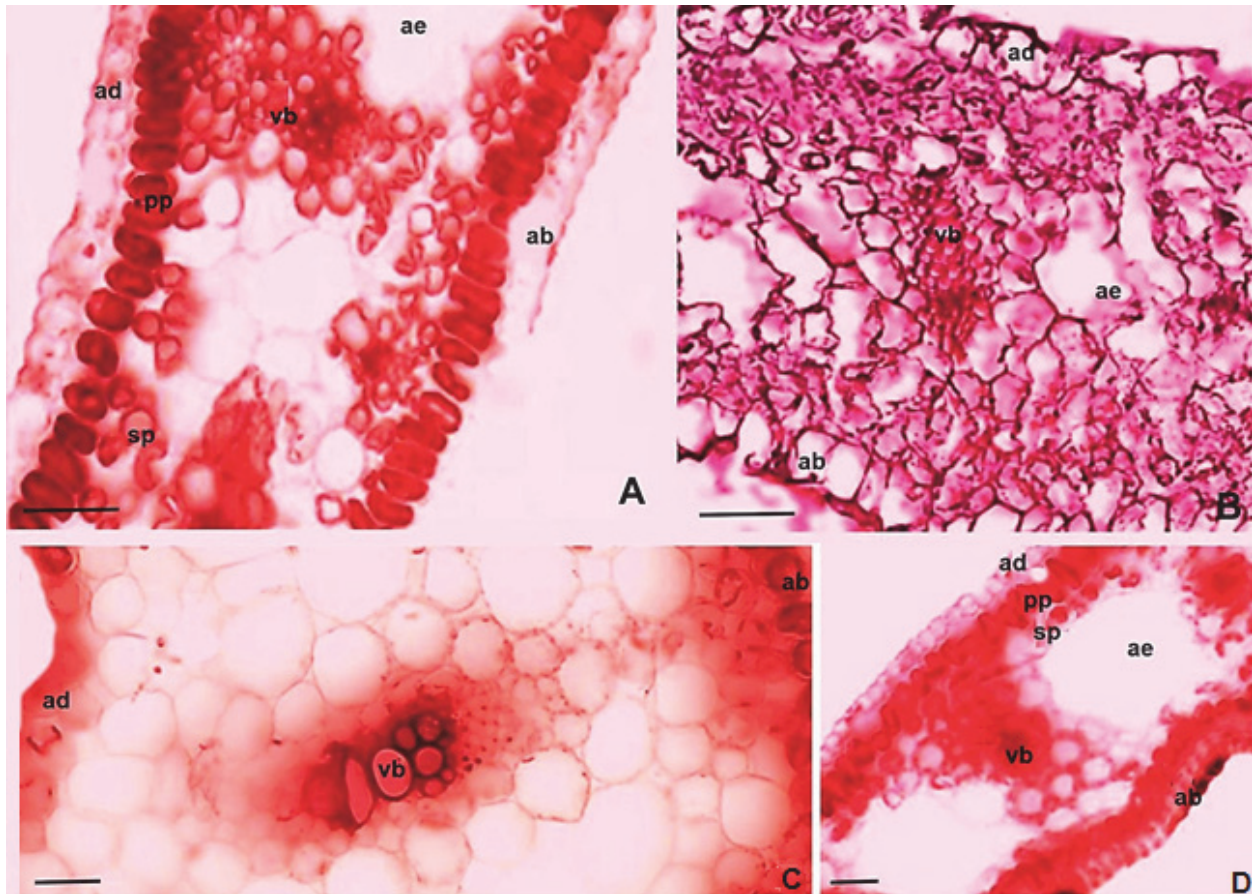


Figure 3 - Leaf cross sections; A: *O. narbonense*, B: *O. montanum*, C: *O. sigmoedeum*, D: *O. lanceolatum*; ab: abaxial epidermis, ad: adaxial epidermis, ae: aerenchyma, pp: palisade parenchyma, sp: spongy parenchyma, vb: vascular bundle; scale bar 50 µm.

differences. The mesophyll in *O. montanum* and *O. sigmoedeum* species is unifacial while it is equifacial in other taxa. The mesophyll in *O. narbonense*, *O. wiedemannii* var. *wiedemannii*, *O. lanceolatum*, differentiates as palisade and spongy parenchyma. The palisade parenchyma is present in both the adaxial and abaxial side. Also, the mesophyll in *O. lanceolatum* contains larger aerenchyma between vascular bundles in spongy parenchyma.

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