POLLEN MORPHOLOGY OF THE GENUS ROSA L. (ROSACEAE) IN IRAN

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Received 22.04.2012. Accepted for publication 07.11.2012.

Fatemi, N, Attar, F., Assareh. M. H. & Hamzehee, B. 2012 12 31: Pollen morphology of the Genus *Rosa* L. (*Rosaceae*) in Iran. *-Iran. J. Bot 18 (2): 284-293.* Tehran.

Pollen grains of 13 species of the genus *Rosa* belonging to two subgenera, *Rosa* and *Hulthemia*, and one hybrid species were performed using light (LM) and scanning electron microscopy (SEM). The basic shape of pollen grains in 11 studied taxa is subprolate but prolate and rarely prolate- spheroidal pollen grains also can be found in nine species. The grains are usually trizonocolporate, aperture structure consists of 3 ectocolpi and 3 endopores. Endopores are located in the middle part of ectocolpi. Similar to the other genera of *Rosaceae*, striate sculpturing is the main ornamentation of pollen grains. According to surface sculpturing features such as slope, diameter and distance between ridges, number and size of perforations is classified into four major types and four subordinate types; however, other ornamentation types such as gemmate are observed. Characters of pollen grain provide useful criteria for separating taxa in sectional and specific levels.

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Key words. Iran, pollen grain, *Rosa*, *Rosaceae*, Taxonomy.

مطالعه دانه گرده جنس **Rosa L. (Rosaceae)** در ایران

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در این مطالعه دانه گرده ۱۳ گونه از جنس *Rosa* متعلق به دو زیر جنس *Rosa* و *Hulthemia* و یک دورگه با استفاده از میکروسکوپ نوری و الکترونی مورد مطالعه قرار گرفت. بر اساس شکل دانه گرده، در ۱۱ تاکسون شکل Subprolate و به ندرت Prolate, Prolate-spheroidal مشاهده شد. دانه‌های گرده سه شیار منفذی و ساختار دریچه شامل ۳ ectocolpi و۳ endopores است. endopores معمولا در بخش میانی ectocolpi قرار گرفته‌اند. مشابه جنس‌های دیگر این خانواده،تزئینات سطح دانه گرده شیاردار (striate) است که بر اساس صفاتی از جمله شیب، قطر و فاصله بین شیارها، تعداد و اندازه منافذ به ٤ گروه اصلی و ٤ زیر گروه تقسیم می‌شود. با این حال تزئینات نادر دیگری مثل gemmate نیز مشاهده شد. بر اساس بررسی‌های انجام شده مشخص شد که صفات گرده‌شناسی ابزار مفیدی برای جداسازی در سطح بخش و گونه در این جنس هستند.

INTRODUCTION

Rosa L. is one of the important genera of subfamily *Rosoideae*, family *Rosaceae* (Zielinski 1982). This genus comprises four subgenera including *Hulthemia* (Dumort) Focke, *Platyrhodon* (Hurst) Rehder, *Hesperhodos* Cockerell and *Rosa* (Wissemann & Ritz 2007) and about 150-200 morphospecies (Wissemann & Ritz 2007). Its members are native to temperate regions of the northern hemisphere, including North America, Europe, Asia and the Middle East. The greatest diversity of species is observed in western China (Australian Government 2005). Two subgenera

Hulthemia and *Rosa* with 13 (Zielinski 1982) to 14 (Khatamsaz 1992) wild species and six (Zielinski 1982) to eight hybrid (Khatamsaz 1992) taxa occur in Iran. This genus is distributed in most areas of Iran but mainly is distributed in scrublands of southern slopes of Elburz and Zagros mountains, especially in northwest (Azerbaijan province) and middle parts of it. Due to widespread distribution of some species such as *R. canina* L. there is remarkable variation in morphological features in this species, therefore some authors recognized several morphological form-series in this species (Nilsson 1972). Pollen morphological features has been proved to be useful in systematic of the family *Rosaceae* (Hebda & Chinnappa 1990) and some its particular genera such as *Sorbus* L., *Pyrus* L. and species such as *Rubus gracilis* Roxb. ex Ser. and *Prunus armeniaca* L. (Reitsma 1967; Fang & Yi-Xuan 1990; Arzani et al. 2005; Bednorz et al. 2005; Wronska-Pilarek et al. 2006; Zamani et al. 2010). Moore et al. (1991) have emphasized that pollen morphology (especially pollen size) in taxa of *Rosaceae* is very variable, even among the populations within the same species, which is related to frequency of hybrid, and polyploid species in this family. On the other hand, pollen size is generally influenced by internal (genetical) and external (environmental) factors (Jacob & Pierret 2000). On the basis of above-mentioned studies, pollen grains of most taxa of the family have a more or less similar morphological structure so that regarding two important features, aperture and exine sculpturing, most of taxa belong to trizonocolporate and striate types respectively. There are some variations in these characters (Hebda & Chinnappa 1990). Until now, several authors have studied pollen morphology in *Rosa* (Ueda & Tomita 1989; Jacob & Pierret 2000; Wronska-Pilarek & Boratynska 2005; Wronska-Pilarek & Lira 2006). On the basis of these studies it is suggested that pollen morphology may be valuable criterion in taxonomy of the genus. The present study aims to survey general pollen morphological characters and to assess their taxonomical value in separation of taxa in different levels, both in SEM and LM.

MATERIALS AND METHODS

Information of the studied voucher specimens is given in Table 1. Most specimens were collected directly from the field and some of them were obtained from herbaria, TUH, FUMH (acronyms according to Holmgren et al. 1990) and herbarium of Research Centre of Agricultural and Natural Resources of Kurdistan. The study using light (LM) and scanning electron microscopy (SEM) was performed on 20 taxa representing 13 species of the Iranian *Rosa* and one hybrid species. For assessment of probable effects of geographical distribution on pollen characters, several populations of some species were surveyed (Table 1). Pollen materials were prepared for light and scanning electron microscopy using methods described in Harley (1992) with some modifications. For LM studies, after acetolysis, pollen grains were mounted in glycerin jelly and the examined characters were measured by Nikon light microscope, model 200 M (Japan) with aid of a × 100 eyepiece: For each taxon, about 15-30 pollen grains were examined. The measured characters are provided in Table 2. For SEM, after acetolysis, the specimens were mounted on 12.5 mm diameter stubs and then coated in sputter coater with approximately 25 nm of gold- palladium. The specimens were examined and photographed with Philips scanning electron microscope model XL 30 (Netherlands) at an accelerating voltage of 5 to 20 kV. SEM micrographs were used mainly for studying the overall shape (I) and type of sculpturing (K) (Table 2). The terminology follows mainly that of Ertdman (1952) and Halbritter et al. (2007) but for detailed data, the terminology of Ueda & Tomita (1989) was used in this survey.

RESULTS

The main features of the investigated pollen grains are presented in Table 2. Selected LM and SEM micrographs of studied pollen grains are presented in Figs. 1-51. Pollen grains are shed as monad, apertures type is trizonocolporate. Endopores are located in the middle of ectocolpi. All species have operculum, which is located on aperture membranes in the middle of ectocolpi and covered partly or completely. Sculpture of operculum usually is psilate. The mean of polar axis (column B, Table2) varies from 24.60 µm in *Rosa kopetdagensis* to 38.67 µm in *R. iberica*-1. Equatorial axis (column C, Table 2) ranges from 18.00 (21.40±1.10) 26.00 µm in *R. elymaitica* to 32.00 (35.08±2.06) 40.00 µm in *R.iberica*-2. Thickness of exine (column G, Table 2) that is thin and ranges from 1.02 µm in *R. villosa* to 1.16 µm in *R. foetida*-1. Ratio of polar axis length to equatorial axis length (column D in Table 2) ranges from 1.02 µm in *R. iberica*-2 to 1.48 µm in *R. elymaitica*. Length of colpus (column H in Table 2) ranges from 22.33 µm in *R. villosa* to 30.07µm in *R. iberica*-1. Number of perforations per one square of micrometer ranges from 1.64 in *R. beggeriana* (Fig. 21) to 7.57 in *R. webbiana* (Fig. 24), distance of ridges ranges from 0.08 µm in *R. kopetdagensis* (Fig. 6) to 0.35 µm in *R. beggeriana* (Fig. 21). The most important feature in delimitation of borders between species is the pattern of sculpturing. The main exine sculpture is striate, however *R. villosa* by gemmate ornamentation (Fig. 49) is peculiar in this

Table 1. Voucher specimens of *Rosa* species in this study.

Species	Collection Data
R. boissieri Crepin	Azerbaijan: Mianeh to Tabriz, Kord-kandi village; Zamani & Fatemi; 37156-TUH.
R.canina L.	Azerbaijan:15 km to Kalybar from Ahar before Peygham village; Zamani & Fatemi; 38161-TUH (A). Kurdestan: 15 km after Sanandaj to Kamyaran; Zamani &Fatemi; 37168-TUH (C). Tehran: Karaj to Chalus, Sarvdar; Zamani & Fatemi; 37170-TUH (D). Golestan:16 km to Chahar-Bagh; Ghahreman & Attar; 37407-TUH (E).
R. elymaitica Boiss. & Hausskn.	Lorestan: Khoram Abad. Sefid Kuh; Ghahreman; 20174-TUH.
R. iberica Stev.	Azerbaijan: Arasbaran, between Asheqlu and Kalaleh-Olia; Zamani & Fatemi; 37153-TUH (1). Azerbaijan, 3 Km after Peygham to Kalybar; Zamani & Fatemi; 37159- TUH (2).
R. orientalis Dupont ex Ser.	Kurdistan: ca. 5 km from Bijar to Hemedan; Maroofi & Naseri ; 5792*.
R. pulverulenta M. B.	Azerbaijan-Mianeh to Tabriz, Kord-Kandi village; Zamani &Fatemi; 37155-TUH
R. villosa L.	Azerbaijan: Hasht-Rud to Maraqe-16 Km to Marand, Khalife Kandi village; Zamani & Fatemi; 38155- TUH.
R. beggeriana Schrenk.	Karaj-Chalous, 3 Km after Rey-Zamin beginning of Asara, left of the road , ca 30 km to Gachsar ; Zamani& Fatemi;37321-TUH.
R. webbiana Wall. ex Royle	Khorasan. Qaen, Zir-Kuh beginning Ahangaran pass; Joharchi & Zangooi; 36263-FUMH.
R. foetida J. Herrmann	Azerbaijan: Mianeh to Tabriz, after Niegehjeh to Qarreh-Chaman; Attar & Zamani 37157 – TUH (1). Kurdistan,5 km after Marivan to Sanandaj, Zarivar lake; Zamani & Fatemi; 37169-TUH (2).
R. hemisphaerica J. Herrmann	Semnan: after Shah-Kuh village to Derazno; Ghahreman & Attar; 37399-TUH (1). Azerbaijan: Jolfa to Marand-Zonuz, Zonuzaq village; Zamani & Fatemi; 38172 – TUH (2).
R. pimpinellifolia L.	Azerbaijan: Kalybar to Qale,,e-Babak; Zamani & Fatemi; 38163-TUH.
R. persica Michx. ex Juss	Tehran: Tehran to Karaj; Ghahreman; 9311-TUH.
R. kopetdagensis Meff.	Khorasan: Northwest Bojnurd, beginning Kale Emani and Tange Torkaman, north Kale; Emani & Joharchi; 33261- FUMH.

Abbreviations. TUH: Central herbarium of Tehran University. FUMH: Ferdowsi University Mashhad Herbarium. *: Research Institute of Forests and Natural Resources of Kurdistan.

case. Adopted from Ueda & Tomita (1989), some characters such as differences in number and diameter of perforations, slope of ridges and interval among them, striate sculpturing can be classified into four major types and four subordinate categories as follow:

Type I: This type is recognized by having merely deep and finger-print like ridges on the surface of pollen. This type is divided into two subordinates: 1-A with short interval between ridges that ranges from 0.08-0.19 µm in *R. hemisphaerica* (Fig. 41, 0.19 µm), *R. persica* (Fig. 3, 0.19 µm) and *R. kopetdagensis* (Fig. 6, 0.08 µm) and 1-B with long interval between ridges which ranges from 0.20- 0.24 µm in *R. foetida* (Fig.9, 0.22 µm), *R. canina* (*R. canina* E2) (Fig. 18), *R. orientalis* (Fig. 43, 0.20 µm) and *R. iberica*-1 (Fig. 45, 0.24 µm).

Type II: Differs from type **I** by having between discrete distinct ridges. This type is also divided into two subordinates: II-A with more distinct ridges observed in *R. boissieri* (Fig. 12), *R. elymaitica* (Fig. 15), *R. pulverulenta* (Fig. 35) and *R. iberica*-2 (Fig. 47) and II-B with completely discrete ridges observed in *R. canina*-E (Fig. 37) solely.

Type III: This type is recognized from Type II by having perforations between more distinct and continuous ridges. This type is observed in *R. canina*-C (Fig. 39), *R. beggeriana* (Fig. 21), *R. webbiana* (Fig. 24), *R. canina*-D (Fig. 27) and *R. canina*-A (Fig. 30).

Type V: Type V is an intermediate of striate and psilate sculpturing. It is recognized by having obscure ridges and lacking any perforation. This type is observed only in *R. pimpinellifolia* (Fig. 33).

DISCUSSION

Rosa is a taxonomically complicated genus and its species are remarkably variable (Zielinski 1982) and its

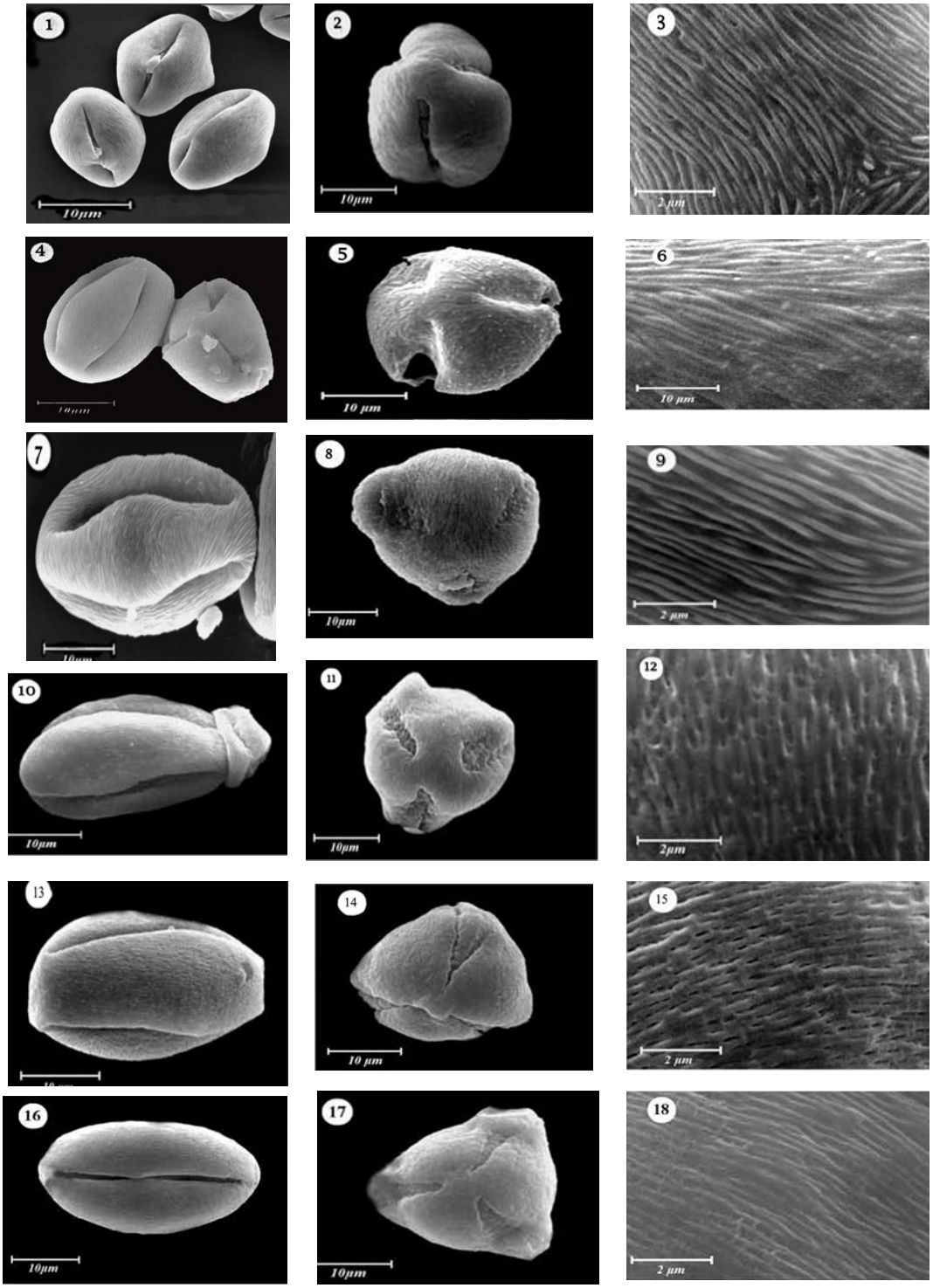
Table 2. Results of pollen morphology in the genus *Rosa*.

A	B	C	D	E	F	H	G
R. boissieri	30.00(34.06±2.84)40.00	22.00(26.40±3.27)32.00	1.30	14.00(16.40±1.84)21.00	4.00(4.93±0.68)6.00	22.00(26.47±3.36)34.00	1.00(1.13±0.23)1.50
R. canina-A	25.00(33.13±3.11)37.00	20.00(24.09±4.25)36.00	1.37	13.00(17.73±3.90)25.00	5.00(6.40±0.98)8.00	21.00(26.40±2.27)30.00	1.00(1.04±0.10)1.30
R. canina-C	30.00(32.77±2.19)37.00	21.00(23.03±2.44)30.00	1.42	18.00(22.27±2.37)25.00	5.00(5.53±0.64)7.00	24.00(26.40±2.03)31.00	1.00(1.03±0.13)1.50
R.canina-D	25.00(33.13±3.11)37.00	20.00(24.93±4.25)36.00	1.32	13.00(17.73±3.90)25.00	5.00(6.40±0.98)8.00	21.00(26.40±2.47)30.00	1.00(1.04±0.10)1.3
R.canina-E	33.00(36.13±1.72)39.00	23.00(29.00±3.58)33.00	1.24	17.00(20.80±2.78)25.00	5.00(5.67±0.61)7.00	25.00(27.80±2.40)32.00	1.00(1.06±0.17)1.50
R. elymaitica	26.00(31.60±2.70)35.00	18.00(21.40±1.10)26.00	1.48	10.00(13.73±2.43)20.00	4.00(7.00±1.70)10.	20.00(24.27±2.87)28.00	0.80(1.06±0.14)1.30
R.ibrica-1	35.00(38.67±2.77)43.00	26.00(31.60±3.56)37.00	1.24	15.00(19.00±2.80)24.00	5.00(6.00±0.92)8.00	25.00(30.07±3.21)39.00	1.00(1.08±0.14)1.30
R.iberica-2	33.00(35.87±2.06)41.00	32.00(35.08±2.06)40.00	1.02	14.00(16.93±1.94)20.00	5.00(5.60±0.63)7.00	25.00(26.73±1.33)29.00	1.00(1.04±0.10)1.30
R. orientalis	28.00(30.13±1.68)34.00	20.00(24.40±2.92)29.00	1.25	13.00(15.87±2.13)20.00	4.00(5.27±0.78)7.00	20.00(23.4±1.88)25.00	1.00(1.07±0.17)1.50
R.pulverulenta	32.00(37.73±2.84)42.00	22.00(27.20±2.83)31.00	1.40	14.00(18.53±2.72)25.00	4.00(5.13±0.64)6.00	25.00(29.13±2.82)35.00	1.00(1.10±0.21)1.50
R.villosa	29.00(31.20±1.61)35.00	18.00(23.40±4.22)31.00	1.37	14.00(16.93±1.94)20.00	5.00(7.33±1.63)11.0	18.00(22.33±2.43)25.00	1.00(1.02±0.07)1.20
R. beggeriana	31.00(37.73±3.06)41.00	24.00(28.93±3.53)37.00	1.30	15.00(22.06±5.22)31.00	4.00(5.40±0.91)8.00	25.00(28.26±2.09)32.00	1.00(1.13±0.22)1.50
R. webbiana	30.00(33.20±1.37)35.00	26.00(29.73±1.79)32.00	1.12	18.00(22.33±2.47)25.00	5.00(5.53±0.64)7.00	21.00(25.13±1.35)27.00	1.00(1.10±00.21)1.50
R. foetida-1	26.00(28.27±1.39)29.00	20.00(23.27±1.58)25.00	1.22	15.00(16.63±1.23)19.00	5.00(5.57±0.72)7.00	20.00(22.43±1.78)26.00	1.00(1.16±0.24)1.50
R. foetida-2	27.00(30.60±1.80)35.00	24.00(25.87±2.06)31.00	1.18	14.00(17.00±3.36)28.00	4.00(4.53±0.52)5.00	25.00(29.33±3.18)36.00	1.00(1.12±0.15)1.30
R.hemisphaerica-1	31.00(34.87±2.17)39.00	22.00(27.73±3.32)33.00	1.27	12.00(17.13±3.10)25.00	4.00(5.33±0.75)7.00	20.00(25.80±2.18)30.00	1.00(1.03±0.13)1.50
R.hemisphaerica-2	27.00(30.50±2.70)33.00	22.00(26.35±3.27)30.00	1.17	15.00(18.14±1.99)21.00	5.00(6.00±0.87)7.00	20.00(24.14±2.68)29.00	1.00(1.01±0.05)1.20
R. pimpinellifolia	30.00(32.00±1.64)35.00	21.00(23.53±3.04)31.00	1.36	10.00(14.60±3.22)20.00	4.00(6.06±1.27)9.00	20.00(23.53±1.96)28.00	1.00(1.03±0.9)1.30
R .persica	30.00(31.53±1.30)35.00	25.00(26.93±1.49)30.00	1.17	16.00(20.67±2.74)28.00	4.00(5.20±0.56)6.00	23.00(25.20±1.32)28.00	1.00(1.09±0.18)1.50
R. kopetdagensis	21.00(24.60±1.65)29.00	20.00(21.50±0.91)23.00	1.14	15.00(16.73±1.39)19.00	3.00(4.53±0.74)5.00	19.00(21.53±2.20)25.00	1.00(1.00±0.00)1.00

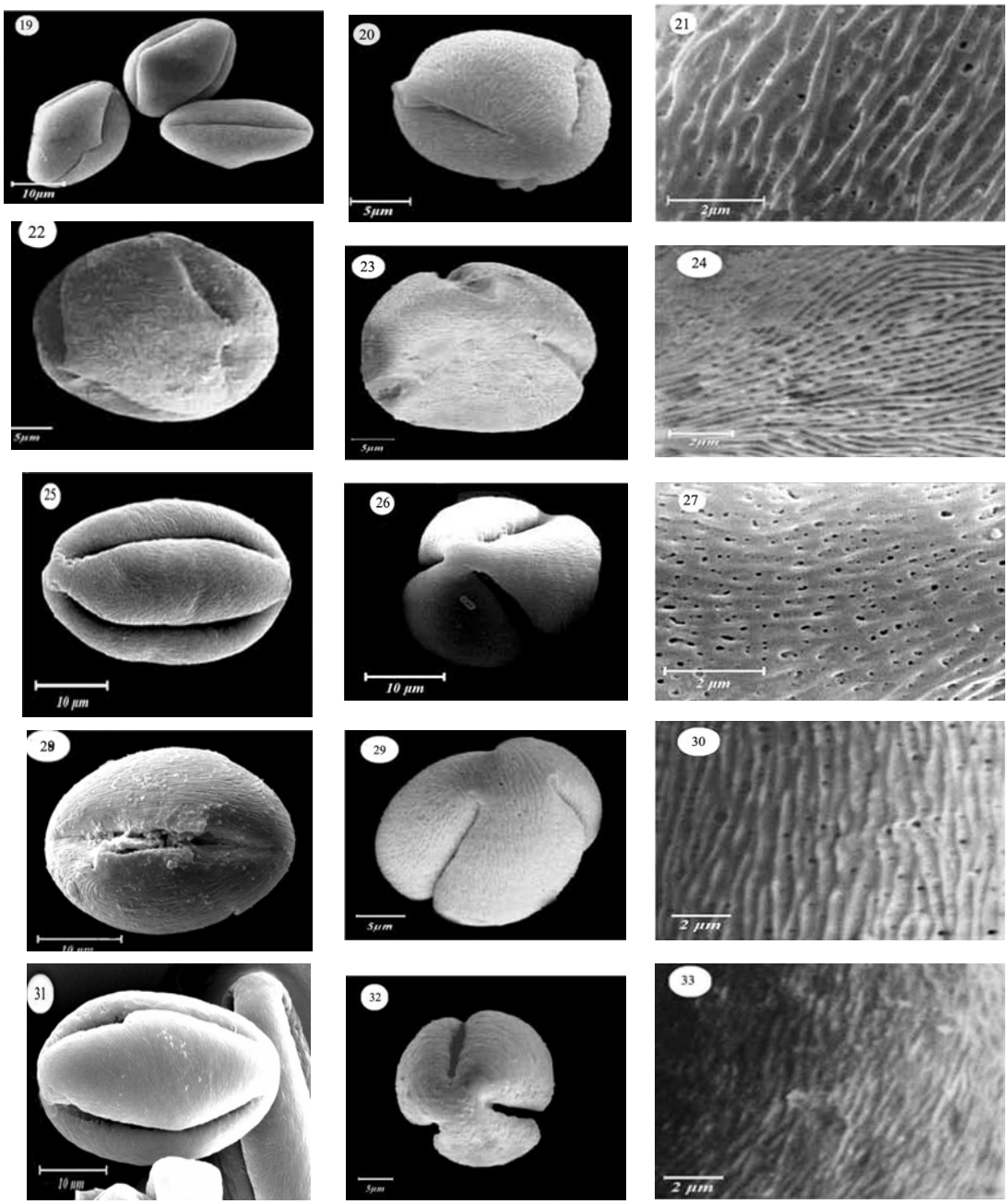
Table 2. Continued.

A	I	J	K	L	M	N	O
R.boissieri	Subprolate	0.61(0.77±0.10)0.93	Type II-A	0.13(0.21±0.04)0.30	0.15(0.21±0.04)0.30	1.00(3.00±0.92)4.00	0.12(0.23±0.05)0.30
R.canina-A	Prolate	0.63(0.80±0.10)1.08	Type III	0.10(0.18±0.04)0.26	0.10(0.13±0.01)0.15	0.00(1.71±1.06)3.00	0.10(0.12±0.03)0.21
R.canina-C	Prolate	0.71(0.80±0.06)0.93	Type III	0.15(0.28±0.13)0.60	0.13(0.18±0.03)0.26	0.00(1.92±1.60)4.00	0.08(0.10±0.02)0.16
R.canina-D	Subprolate	0.68(0.77±0.04)0.83	Type III	0.13(0.24±0.07)0.40	0.11(0.14±0.02)0.18	3.00(4.92±1.07)7.00	0.07(0.14±0.06)0.28
R.canina-E	Subprolate	0.66(0.76±0.05)0.84	Type II-B	–	–	–	0.05(0.09±0.02)0.13
R. elymaitica	Prolate	0.57(0.77±0.10)0.96	Type II-A	0.06(0.12±0.04)0.21	0.18(0.24±0.05)0.4	1.00(3.14±1.01)5.00	0.16(0.29±0.06)0.42
R.ibrica-1	Subprolate	0.64(0.78±0.10)1.02	Type I-B	0.07(0.11±0.03)0.18	0.17(0.28±0.60)0.4	–	–
R.iberica-2	Prolate-Spheroidal	0.60(0.74±0.05)0.80	Type II-A	0.16(0.24±0.08)0.5	0.06(0.10±0.3)0.14	0.00(2.30±1.60)5.00	0.05(0.08±0.02)0.13
R.orientalis	Subprolate	0.66(0.77±0.05)0.86	Type I-B	0.10(0.2±0.20)0.90	0.22(0.34±0.10)0.6	–	–
R.pulverulenta	Prolate	0.69(0.77±0.05)0.88	Type II-A	0.17(0.26±0.06)0.39	0.1(0.12±0.02)0.16	3.00(4.07±0.73)5.00	0.09(0.11±0.02)0.17
R.villosa	Prolate	0.58(0.71±0.09)0.86	Gemmate				
R.beggeriana	Subprolate	0.64(0.75±0.07)0.93	Type III	0.22(0.35±0.09)0.56	0.11(0.20±0.06)0.32	0.00(1.64±1.08)04.00	0.09(0.14±0.04)0.21
R.webbiana	Prolate- Spheroidal	0.61(0.75±0.05)0.81	Type III	0.06(0.10±0.01)0.12	0.12(0.17±0.03)0.22	5.00(7.57±2.20)13.00	0.11(0.18±0.06)0.30
R.foetida-1	Subprolate	0.74(0.85±0.0.5)0.92	Type I-B	0.05(0.22±0.11)0.40	0.11(0.16±0.01)0.18	–	–
R.foetida-2	SubProlate	0.60(0.72±0.06)0.85	Type I-B	0.11(0.22±0.07)0.30	0.15(0.19±0.03)0.25	–	–
R.hemisphaerica-1	Subprolate	0.64(0.74±0.05)0.85	Type I-A	0.08(0.11±0.02)0.16	0.11(0.13±0.02)0.17	–	–
R.hemisphaerica-2	Subprolate	0.66(0.79±0.07)0.93	Type I-A	0.12(0.19±0.07)0.40	0.13(0.15±0.02)0.19	–	–
R.pimpinellifolia	Prolate	0.64(0.75±0.07)0.93	Type V	–	–	–	–
R.persica	Subprolate	0.62(0.73±0.06)0.87	Type I-A	0.08(0.19±0.05)0.28	0.12(0.15±0.02)0.20	–	–
R.kopetdagensis	Prolate-Spheroidal	0.64(0.76±0.06)0.86	Type I-A	0.06(0.08±0.01)0.12	0.11(0.18±0.02)0.21	–	–

Abbreviations: All size are in µm. column A: species and sections, B: polar axis, C: equatorial axis, D: P/E ratio, E: Mesocolpium, F: Apocolpium, G: exine thickness, H : length of colpus, I: shape, J: ratio Length of colpus / polar axis, K: Sculpturing , L: Distance of ridges, M: Thickness of ridges, N: perforation number, O: Diameter of perforation.

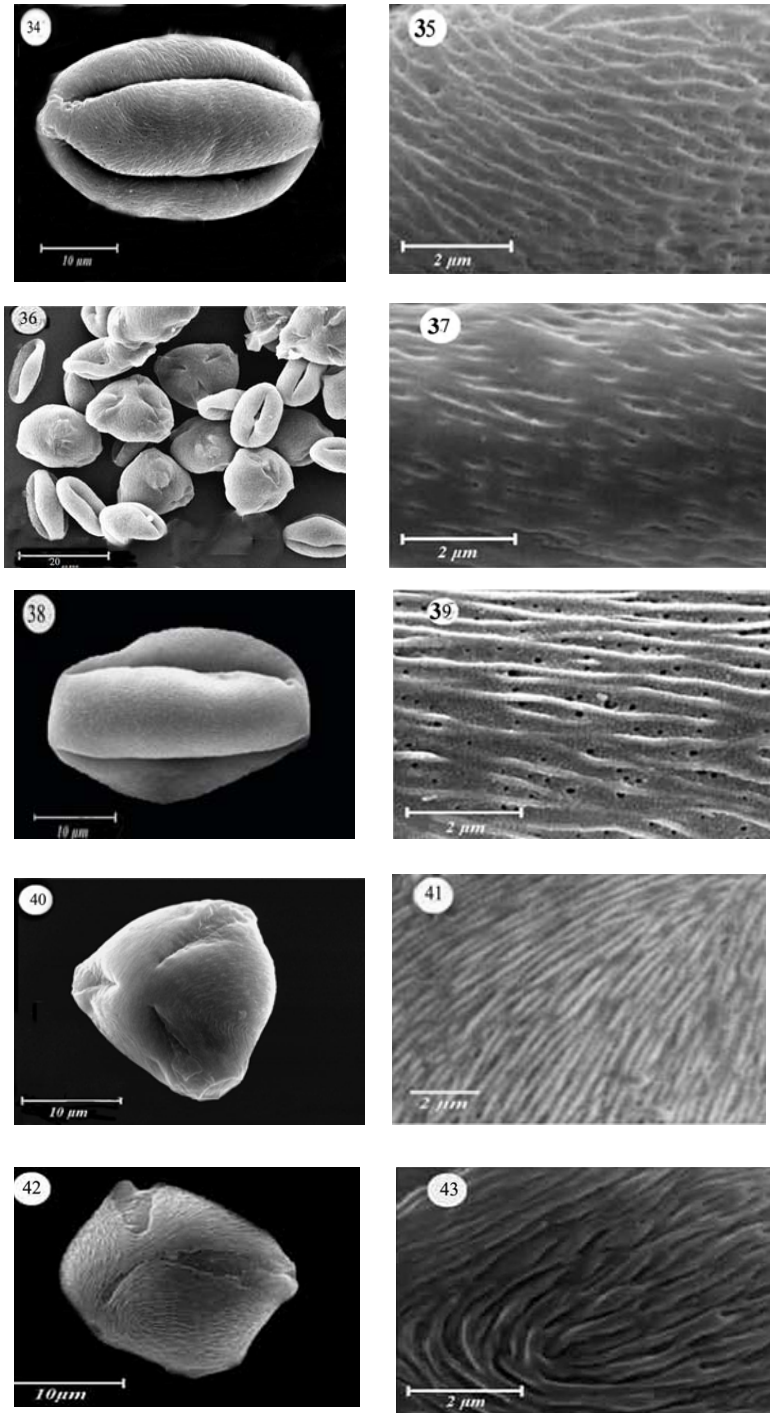


Figs. 1-18. SEM micrographs of pollen grains in species of *Rosa*, *R. persica* (1-3), *R. kopetdagensis* (4-6), *R. foetida* (7-9), *R. boissieri* (10-12), *R. elymaitica* (13-15), *R. canina* E2 (16-18).

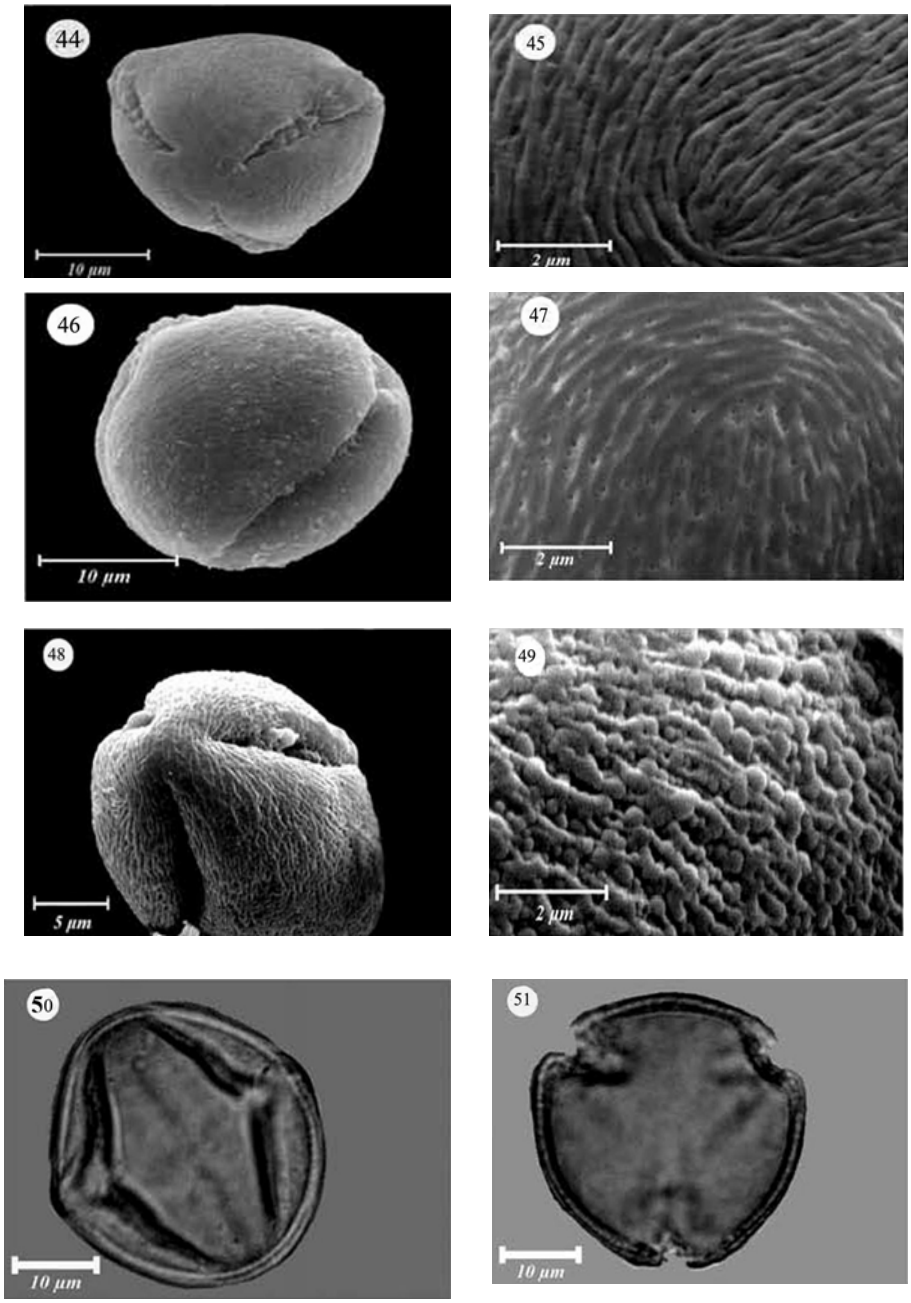


Figs. 19-33. SEM micrographs of pollen grains in species of *Rosa*, *R. beggeriana* (19-21), *R. webbiana* (22-24), *R. canina* D (25-27), *R. canina* A (28-30), *R. pimpinellifolia* (31-33).

species number ranges from 100 (Mabberley 1997) to 200 (Wissemann & Ritz 2007). The ease of hybridization and the great influence of the genus on human cultural evolution (Wissemann & Ritz 2005) leading to naturally or artificially formation of different individuals are two main factors in difficult taxonomy of *Rosa*. Verifying this problem, results of SEM and LM examination showed a wide variation in exine sculpturing, even in different populations of the same species and similarity to other genera of the family *Rosaceae* (Hebda & Chinnappa 1990). The importance of pollen morphological characteristics and their fitness for the actual subgeneric taxonomic grouping are discussed in the following below:



Figs. 34-43. SEM micrographs of pollen grains in species of *Rosa*. *R. pulverulenta* (34-35), *R. canina* E (36-37), *R. canina*. C (38-39), *R. hemisphaerica* (40-41), *R. orientalis* (42-43).



Figs. 44-51. SEM (44-49) and LM (50-51) micrographs of pollen grains in species of *Rosa*. *R. iberica*-1 (44-45), *R. iberica*-2 (46-47) and *R. villosa* (48-49).

Rosa* subgenus *Rosa

R.* sect. *Cinnamomeae DC.

Regarding most important character of pollen morphology, both species are attributed to Type III sculpturing. Moreover subprolate and prolate – spheroidal shape of pollen is characteristic for the members of *R.* sect. *Cinnamomeae*. On the basis of pollen morphology, these species are close to each other, however as only two species of the section occur in Iran, reliable judgment on the pollen morphology of the section requires examination of more species.

R.* sect. *Pimpinellifoliae DC.

The section consists of *R. foetida*, *R. hemisphaerica* and *R. pimpinellifolia* in Iran (Zielinski 1982). Based on morphology, this section is recognized by single flowers without bracts per inflorescence, high number of small, rounded leaflets per leaf, and intensive colored, often black hip (Wissemann & Ritz 2005).

Regarding geographical distribution, two former species exist in north, northwest, west and center of Iran while the last one occurs only in northwest. Interestingly there is a relationship between distribution and pollen morphology of members of the section so that *R. foetida* and *R. hemisphaeriaca* classified into Type I of sculpturing and subprolate shape while *R. pimpinellifolia* classified into Type V and prolate shape.

R.* sect. *Caninae DC.

Results of pollen morphology study also verifies this section's complexity (specifically in *R. canina*) so that according to exine sculpturing, three types are observed in the species as follow: Type I in *R. canina* E2, *R. iberica*-1 and *R. orientalis*, Type II in *R. canina* E, *R. iberica*-2, *R. boissieri* and *R. elymaitica*, Type III in *R.canina* A, C, D. Interestingly only *R. villosa* shows diagnostic gemmate sculpturing in comparison with other species of *Rosa* in Iran. As mentioned above, the main characters of pollen even in different populations of the same species are variable.

Rosa* subgenus *Hulthemia (Dumort.) Focke.

The main pollen morphological features of the species are as follow: sculpturing is Type I-A and shape of pollen is subprolate. In addition to above-mentioned species, hybrid taxon (*R.* × *kopetdagensis*) was examined. This taxon is a hybrid between two species, *R. persica* and *R. hemisphaeriaca* and is distributed in some localities of east and center of Iran (Zielinski 1982). Some morphological characters specially habit and presence of violet blot in the base of petal is alike *R. persica* while number of leaflet is similar to *R. hemisphaerica*. According to sculpturing of exine, this hybrid shows similarity to the both parents (i.e. Type I-A). Interestingly among all studied species, this type is only observed in these three taxa.

CONCLUSIONS

Results of the present study emphasizes other studies (e.g. Hebda and Chinnappa 1990; Fang and Yi-Xuan 1991; Moore et al. 1991; Vafadar et al. 2010) showing the rather little importance of pollen morphology in separating species. Regarding to the most important character, some diagnostic sculpturing (gemmate in *R. villosa* and Type V in *R. pimpinellifolia*) were observed in the study, however most species not only include striate ornamentation, but also different individuals of the same species show variation in sculpturing. It seems that two above-mentioned factors (hybridization and human interference in its evolution) have exerted remarkable influence on several aspects consisting of macro and micromorphological features of the genus. For more precise judgment on the taxonomy, other complementary studies on the genus seem to be necessary, specifically molecular approach. Prior to any study, accessing to the most of the genus in the world is a key factor in future surveys

ACKNOWLEDGEMENTS

We wish to thank Mr. Zamani (Centeral Herbarium of University of Tehran) for his assistance in elaborating and arrangement of the SEM micrographs and also collecting some specimens of field, Mr. Rezaee (University of Tarbiat Modares) and Mr. Hashemi (University of Tehran) for their assistance in electron microscopy.

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