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PALYNOLOGICAL STUDIES ON SOME SPECIES OF *ANABASIS* L. (AMARANTHACEAE) FROM IRAN

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Abstract

The paper presents pollen micromorphology by scanning electron microscopy of seven *Anabasis* L. species namely, *A. haussknechtii* Bge., *A. aphylla* L., *A. calcarea* (Charif & Allen) Bokhari & Wendelbo, *A. eugeniae* Iljin, *A. eriopoda* (Shrernk) Volkens, *A. annua* Bge. and *A. setifera* Moq. from Iran. Pollen grains in all studied species are peripolyporate, spherical and are of two basic types based on pores diameter inner of holes. The study showed that the sculpturing of exine provides valuable characters in species delimitation, sometimes even for closely related ones. An artificial key based on pollen characters for seven species is provided.

Introduction

Amaranthaceae comprises of approximately 163 genera and 1825 species (Kadereit *et al.*, 2003 and APG III, 2009). *Anabasis* belonging to the tribe Salsoleae *s.l.* is one of the largest tribes in Amaranthaceae, includes one-third of the genera currently recognized in the family (Ku¨hn *et al.*, 1993), distributed throughout arid, semiarid, saline, and hypersaline ecosystems of temperate and subtropical regions (Pyankov, *et al.*, 2001; Kadereit *et al.*, 2003 and Akhani *et al.*, 2007). *Anabasis* is distributed in Iran by 10 species and 2 varieties (Freitag, 1997 and Assadi, 2001). Iran is one of the distribution centers for *Anabasis* (Akhani *et al*., 2007).

Tsukada (1967) studied amranth-chenopoid pollens by electron microscope and used pollen characters like pores, shape, size and conical tubercle as key characters. There is no study on the pollen micromorpholgy on *Anabasis* from Iran. The present study aims to investigate the pollen micromorpholgy of *Anabasis*, to evaluate its taxonomic value and to prepare an identification key for seven *Anabasis* species from Iran based on pollen micromorphological characters.

Materials and Methods

This study includes seven *Anabasis* species from Iran based on materials deposited in the National Herbarium of Iran, Research Institute of Forests and Rangelands (TARI) and Islamic Azad University Garmsar Herbarium (IAUGH) and also collected from different localities of Iran during 2013-2014 (Table 1). Pollen grains of 7 species of the genus *Anabasis* were studied by scanning electron microscope. Samples were obtained mostly from fresh collected herbarium specimens. The voucher and the pollen specimens, deposited in TARI Herbarium, are listed under table 1. For SEM, were used the protocol explained by Davies (1999) with some modifications. The specimens were mounted on 12.5 mm diameter stubs and attached with sticky tabs and then coated in a sputter coater with approximately 25 µm of Gold- Paladium. Pollens were examined and photographed by a Philips scanning electron microscope model XL. Following quantitative

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parameters were recorded: polar and equatorial pollen, P/E, pore diameters inner and outer, number of conical tubercle, pore high, distance between of centers of the adjacent pores and pores number. The terminology used for describing the pollens features followed in general by Moore *et al.* (1991) and Punt *et al.* (1994).

Table 1. Distribution of species of *Anabasis* L. studied.

Species	Locality	Collector	Altitude (m)	Herbarium number	Herbarium name
Anabasis setifera Moq.	Tehran-Eyvaneky, Roude Shour	Fajani	780	5899	IAUGH
A. annua Bge	Kerman, 45 km to Mahan,	Assadi & Amirabadi	2300	66521	TARI
A. aphylla L.	Tehran, 31 km south of Firouzkouh, Pirdeh	Fajani	2200	5900	IAUGH
A. haussknechtii Bge.	Semnan, 10 km, S.-E. Semnan, near Aella village	Fajani	1050	5901	IAUGH
A. eugeniae Iljin	Azerbaijan, 34 km from Alamdar toward Khodaafarin, between Ahmadabad and Siahroud	Assadi and Shahsavari	700	65828	TARI
A. eriopoda (Shrenk) Volkens	Protected of Touran area, west-nourth of Dochah, in road of Chah Jaam	Feritag	1150	14103	TARI
A. calcarea (Charif&Aellen) Bokhari and Wendelbo	Semnan, 25 km east-south of Masnan in road of Taroud	Wendelboo and Foroughi	1120	18684	TARI

Results

The main features of the investigated of pollen are summarized in Table 2. Our studies show that the sculpturing of exine provides valuable characters for separating the species, sometimes even for closely related ones, and delimitation of species. Pollen grains of all studied species are peripolyporate, spherical, having 32-83 conical tubercles on pore of pollen surface, polar length 12.4-26.10 µm, equatorial length 9.83-25 µm, number of pores 8-25 on pollen surface, 23-85 conical tubercle per 5 µm, distance between the center of adjacent pores 4.84-10 µm, pores diameter (outer) 3.5-10.2 µm, pores diameter (inner) 2-6 µm, pores height 0.1-0.35 µm and tectal of conical tubercle length 0.2-0.6 µm.

Following Punt *et al.* (1994) two basic types of pollen grains are distinguished based on holes pore diameters (inner), such as, Type A: pore diameter of holes (inner) on the exine is less than 3 µm² and Type B: pore diameter of holes (inner) on the exine is more than 3 µm (Table 2).

Type A includes *A. eriopoda, A. haussknechtii, A. annua* and *A. aphylla*; and *Type* B includes *A.eugeniae, A. calcarea and A. setifera.* On the basis of the exine sculpturing at proximal face, two main pollen types, as faveat tectum and faweat tectum are recognized (Table 2, Figs. 1& 2).

Table 2. Characteristic features of pollen grains in Iranian representatives of *Anabasis* L.

Species	Vouchers	Polar pollen (µm)	Equatorial pollen (µm)	P/E pollen	Pores diameter outer (µm)	Pores diameters inner (µm)	No. of conical tubercle(5 µm)	Pores high (µm)	No. of conical tubercle on holes	Distance between of centers of the adjacent pores (µm)	Pores number
Anabasis setifera Moq.	Fajani 5899 IAUGH	13.8-14.2	12.04-12.29	1.08	8.1-8.3	3.30-3.40	70-75	0.3-0.4	35-37	6-6.2	13-14
A. annua Bge	Assadi and Amirabadi 66521 TARI	12.4-12.5	9.83-10.21	1.21	5.1-5.2	2.10-2.20	72-78	0.3-0.35	80-83	6-7.5	8-9
A. aphylla L.	Fajani 5900 IAUGH	18.3-18.6	17.90-18.33	1.21	6.5-6.7	2-2.5	60-63	0.25-0.3	32-35	6.3-6.6	18-19
A. haussknechtii Bge.	Fajani 5901 IAUGH	15.3-15.45	15.30-15.65	0.96	3.5-3.6	1.93-2.15	23-25	0.20-0.25	38-45	4.84-5.15	24-25
A. eugeniae Iljin	Assadi and Shahsavari 65828 TARI	25.30-26.10	24 -25	1.12	10-10.2	5-5.30	46-49	0.10-0.20	75-80	9.5-10	17-18
A. eriopoda (Shrenk) Volkens	Feritag 14103 TARI	14.16-14.30	14-15	1.09	6.5-6.6	2.5-2.7	39-43	0.1-0.15	40-42	7-7.5	17-19
A. calcarea (Charif & Aellen) Bokhari and Wendelbo	Wendelboo and Forougi 18684 TARI	18.50-19.27	18.40-18.80	1.01	7.5-7.7	5.8-6	80-85	0.3-0.33	55-60	8.5-8.8	20-22

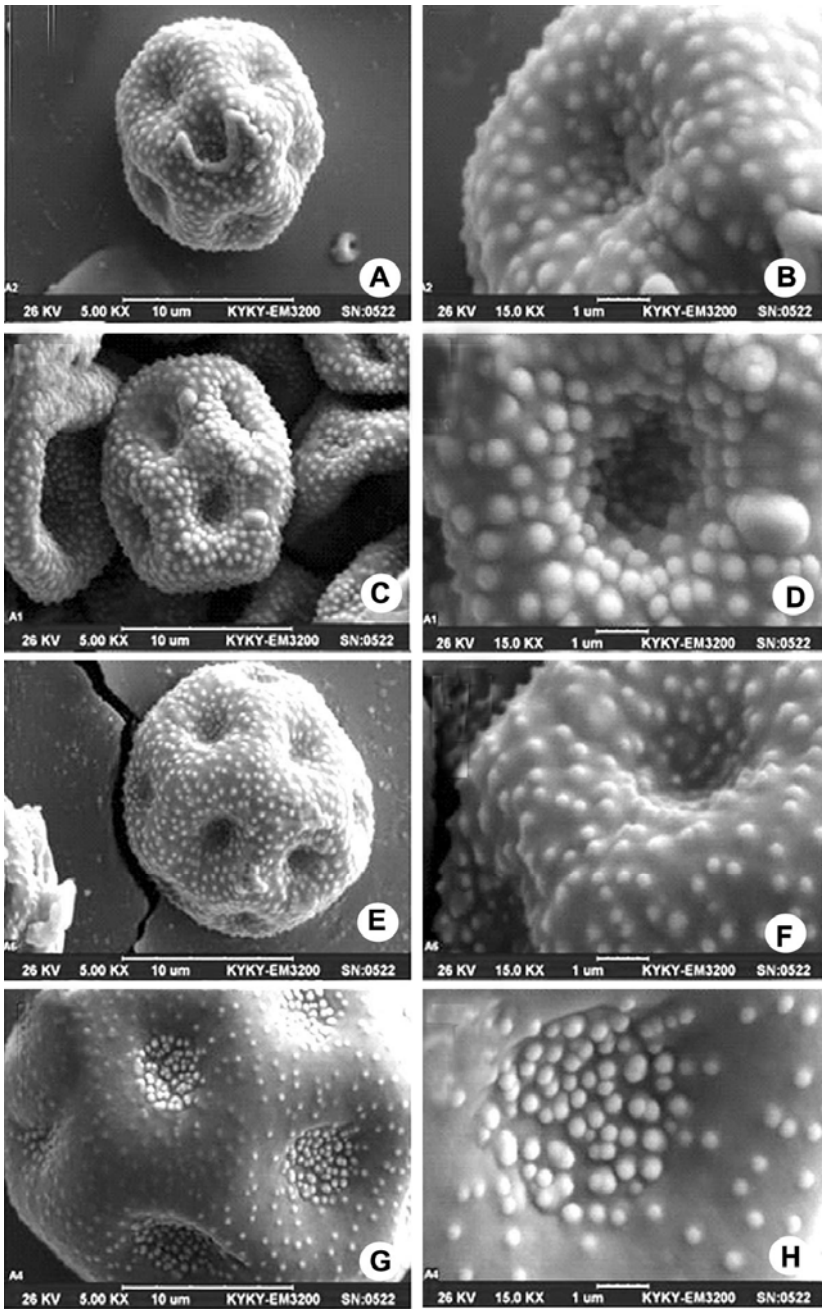

Fig. 1. Micrograph of pollen grains in *Anabasis* (Amaranthaceae). A-B, faveat tectum at the proximal face in *A. setifera* pollen with faveat ornamentation of exine. C-D, faweat tectum at the proximal face in *A. annua* pollen with faveat ornamentation of exine. E-F, faweat tectum at the proximal face in A. eriopoda pollen with faveat ornamentation of exine. G-H, faweat tectum at the proximal face in *A.eugenia*. pollen with faveat ornamentation of exine. Scale bars: A, C, E & G= 10 µm; B, D, F, H = 1 µm.

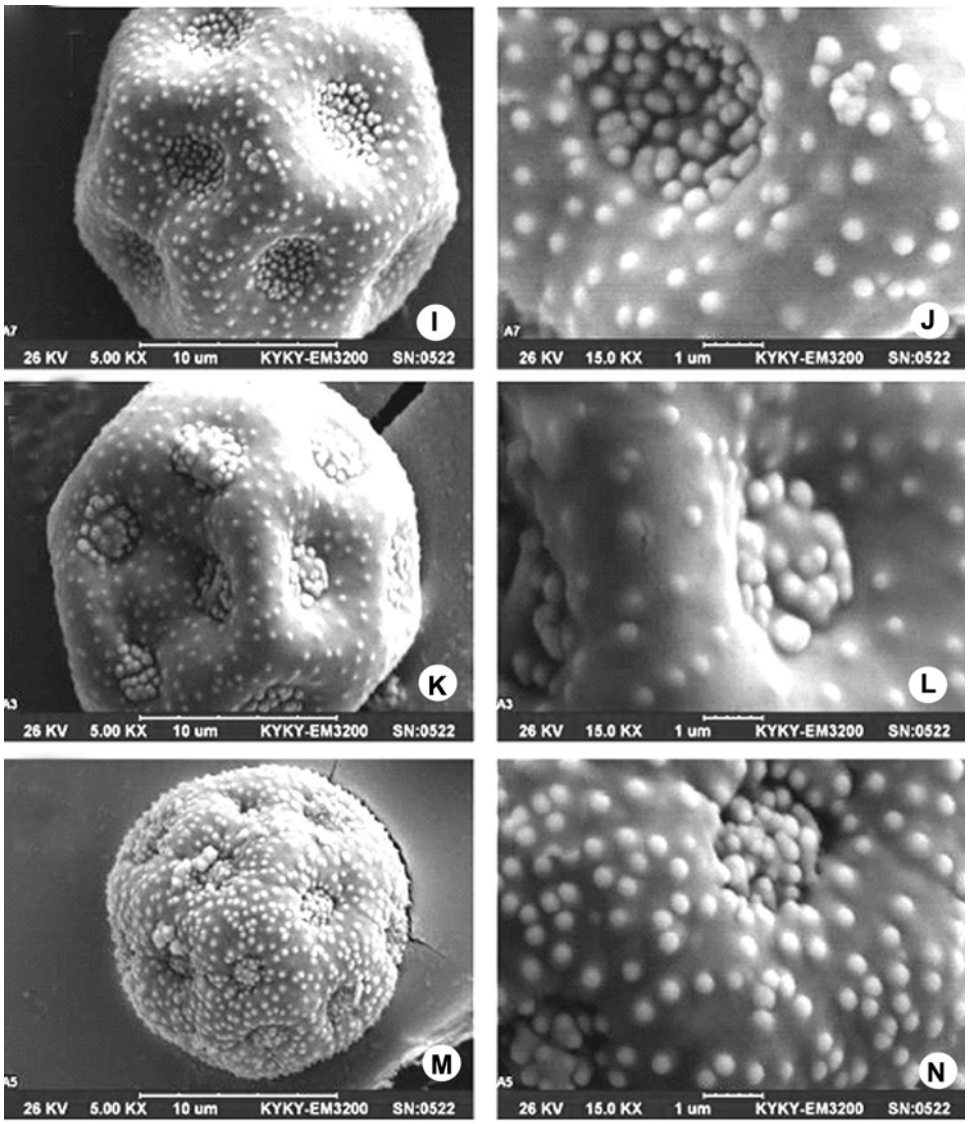

Fig. 2. Micrograph of pollen grain in *Anabasis* (Amaranthaceae). I-J. Faveat tectum at the proximal face in *A. calcarea* pollen with faveat ornamentation of exine. K-L. Faweat tectum at the proximal face in *A. aphylla* pollen with faveat ornamentation of exine. M-N. Faweat tectum at the proximal face in *A. hausskanchtii* pollen with faveat ornamentation of exine. Scale bars: I, K & M = 10 µm; J, L & N = 1 µm.

Discussion

The basic palynomorphological characters of *Anabasis* in all studied species are the occurrence of spherical shape and peripolyporate pollens. The importance of pore number and C/D ratio in the *Chenopodium* L. species was emphasised by Andrews & Swanson (1967) and Uotila (1997). The present study does not show any correlation between pore number and pollen size.

The present study confirms the findings of Pinar & Inceoglu (1999) and Hamdi *et al.* (2009) that the pollen morphology of the *Salsola* L. and *Chenopodium* species in general shows uniform type characteristics by pollen micromorphology. Pollen grains in the *Anabasis* can be grouped into two groups as found in Amaranthaceae by Tsukada (1967).

Pollen morphological characters of the *Anabasis* species are closely related to *Salsola, Suaeda* Forssk. Ex Scop., *Chenopodium*, *Halocharis* Moq. , *Sarcobatus* Nees , *Traganum* Delile of Amaranthaceae, as well as to the pollen morphology type found in Portulacaceae, Phytolacaceae and Caryophyllaceae (Tsukada, 1967; Uotila, 1974; Skvarla & Nowicke, 1976), Youngjae & Lee, 1995; Borsch, 1998); Pinar & Inceoglu, 1999; Hamdi *et al.*, 2009 and Nikolaevna Toderich *et al*., 2010). There is variation in distance between the centers of the adjacent pores and corresponding pore number (Mc Andrews & Swanson, 1967). Nikolaevna Toderich (2010) noted the correlation between length of the polar and equatorial axes and size of the flower in *Salsola*. This study suggests that there are significant differences in pollen size, tubercles on surface exine, distance between the centers of the adjacent pores and pore numbers on surface exine within *Anabasis* species. The results of this study show that pollen micromorphology can be used in delimiting species of this genus.

Based on pollen morphological characters following key is provided in indentifying seven species in *Anabasis* from Iran

Key to Iranian *Anabasis* species based on pollen characters

1.	Pore diameter (inner) of holes on the exine less than 3 µm	2
-	Pore diameter (inner) of holes on the exine more than 3 µm	5
2.	Pore diameter (outer) of holes on the exine less than 4 µm	*A. haussknechtii*
-	Pores diameter (outer) of holes on the exine more than 4 µm	3
3.	Pore height less than 0.3 µm	*A. eriopoda*
-	Pore height more than 0.3 µm	4
4.	Number of conical tubercle on holes 80-83	*A. annua*
-	Number of conical tubercle on holes 32-35	*A. aphylla*
5.	Pore diameter inner less than 0.5 µm	*A. setifera*
-	Pore diameter inner more than 0.5 µm	6
6.	Number of conical tubercle on holes 46-49	*A. eugeniae*
-	Number of conical tubercle on holes 80-85	*A. calcarea*

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