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A MICROMORPHOLOGICAL STUDY OF SOME GENERA OF THE PAPILIONOIDEAE SUBFAMILY IN CENTRAL AND NORTHERN IRAQ

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Abstract

This research involved a micro-morphological pollen study on 23 wild plant species belonging to six genera of the Papilionoideae subfamily growing in the central and northern districts of Iraq. These are *Astragalus, Lathyrus, Medicago, Pisum, Trifolium*, and *Vicia.* The samples were collected from February 2022 to June 2023. Altogether 34 field tours were made for conducting a comprehensive survey and to examine preserved herbarium specimen samples from the National Herbarium of Iraq and various universities. Pollen grains were examined for the arrangement of genera using a light microscope (LM 1000X) and a field-emission scanning electron microscope (FESEM). Diagnostic characteristics studied included the grain axis, apertures, E/P ratio, size, pollen grain shape, and surface ornamentation. The results show that the pollen grain were small-to-medium sized, tricolporate, isopolar, prolate, and spheroidal-to-subspheroidal. In addition, the surface ornamentation showed reticulate perforates, subperforate reticulate striates, reticulate sub-striate ornamentation, and reticulate perforate-striates. In conclusion, this study presents some morphological characteristics of pollen grains from the Papilionoideae subfamily in which LM (1000X) and FESEM were found to be useful and reliable

tools in determining the importance of this classification in achieving historical knowledge of these seeds.

Keywords: Papilionoideae, FESEM, Astragalus, Lathyrus, Micromorphological studies.

دراسة مظهرية لبعض اجناس العويئلة الفراشية Papilionoideae في مقاطعة وسط وشمال العراق

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الخلاصة

تضمن هذا البحث دراسة مظهرية دقيقة لحبوب اللقاح شملت 23 نوعًا من النباتات البرية تنتمي إلى ستة أجناس من العويئلة الفراشية Papilionoideae النامية في مناطق وسط وشمال العراق. هذه الأجناس *Astragalus* و*Lathyrus* و*Medicago* و*Pisum* و*Trifolium* و*Vicia*. تم جمع العينات خلال عامي 2022–2023. تم إجراء ما يقرب من 34 جولة ميدانية، بما في ذلك مناطق المحافظات الوسطى والشمالية، ومسح شامل للعينات المعشبية المحفوظة في المعشب الوطني العراقي ومعاشب الجامعات الأخرى لغرض التشخيص. تم فحص حبوب اللقاح لمراتب الأجناس باستخدام المجهر الضوئي (LM 1000X) والمجهر الإلكتروني الماسح للانبعاثات الميدانية (FESEM). تضمنت الخصائص التشخيصية لحبوب اللقاح التي تمت دراستها محور الحبوب وفتحات الانبات apertures ونسبة E/P وشكل وحجم حبوب اللقاح وزخرفة سطحها ornamentation. أظهرت النتائج ان صفات حبوب اللقاح هي صغيرة إلى متوسطة الحجم، ثلاثية الاخاديد tricolporate، متماثلة الأقطاب isopolar، مثقبة prolate، كروية إلى شبه كروي sub–spheroidal. بالإضافة إلى ذلك، أظهرت دراسة الزخرفة السطحية بانها ذات أسطح شبكية نقطية، شبكية شبة نقطية، شبكية مخططة، شبكية شبة مخططة، وشبكية نقطية مخططة. وفي الختام، تقدم هذه الدراسة بعض الخصائص المورفولوجية لحبوب اللقاح من الفصيلة الثانوية Papilionoideae حيث تم استخدام (1000X) M و FESEM أداة مفيدة وموثوقة لهذا التصنيف، ناهيك عن أهمية هذا التصنيف الذي يساعد في المعرفة التاريخية لهذه البذور.

كلمات مفتاحية: Papilionoideae، FESEM، Astragalus، Lathyrus، دراسات مظهرية دقيقة.

Introduction

Palynology is closely linked to other sciences and is concerned with the study of plant pollen in terms of shape, size, dimensions, ornamentation, colpi and apertures, and their importance in the field of taxonomy and the distribution of plants on land (5, 11 and 12). The term "palynology" was first used in 1944 by Hyde and Williams, and then the Swedish scientist Linnaeus founded the modern science of pollen analysis. The terms "Pollen" and "Palynogram" were also used by Erdman who showed a diagram of the main phenotypic features of pollen. Furthermore, he contributed a second basic taxonomic work, considered the cornerstone for the comparative morphological study of pollen grains. This science was linked to several essential biological sciences, including breeding systems, pollination, hybridization, archaeology, and plant geography (5, 9 and 21).

Micromorphological studies of pollen grains are important in determining taxonomic groups at various levels, especially with the availability of field-emission scanning electron microscope (FESEM) and the transmission electron microscope (TEM) in the 1970s. Pollen morphology has a crucial role in the classification and identification of plants. Taxonomists utilize pollen morphological features to organize taxa within the appropriate taxonomic ranks (17, 29 and 34). Morpho-palynological research is a valuable tool for modern taxonomists in distinguishing closely related species. Recently, both scanning electron microscopy and light microscopy have become the preferred methods for micromorphological studies of pollen (8 and 37). The Papilionoideae family has high economic and medical potential, and many studies have been conducted to identify the species and species boundaries at various taxonomic levels of this family (6, 26 and 39). Although the pollen grains of this family can be found aggregated in the form of dyads, tetrads, and polyads, they are characterised by being monads among the various genera of the family (6, 7, 10, 21, 26 and 39).

As for the phenotypic characteristics of Papilionoideae pollen grains, Ferguson in 1985 (13) explained that there was a gradual increase in the complexity of pollen grains among the large derived families that have more genera, and even between genera, there may be a gradual increase in complexity, especially in the Exine stratification. However, some species have pollen grains with different wall ornamentation (exine ornamentation) (6 and 24). Most Papilionoideae pollen grains are characterized by features such as radial symmetry, equipolar and prolate-to-subprolate, oblate-to- oblate spheroidal, and rarely prolate-spheroidal. Moreover, some pollen grains are Tricolporate in polar view and infrequently are colpate or porate only (7 and 25).

Recently, several morphological studies have been conducted on the pollen grains of several genera of the leguminous family using light and electron microscopy. (31) conducted a study about the characteristics of the pollen grains of 37 genera of the Papilionoideae divided into 16 families in Pakistan. They then classified the pollen grains of these genera into ten species based on the number of characteristics, including grain type, the ratio of the length of the polar axis to the equatorial axis P/E, shape, and number of apertures. They indicated that most of the Papilionoideae tribes can be easily distinguished based on the characteristics of the pollen grains. Also, (1) studied the

morphology of pollen grains from different plant families, including Mimosoideae, in Pakistan, while (32) studied the pollen grains of selected genera of the family in eastern India.

In Turkey, (19) studied some individuals of the genus *Lathyrus* in the Thrace region, located on the European side of Turkey, where they concluded that the type of pollen grain was 3-zoncolporate. Likewise, (18) described the pollen grains of the subgenus Pratensis, including the shape of the pollen grain, the size of apertures, and the polar and tropical appearance of the grain, in addition to the P/E ratio and the exine ornamentation. Furthermore, (20) indicated that the thickness of the exine of the pollen grain was two to three times greater than around the apertures.

No detailed studies of the Papilionoideae genera using FESEM have been conducted in Iraq. Simple phenotypic studies of pollen grains of some genera of the leguminous family were conducted as part of a taxonomic study using a LM only. For example, (3) researched the morphology of pollen grains of wild dicotyledonous species growing in the Baghdad University Campus, Jadriya. Pollen grains of *Trifolium* species were also studied as part of a taxonomic study of the genus by (2).

This study investigated the micro-morphological characteristics of pollen grains of each species using grain size based on the length of the polar and equatorial axes, number of apertures, and pattern of the surface ornamentation of the external grain wall (exine ornamentation) using LM and FESEM to access its evolutionary trends.

Materials and Methods

Fresh plant samples were collected directly from the field in the study counties which had most orders of the Papilionoideae subfamily. To accomplish the various aspects of this study over 31 field visits were made to different locations in central and northern Iraq provinces from mid-February 2022 until end-May 2023 to conduct surveys on genera and plant species (Table 1).

Table 1: Natural regions and districts in central and northern Iraq covered in this study (16).

(M) Mountain Range	
MAM	**Amedia district**
MRO	**Rawandiz district**
MSU	**Sulaymaniyah district**
MJS	**Sinjar Mountains district**
(F) Alluvial and Upland Plains	
FUJ	**Upland Plain district**
FNI	**Ninawa district**
FAR	**Erbil district**
FKI	**Kirkuk district**
FPF	**Eastern Border Highlands district**

Mature flower buds collected from the field were fixed with Carnoy's solution (ethyl alcohol: glacial acetic acid 3:1 v/v) for 24 hours. They were then washed with 70% ethyl alcohol and refrigerated with the same alcohol concentration until use.

A. Preparation of samples for study under a light microscope (LM 1000X): The phenotypic study of pollen grains was based on fresh samples. Wilson and Goodman

(1964) (38) used the acetolysis method with some modifications. Glycerin gel was prepared according to the process of (36), as follows:

Gelatin	5 gm	Distilled water	30 ml
Glycerin	35 ml	Phenol	0.5 gm (Phenol dissolved in distilled water)

- Several anthers of small flowers or large buds preserved in 70% ethyl alcohol were placed in a watch glass bottle containing drops of water. The anthers were crushed using two fine dissecting needles to release the pollen, and the excess anthers were removed from the bottle.
- The watch bottle was placed on a hot plate at 60°C until the water dried.
- 3-4 drops of acetolysis solution prepared from HCL: H2SO4 (9:1 v/v) were added. The pollen grains were covered with the solution and gently heated on a hot plate at 70°C until the solution turned brown.
- A few drops of 100% absolute ethyl alcohol were added to the hot mixture. The solution is displaced towards the edge of the bottle as it dries by wiping with blotting paper.
- A few drops containing the pollen solution were taken with a clean dropper (one for each sample).
- A drop of glycerine jelly (previously prepared) was added to the slide, covered with a slide cover, and the pollen grains were photographed using an NSZ-606 camera with a light microscope with 1000 X magnification mounted under the lens. Measurements were taken of the polar and the equatorial views of the pollen grains, the P/E value was calculated, and the wall thickness of the grain was measured using an Ocular micrometre. It also described the shapes of pollen grains for the polar and tropical views and arranged the data in a table. In addition, the surface ornamentation of pollen grains explaining the variations in the polar and equatorial axis of species ranks were studied for each species at a rate of 10-16 pollen grains per sample. Between 5 to 8 samples for each genus type were analysed depending on the distribution site. The terms mentioned are adopted from (11 and 23).

B. Preparing samples for study in FESEM: In this method, pollen grains stored in 2 ml Eppendorf tubes containing 70% alcohol were used and prepared for light microscopy. Then, the pollen was withdrawn using micropipettes and placed on a special disc for Stup investigation after drying at room temperature. The disc was covered with double-sided adhesive tape. The samples were plated with gold using an ion sputter coating device. After that, the discs were transferred to an Inspect S50 Field-emission scanning electron microscope, and the samples were photographed. This research was conducted in the central service laboratory, College of Science, University of Kufa. Most of the samples were also sent to neighbouring countries for investigation.

Results and Discussion

Palynological Study: Research on the variations in the phenotypic features of pollen grains is considered one of the studies on their micromorphological characteristics and has a significant taxonomic value. This study made it clear that the Papilionoideae pollen grains were monads, regular, and isopolar, and that the polar and tropical views contained apertures and furrows for germination. This study covered the following aspects:

1. Type: Papilionoideae pollen grains. The results of quantitative and qualitative characteristics and the use of LM (1000X) and FESEM showed a clear discrepancy in terms of types, and more than one type was found (Table 1). On this basis, the studied species were divided into two types according to the number of apertures and colpi, that is:
   - 3-colpate type distinguished by all species except for *M. rigiduloide*.
   - 4-colpate type distinguished by *M. rigiduloide* and 4 apertures.
2. The shape of pollen grains: Most of the pollen grains were classified into several shapes depending on the ratios between the polar and equatorial views (P/E). The shape of the pollen grains was determined as follows:
   - Subspheroidal-subprolate: *L. tuberosus, L. tuberosus* A, *L. inconspicuous, M. orbicularis, T. boissieri, T. phitosianum, T. nigrescens, T. resupinatum, V. michanxii* (Table 1), (Figure 1, 2 and 4).
   - Wide ellipsoid (semi-square): *M. minima.* (Figure 2).
   - Narrowly ellipsoid (with semi-rhombus-shaped ends): *M. minima* A, *M. rigiduloide, M. polymorpha, M. polymorpha* A (Figure 2 and 3).
   - Prolate pollen grains are found in the rest of the plant species under study.
3. Size: This study was based on measuring the lengths of the polar and equatorial axes. The results showed that the polar axes average lengths ranged from a minimum of 20 µm in *A. hamosus* A, *M. minima* and *T. resupinatum* to a maximum of 33 µm in *L. tuberosus*. For the equatorial axis, the highest rate was in *T. dichoranthum* at 47 µm and the lowest in *M. minima and M. polymorpha* at 23 µm. While according to (12 and 13) the locations of the species were categorized into two based on size in general and depending on the length of pollen axes.
   - Category 1: small-sized, ranging between 10 to 25 µm, and included the *M. minima* and *M. polymorpha* species. (Figure 2).
   - Category 2: between the small and large sizes, ranging from 23 to 26 µm, and included the *M. polymorpha* A, *T. boissieri* and *T. resupinatum.* (Figure 2 and 4)
   - Category 3: medium-sized at 25 to 50 µm and contained all species.
4. Apertures: The dimensions of the germination apertures varied depending on the pollen grains of the species, averaging 1-2 µm in length for *M. polymorpha,* 8.5 µm in *L. tuberosus,* and between these two limits for the others (Figure 1 and 2).
5. Colpi: This study found a clear difference between the types of genera in terms of the dimensions of the colpi. The lowest average length of the colpi was 15 µm for *T. boissieri,* while the highest was 39 µm for *L. tuberosus* (Figure 2, 4). In contrast, the average width of the colpi ranged from 1.2 µm for *M. rigiduloide* and 4 µm for

M. polymorpha and *P. sativa*. Other dimensions ranged between these two limits (Figure 2 and 3).

6. Mesocolpium: The dimensions of the furrows varied for the studied species depending on pollen grain size. There was a direct relationship between the sizes of the pollen grains and the distances between them. The average distance between two furrows decreased to reach 7 μm in *A. hamosus, A. hamosus* A and *A. hamosus* N. as the shortest distance. Compared to *L. tuberosus* had the widest average distance between two furrows, and the other species came in succession between them (Figure 1). Although they were close in some species, they differed in others to the extent that it was possible to benefit from successfully isolating the species.
7. Surface ornamentation: Scanning electron microscope images showed clear differentiation in the outer surfaces of the pollen grain walls. Based on this, they were divided into five groups:
   - Group 1: outer surface characterized by reticulate-perforate ornamentation for the *A. hamosus, A. hamosus* A, *L. tubrosus, M. minima, M. rigiduloide, M. polymorpha, M. polymorpha* A, and *V. assyriaca* species (Figure 1, 2, 3 and 5).
   - Group 2: outer surface ornamentation was reticulate-subperforate for *M. minima* A, *T. phitosianum, T. resupinatum,* and *T. nigrescens* (Figure 2 and 4).
   - Group 3: reticulate-striate surface for *A. hamosus* N, *M. orbicularis, P. sativum, P. sativum* N, and *V. sativa* var. sativa (Figures 1, 2, 3 and 5).
   - Group 4: reticulate sub-striate ornamentation for the species *V. michanxii* (Figure 5).
   - Group 5: reticulate perforate-striate ornamentation for *L. tuberosus* A, *L. inconspicuous, P. sativum* A, *T. boissieri,* and *T. dichoranthum.* (Figure 1,2,3 and 4).

Table 1: Micromorphological characteristics of the Papilionoideae subfamily pollen genera (µm).

No	Species	Polar axis	Equatorial axis	E/P	Pollen grain size	Aperture dimensions	Colpate length	Colpate width	Mesocolpium average	Porate and colpate	Pollen shape	Ornamentation
1	*A. hamosus*	15(22)27	30(34)37	1.54	Medium	3(4)5	2(28)306	1(1.3)1.5	6(7)7.5	Tricolporate	Prolate	Reticulate perforate
2	*A. hamosus* A	15(20)25	30(33)35	2.2	Medium	3(3.5)4	2(25)304	1.5(1.6)2	6.5(7)7.5	Tricolporate	Prolate	R. perforate
3	*A. hamosus* N	15(22)26	32(34)36	1.54	Medium	4(5)6	2(27)296	1.5(1.6)2	6.5(7)8	Tricolporate	Prolate	R. Striate
4	*L. inconspicuus*	31(32)34	36(38)40	1.18	Medium	6(7)8	3(35)390	1(1.5)2	19(22)24	Tricolporate	Subspheroidal-subprolate	R. perforate/striate
5	*L. tuberosus*	30(33)35	41(42)43	1.27	Medium	7(8.5)10	3(39)413	1.5(2)2.5	32(35)37	Tricolporate	Subspheroidal-subprolate	R. perforate
6	*L. tuberosus* A	27(28)30	30(32)33	1.14	Medium	7(7.5)8	1(21)249	1(1.3)1.5	9(15)17	Tricolporate	Subspheroidal	R. perforate/striate
7	*M. minima*	19(20)21	22(23)24	1.15	Small	2(5)7	1(18)197	1(1.3)1.5	14(15)16	Tricolporate	Wide ellipsoid	R. perforate
8	*M. minima* A	21(22)23	28(29)30	1.31	Medium	3(3.5)4	2(26)275	1.5(2)3	21(21.5)22	Tricolporate	Narrowly ellipsoid	R. subperforate
9	*M. orbicularis*	25(27)28	30(31)32	1.14	Medium	4(5)6	2(23)242	2.5(2)3.5	19(20)21.5	Tricolporate	Subspheroidal	R. striate
10	*M. polymorpha*	21(22)23	18(23)24	1.04	Small	2(3)4	1(16)194	3(4)5	16(17)18	Tricolporate	Narrowly ellipsoid	R. perforate
11	*M. polymorpha* A	23(24)26	21(26)27	1.08	Small-medium	1(1.2)1.5	2(24)252	1.5(1.6)2	18(19)20	Tricolporate	Narrowly ellipsoid	R. perforate
12	*M. rigiduloide*	29(30)33	29(32)34	1.06	Medium	4(4.5)5	2(25)270	1(1.2)1.5	17(21)24	Tetracolprate	Semi-rhombus polygon	R. perforate
13	*P. sativum*	25(27)28	43(44)45	1.6	Medium	5(6)7	2(30)318	3(4)5	15(16)17	Tricolporate	Prolate	R. Striate
14	*P. sativum* A	25(26)28	36(38)39	1.4	Medium	5(5.5)6	3(32)331	2.5(2.6)3	10(13)15	Tricolporate	Prolate	R. perforate/striate
15	*P. sativum* N	25(26)27	40(45)47	1.7	Medium	4(5.5)7	3(34)352	2(2.3)2.5	11(12)13	Tricolporate	Prolate	R. striate
16	*T. boissieri*	20(23)25	24(25)27	1.1	Small-medium	3(3.5)4	1(15)164	1(1.3)1.5	16(17)19	Tricolporate	Subspheroidal	R. perforate/striate
17	*T. dichoranthum*	22(23)25	46(47)49	2.4	Medium	4(5)6	3(35)363	1.5(1.6)2	25(26)27	Tricolporate	Prolate	R. perforate/striate
18	*T. nigrescens*	23(24)26	25(26)27	1.08	Medium	5(6)7	1(20)218	2(2.3)2.5	15(16)17	Tricolporate	Subspheroidal-subprolate	R. subperforate
19	*T. phitosianum*	22(24)25	28(29)30	1.2	Medium	3(3.5)4	2(22)231	1(1.5)2	9(10)11	Tricolporate	Subspheroidal	R. subperforate
20	*T. resupinatum*	19(20)21	23(24)26	1.2	Small-medium	3(4)5	1(21)229	3(3.5)4	15(16)17	Tricolporate	Subspheroidal	R. subperforate
21	*V. assyriaca*	25(26)27	44(45)47	1.73	Medium	4(5)6	2(30)326	2(2.2)2.5	19(21)22	Tricolporate	Prolate	R. perforates
22	*V. michanxii*	24(25)27	35(36)37	1.44	Medium	5(6.5)8	3(33)342	2(2.2)2.5	20(21)22	Tricolporate	Subspheroidal-subprolate	R. substriate
23	*V. sativa var. sativa*	21(23)26	32(35)37	1.52	Medium	4(5)6	1(16)185	1.5(1.6)2	15(16)17	Tricolporate	Prolate	R. striate

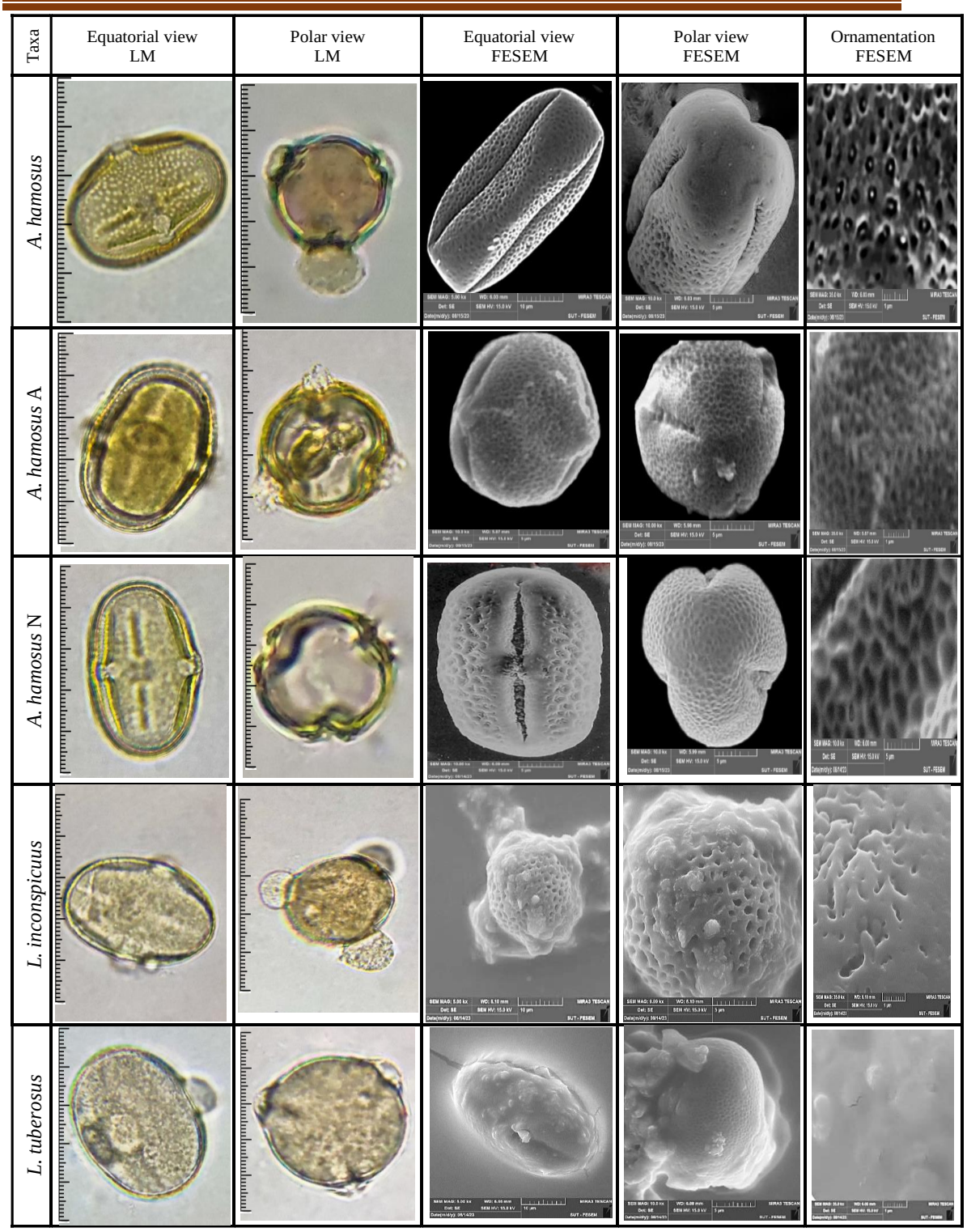

Fig 1: LM1000X and FESEM micrographs of pollen grains in various Papilionoideae species.

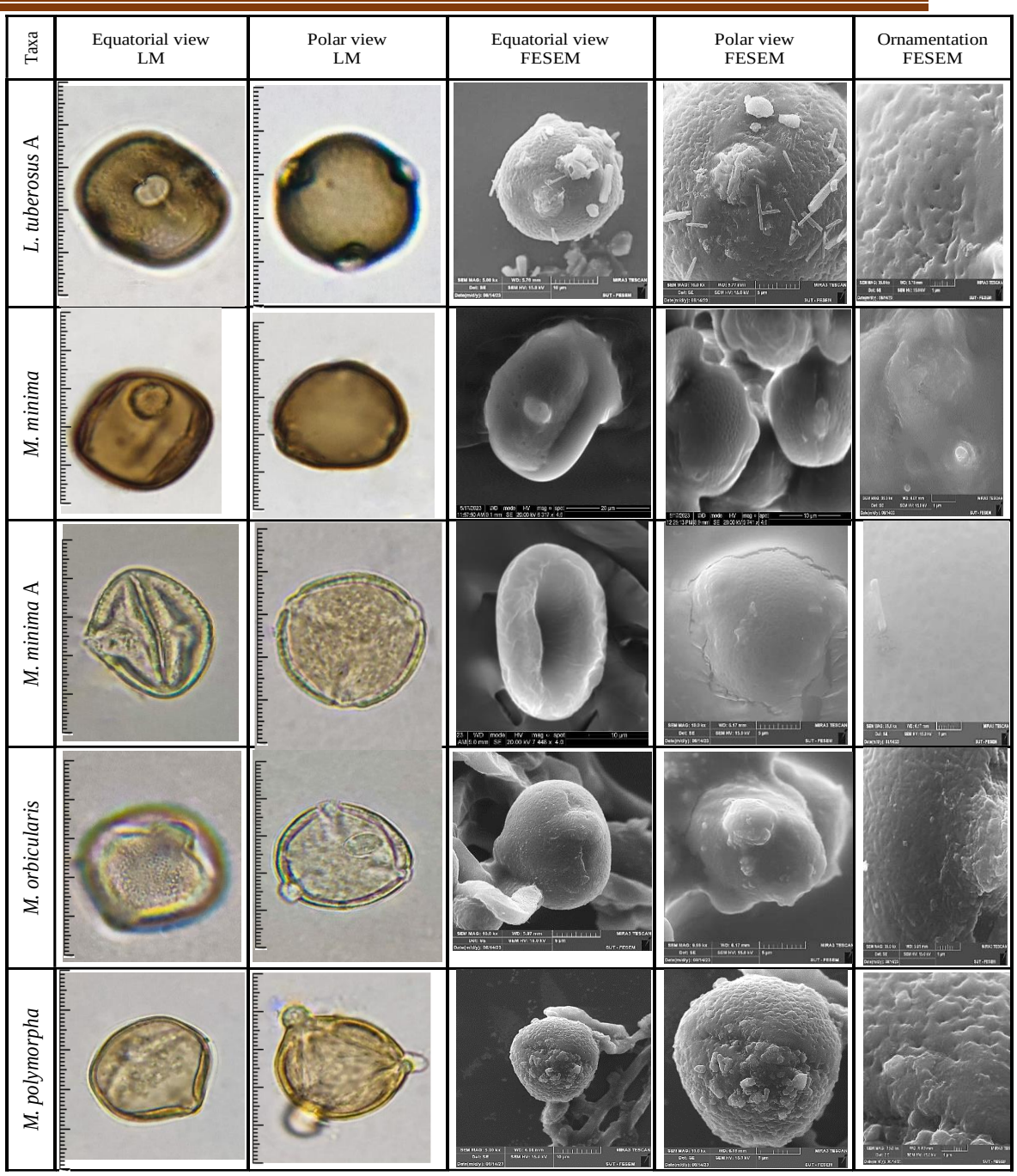

Fig 2: LM1000X and FESEM micrographs of pollen grains in various Papilionoideae species.

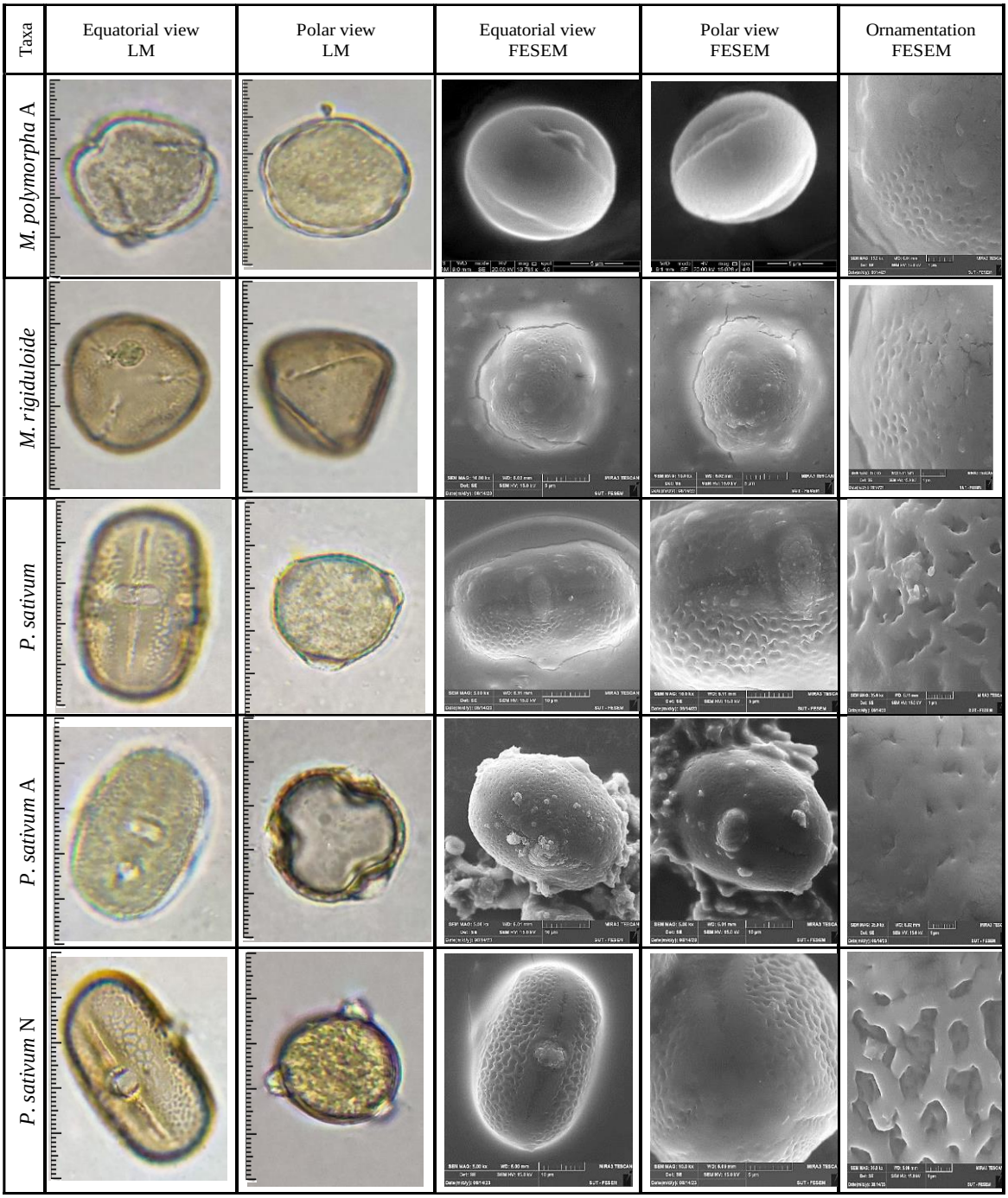

Fig 3: LM1000X and FESEM micrographs of pollen grains in various Papilionoideae species.

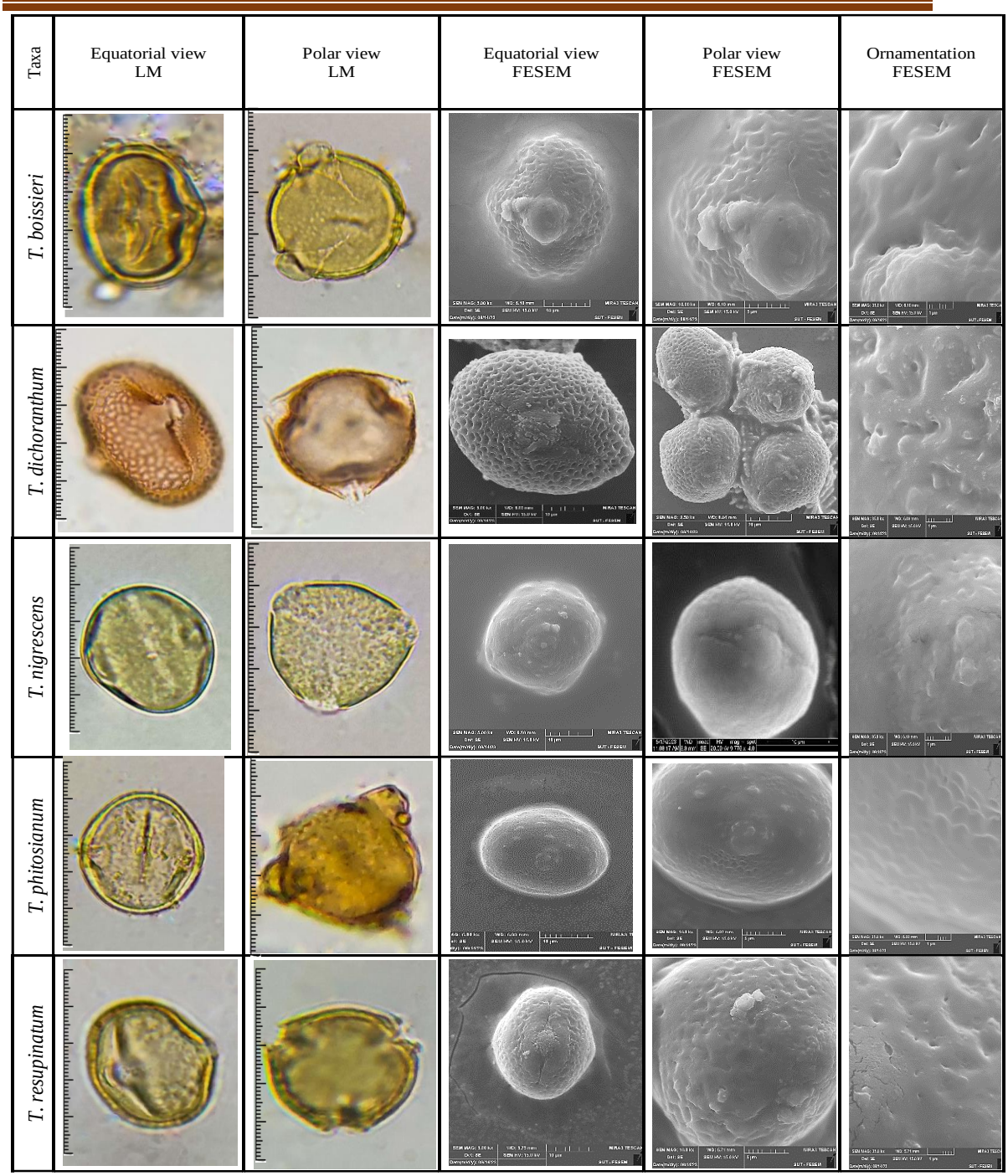

Fig 4: LM1000X and FESEM micrographs of pollen grains in various Papilionoideae species.

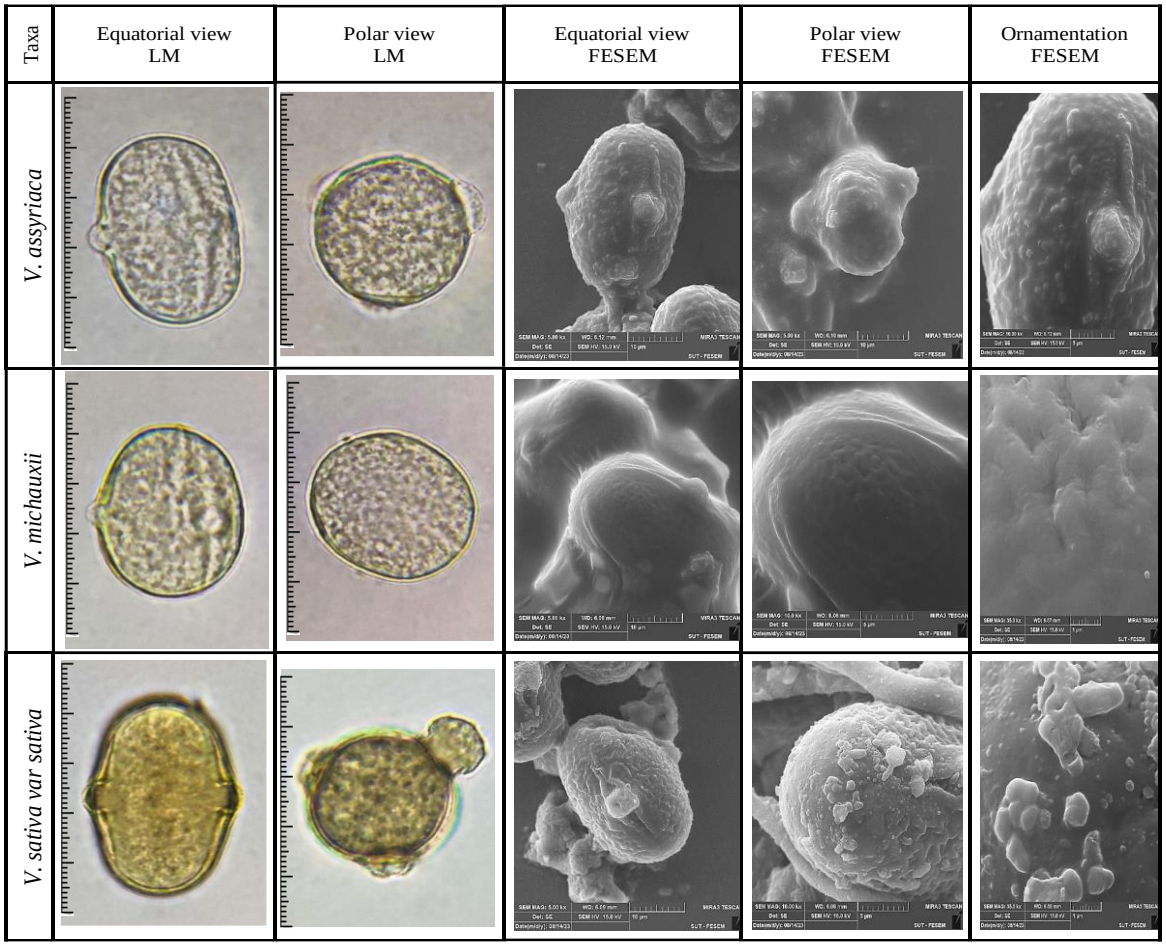

Fig 5: LM1000X and FESEM micrographs of pollen grains in various Papilionoideae species.

This study offered valuable findings on the micromorphology of 23 genera of the Papilionoideae subfamily wild plant species (Table 2). The table displays some micro-phenotypic characteristics of the plant including the polar axis, equatorial axis, the ratio between the polar and equatorial views (P/E), pollen grain size, aperture dimensions, length and width of colpate, mesocolpium average, porate colpate, pollen shape, and ornamentation. These properties are genetically determined and remain unaffected by environmental variations. Palynotaxonomy has been particularly valuable in studying families such as Asteraceae, Passifloraceae, Podostemaceae, Vitaceae, and Leguminosae. Additionally, the increasing application of palynology in cladistic and multidisciplinary research has helped establish relationships and degrees of kinship among various plant groups, contributing to the understanding of their evolutionary history (15).

The Fabaceae families are classified as eurypalynous, and their pollen characteristics exhibit a variety of heterogeneous types (27 and 28). The 23 species of pollen were found to possess various shapes including prolate, subspheroidal, subprolate, sub spheroidal, wide ellipsoid, narrowly ellipsoid, semi-rhombus, and polygon. In addition, all these grains ranged from small to medium in size and they were monad (26).

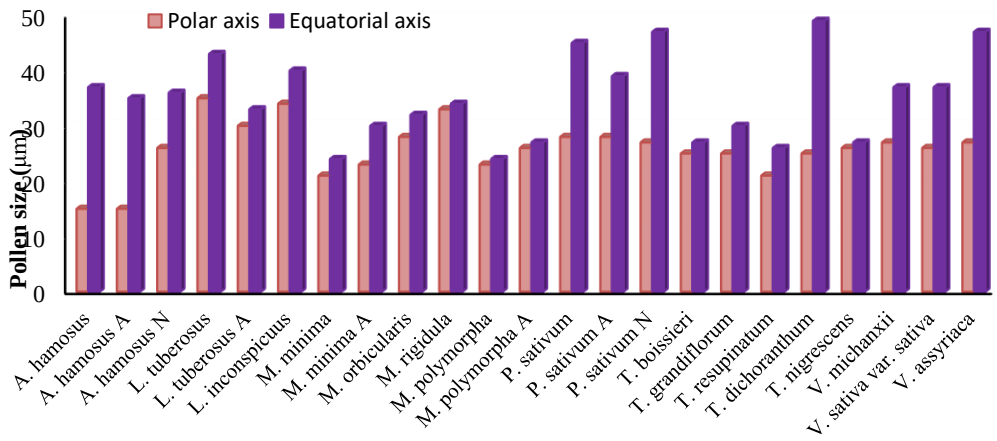

Fig 6: Polar and equatorial size of pollens.

Figure 6 show a wide difference in the polar and equatorial sizes of all the pollen grains of the studied species, ranging from small to medium. This is consistent with (4), which classified the sizes of pollen grains from small to medium and large, as well as large pollen grains. That also explains that the size classifications of pollen grains play a vital role in describing them. The results show that the *Pisum* has the largest size among the six genera.

The FESEM and LM (1000X) results show that the *Astragalus* genera are characterized by the same shape and size as tricolporate. The surface ornamentation appears as reticulate-perforate and reticulate-striate (Figure 1) while the *Lathyrus* genera are distinguished by variations in both polar and equatorial axes, length and width of the colpate, and average mesocolpium though having the same size. In the case of surface ornamentation, the results show two types of ornamentation i.e., reticulate-perforate and reticulate-perforate or striate (Figures 1 and 2). The third type of genera is *Medicago* which has six species and all differ in their features. Their polar and equatorial axes ranged between 19 to 29 µm and 18 to 30 µm, respectively (Figure 6). Furthermore, all these species varied in grain size, dimension of aperture, length, and width of colpate. Also, FESEM and LM (1000X) show the differentiation in the shape of the grains (sub-spheroidal, wide, or narrowly ellipsoid, semi-rhombus, or polygon) and all species are tricolporate together with being reticulated-perforate, reticulate-sub perforate, or reticulate-striate in the ornamentation surfaces. (Figures 2 and 3). These results are consistent with the study by (30).

The FESEM and LM (1000X) also reveal that the pollen of the *Pisum* genera are of three species and characterized as tricolporate, having small variations in their axes, and with the same size and grain shape. In addition, they almost possess the same surface ornamentation (Figure 3). This study also shows that there are five species under the same genera namely *Trifolium*. The grain of the *Trifolium* has different species distinguished by variations in their axes, length, and colpate width, average mesocolpium, grain size, and aperture dimensions. Further, these species are characterized by changes in their ornamentation of the surface, but almost all have the same grain shape (Figure 4). The last genera found in our investigation was the *Vicia*. It has three species characterized by the same size and variety in both axes and in length and width of colpate. These species change also in their shapes (subspheroidal-

subprolate and prolate) and types of grain ornamentation (reticulate substriate, reticulate-striate, and reticulate-perforate) (Figure 5). These results agree with (30) in some features such as size and shape.

In general, our findings are consistent with 15 and 23 who described the pollens as characterized by properties such as shape, porate, prolate, and isopolar that are similar to those obtained. Also, these results match Kayani's study (24) in some characteristics such as tricolporate grain, isopolar, spheroidal to sub-spheroidal and prolate

Conclusions

Micromorphological characteristics are potential taxonomic tools in the classification of grains and their genera. Variations in their features play a vital role in describing and classifying pollen grains. This study focused on 23 pollen species of the Fabaceae Papilionoideae subfamily, divided into six genera. The size of these grains, which ranged from small to medium, was studied. The shape of these grains ranged from prolate, subprolate, spherical to sub-spheroidal. The form of the surface ornamentation was also studied, which can be used to access information and evidence about these grains and their families and then classify the plants belonging to them. This study highlights the pollen grain morphologies of the Fabaceae family and provides valuable insights into their taxonomy by focusing on the shape, size, and types of surface patterns of these grains.

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No Supplementary Materials.

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The authors declare no conflict of interest.

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