

# Pollen Morphology of Tribes Gnaphalieae, Helenieae, Plucheeae and Senecioneae (Subfamily Asteroideae) of Compositae from Egypt

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Received October 10<sup>th</sup>, 2010; revised December 9<sup>th</sup>, 2010; accepted December 20<sup>th</sup>, 2010.

## ABSTRACT

*POLLEN morphology of twenty five species representing 12 genera of tribes Gnaphalieae, Helenieae, Plucheeae and Senecioneae (Asteroideae: Asteraceae) was investigated using light and scanning electron microscopy. The genera are Phagnalon, Filago, Gnaphalium, Helichrysum, Homognaphalium, Ifloga, Lasiopogon, Pseudognaphalium, Flaveria, Tagetes, Sphaeranthus and Senecio. Two pollen types were recognized viz. Senecio pollen type and Filago pollen type. Description of each type, a key to the investigated taxa as well as LM and SEM micrographs of pollen grains are provided.*

**Keywords:** Pollen, Morphology, Asteroideae, Asteraceae, Egypt

## 1. Introduction

Gnaphalieae, Helenieae, Plucheeae and Senecioneae (Asteroideae: Asteraceae) are of the well represented tribes in Egypt, where 12 genera with about thirty five species are native in the country [1]. Reference [2] separated the Compositae pollen into two groups based on the gross morphology of the pollen grain: the liguliflorae-type characterized by echinolophate pollen, which is generally found in the Cichorioideae; and the tubuliflorae-type, which is found in many other tribes. Reference [3] recognized three pollen types, i.e., psilate (this type can not be easily recognized), echinate, and lophate pollen. Based on pollen wall ultrastructure, [4] and [5] reconsidered these pollen types and recognized five major pollen wall types, the Helianthoid, the Senecioid, the Arctotoid, the Anthemoid and pollen types without designated patterns. These pollen types are variously distributed among the Cichorioideae and the Asteroideae. Pollen of the Barnasioideae is similar to the echinolophate pollen of the liguliflorae-type, but lacks the spines [6]. Reference [7] observed that the pollen grains of some Compositae tribes consist of three compound apertures, each one of them is made up of ecto-, meso- and endo-aperture, the apertural membrane is formed by a foot layer and endexine with complete ectexine granules, the ectoaperture involves the tectum and infratectum, the mesoaper-

ture involves the foot layer and the outer layer of the endexine and the endoaperture involves the inner layer of the endoxine. The intine is thickened considerably in Anthemideae near the aperture. Reference [8] described Gnaphalieae pollen as a two-layered pollen sexine with an outer baculae and an inner perforated layer. Reference [9,10] observed that the pollen morphology and anatomy of the Plucheeae correspond to that of the Inuleae; thus, the pollen is echinate and caveate with one layer of baculae between the spines and two baculate layer in the spines bases. This paper considers pollen grains of the tribes Gnaphalieae, Helenieae, Plucheeae and Senecioneae in the flora of Egypt, which may prove of value in systematic treatments. Pollen types that show all the possible characteristic features (shape, size, apertures, wall stratification) are considered, with special reference to the specific characters of each pollen type. The available palynological data will be discussed.

## 2. Materials and Methods

Pollen materials were removed from herbarium specimens identified according to [1,11,12] and [13]. The specimens were kept in Cairo University Herbarium (CAI) and Herbarium of South Valley University (QNA, proposed abbreviation) (**Table 1**). Light microscopy (LM) observations were carried out on acetolyzed pollen and

**Table 1. Investigated specimens of 25 species (12 genera) of Gnaphalieae, Helenieae, Plucheeae & Senecioneae (Asteraceae) according to [14].**

Species	Collector	Herb.
<b>Subfamily Asteroideae</b>		
<b>I-Tribe Gnaphalieae</b>		
<b>1. Unassigned Gnaphalieae</b>		
<i>Phagnalon barbeyanum</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	QNA
<i>P. nitidum</i>	FAYED <i>et al.</i> <i>s.n.</i>	QNA
<i>P. rupestre</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	QNA
<i>P. schweinfurthii</i>	A. K. OSMAN & K.N. ABDEL KHALIK, <i>s.n.</i>	CAI
<b>2.Subtribe Gnaphaliinae</b>		
<i>Filago contracta</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<i>F. desertorum</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	QNA
<i>F. mareotica</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	QNA
<i>F. prolifera</i>	A. K. OSMAN & K.N. ABDEL KHALIK, <i>s.n.</i>	CAI
<i>Gnaphalium uliginosum</i>	A. K. OSMAN, <i>s.n.</i>	CAI
<i>Helichrysum conglobatum</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<i>H. glumaceum</i>	A. K. OSMAN & K.N. ABDEL KHALIK, <i>s.n.</i>	CAI
<i>H. orientale</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<i>Homognaphalium pulvinatum</i>	A. K. OSMAN, <i>s.n.</i>	CAI
<i>Ifloga spicata</i>	(Forssk.) Sch.Bip. FAYED <i>et al.</i> <i>s.n.</i>	QNA
<i>Lasiopogon muscoides</i>	(Desf.) DC. EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<i>Pseudognaphalium luteoalbum</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<b>II-Tribe Helenieae</b>		
<b>1.Subtribe Flaveriinae</b>		
<i>Flaveria bidentis</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<b>2.Subtribe Pectidinae</b>		
<i>Tagetes minuta</i>	A. K. OSMAN, <i>s.n.</i>	QNA
<b>III-Tribe Plucheeae</b>		
<i>Sphaeranthus suaveolens</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<b>IV-Tribe Senecioneae</b>		
<b>1.Subtribe Senecioninae</b>		
<i>Senecio aegyptius</i>	A. K. OSMAN, <i>s.n.</i>	CAI
<i>S. flavus</i>	FAYED <i>et al.</i> <i>s.n.</i>	QNA
<i>S. glaucus</i>	subsp. <i>coronopifolius</i> EL-GARF & A.K.OSMAN, <i>s.n.</i>	QNA
<i>S. glaucus</i>	subsp. <i>glaucus</i> EL-GARF & A.K.OSMAN, <i>s.n.</i>	CAI
<i>S. hoggariensis</i>	A. K. OSMAN & K.N. ABDEL KHALIK, <i>s.n.</i>	CAI
<i>S. vulgaris</i>	EL-GARF & A.K.OSMAN, <i>s.n.</i> CAI	

CAI = Cairo University Herbarium, QNA = Qena University Herbarium (proposed name), *s.n.* = collecting number is missing.

prepared according to the method of [15] and SEM observations were made on acetolyzed grains coated with a thin layer of gold/palladium for 3 minutes using a EMITECH K550 sputter according to the Erdtman method [16]. SEM examined with a JEOL-6300 SEM of Central Lab., Faculty of Science, South Valley University, Qena, Egypt. The terminology used is that of [17,18] and [19].

### 3. Results

The subtribes, genera and species of tribes Gnaphalieae, Helenieae, Plucheeae and Senecioneae (according to [14]) that are represented in the flora of Egypt are arranged alphabetically to facilitate consultation. For each species, the valid scientific name is given followed by the citation of the authority and the date of publication. Synonymy is at a minimum to avoid complications. For full synonymy of the species see [1,12] and [13].

A careful examination of the available pollen material of the Egyptian species of tribes Gnaphalieae, Helenieae, Plucheeae and Senecioneae revealed the presence of 2 pollen types, which can be distinguished through the following key.

- 1.a. Pollen grains 3-zonocolporate..*Senecio pollen type*
- b. Pollen grains 3-zonocolporate.....*Filago pollen type*

Main characters of pollen types.

1. *Filago pollen type*.

LM **Figures 1(i)-(p), Figures 2(a), (b), (i), (j), (m-p).**

SEM **Figures 3(i)-(m), Figures 4(e)-(i). (Tables 2, 3).**

Pollen grains 3-colporate, (NPC = 345 ), spheroidal to prolate-spheroidal (P/E = 1.00-1.09), 20-24 (18-25) × 20-23 (19-25) μm. Apocolpium diameter 5-7 (3-8) μm. Colpi 13-16 (12-18) μm long, 2-4 (2-5) μm slightly wide, wide or slender at the equator, pointed or tapered towards the ends. Mesocolpia 12-16 (10-18) μm wide. Ora lolate (circular only in *Homognaphalium pulvinatum*) with elliptic to ovate-shaped, 4-6 (3-8) μm in diameter. Exine 3-5 (2-6) μm thick (spinules included) at centre of mesocolpia, decreasing slightly in thickness towards the aperture margins. Sexine as thick as nexine or thicker than nexine in *Gnaphalium uliginosum* and *Lasiopogon muscoides*, tectate, has sharp spinules (spines in *Gnaphalium uliginosum*) with broad bases, 1-3 (1-4) μm high, perforated; sculpturing diameter the same on the whole of the pollen surface or occasionally restrict to the echinae bases that beset all the pollen surface (perforation increases towards the apertures margins in *Gnaphalium uliginosum*); the intratectal elements thin, minute, radial and supported by fairly thin and short infratectal columellae. Nexine 1-2 (1-3) μm thick, increasing in thickness towards the aperture margins.

The following taxa belong to this type:

I-Tribe Gnaphalieae

Subtribe Gnaphaliinae Less.

Genus *Filago* L. Syn. *Evax* Gaertn (4 species).

Species included:

1. *F. contracta* (Boiss.) Chrtek & Holub, Preslia 45: 3 (1963).

Syn. *Evax contracta* Boiss., Diagn. Pl. Orient., ser. 1, 11: 3 (1849).

2. *F. desertorum* Pomel, Nouv. Mat. Fl. Atlant. 1: 46 (1874).

Syns. *Filago spathulata* C. Presl forma *desertorum* (Pomel) Pamp., Atti R. Ist. Ven. Sci. Lett. Arti 92: 234 (1932).

*Evax mauritanica* Pomel var. *cyrenaica* Pamp., Nuovo Giorn. Bot. Ital., n. s., 34: 962 (1927).

3. *F. mareotica* Delile, Descr. Egypte, Hist. Nat. 274, t. 47, f. 2 (1814).

Syns. *Filago mareotica* Delile var. *floribunda* (Pomel) Maire, Bull. Soc. Hist. Nat. Afr. Nord 26: 209 (1935).

*Gifolaria mareotica* (Delile) Chrtek & Holub, Preslia 35: 10 (1963).

4. *F. prolifera* Pomel, Nouv. Mat. Fl. Atlant. 1: 47 (1874).

Syns. *Filago germanica* L. subsp. *prolifera* (Pomel) Maire, Cat. Pl. Maroc 3: 746 (1934).

*Filago prolifera* Pomel subsp. *taeckholmiana* Chrtek in Tackh., Stud. Fl. Egypt, ed. 2, 554 (1974).

Genus *Gnaphalium* L. Syns. *Amphidoxa* DC., *Filaginella* Opiz (one species).

Species included:

5. *G. uliginosum* L., Sp. Pl., ed. 1, 856 (1753).

Syn. *Filaginella uliginosa* (L.) Opiz, Abh. Bohm. Ges. Wiss., ser. 5, 8 (Sitzungsber. Sect.): 52 (1854).

Genus *Homognaphalium* Kirp. Syn. *Homognaphalium* fayed & Zareh non Kirp (one species).

Species included:

6. *H. pulvinatum* (Delile) Fayed & Zareh, Willdenowia 18: 451 (1989).

Syn. *Gnaphalium pulvinatum* Delile, Descr. Egypte, Hist. Nat. 266, t. 44 (1814).

Genus *Lasiopogon* Cass (one species).

Species included:

7. *L. muscoides* (Desf.) DC., Prodr. 6: 246 (1838).

Syn. *Gnaphalium muscoides* Desf., Fl. Atlant. 2: 267, t. 231 (1799).

Genus *Pseudognaphalium* Kirp. Syn. *Hypelichrysum* Kirp (one species).

Species included:

8. *P. luteoalbum* (L.) Hilliard & B. L. Burt, Bot. J. Linn. Soc. 82: 206 (1981).

Syn. *Gnaphalium luteoalbum* L., Sp. Pl., ed. 1, 851 (1753).

**Table 2. Tabular summary showing the Pollen Grains Dimensions (µm).**

Species	P.	E.	P/E.	Ex. th. Incl. echin.	Ech. Len.	Nex. Th.	Colp. Len.	Colp. wid.	Ora. diam.	Apo. diam.	Meso. diam.
I-Tribe Gnaphalieae											
1. Unassigned Gnaphalieae											
<i>Phagnalon barbeyanum</i>	28(25-31)	27(25-30)	1.04	5(4-6)	3(2-4)	2(1-3)	16(15-18)	5(4-6)	8(7-9)	8(7-9)	17(15-18)
<i>P. nitidum</i>	25(20-30)	27(25-30)	0.93	5(3-6)	2(2-3)	2(1-3)	13(12-15)	5(3-7)	8(7-9)	8(7-9)	12(10-13)
<i>P. rupestre</i>	32(30-35)	28(26-35)	1.10	5(3-7)	3(2-4)	2(1-3)	15(13-17)	5(4-6)	8(5-10)	8(7-10)	17(15-20)
<i>P. schweinfurthii</i>	27(23-28)	29(25-33)	0.93	5(3-7)	3(2-4)	1(1-2)	15(13-17)	5(4-6)	7(6-8)	10(8-12)	15(12-16)
2.Subtribe Gnaphaliinae											
<i>Filago contracta</i>	21(20-23)	21(20-23)	1.00	3(2-4)	1(1-2)	2(1-3)	15(13-17)	4(2-5)	5(4-6)	7(5-8)	12(10-15)
<i>F. desertorum</i>	23(20-25)	23(20-25)	1.00	3(2-4)	1(1-2)	1(1-2)	16(15-18)	3(3-4)	5(4-6)	6(5-8)	13(12-15)
<i>F. mareotica</i>	24(22-25)	22(20-25)	1.09	3(2-4)	1(1-2)	2(1-3)	16(15-18)	4(3-5)	6(5-8)	7(5-8)	15(12-18)
<i>F. prolifera</i>	23(20-25)	23(20-25)	1.00	4(2-5)	1(1-2)	2(1-3)	16(15-18)	4(2-5)	5(3-7)	5(3-7)	16(15-18)
<i>Gnaphalium uliginosum</i>	21(20-23)	21(20-23)	1.00	5(4-6)	3(2-4)	1(1-2)	13(12-15)	2(2-3)	4(2-5)	5(3-7)	12(10-13)
<i>Helichrysum conglobatum</i>	21(20-23)	21(20-23)	1.00	3(2-4)	2(1-3)	1(1-2)	13(12-15)	3(2-4)	5(3-7)	8(7-9)	13(12-14)
<i>H. glumaceum</i>	26(25-28)	26(25-28)	1.00	5(4-6)	3(2-4)	2(2-3)	18(15-20)	4(3-5)	5(3-6)	5(4-6)	14(12-15)
<i>H. orientale</i>	26(25-28)	28(25-30)	0.93	5(4-6)	3(2-4)	2(1-3)	12(10-15)	4(3-5)	6(5-7)	7(5-8)	15(13-17)
<i>Homognaphalium pulvinatum</i>	22(20-25)	22(20-25)	1.00	3(2-4)	2(1-3)	1(1-2)	13(12-15)	4(3-5)	5(4-6)	7(5-8)	13(12-15)
<i>Ifloga spicata</i>	21(20-23)	21(20-23)	1.00	4(3-5)	2(1-3)	1(1-2)	13(12-15)	3(2-4)	4(3-5)	7(5-8)	11(9-15)
<i>Lasiopogon muscoides</i>	20(19-23)	20(19-23)	1.00	3(2-4)	1(1-2)	1(1-2)	13(12-14)	3(2-5)	5(4-6)	5(3-6)	12(10-13)
<i>Pseudognaphalium luteoalbum</i>	21(18-22)	21(19-22)	1.00	3(2-4)	2(1-3)	1(1-2)	13(12-15)	3(2-4)	4(3-5)	5(3-7)	12(10-13)
II-Tribe Helenieae											
1.Subtribe Flaveriinae											
<i>Flaveria bidentis</i>	27(25-33)	31(30-33)	0.87	7(6-8)	5(4-6)	2(1-3)	16(15-18)	4(3-5)	7(5-8)	6(5-8)	17(15-20)
2.Subtribe Pectidinae											
<i>Tagetes minuta</i>	44(42-45)	44(42-45)	1.00	8(7-9)	5(4-6)	2(2-4)	21(20-25)	5(3-6)	8(7-9)	16(15-18)	24(22-25)
III-Tribe Plucheeae											
<i>Sphaeranthus suaveolens</i>	23(22-25)	23(22-25)	1.00	4(3-5)	5(3-6)	1(1-2)	12(10-13)	4(3-5)	6(5-8)	8(7-9)	10(8-12)
IV-Tribe Senecioneae											
1.Subtribe Senecioninae											
<i>Senecio aegyptius</i>	31(30-33)	32(30-35)	0.97	5(4-6)	3(2-4)	2(1-3)	18(17-20)	5(4-6)	6(5-8)	6(5-8)	15(13-17)
<i>S. flavus</i>	29(27-30)	29(25-33)	1.00	6(5-7)	3(2-4)	1(1-2)	16(15-18)	5(4-6)	7(5-8)	6(5-10)	14(12-15)
<i>S. glaucus</i> subsp. <i>coronopifolius</i>	25(23-26)	25(23-26)	1.00	5(4-6)	2(2-3)	1 (1-2)	15(14-16)	4(3-5)	5(4-6)	5(3-6)	13(12-14)
<i>S. glaucus</i> subsp. <i>glaucus</i>	31(30-33)	33(31-35)	0.94	5(4-6)	4(3-5)	2(2-3)	19(17-20)	4(3-5)	5(4-6)	8(7-10)	14(12-15)
<i>S. hoggariensis</i>	37(35-38)	42(40-45)	0.88	6(5-8)	3(2-4)	1(1-2)	27(25-30)	4(3-5)	8(7-9)	10(8-12)	18(15-20)
<i>S. vulgaris</i>	35(30-38)	41(35-45)	0.85	7(6-8)	5(3-6)	3(1-4)	19(15-20)	5(4-6)	8(7-9)	8(7-10)	16(15-18)

P. = Polar axis, E. = Equatorial diameter, P/E = The ratio of the length of the polar axis (P) to the equatorial diameter (E), Ech. Len. = echinae length, Ex. Th. incl. echin. = exine thick includes echinae, Nex. Th. = nexine thick, Colp. Len. = colpus length, Colp. wid. = colpus width, Ora. diam. = ora diameter, Apo. diam. = apocolpium diameter, Meso. diam.= mesocolpium diameter, µm = micrometer.

Table 3. Tabular summary showing the Description of LM &amp; SEM Samples.

Species	Pollen Class	Pollen Shape	Col. wid. at eq.	Colpi Ends	Ora Shape	Echinae Type	Sculpture Type	Sculpture State	Columellae State	Nexine State
I-Tribe										
Gnaphalieae										
1. Unassigned										
Gnaphalieae										
<i>Phagnalon barbeyanum</i>	II	P.Sh.	Wide	Tapered	La., rect.	Spines	Perforate	3 + 4	1	+
<i>P. nitidum</i>	II	O.Sh.	Wide	Pointed	Lo., ovate	Spinules	Perforate	6	1	++
<i>P. rupestre</i>	II	P.Sh.	Wide	Tapered	Lo., ovate.	Spines	Perforate	6	1	+
<i>P. schweinfurthii</i>	II	O.Sh.	Wide	Pointed	Lo., ovate	Spines	Perforate	6	1	++
2. Subtribe										
Gnaphaliinae										
<i>Filago contracta</i>	I	Sh.	±Wide	Pointed	Lo. ellep.	Spinules	Perforate	5	1	+
<i>F. desertorum</i>	I	Sh.	±Wide	Pointed	Lo., ovate	Spinules	Perforate	6	1	+
<i>F. mareotica</i>	I	P.Sh.	±Wide	Pointed	Lo. ellep.	Spinules	Perforate	6	1	+
<i>F. prolifera</i>	I	Sh.	±Wide	Pointed	Lo., ovate	Spinules	Perforate	6	1	+
<i>Gnaphalium uliginosum*</i>	I	Sh.	Wide	Tapered	Lo., ovate	Spines	Perforate	6 + 2	1	++
<i>Helichrysum conglobatum</i>	II	Sh.	Wide	Tapered	Lo., ovate	Spinules	Perforate	6	1	+
<i>H. glumaceum</i>	II	Sh.	Wide	Pointed	La., rect	Spines	Perforate	6 + 3	1	+
<i>H. orientale</i>	II	O.Sh.	Wide	Tapered	Circular	Spines	Perforate	3	1	+
<i>Homognaphalium pulvinatum</i>	I	Sh.	Wide	Pointed	Circular	Spinules	Perforate	6	1	+
<i>Ifloga spicata</i>	II	Sh.	±Wide	Tapered	Lo. ellep.	Spinules	Perforate	6	1	++
<i>Lasiopogon muscoides</i>	I	Sh.	Slender	Tapered	Lo. ellep.	Spinules	Perforate	6	1	++
<i>Pseudognaphalium luteoalbum</i>	I	Sh.	Wide	Pointed	Lo., ovate	Spinules	Perforate	6	1	+
II-Tribe Helenieae										
1. Subtribe										
Flaveriinae										
<i>Flaveria bidentis</i>	II	Subob	Wide	Pointed	Lo., ovate	Spines	Perforate	3	1	+
2. Subtribe										
Pectidinae										
<i>Tagetes minuta</i>	II	Sh.	Wide	Pointed	La., rect	Spines	Perforate	3	1	+
III-Tribe Plucheeae										
<i>Sphaeranthus suaveolens**</i>	II	Sh.	Wide	Tapered	Circular	Spines	Perforate	2	1	++
IV-Tribe Senecioneae										
1. Subtribe Senecioninae										
<i>Senecio aegyptius</i>	II	O.Sh.	Narrow	Pointed	La., rect	Spines	Perforate	3	1	++
<i>S. flavus</i>	II	Sh.	Wide	Pointed	Lo., ovate	Spines	Perforate	3	1	++
<i>S. glaucus</i> subsp. <i>coronopifolius</i>	II	Sh.	±Wide	Pointed	Lo., ovate	Spinules	Perforate	6	1	++
<i>S. glaucus</i> subsp. <i>glaucus</i>	II	O.Sh.	±Wide	Pointed	Lo. ellep.	Spines	Perforate	6	1	++
<i>S. hoggariensis</i>	II	O.Sh.	Slender	Tapered	Lo., ovate	Spines	Perforate	6	1	++
<i>S. vulgaris</i>	II	Subob	±Wide	Tapered	Lo. ellep.	Spines	Perforate	5	1	++

Col. wid. at eq. = Colpi Width at equator, Ellep. = Elleptic, La. = Lalongate, Lo. = Lolongate, O. = Oblate, P. = Prolate, Rect. = Rectangular, Sh. = Spheroidal, Subob. = Suboblate, ± Wide = Slightly wide, I = Pollen 3-zonocolporate, II = Pollen 3-zonocolporate, 1 = Columellae with thin, short and unbranched rods, + = Sexine as thick as nexine, ++ = Sexine thicker than nexine, 2 = Sculpturing diameter increases towards the aperture margins, 3 = Sculpturing diameter increases towards the echinae bases, 4 = Sculpturing diameter increases towards the pollen pole, 5 = Sculpturing restrict to the echinae bases, 6 = Sculpturing diameter the same on the whole of the pollen surface, \* = Aperture margins perforate, \*\* = Aperture margins microreticulate.

Key to taxa of Filago pollen type

- 1.a. Pollen prolate-spheroidal in shape..*Filago mareotica*  
 b. Pollen spheroidal in shape.....2  
 2.a. Colpi slender at equator.....*Lasiopogon muscoides*  
 b. Colpi otherwise.....3  
 3.a. Colpi wide at equator.....*Gnaphalium uliginosum*  
     .....*Homognaphalium pulvinatum*  
     .....*Pseudognaphaliumluteoalbum*  
 b. Colpi slightly wide at equator.....*Filago contracta*  
     .....*F. desertorum*  
     .....*F. prolifera*

2. Senecio pollen type

LM (Figures 1(a)-(h), Figures 2(c)-(h), (k), (l), Figures 3(a)-(p), Figures 4(a), (b), SEM Figures 4(c)-(h), Figures 5(a)-(d), (j)-(o), Figures 6(a)-(j).

Pollen grains 3-colporate, spheroidal, oblate-spheroidal, prolate-spheroidal to suboblate (P/E = 0.85-1.10), 21-44 (20-45) × 21-44 (20-45) μm. Apocolpium diameter 5-16 (3-18) μm. Colpi 12-27 (10-30) μm long, 3-5 (2-7) μm wide, wide, slightly wide, slender or narrow at the equator, pointed-tapered towards the ends. Mesocolpium 10-24 (8-25) μm wide. Ora lalongate-lalongate (circular in both *Helichrysum orientale* and *Sphaeranthus suaveolens*), with ovate, rectangular to elliptic-shaped, 4-8 (3-10) μm in diameter. Exine 3-8 (2-9) μm thick (spines included) at centre of mesocolpia, with the same thickness towards the aperture margins. Sexine thicker than nexine or as thick as nexine, tectate, with long, pointed spines or spinules, 2-5 (1-6) μm high, perforated; perforations number and diameter the same on the whole of the pollen surface or increase towards the echinae bases (increase towards the aperture margins in *Sphaeranthus suaveolens* or restrict to the echinae bases in *Senecio vulgaris*); the intratectal elements thin, minute, radial and supported by fairly thin and short infratectal columellae. Nexine 1-3 (1-4) μm thick, increasing in thickness towards the aperture margins.

The following taxa belong to this type:

I-Tribe Gnaphalieae

Gnaphalieae unassigned to Subtribe.

Genus *Phagnalon* Cass (4 species).

Species included:

1. *P. barbeyanum* Asch. & Schweinf., Mém. Inst. Egypt. 2: 87 (1887).

Syn. *P. Aegyptiacum* Boiss., Fl. Orient. Suppl. 296 (1888).

2. *P. nitidum* Fresen., Mus. Senckenb. 3: 81 (1839).

3. *P. rupestre* (L.) DC., Prodr. 5: 396 (1836).

Syn. *Conyza rupestris* L., Mant. 113 (1767).

4. *P. schweinfurthii* Sch. Bip. ex Schweinf., Verh. K. K. Zool. Bot. Ges. Wien 18: 685 (1868).

Subtribe Gnaphaliinae Less.

Genus *Helichrysum* Mill. Syn. *Leontonyx* Cass. (3 species).

Species included:

5. *H. conglobatum* (Viv.) Steud., Nomencl. Bot., ed. 2, 1: 738 (1840).

Syns. *Gnaphalium conglobatum* Viv., Fl. Libyc. Spec. 55, t. 3, f. 5 (1824).

*Helichrysum siculum* Boiss., Fl. Orient. 3: 229 (1875).

6. *H. glumaceum* DC., Prodr. 6: 197 (1838).

Syn. *Achyrocline glumacea* (DC.) Oliv. & Hiern in Oliv., Fl. Trop. Afr. 3: 340 (1877)

7. *H. orientale* (L.) Gaertn., Fruct. Sem. Pl. 2: 404 (1791).

Syn. *Gnaphalium orientale* L., Sp. Pl., ed. 1, 853 (1753).

Genus *Ifloga* Cass. Syn. *Comptonanthus* B. Nord (one species).

Species included:

8. *I. spicata* (Forssk.) Sch.Bip. in Webb & Berthel., Phyt. Canar. 2: 310 (1845).

Syns. *Chrysocoma spicata* Forssk., Fl. Aegypt.-Arab. LXXIII (1775).

*Chrysocoma spicatum* (Forssk.) Vahl, Symb. Bot. 1: 70 (1790).

II. Tribe Helenieae Benth.

Subtribe Flaveriinae Less.

Genus *Flaveria* Juss. (one species).

Species included:

9. *F. bidentis* (L.) Kuntze, Rev. Gen. 3: 148 (1898).

Syns. *Ethulia bidentis* L., Mant. 110 (1767).

*Flaveria contrayerba* (Cav.) Pers., Syn. Pl. 2: 489 (1807).

*Flaveria bonariensis* DC., Prodr. 5: 635 (1836)

Subtribe Pectidinae Less.

Genus *Tagetes* L. (one species).

Species included:

10. *T. minuta* L., Sp. Pl., ed. 1, 887 (1753).

III. Tribe Plucheeae Anderb.

Genus *Sphaeranthus* L. (one species).

Species included:

11. *S. suaveolens* (Forssk.) Dc., Prodr. 5: 370 (1836).

Syn. *Polycephalos suaveolens* Forssk., Fl. Aegypt.-Arab. 154 (1775).

IV. Tribe Senecioneae

Subtribe Senecioninae Dumort.

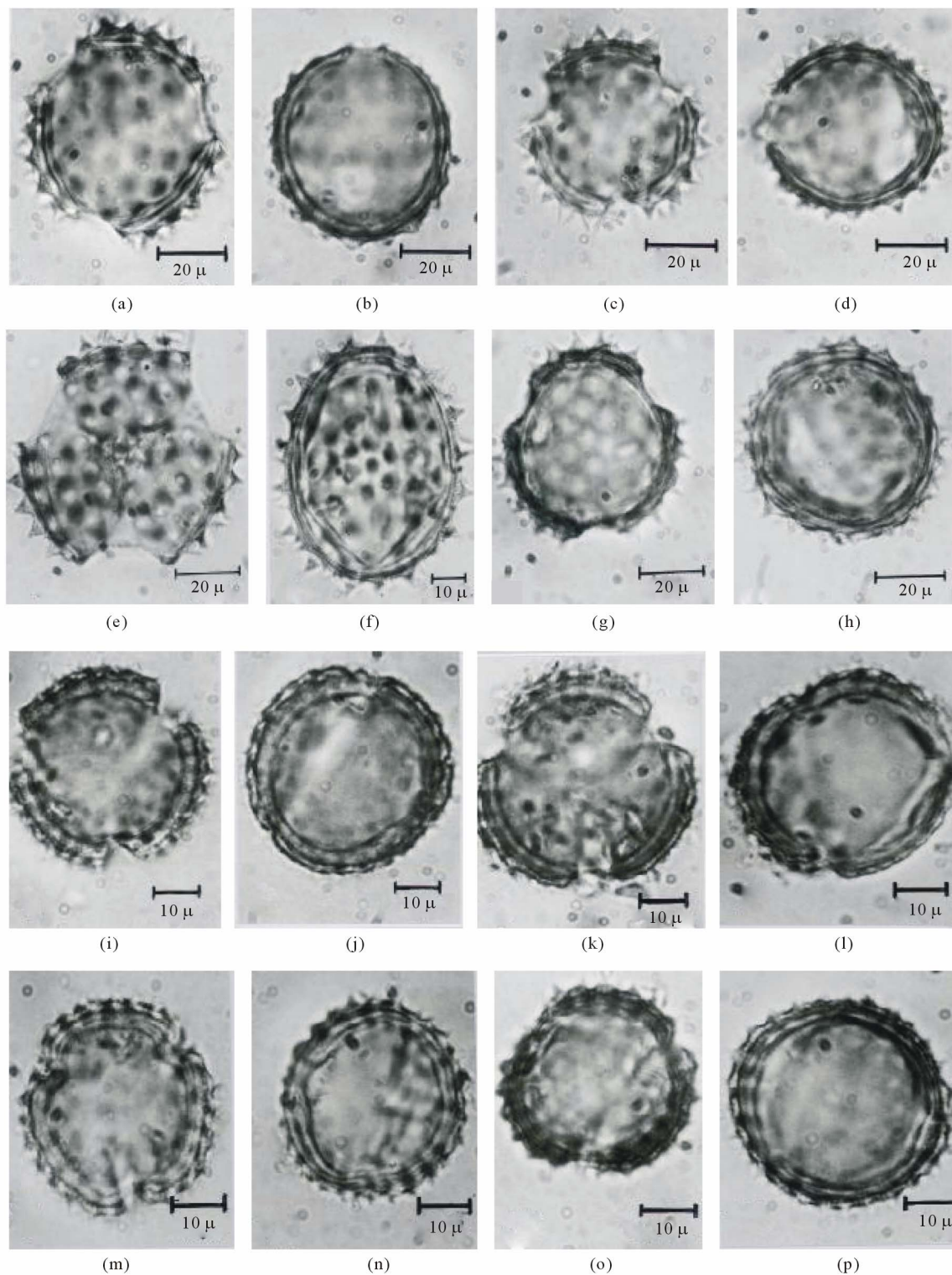
Genus *Senecio* L. (6 species).

Species included:

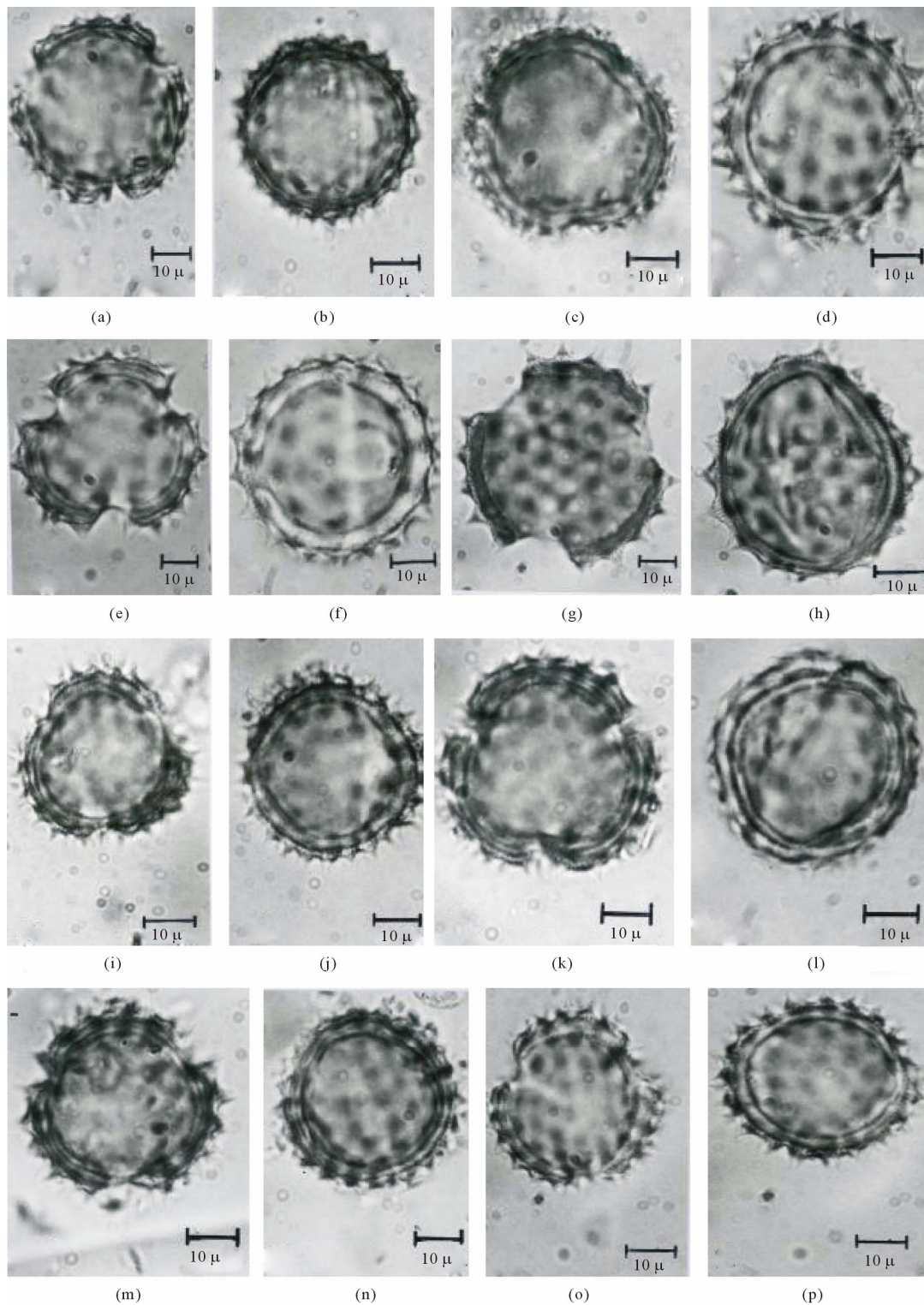
12. *S. aegyptius* L., Sp. Pl., ed. 1, 867 (1753).

13. *S. flavus* (Decne.) Sch. Bip. In Webb & Berthel., Phyt. Canar. 3: 317 (1847).

Syns. *Crassocephalumflavum* Decne., Ann. Sci. Nat.

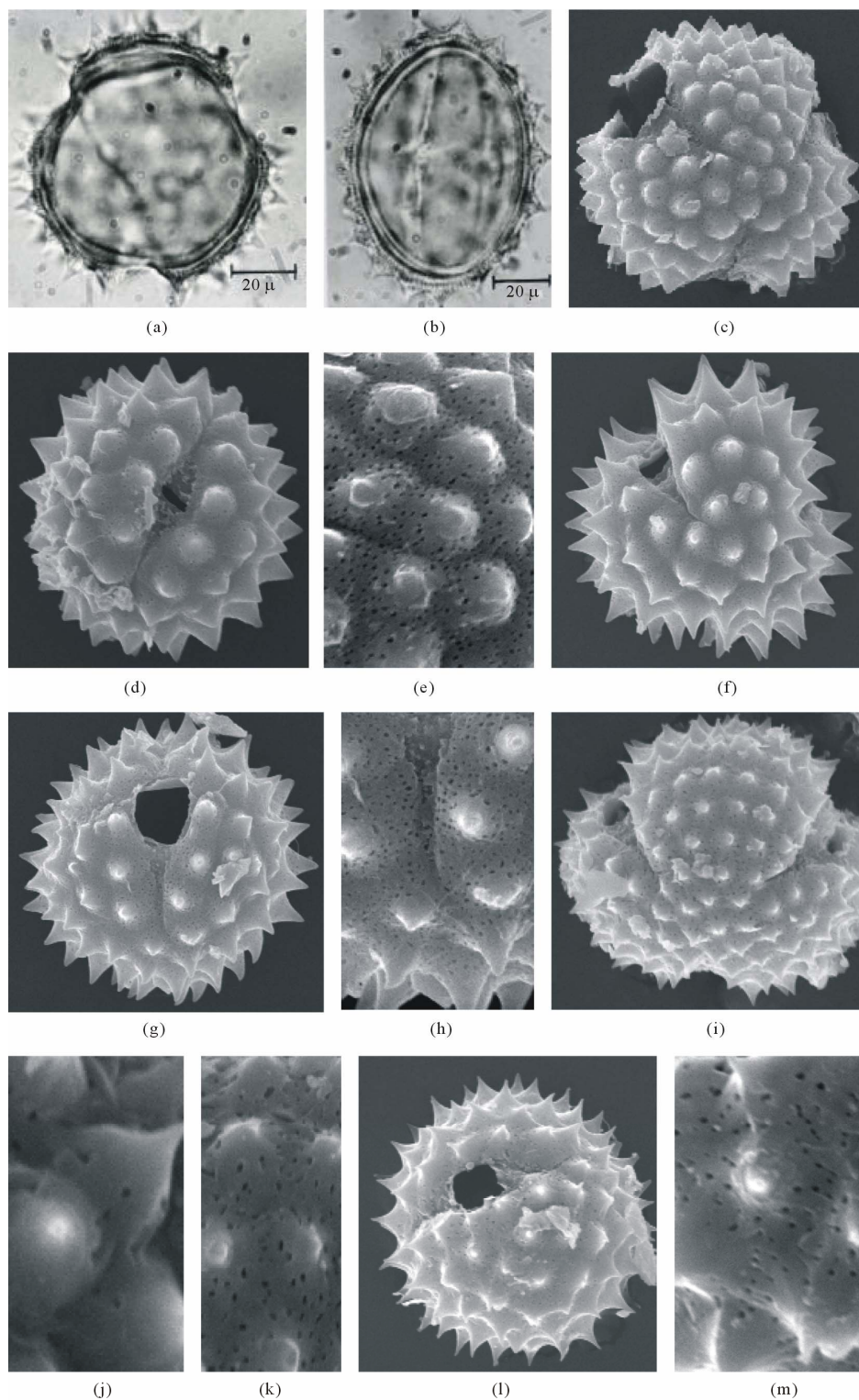


**Figure 1.** LM observations of acetolysed pollen grains (LM  $\times = 1000$ ). (a)-(b) *Phagnalon barbeyanum*, (a) Oblique polar view, (b) Oblique equatorial view. (c)-(d) *P. nitidum*, (c) Polar view, (d) Oblique equatorial view. (e)-(f) *P. rupestre*, (e) Polar view, (f) Equatorial view. (g)-(h) *P. schweinfurthii*, (g) Polar view, (h) Equatorial view. (i)-(j) *Filago contracta*, (i) Polar view, (j) Equatorial view. (k)-(l) *F. desertorum*, (k) Polar view, (k) Oblique equatorial view. (m)-(n) *F. mareotica*, (m) Polar view, (n) Equatorial view. (o)-(p) *F. prolifera*, (o) Oblique polar view, (p) Equatorial view.

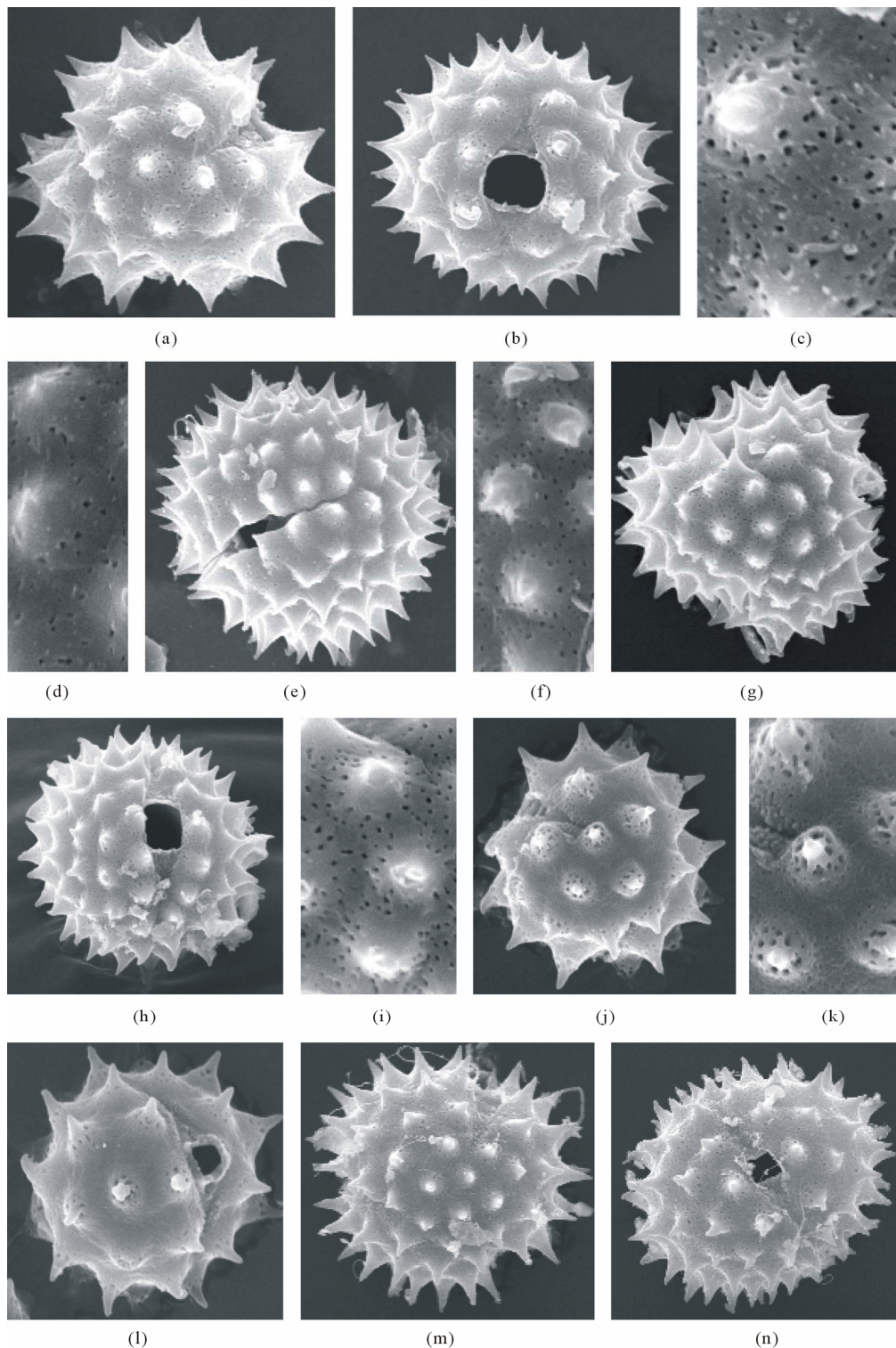


**Figure 2.** LM observations of acetolysed pollen grains (LM  $\times$  = 1000). (a)-(b) *Gnaphalium uliginosum*, (a) Polar view, (b) Equatorial view. (c)-(d) *Helichrysum conglobatum*, (c) Polar view, (d) Equatorial view. (e)-(f) *H. glumaceum*, (e) Polar view, (f) Equatorial view. (g)-(h) *H. orientale*, (g) Polar view, (h) Equatorial view. (i)-(j) *Homognaphalium pulvinatum*, (i) Polar view, (j) Equatorial view. (k)-(l) *Ifloga spicata*, (k) Polar view, (l) Equatorial view. (m)-(n) *Lasiopogon muscoides*, (m) Polar view, (n) Equatorial view. (o)-(p) *Pseudognaphalium luteoalbum*, (o) Polar view, (p) Equatorial view.

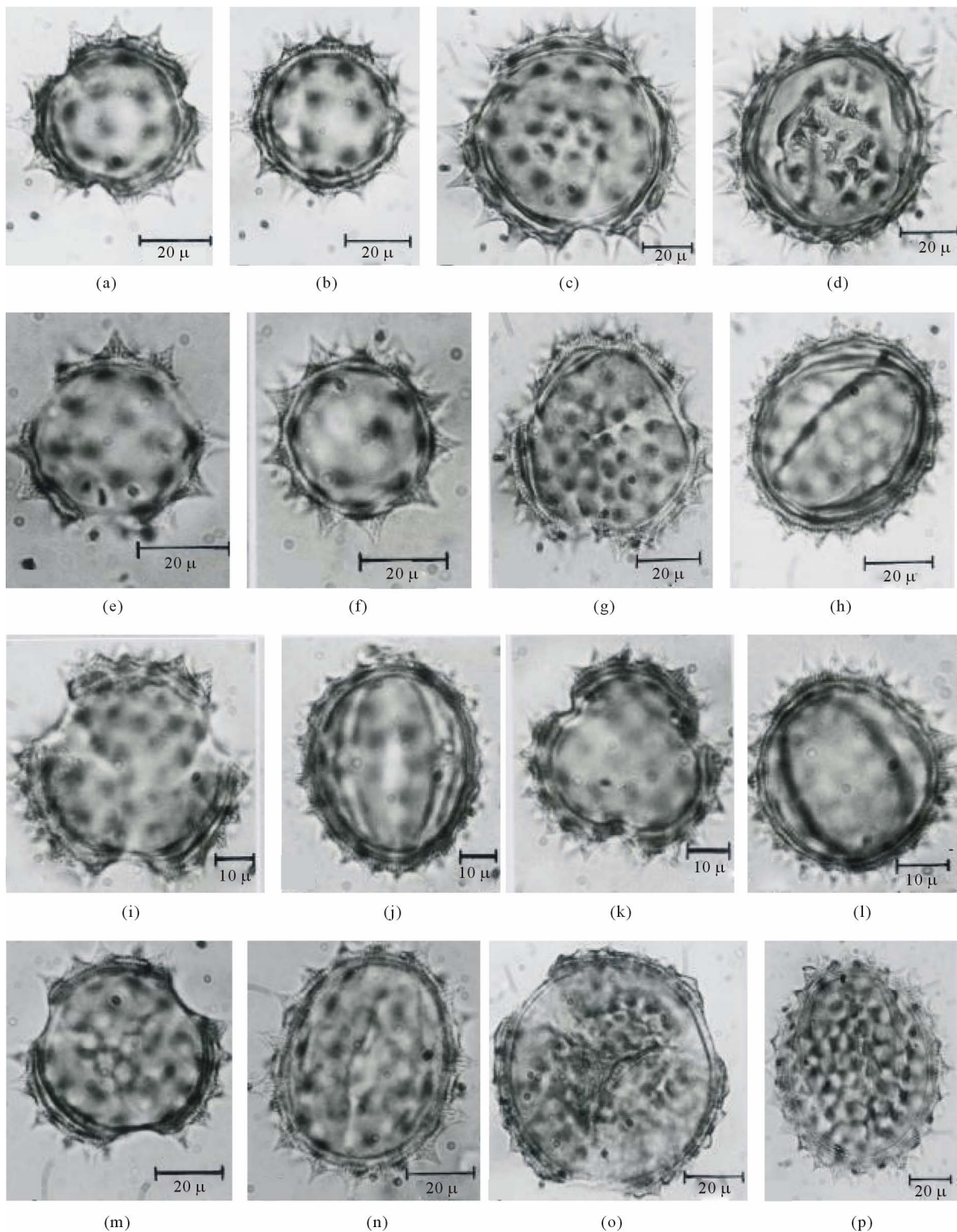




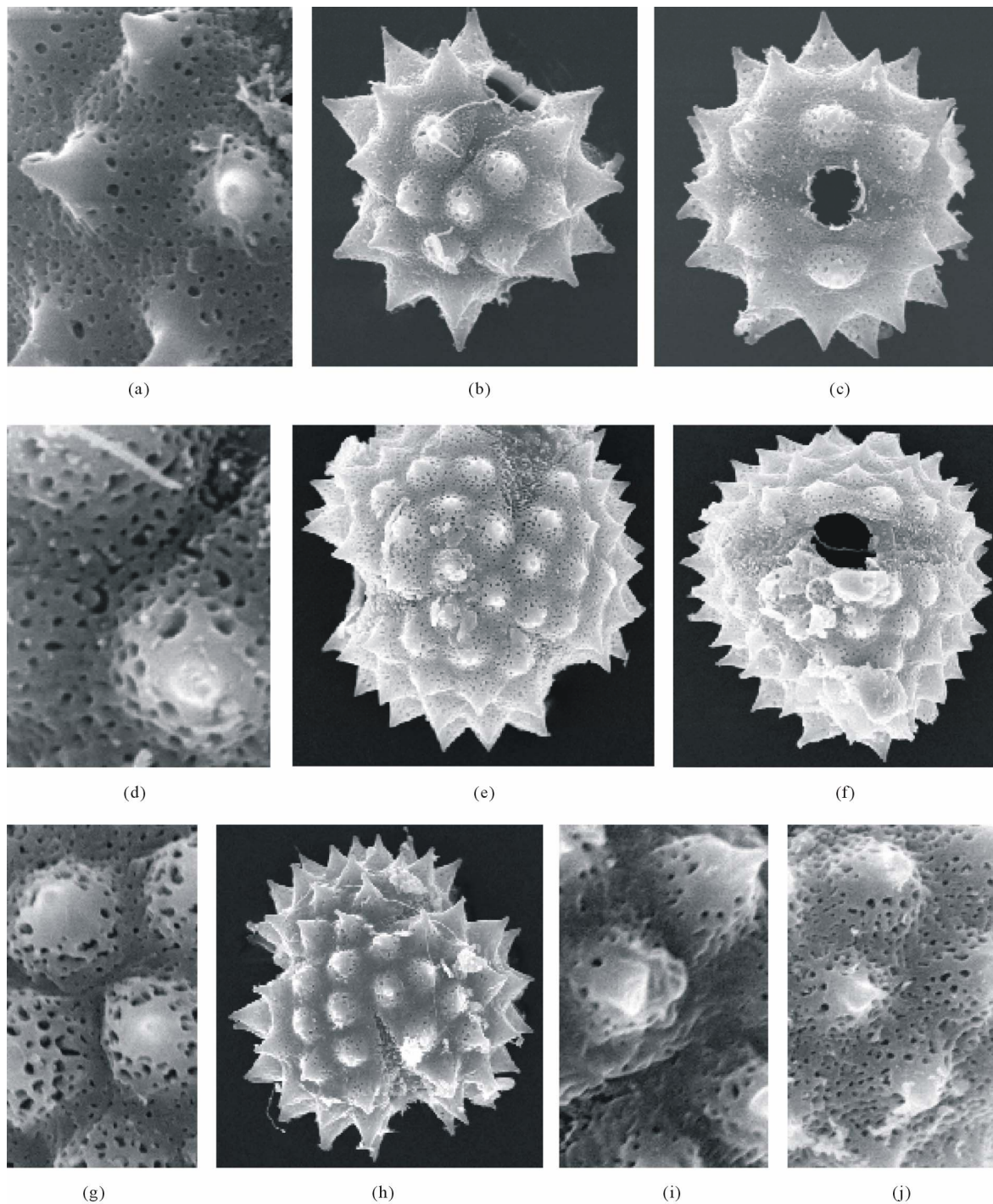
**Figure 3.** LM and SEM observations of acetolysed pollen grains (LM  $\times = 1000$ , SEM  $\times = 5000 - 15000$ ). (a)-(b) *Senecio vulgaris*, (a) Oblique polar view, (b) Equatorial view. (c)-(e) *Phagnalon barbeyanum*, (c) Polar view, (d) Equatorial view, (e) Magnified part of exine. (f)-(h) *Phagnalon rupestre*, (f) Oblique polar view, (g) Oblique equatorial view, (h) Magnified part of exine. (j) *Filago contracta*, (i) Magnified part of exine. (i) (k) *Filago prolifera*, (i) Oblique polar view, (k) Magnified part of exine, (l)-(m) *Gnaphalium uliginosum*, (l) Oblique equatorial view, (m) Magnified part of exine.



**Figure 4.** SEM observations of acetolyzed pollen grains (SEM  $\times$  5000-15000). (a)-(c) *Helichrysum orientale*, (a) Polar view, (b) Equatorial view, (c) Magnified part of exine. (d) *Ifloga spicata*, (d) Magnified part of exine. (e)-(f) *Lasiopogon muscoides*, (e) Oblique equatorial view, (f) Magnified part of exine. (g)-(i) *Pseudognaphalium luteoalbum*, (g) Oblique polar view, (h) Equatorial view, (i) Magnified part of exine. (j)-(l) *Flaveria bidentis*, (j) Oblique polar view, (k) Oblique equatorial view, (l) Magnified part of exine. (m)-(n) *Tagetes minuta*, (m) Polar view, (n) Equatorial view.



**Figure 5.** LM observations of acetolysed pollen grains (LM  $\times = 1000$ ). (a)-(b) *Flaveria bidentis*, (a) Polar view, (d) Equatorial view. (c)-(d) *Tagetes minuta*, (c) Polar view, (d) Equatorial view. (e)-(f) *Sphaeranthus suaveolens*, (e) Polar view, (f) Equatorial view. (g)-(h) *Senecio aegyptius*, (g) Polar view, (h) Equatorial view. (i)-(j) *S. flavus*, (i) Polar view, (j) Equatorial view. (k)-(l) *S. glaucus* subsp. *coronopifolius*, (k) Polar view, (l) Equatorial view. (m)-(n) *S. glaucus* subsp. *glaucus*, (m) Polar view, (n) Equatorial view. (o)-(p) *S. hoggariensis*, (o) Polar view, (p) Equatorial view.



**Figure 6.** SEM observations of acetolyzed pollen grains (SEM  $\times$  5000-15000). (a) *Tagetes minuta*, (a) Magnified part of exine. (b)-(d) *Sphaeranthus suaveolens*, (b) Oblique polar view, (c) Equatorial view, (d) Magnified part of exine. (e)-(g) *Senecio flavus*, (e) Polar view, (f) Equatorial view, (g) Magnified part of exine. (h)-(i) *Senecio vulgaris*, (h) Polar view, (i) Magnified part of exine. (j) *Senecio aegyptius*, (j) Magnified part of exine.

Bot., sér. 2, 2: 265 (1834).

*Senecio decaisnei* DC., Prodr. 6: 342 (1838).

14. *S. glaucus* L., Sp. Pl., ed. 1, 868 (1753). subsp.

*coronopifolius* (Maire) C. Alexander, Notes Roy. Bot. Gard. Edinb. 37: 412 (1979).

Syns. *Senecio coronopifolius* Desf., Fl. Atlant. 2:

273 (1799), nom. illeg., non Burm.f. (1768).

*Senecio desfontainei* Druce, Brit. Pl. List, ed. 2, 61 (1928).

15. *S. glaucus* L., Sp. Pl., ed. 1, 868 (1753). subsp. *glaucus*

Syns. *Senecio vernalis* Waldst. & Kit. var. *carneus* Post. Fl. Syr. Pal. Sinia, ed. 1, 442 (1896).

*Senecio joppensis* Dinsm. In Post, Fl. Syr. Pal. Sinai. Ed. 2, 2: 69 (1933).

16. *S. hoggariensis* Batt. & Trab., Bull. Soc. Bot. France 58: 671 (1911).

17. *S. vulgaris* L., Sp. Pl., ed. 1, 867 (1753).

Key to taxa of *Senecio* pollen type

1. a. Polar area long axis median 21 - 29  $\mu\text{m}$ .....4

b. Polar area long axis median 31 - 44  $\mu\text{m}$ ..... 2

2. a. Polar area long axis 44(42 - 45)  $\mu\text{m}$ ...*Tagetes minuta*

b. Polar area long axis median 31 - 37  $\mu\text{m}$ .....3

3. a. Polar area long axis 31 - 32  $\mu\text{m}$ ...*Phagnalon rupestre*

..... *Senecio aegyptius*

..... *S. glaucus* subsp. *glaucus*

b. Polar area long axis 35 - 37  $\mu\text{m}$ ...*Senecio hoggariensis*

..... *S. vulgaris*

4. a. Polar area long axis 21 - 25  $\mu\text{m}$ ...*Phagnalon nitidum*

..... *Helichrysum conglobatum*

..... *Ifloga spicata*

.....*Sphaeranthus suaveolens*

..... *Senecio glaucus* subsp. *coronopifolius*

b. Polar area long axis 26 - 29  $\mu\text{m}$ .....

..... *Phagnalon barbeyanum*

..... *P. schweinfurthii*

..... *Helichrysum glumaceum*

..... *H. orientale*

..... *Flaveria bidentis*

..... *Senecio flavus*

#### 4. Discussion

Palynological characters applied to the species of Gnaphalieae, Helenieae, Plucheeae and Senecioneae in Egypt proved to be useful in the distinction between two groups. The pollen grains are usually 3-zonocolporate or 3-zonocolporate with lolongate or lalongate (rarely circular) ora.

There is semi-similarity between the pollen grains of the investigated taxa, as a result it will be difficult to make accurate distinguishing and to construct true key between the studied species. Two pollen types are distinguished according to the pollen class. **The *Senecio* pollen type**, in which the pollen are 3-colporate, is characteristic of the species of genera *Phagnalon*, *Helichrysum*, *Ifloga*, *Flaveria*, *Tagetes*, *Sphaeranthus* and *senecio*. **The *Filago* pollen type**, in which the pollen are 3-colporate, is characteristic of the species of genera

*Filago*, *Gnaphalium*, *Homognaphalium*, *Lasiopogon* and *Pseudognaphalium*.

The smallest pollen grains are those of *Lasiopogon muscoides* species 20 (19-23)  $\mu\text{m}$  and the largest are those of *Tagetes minuta* 44 (42-45)  $\mu\text{m}$ . Pollen size of other taxa ranged between (21-37)  $\mu\text{m}$ . Pollen grains are more or less similar in shape being spheroidal, oblate-spheroidal, prolate-spheroidal to suboblate.

Ora shape contributes to differentiate between the related species of *Helichrysum glumaceum*, *Ifloga spicata*, *Flaveria bidentis*, *Tagetes minuta*, *Senecio flavus* and *Senecio vulgaris* are characterized by lalongate ora shape, *Helichrysum orientale*, *Homognaphalium pulvinatum* and *Sphaeranthus suaveolens* exhibit circular ora shape, while lolongate ora shape is observed in the remaining studied species. The aperture width also contributes to differentiate all studied species of genus *Filago*, *Ifloga spicata*, *Senecio glaucus* subsp. *coronopifolius*, *S. glaucus* subsp. *Glaucus* and *S. vulgaris* which exhibit colpi are slightly width at equator, *Lasiopogon muscoides* and *S. hoggariensis* which have slender colpi at equator, *Senecio aegyptius* has narrow colpi at equator from the other investigated taxa which are characterized by wide colpi at equator. It also points to the close relationship between the four *Filago* species which exhibit very close pollen grains being similar in pollen shape, colpi characters, sculpture and dimensions.

The pollen sculpture is more uniform in most investigated species with perforate texture. The pollen grains are spiny to spinulate with perforate echinae bases. In *Gnaphalium uliginosum* aperture margins are perforate while in *Sphaeranthus suaveolens* species they are microreticulate, also in both *Filago contracta* and *Senecio vulgaris* perforation restrict to the echinae bases.

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