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POLLEN MORPHOLOGY OF THE GENUS *OXYTROPIS* DC. IN TURKEY

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Abstract

Pollen morphology of 11 species of the genus *Oxytropis* DC. (Fabaceae) distributed in Turkey were examined with light (LM) and scanning electron microscope (SEM). Morphology of pollen grains shows isopolar, radially symmetric, tricolporate, prolate or subprolate, porus shape oblate or operculate and exine subtectate. The size varies with the polar axis from 19.52 - 33.31 µm and the equatorial axis from 13.50 - 25.82 µm. There are five ornamentation types: perforate at equatorial section and psilate at polar sections, microreticulate at equatorial sections and psilate at polar sections, microreticulate at equatorial sections and perforate at polar sections, microreticulate at both equatorial and polar sections and perforate at both equatorial and polar sections. Pollen aperture, shape and especially different ornamentation patterns at polar and equatorial section of pollen, as found in this study, appear to be important character. The findings of this study indicate the taxonomic implications of pollen morphology in understanding the similarity and relationships in the genus *Oxytropis*.

Introduction

The genus *Oxytropis* DC. belongs to the subfamily Papilionoideae in Leguminosae (nom alt. Fabaceae) under the subtribe Astragalinae of the tribe Galegeae. It is comprised of about 300 species occurring in cold mountainous regions of Europe, Asia and North America, and abundant in Central Asia (Jurtzev 1978, 1988, Lock and Schrire 2005, Polhill 1981, Polozhij 1994).

Polhill (1994) proposed 10 genera (*Halimodendron, Caragana, Calophaca, Spongiocarpella, Chesneya, Astragalus, Astracantha, Oxytropis, Neodielsia* and *Gueldenstaedtia*) under the subtribe *Astragalinae.* Among these genera *Astragalus* seems to be very close to the genus *Oxytropis* in morphological characters. In contrast *Oxytropis* differs from *Astragalus* L. only in keel petal (pointed vs. obtuse) and pod septum (arising from adaxial suture vs. abaxial) (Chamberlain and Matthews 1970, Özhatay 2000**).**

In the Flora of Turkey, 13 species of *Oxytropis* have been described, three of which are considered as endemic (Chamberlain and Matthews 1970, Özhatay 2000). Recently the genus *Oxytropis* has been revised by Erkul and Aytaç (2012) who reduced its species to 11 and considered only one species as endemic to Turkey.

Simons and Chinnappa (2004) studied the pollen morphology and taxonomic status of North American *Astragalus* and *Oxytropis.* Land surface pollen-vegetation relationships in the forest-steppe, taiga and tundra landscapes of the Russian Altai Mountains was studied by Pelánková and Chytrý (2009). Perveen and Qaiser (1998) studied pollen morphology of 157 species, representing 37 genera, of the subfamily Papilionoideae from Pakistan. The pollen morphology of sections *Ammodendron* Bunge, *Onobrychoidei* DC., *Allopecuroidei* DC. and *Hololeuce* Bunge of the *Astragalus* distributed in Turkey was respectively studied by Akan *et al*. (2005), Ekici *et al.*

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(2005), Pınar *et al.* (2009a) and Ceter *et al.* (2013a, b). But the pollen characters of Turkish *Oxytropis* have not been studied yet in details. This is the first comprehensive pollen study in *Oxytropis* of Turkey.

The purpose of this study was to determine pollen morphological differences in *Oxytropis* of Turkey to throw light on the problematic aspects of taxonomy of the genus.

Materials and Methods

Specimens for the study were collected from the wild populations of *Oxytropis*. List of the species and this localities are provided below.

Oxytropis kotschyana Boiss.& Hoh.: C10 Hakkari: Yüksekova-Hakkari road, 13. km, 1830 m, steppe, 27.05.2008, SK 2183. *O. pallasii* Pers.: B8 Erzurum: Oltu-Tortum, 20. km, 1750 m, steppe, 19.05.2008, SK 2181. *O. pilosa* (L.) DC.: A8 Artvin: Artvin road, 10 km from Artvin, 600 m, steppe, 28.05.2008, SK 2185. *O. savellanica* Boiss.: C5 Niğde: Ala Mountain, Tekneliyayla, 3000 m, alpine meadows, 05.07.2007, SK 2129. *O. persica* Boiss.: C5 Niğde: Kızıltepe, 3000 m, rocky slopes, 24.07.2007, SK 2131. *O. albana* Stev.: A9 Kars: Susuz, Kiziroğlu Village, Kısır Mountain, 2940–3165 m, alpine meadows, 10.07.2007, SK 2151. *O. lazica* Boiss.: A8 Rize: İkizdere, Ballıköy, Anzer, Küçük Alcahal, 2658–2750 m, alpine meadows, 11.07.2007, SK 2155. *O. argyroleuca* Bornm.: B4 Ankara: Polatlı-Sazılar, 748 m, gypseous slopes, 01.06.2007, SK 2104. *O. aucheri* Boiss.: B10 Ağrı: Doğu Beyazıt, 1813–1905 m, calcareous slopes, 10.06.2007, SK 2090. *O. karjaginii* Grossh.: B8 Erzurum: Hınıs, near Aras River, 1677 m, calcareous slopes, 06.06.2007, SK 2066. *O. lupinoides* Grossh.: B7 Erzincan: Sürek, 1193 m, steppe, 06.06.2007, SK 2055.

All the plant specimens studied are deposited in the Gazi University Herbarium, Gazi. The order of the species included in this study was adapted following Chamberlain and Matthews (1970), Özhatay (2000) and Erkul and Aytac (2012).

Pollen samples were prepared after Erdtman (1960) and examined by a Leica DM 3000 Digital imaging system microscope. For each morphological character, measurements were recorded based on 30 pollens and the mean value and standard deviation were calculated. During SEM, selected dry samples of pollens were placed on the aluminium stabs with the help of double-sided adhesive tape and coated in gold with vacuum (Altuner *et al.* 2012, Çeter *et al.* 2013a, b, Pinar *et al.* 2009b). The images of the pollen were taken with Jeol JSM 6060 scanning electron microscope in the SEM laboratory of the Department of Biology, Gazi University.

Pollen terminology was adopted from Hesse *et al.* (2009) and Punt *et al.* (1994, 2007). Classification of the pollens shape was determined following Erdtman (1969) based on P/E ratio.

Results and Discussion

The main palynological features of the Turkish *Oxytropis* species that were examined are summarised in the Tables 1 - 2 and are shown in Figs 1 - 2.

Pollens of all *Oxytropis* studied were isopolar and radialy simmetric. Pollen shape was subprolate in *O. persica*, *O. lazica*, *O. aucheri* and *O. karjagini* and prolate in *O. kotschyana, O. pilosa, O. pallasii, O. albana, O. argyroleuca, O. lupinoides* and *O. savellanica*. P/E ratios ranged from 1.24 - 1.51 (Table 2, Figs 1 - 2).

Pollen size varied, with the polar axis, ranging 19.52 - 33.31 µm and the equatorial axis 13.50 - 25.82 µm. (Table 1, Figs 1 - 2).

Table 1. Quantitative pollen morphological parameters of *Oxytropis* spp.

Taxa	P	E	Clg	Clt	Plg	Plt	Et	L	t
O. kotschyana	20.27 ± 0.89	15.20 ± 0.80	16.00 ± 0.92	1.26 ± 0.16	2.90 ± 0.30	5.08 ± 0.50	1.25 ± 0.18	15.78±1.11	4.22 ± 0.41
O. pallasii	24.80 ± 0.71	17.66 ± 0.96	18.08 ± 1.29	1.35 ± 0.24	5.09 ± 0.35	7.26 ± 0.32	1.43 ± 0.19	18.85 ±0.99	5.65 ± 0.52
O. pilosa	23.65 ± 1.14	17.34 ± 1.07	18.57 ± 0.98	1.42 ± 0.18	3.72 ± 0.29	7.70 ± 0.58	0.85 ± 0.18	17.76 ±1.03	3.84 ± 0.49
O. savellanica	22.85 ± 1.56	16.93 ± 0.96	18.05 ± 1.58	1.14 ± 0.19	2.82 ± 0.39	5.43 ± 0.43	1.09 ± 0.16	17.66±0.93	5.10 ± 0.53
O. persica	19.59 ± 1.42	15.30 ± 0.98	13.89 ± 1.18	1.16 ± 0.15	3.49 ± 0.49	6.21 ± 0.78	1.63 ± 0.18	14.53±1.09	5.05 ± 0.87
O. albana	20.61 ± 0.97	15.46 ± 1.11	15.74 ± 0.89	0.98 ± 0.18	3.63 ± 0.65	5.68 ± 0.58	1.01 ± 0.17	14.62±0.97	5.69 ± 0.51
O. lazica	33.31 ± 2.01	25.82 ± 1.78	25.06 ± 1.29	1.90 ± 0.16	5.04 ± 0.46	9.18 ± 0.92	1.99 ± 0.24	26.11±1.34	8.22 ± 1.23
O. argyroleuca	27.55 ± 1.10	18.27 ± 1.37	19.42 ± 0.93	1.28 ± 0.19	4.61 ± 0.30	8.30 ± 0.83	1.29 ± 0.20	20.61±1.38	7.30 ± 0.93
O. aucheri	29.18 ± 1.46	22.08 ± 1.59	21.22 ± 1.16	1.22 ± 0.17	4.83 ± 0.33	8.26 ± 0.44	1.25 ± 0.18	22.56±0.97	8.54 ± 0.64
O. karjaginii	22.91 ± 1.06	17.76 ± 0.86	17.86 ± 0.82	1.38 ± 0.32	4.24 ± 0.36	7.62 ± 0.82	1.09 ± 0.21	19.14±0.91	8.30 ± 1.04
O. lupinoides	22.66 ±1.35	17.30 ± 1.67	20.28 ± 0.93	0.53 ± 0.17	4.42 ± 0.32	6.48 ± 0.43	1.18 ± 0.17	15.62±0.87	7.84 ± 1.08

P: Polar axis, E: Equatorial axis, Clg: Colpus longitude (length), Clt: Colpus latitude (width), Plg: Porus longitude (length), Plt: Porus latitude (width), Et: exine thikness, L: Mesocolpia and t: Apocolpia.

Tricolporate pollens were commonly found in all *Oxytropis* species studied. Colpi were usually long and narrow (Clt: 0.34 ± 0.11- 1.90 ± 0.16 µm, Clg: 13.89 ± 1.18 - 25.06 ±1.29 µm), operculate, operculum membrane granulate. Pores were observed as oblate (Plg: 2.82 ± 0.39 - 5.09 ± 0.35 µm, Plt: 4.79 ± 0.54 - 9.18 ± 0.92 µm) and operculate, Operculum ornamentation was verrucate and granulate (Tables 1 - 2, Figs 1 - 2).

Table 2. Qualitative pollen morphological characters of *Oxytropis* spp.*

Taxa	P/E ratio, Pollen shape	Plg/Plt ratio, Porus shape	Ornamentation	
			Equatorial section	Polar section
O. kotschyana	1.33, prolate	0.57 oblate	Perforate	Psilate
O. pallasii	1.40, prolate	0.70 oblate	Microreticulate	Psilate
O. pilosa	1.36, prolate	0.48 oblate	Perforate	Perforate
O. savellanica	1.35, prolate	0.52 oblate	Microreticulate	Perforate
O. persica	1.28, subprolate	0.56 oblate	Perforate	Perforate
O. albana	1.33, prolate	0.64 oblate	Microreticulate	Microreticulate
O. lazica	1.29, subprolate	0.55 oblate	Perforate	Psilate
O. argyroleuca	1.51, prolate	0.55 oblate	Perforate	Perforate
O. aucheri	1.32, subprolate	0.59 oblate	Microreticulate	Microreticulate
O. karjaginii	1.29, subprolate	0.56 oblate	Perforate	psilate
O. lupinoides	1.31, prolate	0.68 oblate	Perforate	Psilate

*Otherwise, in all the taxa, pollen symetry, polarity, aperture type and colpus shape are isopolar, radially symmetric, tricolporate and long and narrow, respectively.

The smallest (14.53 µm) mesocolpium was found in *O. persica* and the largest (26.11 µm) in *O. lazica*. The smallest apocolpium (3.84 µm) was found in *O. pilosa*, whereas the largest (8.54 µm) was observed in *O. aucheri*. The shortest Clg (13.89µm) was observed in *O. persica*, whereas the longest (25.06 µm) Clg in *O. lazica*. The smallest Clt (0.53 µm) was found in *O. lupinoides*, while the largest Clt (1.90 µm) in *O. lazica*. The shortest Plg (2.82 µm) was recorded in *O. savellanica*, whereas the longest (5.04 µm) in *O. lazica*. *O. kostchyana* pollens were found with the shortest Plt (5.08 µm) whereas those of *O. lazica* with the longest (9.18 µm).

Exine and ornamentation: Exine of all *Oxytropis* species was subtectate with a thickness ranged from 0.85 - 1.99 µm. Ectexine was thicker than endexine. The following five main pollen types were recognized in *Oxytropis* based on the ornamentations at polar and equatorial sections of the pollens:

Type I Equatorial perforate, polar psilate; *O. karjaginii*, *O. kotschyana*, *O. lupinoides* and *O. lazica.*

Type II Equatorial microreticulate, polar psilate; *O. pallasii*.

Type III Equatorial microreticulate, polar perforate; *O. savellanica*.

Type IV Microreticulate at both sections; *O. albana* and *O. aucheri*.

Type V Perforate at both sections; *O. pilosa, O. persica* and *O. argyroleuca.*

On the basis of pollen morphological characters, Perveen and Qaiser (1998) recognized 10 distinct pollen types in 157 species distributed in Pakistan. Pollen of *Oxytropis* were described as fine reticulate, prolate and subprolate with tricolporate aperture in the tribe Galegeae (*Colutea* L., *Astragalus* L., *Oxytropis* DC., *Caragana* Lam.) (Parveen and Qaiser 1998). These features were

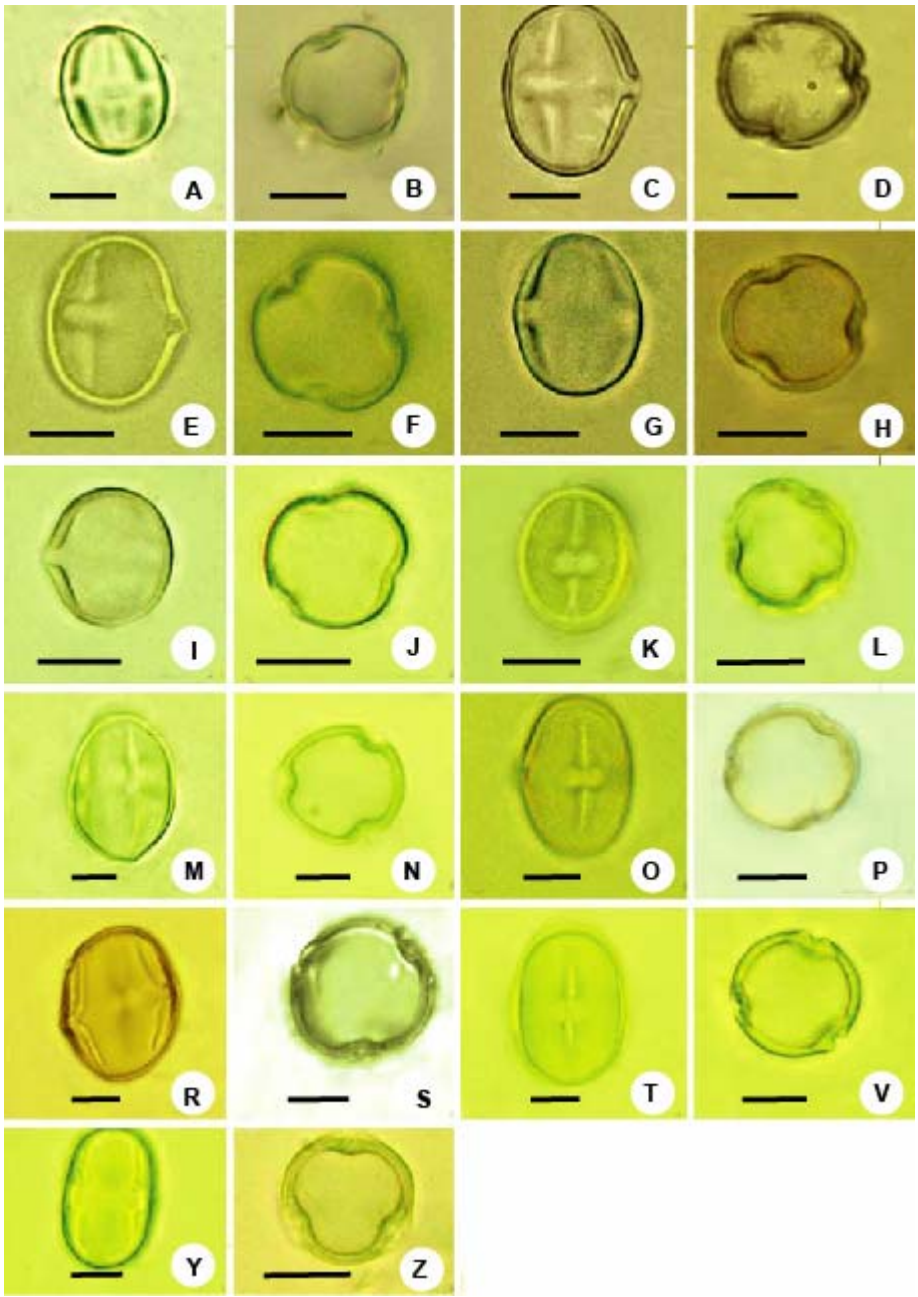

Fig. 1. LM micrograph of the pollen of *Oxytropis*. A-B: *O. kotschyana*, A: Equatorial view, B: Polar view, C-D: *O. pallasii*, C: Equatorial view, D: Polar view, E-F: *O. pilosa* E; Equatorial view, F: Polar view, G-H: *O. savellanica*, G; Equatorial view, H: Polar view, I-J: *O. persica*, I: Equatorial view, J: Polar view, K-L: *O. albana*, K: Equatorial view, L: Polar view, M-N: *O. lazica*, M: Equatorial view, N: Polar view, O-P: *O. argyroleuca,* O; Equatorial view, P: Polar view, R-S: *O. aucheri,* R. Equatorial view, S: Polar view, T-V: *O. karjaginii*, T: Equatorial view, T: Polar view. Y-Z: *O. lupinoides,* Y: Equatorial view, Z: Polar view. (Bar: 10 µm).

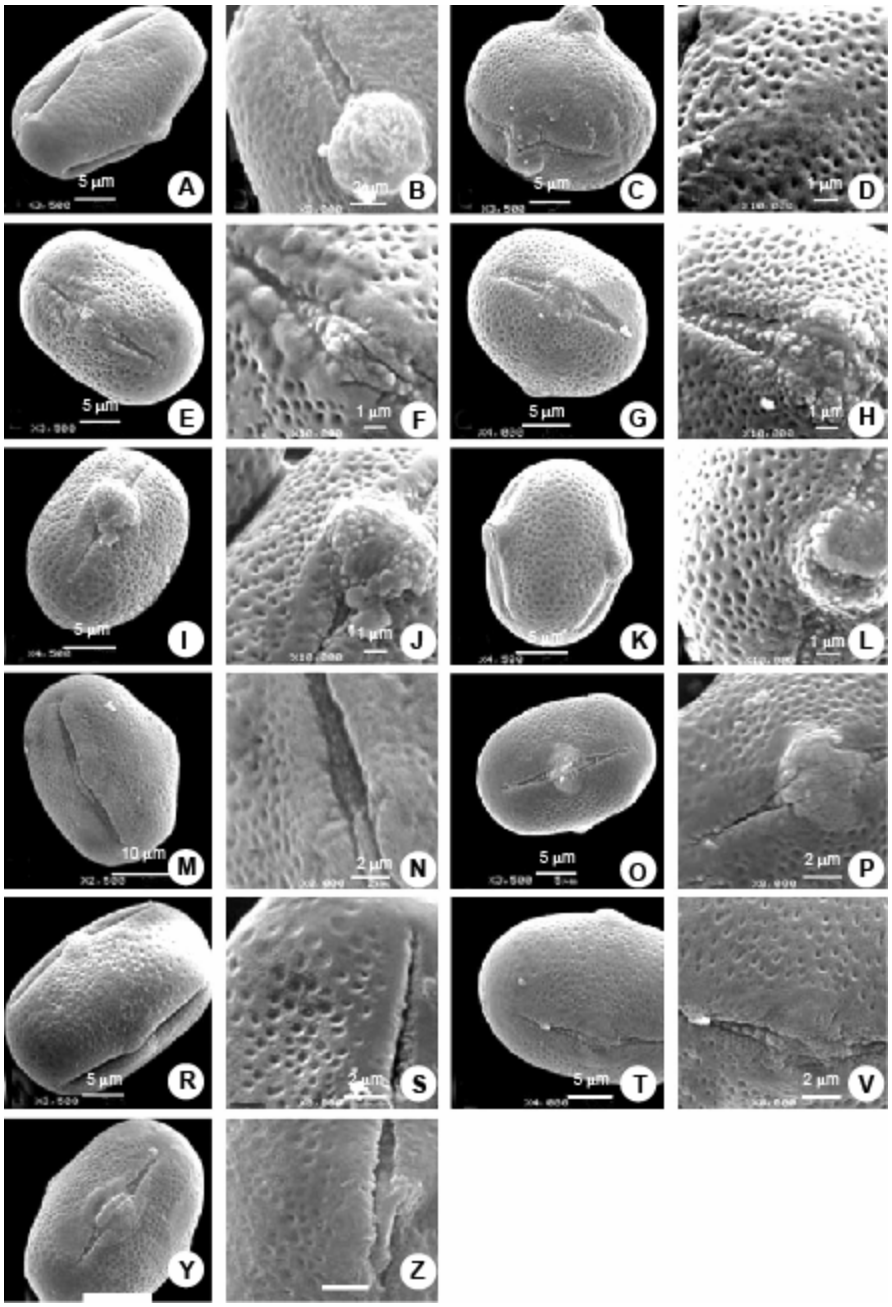

Fig. 2. SEM micrograph of *Oxytropis*. A-B: *O. kotschyana*, A: Equatorial view and apertures, B: Ornamentation, C-D: *O. pallasii*, C: Equatorial view and apertures, D: Ornamentation, E-F: *O. pilosa* E; Equatorial view and apertures, F: Ornamentation, G-H: *O. savellanica*, G; Equatorial view and apertures, H; Ornamentation, I-J: *O. persica*, I; Equatorial view and apertures, J: Ornamentation, K-L: *O. albana*, K: Equatorial view and apertures, L: Ornamentation, M-N: *O. lazica*, M: Equatorial view and apertures, N: Ornamentation, O-P: *O. argyroleuca*, O: Equatorial view and apertures, P: Ornamentation, R-S: *O. aucheri*, R: Equatorial view and apertures, S:Ornamentation, T-V: *O. karjaginii*, T: Equatorial view and apertures, T: Ornamentation. Y-Z: *O. lupinoides*, Y: Equatorial view and apertures, Z: Ornamentation.

also seen in the present investigation. Ferguson and Skvarla (1981) also reported the similar types of pollen in the tribe Galegeae.

The pollen types II, III and IV as recognised in this study are consistent to privious study on *Oxytropis* pollens by Perveen and Qaiser (1998)

Some pollen characters of Turkish *Oxytropis* isopolar symmetry, namely radially symmetric polarity, tricolporate aperture, long and narrow colpus and subtectate exine support the similarity between the eleven species studied. Two types of pollens based on pollen shape characters and five types of pollens based on the ornamentations at equatorial and polar sections can be recognised in Turkish species of *Oxytropis*. The findings of this study indicate the taxonomic implications of pollen morphology in understanding the similarity and relationships in the genus *Oxytropis*.

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References

Akan H, Tatlıdil S and Bıçakçı A 2005. Pollen morphology of Astragalus L. Section Alopecuroidei DC. (Fabaceae) in Turkey. Intl. J. Bot. **1**(1): 50-58

Altuner EM, Çeter T and Alpas H. 2012. High hydrostatic pressure processing: A method having high success potential in pollen protein extraction. High Pressure Research **32**(2): 291-298.

Çeter T, Pınar NM, İnceer H, Hayırlıoğlu-Ayaz S and Yaprak AE 2013a. The comparative pollen morphology of genera *Matricaria* L. and *Tripleurospermum* Sch. Bip. (Asteraceae) in Turkey. Plant Systematics and Evolution **299**(5): 959-977

Ceter T., Ekici M, Pinar NM and Özbek F. 2013b. Pollen morphology of *Astragalus* L. section Hololeuce Bunge (Fabaceae) in Turkey. Acta Botanica Gallica DOI:10.1080/12538078.2013.791641.

Chamberlain DF and Mathews MA 1970. *Oxytropis* DC. *In:* Davis PH (ed.) Flora of Turkey and the East Aegean Islands, Vol. 3, pp. 254. Edinburgh: Edinburgh University Press.

Ekici M, Yüzbaşıoğlu D and Aytaç Z 2005. Morphology, pollen, seed structure and karyological study on *Astragalus ovalis* Boiss & Balansa (sect. Ammodendron) in Turkey. Intl. J. Bot. **1**(1): 74-78.

Erdtman G 1969. Handbook of Palynology Morphology, Taxonomy, Ecology. An introduction to the study of pollen grains and spores. pp. 34-235. New York: Hafner Publication.

Erkul KS and AYTAÇ Z 2012. The revision of the genus *Oxytropis* DC. (Leguminosae) in Turkey, Turkish J. Bot. **37**(2013): 24-38.

Ferguson IK and Skvarla JJ 1981. The pollen morpology of the subfamily Papilionoideae (Leguminosae). *In:* Advances in Legume Systematics, Polhill RM and Raven PH (Eds), pp. 859-896. Royal.

Hesse M, Halbritter H, Zetter R, Weber M, Buchner R, Frosch-Radivo A and Ulrich S 2009. Pollen Terminology, An illustrated handbook. pp. 15-23. Springer-Verlag/Wien, Austria.

Jurtzev R 1978. In Flora Arctica URSS. 9 (2). - Leningerad

Jurtzev R 1988. A new species of the genus *Oxytropis* from the section *Baicalia* (Fabaceae) and the problem of continental relict in the flora of the Wrangel Island. Bot. Zhurn. (Leningrad), **73**(12): 1649-1661

Lock M and Schrire BD 2005. Galegeae. *In:* Lewis GP, BD Schrire, BA Mackinder and M Lock (eds), Legumes of the world. Royal Botanic Gardens, Kew, India. pp. 475-481.

Özhatay N 2000. *Oxytropis* DC. *In:* Güner A, Özhatay N, Ekim T and Başer KHC (eds.) Flora of Turkey and the East Aegean Islands, (suppl. 2), Vol. **11**, p. 88. Edinburgh: Edinburgh University Press.

Pelánková and Chytrý BM 2009. Surface pollen-vegetation relationships in the forest-steppe, taiga and tundra landscapes of the Russian Altai Mountains. Review of Palaeobotany and Palynology **157**: 253-265.

Perveen A and Qaiser M 1998. Pollen Flora of Pakistan. VIII. Leguminosae (Subfamily: Papilionoideae). Tr. J. Bot. **22:** 73-91

Pınar NM, Duran A, Çeter T, and Tuğ GN. 2009b. Pollen and seed morphology of the genus *Hesperis* L. (Brassicaceae) in Turkey. *Turkish Journal Botany* 33(2): 83-96.

Pınar NM, Ekici M, Aytac Z, Akan H, Ceter T and Alan Ş 2009a. Pollen morphology of *Astragalus* L. sect. *Onobrychoidei* DC. (Fabaceae) in Turkey. Turk. J. Bot. **33**: 291-303.

Polhill RM 1981. Tribe 16. Galegeae (Bronn) Torrey and Gray 1838. pp. 357-363. *In:* R.M. Polhill and P.H. Raven (eds), Advances in Legume Systematics, Part 1. Royal Botanic Gardens, Kew.

Polozhij AV 1994. Fabaceae. *In:* Flora Sibiriae, Vol. 9. p. 14-149. Novosibirsk.

Punt W, Blackmore S, Nilsson S and Le Thomas A 1994. Glossary of Pollen and Spore Terminology, pp. 1-246. LPP Foundation, Utrecht.

Punt W, Hoen PP, Blackmore S, Nilsson S and Le Thomas A 2007. Glossary of Pollen and Spore Terminology, Rev Palaeobot Palynol. **143**: 1-81

Simons EP and Chinnappa CC 2004. Pollen morphology and taxonomic status of North American Astragalus and *Oxytropis* (Papilinoideae = Fabaceae). Beiträge zur Biologie der Pflanzen **73**: 307-319

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