Faculty of Women for, Arts, Science, and Education

Scientific Publishing Unit

Journal of Scientific Research in Science

Biological Sciences

Volume 40, Issue 2, 2023

ISSN 2356-8372 (Online) \ ISSN 2356-8364 (print)

Journal of Scientific Research in Science 2023, 40, (2): 84-106

Contents lists available at EKB

Journal of Scientific Research in Science

Journal homepage: https://jsrs.journals.ekb.eg/

Pollen morphology of some *Rosa* L. cultivars from Egypt

Fatma Abdel Naby Ali[1,*], Wafaa Morsy[1], Reem Mohamed[1], Sahar Abdel Rahman[1], Sahar Abdel Fattah[1]

[1]Botany department, Faculty of Women for Arts, Science and Education, Ain shams university, Egypt.

Abstract

In this study, the pollen morphology of 24 cultivars of Rose (*Rosa x hybrida* L.) cultivated in Egypt Pollen grain has been studied by using Light (LM) and Scanning Electron Microscopy (SEM). The pollen grains of all cultivars were monads, radially symmetrical, isopolar, and tricolporate. The size of pollen ranged from small to medium-sized. The shape varied from prolate-spheroidal, sub-prolate to prolate. Based on the exine sculpture features, four major types are recognized: striate, striate-psilate, psilate and granular verrucate. The striate type is the most dominant ornamentation with different patterns (striate with parallel striae to colpi, striate with perpendicular striae to colpi and striate with irregular pattern), while psilate and granular verrucate patterns were rarely observed in certain cultivars. The qualitative and quantitative features studied here used for cluster analysis and provide few taxonomic details which separate the cultivars. The diagnostic features of pollen grains of the studied cultivar pollen size, shape and exine sculpture.

Keywords: *Rosa* L, Pollen morphology, Light Microscope and Scanning Electron Microscope.

1. Introduction

Rosa L. is one of the important genera in the subfamily Rosoideae, family Rosaceae. The genus comprises approximately 200 species, distributed mainly in Asia, temperate and subtropical regions of the northern hemisphere as North America, Europe, and North Africa (1, 2, 3). However, the majority of Wild Species are found in Asia **[4]**. In Egypt *Rosa arabica* Crép. (1869:344) , is the only wild and endemic to Saint Catherine Protectorate, southern Sinai. **[5,6,7,8,9].** Also, it is considered critically endangered and recorded as one of the 100 species most threatened in the world **[10,11,12].** The cultivation of *Rosa* spp. began at 5000 years at least in Asia **[13,14].** Roses have great economic value in the ornamental, cosmetic, and pharmaceutical trades as cut flowers, rose essential oil and are an excellent source of vitamin C **[15]**

*Corresponding author: Fatma Abdel Naby Ali, Botany Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Egypt.
E-mail: fatma.abdelnaby@women.asu.edu.eg
(Received 23 May 2023, revised 06 July 2023, accepted 10 July 2023)
https://doi.org/10.21608/JSRS.2023.309844

Roses are ideal crops that characterized with semi woody, perennial shrubs that can tolerate cold and grow in almost all habitats **[16].** Wild roses are morphologically described as having prickly stems, rarely smooth. Leaves imparipinnate, and leaflet elliptic to ovate-lanceolate in shape with a serrate margin. Flowers solitary or in corymb clusters have five sepals and five petals, with numerous stamens, and abundant styles distinguished by a sticky stigma **[17,18].** Also, have long canes in open growth of branches, a single androgynous flower, that generates edible hips comprising achenes and single-seed fruit **[19,20].**

According to Wissemann **[3]** the genus classified into four subgenera, *Platyrhodon* (Hurst) Rehder, *Hulthmia* (Dumort.) Focke, *Hesperhodos* Cockerell and *Rosa* L. However, most of *Rosa* species have been placed in the Subgenus *Rosa* where ten sections have been recognized **[13,21].**

Many of the *Rosa* species developed by hybridization that is accompanied by polyploidization **[22]**. Also, many hybrids and cultivars have evolved from interspecific hybridization with special features of flower quality and yield as well as different levels of polyploidy making *Rosa* a more complex genus in the family Rosaceae **[23]**.

All over the world millions of roses are cultivated in gardens and billions of roses are marketed as cut flowers as mentioned by **[24]**. Numerous rose hybrids have evolved over the past two centuries which made the breeding of roses the most intensive when compared to any other ornamental crop **[25]**.

The importance of pollen morphology in plant systematics has been emphasized by several scientists. **[26,27,28,29]** stated that pollen grains can be used as a significant tool in modern taxonomy due to their specific variation in features.

Palynological investigations of the genus *Rosa* were carried out by numerous authors. The different taxonomic studies have indicated that different characteristics of pollen grains such as the shape of pollen, length of equatorial and polar axes, colpi length, and structure of operculum are very significant in the taxonomy of Rose **[30,31,32,33,34,35,36,37,38,39,40].**

Pollen grains of the genus *Rosa* are morphologically described as isopolar, and radially symmetric. Pollen is three colporate. Endoaperture is well developed, elliptic or spheroidal, and lie in the center of colpus. Exine sculpturing is striate and rarely verrcute **[30,32,34,35,40,41].**

The aim of this study was to study the palyno-morphological characteristics of *Rosa* cultivars by using Light (LM) and Scanning Electron Microscope (SEM) and to determine whether the palynological information has potential for taxonomic evidence of *Rosa* cultivars.

2. Materials and Methods

2.1. Sample Collection:

Studied Pollen grains were extracted from the anthers of fresh mature flowers of 24 Rose cultivars **(*Rosa x hybrida* L.)** randomly collected from Jazirat Alshaeir Albahria, Madinat Al Qanater Al Khayreyah, El Qanater El Khayreya, Al Qalyubia Governorate Egypt https://g.co/kgs/5E2oPf during March–August 2020- 2022.

2.2. Sample preparation for light microscopy:

Pollinoferous material for light microscopy (LM) was acetolysed according Erdtman's method **[42]**. After acetolysis, pollen grains were mounted in stained glycerin jelly on glass slides. The pollen was examined using a 100x oil immersion objective lens and 10x eyepieces of Carl Zeiss Jena (Nr.683454), microscope, Germany, and photomicrographs were taken under an Olympus type BH-2 Code No. 245893 photomicroscope (Fig. 3 column A). The measurements were based on 15 fully developed pollen grains for each *Rosa* cultivar.

2.2. Scanning Electron Microscopy:

For scanning electron microscopy (SEM) Pollen grains were prepared according to the procedure given by **[43]**. Air-dried pollen grains were mounted on aluminum stubs covered with a double-sided transparent tape, sputtered with technical gold (gold layer of 0.02 µm thick) in a sputter coater BAL-TEC SCD 005 (Capovani Brothers Inc., Scotia, NY, USA), then examined and photographed at 150 kv in a JOEL JSM 5200 SEM (JEOL, Tokyo, Japan) in Scanning Electron Microscope Unit Agriculture Research Center, Giza, Egypt. (Fig. 3 column B &C).

2.3. Morphological analysis:

Pollen grains were analyzed for seven quantitative features as Polar (P) and Equatorial (E) axes (µm), P\E ratio, Colpi length (µm), Exine thickness (the same thickness was found along polar and equatorial axes)and additionally anew term relative exine thickness has been used**[44**]which identified as the ratio of the mean exine thickness measured along P or E axis to the mean length of P or E axis (Exe/p, Exe/e (µm), and seven qualitative features as Pollen size, Shape, Colpus number, Aperture membrane, and exine sculpture (Table 2 and 3).

The pollen description, identification, and terminology used are in accordance with **[45,46]** and for describing exine ornamentation **[47]**.

2.4. Statistical analysis

One-way analysis of variance (ANOVA) was applied to seven quantitative pollen grain characters to find out the difference in mean values among the cultivars for variability assessment when the F- test was significant ($p< 0.05$) using SPSS 26.0 software **[48]** (Table 2).

2.5. Cluster Analysis:

Principal Component Analysis (PCA) was done on five quantitative variables (Polar (P) and Equatorial (E) axes (µm), P\E ratio, Colpi length (µm), Exine thickness) and for Hierarchical clustering, the Dice similarity coefficient and UPGMA method were done on seven qualitative characters (Pollen size, Shape, Colpus number, Aperture membrane, and exine sculpture) by using the Paleontological Statistics Software Package for Education and Data Analysis (PAST) version 4.03. **[49]**.

3. Results and Discussion:

The pollen grains of the studied 24 *Rosa* cultivars were described morphologically by using LM and SEM microscopy. The morphological observations of the quantitative and qualitative features are summarized in Table 1 & 2, and selected photomicrographs are presented in Fig. 3. Morphological features of pollen grains indicating variation were pollen shape, size, colpus length, and exine sculpture in different *Rosa* cultivars from Egypt.

According to **[39]** the palynological characters of shape, length of polar and equatorial axes, the thickness of exine, and length of ectocolpi were recognized as useful features for discriminating between species of the genus *Rosa*; while sculpturing at L.M was found to be a poor character for identification as indicated in our result.

On the other hand, the previous studies on pollen grains of the family Rosaceae and the genus *Rosa* indicated that the exine sculpture was used as a significant feature for identification **[32,33,34, 38,50,51,52,53]**. In the present study, the pollen grains of all studied *Rosa* cultivars are isopolar, monad, and radially symmetric. The outline shape of the pollen grain is elliptical in the equatorial view and round or circular in the polar view. The mean length of polar axis diameter (P) ranged from 12.48 µm to 33.85µm. The smallest P was shown in cultivar 5 (12.48 µm) while the longest (P) in cultivar 21 (33.85 µm). The mean length of equatorial diameter

(E) ranged from 9.20 μm to 25.94 μm. The shortest E (9.20 μm) was shown in cultivar 5 and the longest (25.94 μm) in cultivar 1.

According to **[42]**, pollen grain size classification the majority pollen of studied cultivars is medium-sized (25.1-50 μm), rarely small (10.1-25 μm) found in cultivars 4, and 5, while in cultivars 8 and 14 medium-sized and sometimes small pollen grains. The results obtained in this study agreement with **[52],** in which Rosa pollen size ranged from small to medium-sized.

Pollen characters including pollen shape, length of the equatorial and polar axis, and colpi length might be utilized to distinguish between different *Rosa* species as stated by **[32,34,39]**. However, our results indicates that this criterion cannot be applicable to all cultivars of *Rosa* because some of the studied cultivars (cultivar 8 and 14) are observed in two sizes as obtained for pollen grain of *R. damascena* and *R. multiflora* **[52].**

In the present work, the mean P\E ratio ranged from 1.11μm to 1.65 μm showed in cultivar 12 and cultivar 15 respectively. The majority of pollen of the examined cultivars were prolate (83.33%), less frequently – sub-prolate (12.5%) was found in cultivars 1, 4, and 10, and rarely prolate-spheroidal (4.16%) in cultivar 12 [**52].**

All investigated cultivars possess trizonocolporate pollen grains, where the colpi are allocated symmetrically and constructed toward the poles with acute or obtuse apex as well as striate or smooth aperture membrane. The colpus almost constituted the full length of the polar axis. The mean length of colpus varied from 9.36 to 29.95 μm where the longest colpi (29.95 μm) appeared in cultivar 21 occupies 90% of the polar axis length and cultivar 10 (29.94 μm) which constituted 95% of the polar axis length. The shortest colpi (9.36 μm) was found in cultivar 5 and comprised 75% of the polar axis length followed by 20.12 μm was showed in cultivars 4 and 7 which constituted 91% and 67 % of the polar axis length respectively.

The colpus was split into two parts at the equator by a bridge which formed by two bulges of ectexine in the middle. This bridge was found in cultivars 15, 16, 19 & 22 and absent in the remaining cultivars. These results showed close conformity with the findings of **[40]** who reported the same results in *R. banksiea* and *R. canina* and in *Sorbus* species that resemble *Rosa* in this character **[55].**

Although the feature of tricolporate pollen grain is present in some primitive families, it is considered an advanced character and observed in many advanced dicotyledonous families. As well as shape class ranging from prolate, sub-prolate to prolate spheroidal. These

characteristics are in agreement with those described previously for Rosaceae by **[41,55,56,57,58,59,60,61].**

Exine well marked in LM and formed of two-layered**.** The thickness of ectexine and endexine is usually the same. The mean thickness of exine varied between 1.64 μm to 2.96 μm. Where thinnest exine 1.64 μm, appeared in cultivar 18. While the thickest exine 2.96 μm in cultivars 19 and 21. The mean relative thickness of the exine along the polar axis (Exp\P) ranged from 0.06 μm in cultivar 1 to 0.15 μm in cultivar 5 and the mean relative thickness of the exine along the equatorial axis (Exp\E) ranged from 0. 07 μm in cultivar 1 to 0.21 μm in cultivar 5. (Table 2).

Exine sculpture features of the pollen grains exhibit variation in the studied cultivars in which 4 types of sculpture were recognized; striate, striate psilate, psilate, and granular verrucate whereas the major type of sculpture was striate with different patterns (Table 2, Fig.3)

In the present study, cultivars 6, 10, 20, and 24 have striate sculptures type with an irregular pattern that may form network-like structures as shown in apple cultivars **[62]**, cultivars 11 and 21 have striate ornamentation with striae parallel to colpi as recorded for *R. damascene, R. centifoloia,* and *R. macrophylla* **[52]** also sculpture surface of cultivar 21 may look like a fingerprint. Cultivars 14 and 19 have a striate type with striae perpendicular to colpi while cultivar 8 exine striation is wave-like that appeared at some places and disappeared after a certain interval as observed on *Rosa foetida* by **[52]**. Granular-verrucate sculpture that showed in cultivars 7,13 and 22, and striate-psilate type reported in cultivars 2, 3, 17, and 18 and psilate sculpture in cultivars 1, 4, 5,9, 12,15, and 23; these results showed a harmony with the findings of **[40]** in *R. stellate, R. minutifolia* and *R. multibracteata* respectively.

Statistically, significant differences were found between the studied cultivars for six of the pollen grain characters analyzed, the result indicated that a very highly significant difference was shown between the 24 studied cultivars for analysis of five pollen grains characters (p<0.0001), highly significant for one character Exe/p(μm) P<0.05 and non-significant for Exe/e(μm) character (p>0.05), the statistical result was summarized in Table 1.

According to Dice coefficient similarities, UPGMA dendrogram (Fig. 1) by using seven qualitative characters showed that the 24 cultivars of *Rosa* were classified into two main clusters. The first cluster is divided into two groups. The **first group** was separated into four subgroups, **Subgroup 1** contains cultivars 1 and 12, and also cultivar 5 which splits from them although it resembles others in all qualitative features but discriminates in pollen size, also

cultivars 9& 23 are very closely related to each other, while cultivar 15 separated from them which differs only in containing bridge that dividing ectocolpus into two parts. **Subgroup 2** includes two cultivars; cultivars 6 & 20 where they resemble each other in pollen shape, size, acute colpus apex, smooth aperture membrane, and striate exine sculpture with irregular shape. **Subgroup 3** contains cultivars 11, 21& 8 where they differentiate in striation pattern, and cultivars 10 & 24where they are very closely related to each other except in the aperture membrane. As well as cultivars 14&19 included in the same subgroup and resemble each other in striate ornamentation with striae perpendicular to colpi and cultivar 16 which split from them due to the striate pattern in which striae parallel to colpi but contains a bridge that divides ectocolpus into two parts as in cultivars 19. **Subgroup 4** includes cultivars 17 &18 which are very closely related to each other in all pollen grain features also cultivars 2 splits from them and distinguish by un-granulated exine. **The second group** includes cultivars 7 &13 which observe very closely related in all pollen grain features and cultivar 22 is also related to cultivar 7 &13 (granulated verrucate sculpture) except in the presence of a bridge that divides ectocolpus into two parts moreover cultivar 3 discriminated from them in striate- psilate exine sculpture pattern.

While **the second cluster** contains only cultivar 4 characterized by a small pollen grain size with sub prolate shape, colpus with an obtuse apex, striate aperture and psilate sculpture with ungranulated exine.

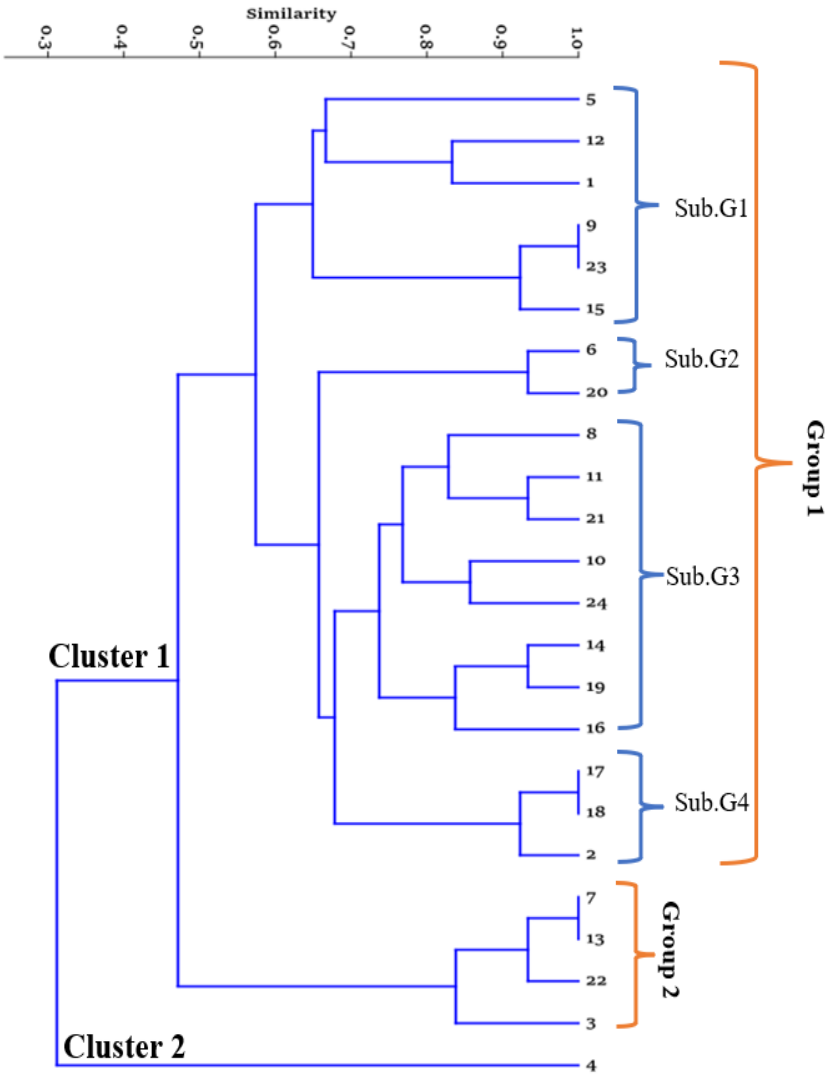


Figure 1: Dendrogram of cluster groupings of *Rosa* cultivars based on Qualitative pollen grain morphological features.

Principal Component Analysis (PCA) was done on five quantitative variables (Polar (P) and Equatorial (E) axes (µm), P\E ratio, Colpi length (µm), Exine thickness)

Results obtained from Principal Component Analysis (PCA) indicated that the first two principal components analysis (PCs) with Eigenvalues higher than 1 encompassed 72.28 % of the total variation as indicated in Table 1. The first principal component (PC1) covered 51.35 % of the total variability and have P as the significant variable whereas the second component (PC2) attributed 20.93 % of the total variation and contain E diameter as the significant variable and the third PC3 covered 18.25 % of the total variability and having colpi length as the significant variable while the remaining PC covered 9.47 % of the total variability and related exine thickness and P/E ratio. The Three cultivars 4, 5, and 24 are separated from each other which indicates the significant dissimilarity between them in PCA while cultivars 1, 11, and 13 are separated into the same group while the remaining cultivars are separated into a group with each other as dictated in fig. 2. the PCA analysis can provide us with a general indication in the possible use of quantitative characters of pollen grain to discriminate between the studied cultivars of *Rosa* from each other **[52]** so that separated *Rosa* cultivar 4, 5, 8 & 24 in distinct group and separated cultivars 2, 7and 9 in the same group as well as cultivars 11, 13 and 1 in the same group while the remaining cultivars in a group with each other.

Table (1) Summary of PCA with eigenvalue and percentage variance.

	PC	Eigenvalue	% variance
1	(P)	2.57	51.35
2	(E)	1.046	20.93
3	(Col.L)	0.912	18.25
4	(Exine)	0.441	8.83
5	(P/E)	0.032	0.64

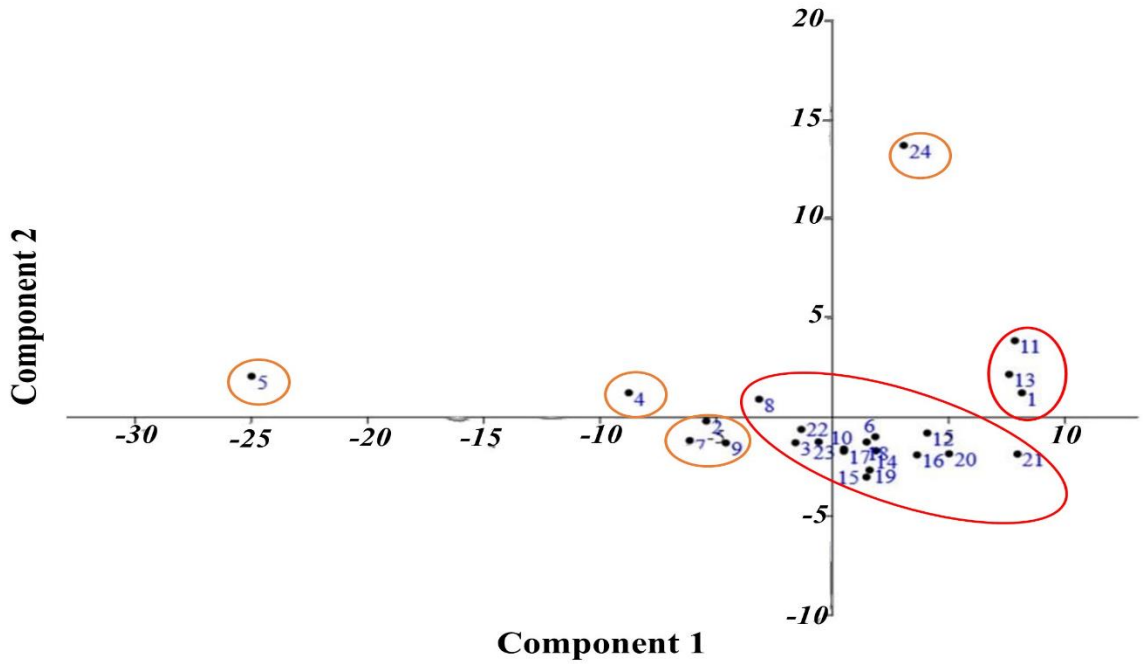


Figure 2: PCA of the first two components describing 72.28 % of the total variation using five quantitative characters of pollen grains.

4. Conclusion:

The present study allowed us to find out morphological characters of pollen grains of 24 cultivars of ***Rosa hybrid*** as the length of polar and equatorial axis, colpi length, Exine thickness sculpture types as well as pollen shape and size. These criteria show a very close relation between the studied cultivars where most of them have the same shape and size of pollen. However, the result indicated different types of exine sculpture that can discriminate between them.

Table 2: Quantitative pollen grain characters of the studied *Rosa* cultivars

One -Way ANOVAs were carried out separately for each character of pollen grain to indicate the difference between cultivars of *Rosa.* $P < 0.05$

Cultivar	Polar axis (µm)	Equatorial axis (µm)	P\E ratio(µm)	Colpi length(µm)	Exine thickness (µm)	Exe/p(µm)	Exe/e(µm)
	Min-Max Means ±SD	Min-Max Means ±SD		Min-Max Means ±SD	Min-Max Means ±SD	Min-Max Means ±SD	Min-Max Means ±SD
1	29.64-35.88 32.76±2.32	17.66-29.64 25.94±3.56	1.26±0.4	26.5- 32.76 29.63±2.33	1.56-2.34 1.95±0.4	0.05-0.07 0.06±0.01	0.08-0.09 0.07±0.01
2	23.4-28.08 25.43±1.81	14.04 -28.08 17.63±2.21	1.46±0.22	20.08- 23.4 21.60±1.46	1.56-3.12 2.18±0.61	0.06 -0.12 0.08±0.03	0.07 - 0.15 0.10±0.04
3	24.92 -31.2 27.92±2.26	15.6 -20.28 18.41±1.93	1.53±0.21	21.89- 28.08 24.81±2.25	1.56-2.34 1.79±0.37	0.06 - 0.08 0.07±0.01	0.08 -0.13 0.10±0.03
4	18.72 - 26.52 22.15±3.66	14.04 -20.28 16.69±2.21	1.32±0.21	15.6 -23.4 20.12±3.32	1.56-2.34 1.95±0.41	0.07 - 0.1 0.09 ±0.01	0.09 -0.14 0.12±0.02
5	12.48- 14.04 12.48±1.27	7.8 -10.92 9.20±1.36	1.38±0.22	7.8 -10.92 9.36±1.27	1.56-2.34 1.87±0.40	0.12 -0.19 0.15 ±0.03	0.17 - 0.25 0.21±0.04
6	26.5- 31 29.35±2.06	18.72 -22 20.17±1.43	1.46±0.17	23.4 -28 27.49±1.92	1.56-3.12 2.18±0.71	0.05 -0.1 0.08±0.02	0.07 - 0.15 0.10±0.04
7	26.5 -32.76 26.36±5.81	14.04 -20.28 17.00±2.49	1.59±0.48	15.6- 23.4 20.12±3.32	1.56-2.34 1.95±0.41	0.06 -0.09 0.07 ±0.01	0.09 - 0.14 0.11±0.02
8	24.96 -28.08 26.05±1.28	15.6 -21.89 19.66±3.32	1.36±0.20	21.89- 23.4 22.96±1.26	1.56-3.12 2.34±0.82	0.06 -0.12 0.09±0.03	0.06 - 0.16 0.12±0.05
9	24.96 -28.08 26.36±1.36	15.6 -18.72 17.00±1.36	1.55±0.04	20.28- 24.96 22.62±1.68	1.56-2.34 1.95±0.41	0.06 -0.09 0.07±0.01	0.09 - 0.14 0.11±0.02
10	28.08-35.88 31.36±3.40	21.84-31.2 26.05±4.47	1.22±0.11	26.5-32.76 29.94±2.63	1.56-3.12 2.26±0.68	0.05-0.09 0.07±0.01	0.07-0.10 0.09±0.02
11	28.08-32.76 29.64±2.65	15.6 -21.89 19.50±3.62	1.55±0.21	21.89- 28.08 25.59±2.55	1.56-3.12 2.34±0.82	0.05 -0.10 0.08±0.02	0.08 - 0.16 0.12±0.04
12	28.08-32.76 31.51±2.05	26.52-31.2 28.24 ±1.72	1.11±0.01	21.89- 28.08 28.39±2.05	1.56-3.12 1.95±0.41	0.05 -0.10 0.08±0.02	0.08 - 0.16 0.12±0.04
13	29.64 -34.3 31.64±2.09	18.72 -24.96 22.31±1.95	1.43±0.14	26.5- 28.08 27.10±0.77	2.34 -3.12 2.73±0.41	0.07 -0.10 0.09±0.01	0.10 - 0.14 0.12±0.02
14	20 -34.3 29.85±4.08	17 -20.28 19.67±1.59	1.53±0.26	26.5- 28.08 27.49±1.92	1.56 -3.12 2.18±0.72	0.05 -0.10 0.08±0.02	0.08 - 0.16 0.12±0.04
15	26.52 -34.3 30.88±3.80	15.6 -21.84 18.72±2.32	1.65±0.04	23.4- 26.52 26.67±3.32	1.56 -3.12 2.02±0.75	0.05 -0.10 0.08±0.02	0.08 - 0.17 0.10±0.04
16	28-34.30 31.64±2.35	17.16 -23.4 20.90±2.23	1.53±0.21	26.52-29.6 27.58±1.47	1.56 -3.12 2.65±0.75	0.05 -0.10 0.08±0.02	0.08 - 0.15 0.13±0.03
17	24.9 -31.3 29.63±2.34	17.16 -21.84 19.34±1.62	1.54±0.14	21.8 -28.08 25.74±2.47	1.56 -2.34 2.18±0.72	0.05 -0.08 0.07 ±0.01	0.08 - 0.12 0.11±0.02
18	26.52 -32.76 29.64±2.08	17.16 -21.84 19.97±2.05	1.49±0.06	23.4 -29.64 26.83±2.18	1.56 -2.34 1.64±0.25	0.05 -0.08 0.07 ±0.01	0.06 - 0.1 0.08±0.02
19	28.08 -32.76 30.58±1.83	17.16 -20.28 19.03±1.43	1.61±0.04	24.96 -28.08 26.83±1.43	2.34-3.12 2.96±0.32	0.08 -0.10 0.09 ±0.01	0.12 - 0.16 0.14±0.03
20	29.64 -37 32.23±2.44	17.16 -26.5 21.51±3.10	1.54±0.33	26.5- 35.5 28.75±2.67	1.56-3.12 2.42±0.77	0.05 - 0.09 0.07 ±0.02	0.07 - 0.15 0.09±0.02
21	31.2- 37.40 33.85±1.95	20.28- 26.5 23.40±2.32	1.46±0.13	24.9- 32.78 29.95±2.30	1.56-3.12 2.96±0.49	0.05- 0.10 0.09±0.02	0.07- 0.13 0.12±0.03
22	24.96 -29.64 27.92±1.72	17.16 -21.84 19.34±1.67	1.45±0.11	21.84-26.64 24.36±1.86	2.34 -3.12 2.73±0.41	0.08 -0.11 0.10 ±0.01	0.12 - 0.16 0.14±0.02
23	26.5- 31.2 28.70±1.68	15.6- 21.84 19.19±2.08	1.51±0.13	23.4- 28.08 24.96±1.80	1.56-3.12 2.65±0.75	0.10- 0.08 0.09 ±0.01	0.17- 0.12 0.13±0.02
24	31.2-34.30 32.29±2.26	17- 21.84 20.89±2.26	1.56±0.20	24.9 - 30 27.29±1.72	1.56-3.12 1.87±0.54	0.06- 0.09 0.07 ±0.01	0.07 - 0.15 0.11±0.02
F-value	31.970*** $P < 0.001$	39.913*** $P < 0.001$	3.078*** $P < 0.001$	40.816*** $P < 0.001$	33.679*** $P<0.001$	2.054* $P< 0.05$	1.9 $P= 0.06$

Table3: Qualitative pollen grain characters of the studied *Rosa* cultivars

Cultivar	Pollen size	Shape	Colpi No.	Colpus apex	Aperture membrane	Granulated exine	Sculpture
1	Medium	Sub prolate	3	Acute	Smooth	Ungranulated	Psilate
2	Medium	Prolate	3	Acute	Smooth	Un Granulated	Striate - psilate
3	Medium	Prolate	3	Obtuse	Striate	Granulated	Striate - psilate with granulated exine.
4	Small	Sub prolate	3	Obtuse	Striate	Ungranulated	Psilate
5	Small	prolate	3	Acute	Smooth	Ungranulated	psilate
6	Medium	prolate	3	Acute	Striate	Granulated	Striate with irregular shape.
7	Medium	prolate	3	Obtuse	Striate	Granulated	Granular-verrucate
8	Medium	Prolate	3	Acute	Smooth	Ungranulated	Striate, and the striae are wave-like that appeared at some places and disappeared after a certain interval.
9	Medium	prolate	3	Obtuse	Smooth	Ungranulated	Psilate
10	Medium	Sub prolate	3	Acute	Smooth	Ungranulated	Striate with irregular shape.
11	Medium	prolate	3	Acute	Smooth	Ungranulated	striate with striae parallel to the colpi
12	Medium	Prolate-spheroidal	3	Acute	Smooth	Ungranulated	psilate
13	Medium	prolate	3	Obtuse	Striate	Granulated	Granular-verrucate
14	Medium	prolate	3	Acute	Smooth	Ungranulated	striate with striae perpendicular to the colpi and the continuity of striae is often broken after a certain distance and has a small number of pores in the exine.
15	Medium	prolate	3	Obtuse	Smooth	Ungranulated	Psilate. Ectocolpus crossed at the equator by a bridge dividing into two parts which formed by two intersecting bulges of ektexine
16	Medium	prolate	3	Obtuse	Smooth	Ungranulated	Striate with striae parallel to the colpi Ectocolpus crossed at the equator by abridge dividing into two parts which formed by two intersecting bulges of ektexine
17	Medium	prolate	3	Acute	Smooth	Granulated	Striate-psilate with few granules on the exine.
18	Medium	Prolate	3	Acute	Smooth	Granulated	striate-psilate with few granules on the exine
19	Medium	prolate	3	Acute	Smooth	Ungranulated	Striate with striae perpendicular to the colpi. Ectocolpus crossed at the equator by abridge dividing into two parts which formed by two intersecting bulges of ektexine. Margin of ectocoplus with slightly undulation
20	Medium	prolate	3	Acute	Striate	Ungranulated	Striate with an irregular pattern and have small number of pores in the exine
21	Medium	prolate	3	Acute	Smooth	Ungranulated	Striate with parallel striae and have small pores in the exine. Also, the surface may look like a fingerprint
22	Medium	prolate	3	Obtuse	Striate	Granulated	Granular-verrucate Ectocolpus crossed at the equator by abridge dividing into two parts which formed by two intersecting bulges of ektexine
23	Medium	prolate	3	Obtuse	Smooth	Ungranulated	psilate
24	Medium	prolate	3	Acute	Striate	Ungranulated	striate with an irregular pattern without perforation.

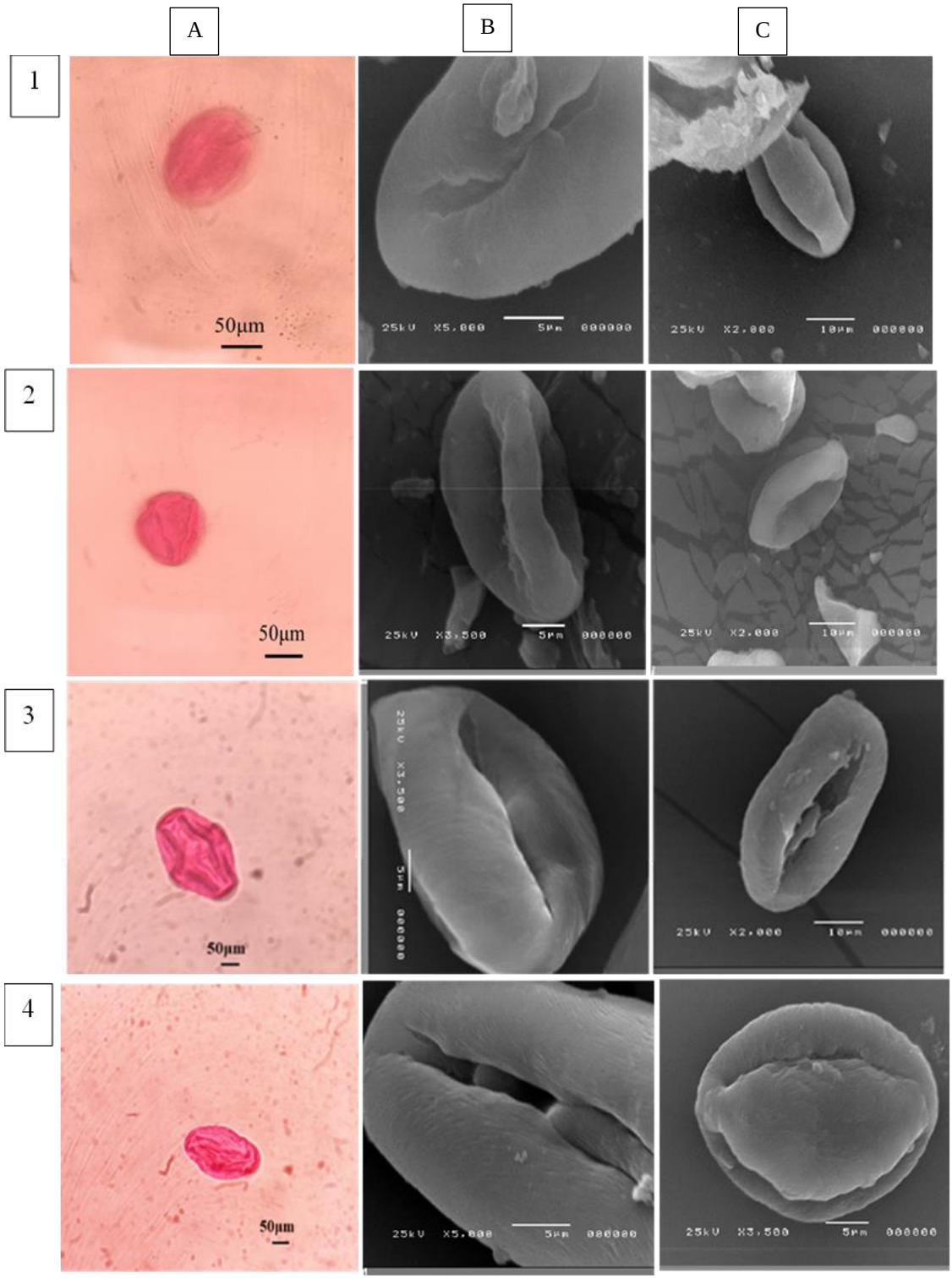


Fig.3: Light Microscopy micrographs (column A) and SEM micrographs (column B& C) showing pollen grain shape and surface feature of 24 cultivar of *Rosa* studied.

Fig.3 continued

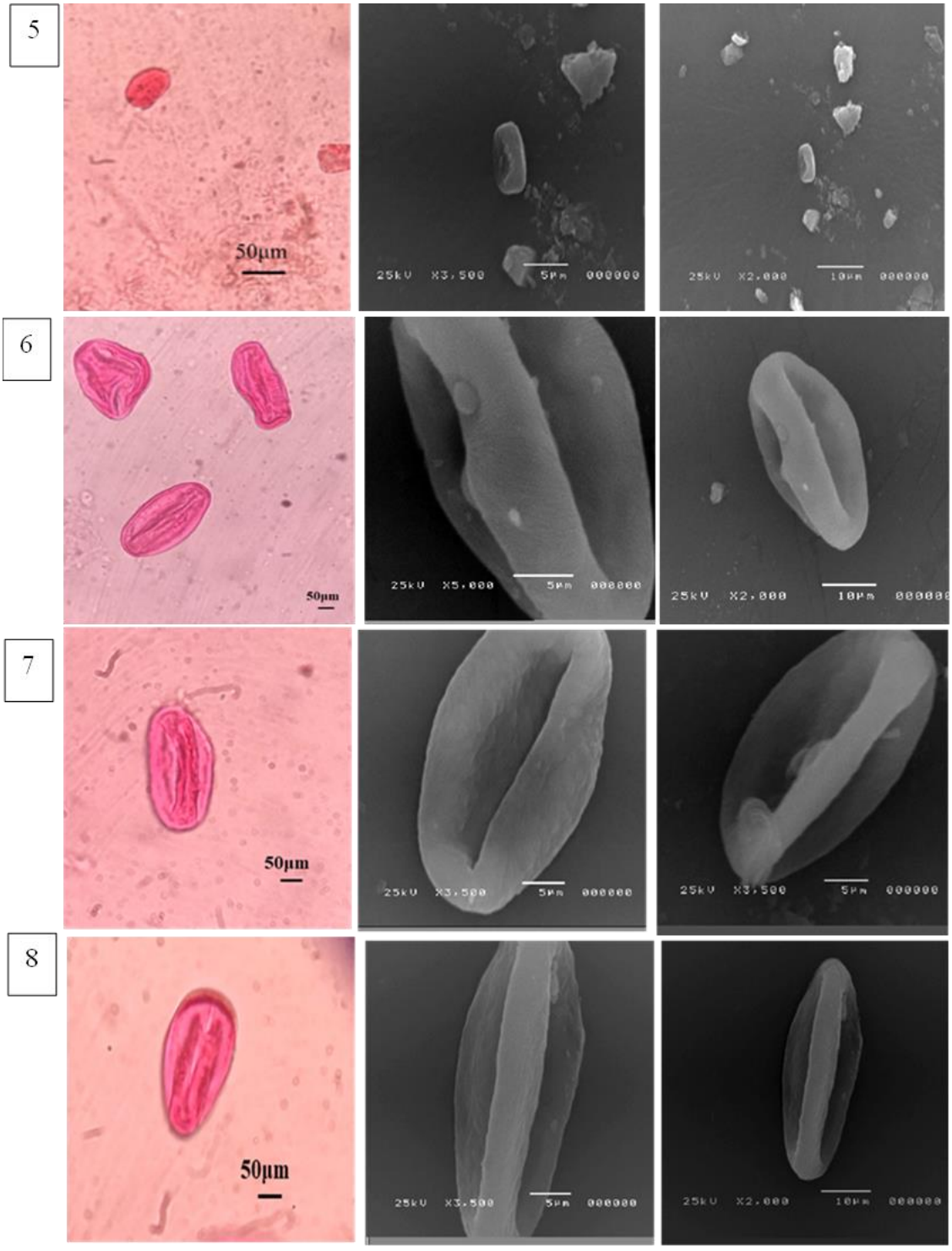


Fig.3 continued

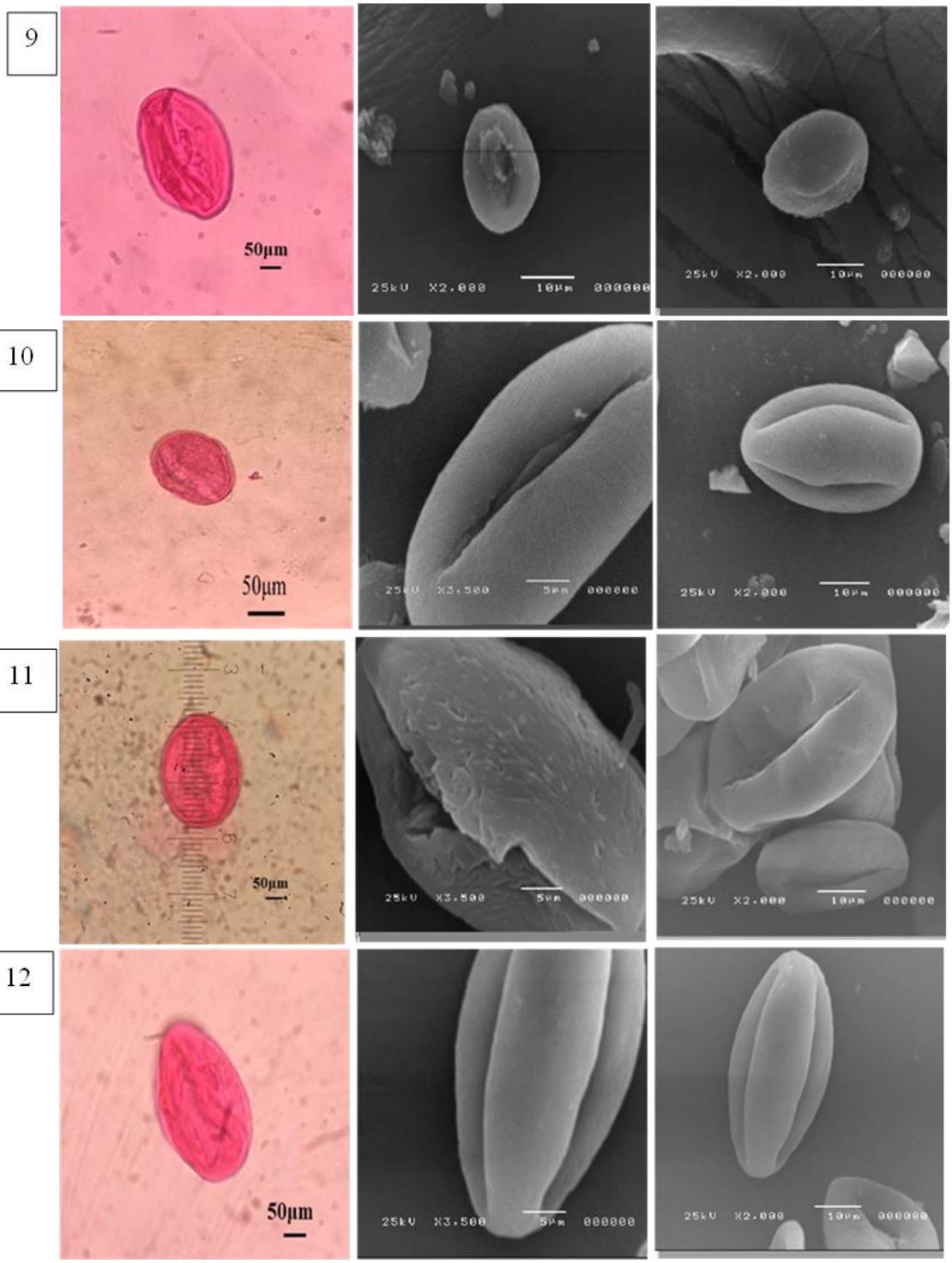


Fig.3 continued

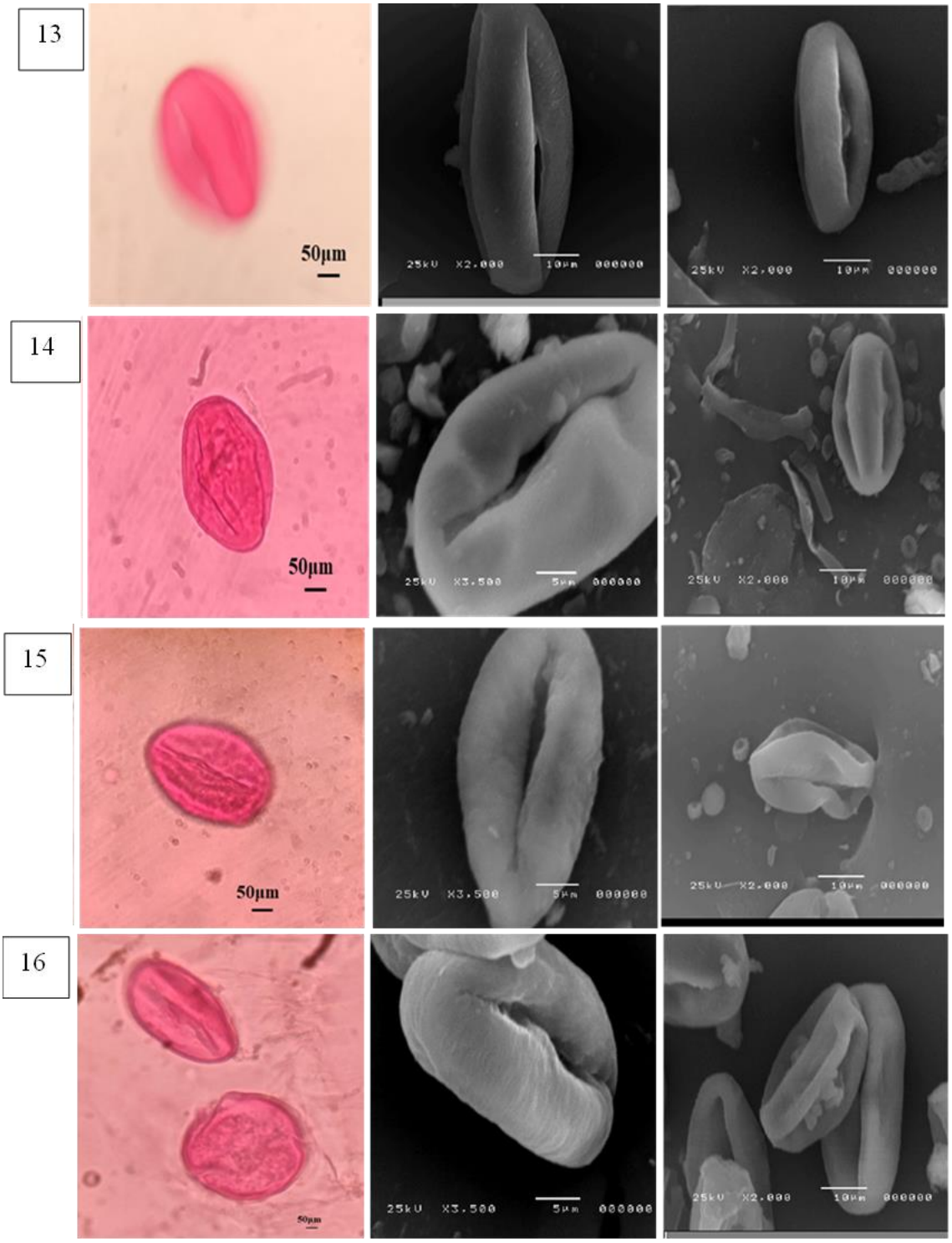


Fig.3 continued

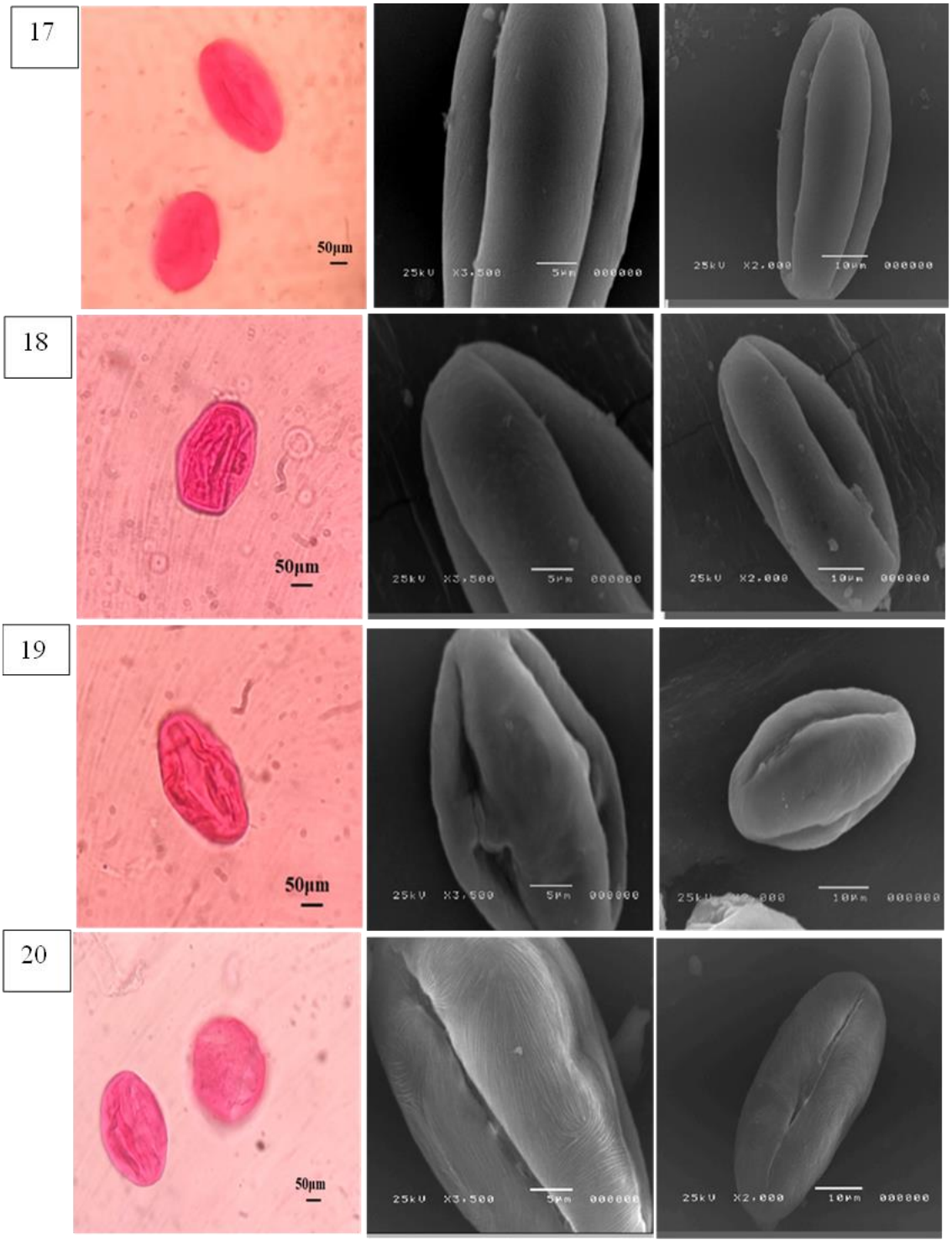
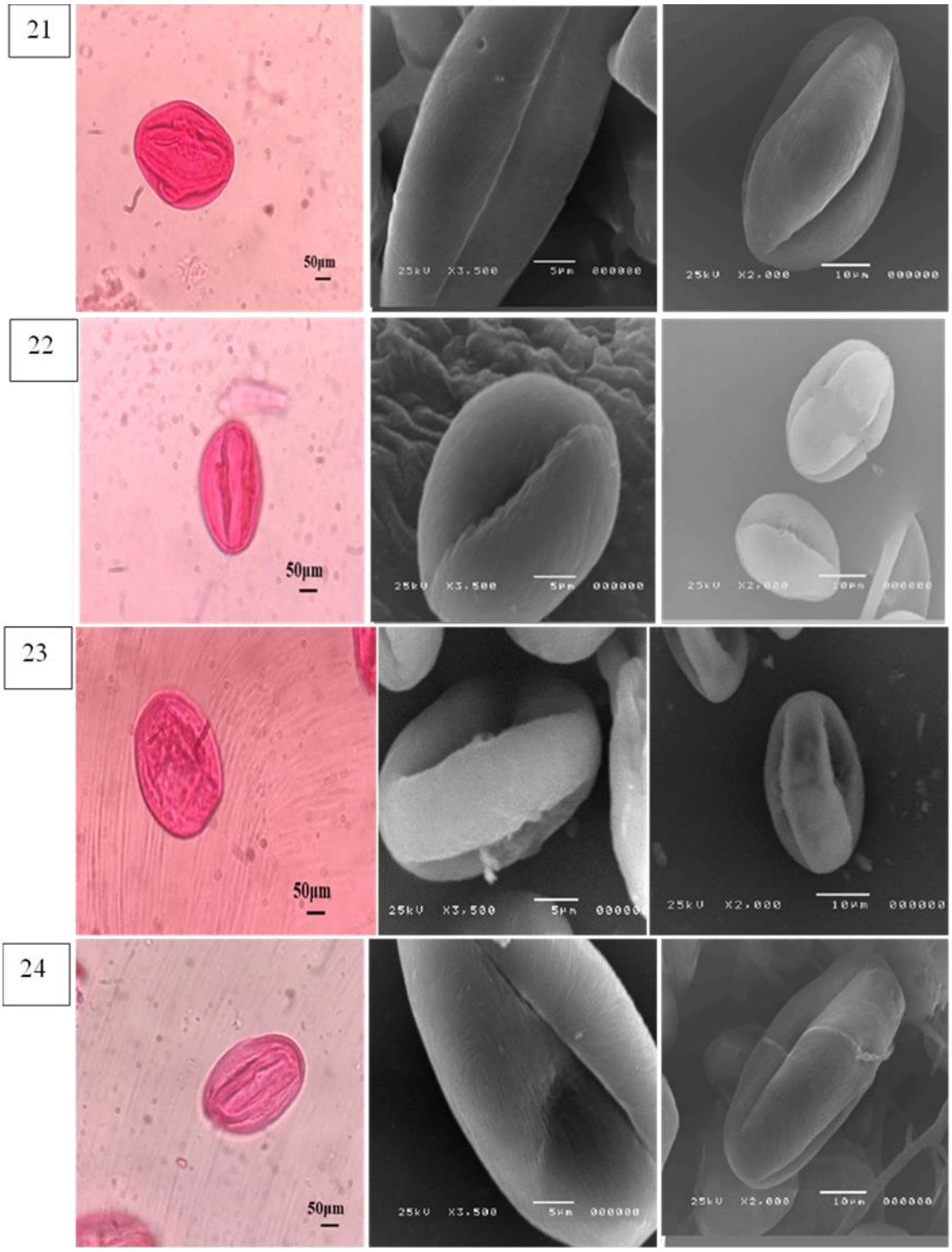


Fig.3 continued



References

[1] A. Rehder (1949). Manual of cultivated trees and shrubs. Manual of Cultivated Trees and Shrubs.

[2] Gu. Cuizhi, R.K. Robertson, *Rosa* in Z-y. Wu & P.M. Raven (eds.) Flora of China (2003). **9**: 368– 369. Science Press (Beijing) & Missouri Botanic Garden Press (St. Louis).

[3] Wissemann, V. (2003). Conventional taxonomy of wild roses. Encyclopedia of Rosa science. Eds. by A. Roberts, T. Debener, S. Gudin. London: Academic Press.

[4] C. Broetjes, A. M. van Harten, Application of mutation breeding methods in the improvement of vegetatively propagated crops. An interpretive literature reviews. Developments in Crop Science (Netherlands). No. 2*:* (1978).

[5] M.N. El Hadidi, H.A. Hosni, (2000) Flora Aegyptiaca: part 1-vol. 1, part 2. Palm press.

[6] K.A. Omar, Evaluating the effectiveness of in-situ conservation on some endemic plant species in South Sinai, Egypt, Am J Life Sci, 2(3), (2014)164–175.

[7] A.A.Moustafa, M. S. Zaghloul, R.H.A. El-Wahab, M. Shaker, Evaluation of plant diversity and endemism in Saint Catherine Protectorate, South Sinai, Egypt., Egyptian Journal of Botany, 41(1), (2001) 121–139.

[8] A.A. Moustafa, M.S. Zaghloul, S.R. Mansour, D.H. Alsharkawy, M. Alotaibi, Long term monitoring of *Rosa arabica* populations as a threatened species in south Sinai, Egypt, J. Biodivers. Endanger. Species, 5, (2017) 1-8.

[9] M. Abdelaal, M.Fois, G. Fenu, G.Bacchetta, Using MaxEnt modeling to predict the potential distribution of the endemic plant *Rosa arabica* Crép. in Egypt, Ecological informatics, 50, (2019):68–75.

[10] H. Hosni, A. Hosny, E.Shamso, R.Hamdy, Endemic and near-endemic taxa in the flora of Egypt. Egyptian Journal of Botany, 53(2), (2013) 357-383.

[11] M.N. El Hadidi, H. Hosni, (2000). Conservation and threats. In: El Hadidi, M.N. (Ed.). Flora Aegyptiaca. Vol. 1, Part 1. The Palm Press & Cairo University Herbarium, Cairo. 105–151

[12] E. Shamso, A. Sadek, H.A. Hosni, "Morphological and anatomical characteristics of endemic *Rosa arabica* (Rosoideae, Rosaceae) from Sinai, Egypt ". Taeckholmia, 39(1), (2019) 34-43.

https://10.21608/TAEC.2019.17752.1006

[13] S. Gudin, Rose breeding technologies. III International Symposium on Rose Research and Cultivation 547 (2000), 23–33. https://doi.org/10.17660/ActaHortic.2001.547.2

[14] R. E. Shepherd (1954). History of the Rose (Vol. 77, Issue 5). LWW.

[15] R. Marchant, J. B. Power, M. R. Davey, J. M. Chartier-Hollis, P. T. Lynch, Cryopreservation of pollen from two rose cultivars. Euphytica, 66: (1992) 235–241.

[16] V. J. MacPhail, (2007). Pollination biology of wild roses (*Rosa spp*.) in eastern Canada. University of Guelph.

[17] V. Tackholm (1974) 'Students Flora of Egypt'. Cairo Univ. Press.

[18] L. Boulos, (1999) 'Flora of Egypt, vol. 1', Cairo: Al Hadara Publishing, p. 417.

[19] P.G., KEVAN, D., Eisikowitch, J.D. AMBROSE, J.R., Kemp, "Cryptic dioecy and insect pollination in Rosa setigera Michx. (Rosaceae), a rare plant of Carolinian Canada", Biological Journal of the Linnean Society, 40(3), (1990) 229–243.https://doi.org/10.1111/j.1095-8312.990.tb00537.x

[20] A.A., El-Ghamery, H. Hosni, A., Sadek, "Pollen and seed morphology of some endemic taxa in Saint Catherine, Sinai, Egypt". Taeckholmia, 38(1), (2018)40-60. https://10.21608/taec.2018.11916

[21] I. Klášterský, (1968). *Rosa* L. Flora Europaea, 2, pp.25-32.

[22] M.J.M. Smulders, P.Arens, , C.F.S. Koning-Boucoiran, V.W. Gitonga, F.A. Krens, A. Atanassov, K.E. Rusanov, M. Bendahmane, A. Dubois, and O. Raymond, *Rosa*. Wild crop relatives: genomic and breeding resources: Plantation and ornamental crops, (2011)243-275

[23] A. Agarwal, V. Gupta, S.Ul Haq, P.K. Jatav, S.L. Kothari, S.Kachhwaha, " Assessment of genetic diversity in 29 rose germplasms using SCoT marker" , Journal of King Saud University - Science, 31(4), (2019): 780–788. https://doi.org/10.1016/J.JKSUS.2018.04.022.

[24] M. Khosh-Khui, J. A. da Silva, In vitro culture of the Rosa species. Floriculture, Ornamental and Plant Biotechnology, Global Science Books Ltd., London, UK. 2 (2006) 513–526.

[25] M. Marriott, (2017). Modern (Post-1800).

[26] M. Ghazaeian, (2003). Study on pollen of some Asian pear genotypes by scanning electron microscopy (SEM) and suitable pollen germination medium. MS Thesis, Tarbiat Modares Univ., Tehran, Iran.

[27] M. Schori, C. A. Furness. "Pollen diversity in Aquifoliales. " Botanical Journal of the Linnean Society, 175(2): (2014)169–190. https://doi.org/10.1111/boj.12163

[28] J.H. Song, M.K. Oak, H.S. Roh, S.P. Hong, "Morphology of pollen and orbicules in the tribe Spiraeeae (Rosaceae) and its systematic implications". Grana, 56(5): (2017)351-367. https://doi.org/10.1080/00173134.2016.1274334

[29] G. dos S. Almeida, A. C. Mezzonato-Pires, C. B. F.Mendonça, V. Goncalves-Esteves, "Pollen morphology of selected species of Piriqueta Aubl. (Passifloraceae sensu lato) ", Palynology, 43(1) (2019), 43–52.

[30] T. J. Reitsma, Pollen morphology of some European Rosaceae. Acta Botanica Neerlandica, 15(2): (1966) 290–307

[31] H.W. Fogle, "Identification of Clones within Four Tree Fruit Species by Pollen Exine Patterns1". Journal of the American Society for Horticultural Science, 102(5): (1977) 552–560. https://doi.org/10.21273/JASHS.102.5.552

[32] F. y. Eide, Key for northwest European Rosaceae pollen. *Grana*, 20(2): (1981)101-118.

[33] M. C. Marcucci, S. Sansavini, F. Ciampolini, M. Cresti " Distinguishing apple clones and cultivars by surface morphology and pollen physiology". Journal of the American Society for Horticultural Science, 109(1): (1984)10–19. DOI: https://doi.org/10.21273/JASHS.109.1.10

[34] R. J. Hebda, C. C. Chinnappa, "Studies on pollen morphology of Rosaceae in Canada". Review of Palaeobotany and Palynology, 64(1- 4): (1990), 103–108.https://doi.org/10.1016/0034-6667(90)90123-Z

[35] R. J. Hebda, C. C. Chinnappa, "Studies on pollen morphology of Rosaceae". Acta Botanica Gallica, 141(2): (1994), 183–193. https://doi.org/10.1080/12538078.1994.10515150

[36] Y. Ueda, Pollen surface morphology in the genus *Rosa* and related genera. Japanese Journal of Palynology, 38(2): (1992), 94-105.

[37] Y. Ueda, Y. Okada, "Discrimination of rose cultivar groups by pollen surface structure". Journal of Horticultural Science, 69(4): (1994) 601- 607. https://doi.org/10.1080/14620316.1994.11516492

[38] R. Popek, (1996). Biosystematyczne studia nad rodzajem *Rosa* L. w Polsce i krajach ościennych. Wydawnictwo Naukowe Wyższej Szkoły Pedagogicznej, Kraków.

[39] M.I. Shinwari, M. Khan, Pollen morphology of wild roses from Pakistan. Hamdard Medicus, 47:(2004) 5-13.

[40] D. Wrońska-Pilarek, Pollen morphology of Polish native species of the *Rosa* genus (Rosaceae) and its relation to systematics. Acta Societatis Botanicorum Poloniae, 80(3): (2011) 221-232

[41] Bai, J., Zhang, Q., Luo, L., Pan, H., Yu, C., Pollen morphology of some Chinese traditional roses. Bulletin of Botanical Research, 31(1): (2011)15-23.

[42] G. Erdtman (1952). Pollen morphology and plant taxonomy. Angiosperms. An introduction to palynology 1. Almquist and Wiksell. Stockholm.

[43] B.R. Baum, V.E. Hadland, The epicuticular waxes of glumes of Avena: a scanning electron microscopic study of the morphological patterns in all the species. Canadian Journal of Botany, 53(16), (1975)1712-1718.

[44] D. Wrońska-Pilarek, Pollen morphology of the Polish species of the genus Ribes L. Acta societatis botanicorum Poloniae, 67(3-4), (1998).275-285.

[45] W. Punt, P.P. Hoen, S. Blackmore, S. Nilsson, A. Le Thomas, "Glossary of pollen and spore terminology. Review of paleobotany and palynology", 143(1-2), (2007)1-81. https://doi.org/10.1016/j.revpalbo.2006.06.008

[46] M. Hesse, H. Halbritter, R. Zetter, M. Weber, R. Buchner, A. Frosch–Radivo,S. Ulrich (2009) Pollen Terminology. An illustrated Handbook. Springer, Vienna

[47] H. Halbritter, S. Ulrich, F. Grímsson, M. Weber, R. Zetter, M. Hesse, R. Buchner, M. Svojtka, A. Frosch-Radivo, (2018). Illustrated pollen terminology. Springer.

[48] IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp

[49] Ø.Hammer, D.A. Harper, P.D. Ryan. PAST: Paleontological statistics software package for education and data analysis. Palaeontologic electronica, 4(1) (2001) 9.

[50] R. Hebda, C. C. Chinnappa, "Pollen morphology of the Rosaceae of Western Canada I. Agrimonia to Crataegus Grana", 27(2): (1988) 95-113. https://doi.org/10.1080/00173138809432836

[51] Y. Ueda, H. Tomita, "Morphometric analysis of pollen exine patterns in roses". Journal of the Japanese Society for Horticultural Science, 58(1) (1989)211-220. https://doi.org/10.2503/jjshs.58.211

[52] K. Singh, Y.P. Sharma, P.R. Sharma, S. Gairola, Pollen morphology and variability of the *Rosa* L. species of Western Himalaya in India. Genetic Resources and Crop Evolution, 67(2020)2129-2148.

[53] W.K., Taia."Pollen grain diversity and application in taxonomy and evolution". Taeckholmia, 42(1), (2022) 27-42. https://doi.org/10.21608/taec.2022.258213

[54] L. Bednorz, I.R.M.I.N.A. Maciejewska-Rutkowska, D.O.R.O.T.A. Wronska-Pilarek, T. Fujiki,. "Pollen morphology of the Polish species of the genus *Sorbus* L. " Acta Societatis Botanicorum Poloniae, (2005)74(4)https://doi.org/10.5586/asbp.2005.040

[55] Hua, Z.L., W.Z. Xin and W.Z. Yi (1999). Acta Bot.Yunnanica 21(2): 207-211.

[56] J. Kolodziejek, B. Gabara, Palynological study of Polish taxa of Potentilla subsect. Collinae (Rosaceae). Acta Botanica Croatica, 67(2), (2008)139-146.

[57] S. Lee, M. Kang, K.I. HEO, W.L. CHEN, C. Lee, A palynotaxonomic study of the genus *Filipendula* (Rosaceae). Journal of Systematics and Evolution, 47(2), (2009)115-122.

[58] A.Ghosh, I.Saha, Pollen morphological study of some selected Indian taxa of Rosaceae. Indian J Applied & Pure Bio, 32, (2017). 121-130

[59] F. Ullah, Y. Gao, İ. Sari, R.F. Jiao, S. Saqib, X.F. Gao, "Macro-Morphological and Ecological Variation in *Rosa sericea* Complex". Agronomy, 12(5), (2022)1078. https://doi.org/10.3390/d14090705

[60] F., Ullah, Y.D., Gao, W. Zaman, X.F., Gao. "Pollen morphology of *Rosa sericea* complex and their taxonomic contribution". Diversity, 14(9), (2022) 705. https://doi.org/10.3390/d14090705

[61] D. Wronska-Pilarek, K. Boratynska, Pollen morphology of *Rosa gallica* L. [Rosaceae] from Southern Poland. Acta Societatis Botanicorum Poloniae, 74(4) :(2005) 297-304

[62] J. A. Dar, A. A. Wani, Manoj, K. Dhar. "Preliminary Pollen Analysis of Some Apple Cultivars in Kashmir: Towards Understanding the Apple Pollen Morphology" Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 90: (2020),431- 438. https://doi.org/10.1007/s40011-019-01117-6

الملخص العربى

دراسة تصنيفيه لحبوب اللقاح لبعض اصناف من نبات الورد في مصر

فاطمه عبدالنبي علي*١, وفاء مرسي سعيد١, ريم محمد صلاح الدين١, سحر عبدالرحمن١, سحر عبدالفتاح١

[1] قسم النبات- كلية البنات للأداب والعلوم والتربية – جامعة عين شمس – القاهرة - جمهورية مصر العربية.

تضمن البحث دراسه تصنيفيه مقارنه للصفات المظهريه لحبوب اللقاح والتي شملت ٢٤ من نبات الورد Rosa L المنزرع في مصر والتي تم تجميعها من جزيرة الشعير البحريه بمنطقه القناطر الخيريه. تم فحص حبوب اللقاح باستخدام المجهر الضوئي Light Microscope والمجهر الالكتروني الماسح Scanning Electron Microscope واظهرت نتائج الدراسه بأن حبوب اللقاح من طراز ثلاثيه الأخاديد والثقوب Tricolporateوشكلها في المنظر القطبي Polar view مستديرة circular وفي المنظر الأستوائي Equatorial viewبيضاويه elliptical. واظهرت الدراسه اختلافات في شكل حبوب اللقاح فتنوعت بين ثلاث اشكال Prolate, Sub prolate, Prolate spheroidal وكذلك حجم الحبه تنوع بين الصغيرة والمتوسطه Small and medium.

اوضحت الدراسه اختلافات في قياس المحور القطبي والأستوائي Polar and Equatorial axesوكذلك طول الأخدود Colpi length وسمك جدار الحبه Exine thickness والتي ادت الي التمييز بين الاصناف وبعضها.

وكذلك تم دراسه الزخرفه السطحيه للحبوب اللقاح Exine Sculpture والتي اظهرت اختلافات بين الأصناف واعتبرت احد اهم صفات التمييز بينهم وكان النوع السائد في الزخرفه هو المخطط Striate والذي اخد اشكال مختلفه بين الأصناف المدروسه المخطط الموازي للاخدود Parallel to colpiوالمخطط العمودي علي الأخدود Perpendicular to colpi و شكل بصمه اليد Striate like finger printوكذل ك المموج Wave like.

وظهر ايضا في بعض الأنواع نوع الزخرفه الأملس Psilate وكذلك المحبب Granular- Verccuate.

اوضحت دراسه الصفات المظهريه والكميه لحبوب اللقاح انها ذات قيمه تصنيفيه في فصل اصناف نبات الورد المدروسه والتي يصعب فصلها وتعريفها تصنيفيا نظرا لأنها مهجنه بين اكتر من نوع من نبات الورد.