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Pollen types of the Egyptian species of tribe Lactuceae (subfamily Cichorioideae-Compositae)

AHMED K. E. OSMAN*

South Valley University, Faculty of Science-Qena, Botany Department, Qena, Egypt.

Pollen morphology of forty six Egyptian species representing twenty three genera of the tribe Lactuceae was investigated using light and scanning electron microscopy. Seven pollen types were recognized: *Geropogon* pollen type, *Koelpinia* pollen type, *Lactuca* pollen type, *Launaea* pollen type, *Rhagadiolus* pollen type, *Scolymus* pollen type and *Scorzonera* pollen type. Descriptions, a key, light microscope (LM) and scaning electron microscope (SEM) micrographs of each pollen type are provided.

Key Words: Pollen, Compositae, Lactuceae, Egypt.

Introduction

Compositae is one of the most important and largest of the Angiosperm families, with ca 25000 species grouped in 1100 genera (LEWIS et al. 1983, HEYWOOD 1978). In Egypt Compositae is a well represented family, about 235 species and 93 genera being native to the country (TÄCKHOLM 1974; EL HADIDI and FAYED 1995; BOULOS 1995, 2002).

Pollen morphology has great value in the taxonomy of the Compositae (WODEHOUSE 1926). In some subdivisions of Compositae, the sexine usually consists of two parts: an inner layer (endosexine, bacula) and an outer layer (often subdivided into several distinct strata), which partially at least may correspond to the ectosexinous tegillum in other pollen grains. It is usually much thicker than the ordinary tegillum and is referred to in the present work as »tectum«. In the rest and main part of the family there is no typical baculation and the sexine often consists only of a tectum. These pollen types are either tectate or have an outer exine that is raised in a pattern of ridges (lophae) surrounding lacunae, the ridges often forming regular beautiful patterns. Grains with such ridges are known as »lophate«. »Psilolophate« grains have smooth ridges, whereas those of »echinolophate« grains are spinulose (»echinate«). Sometimes the sides of the ridges are perforated; such grains seem to be 'more or less' of the same type as ordinary reticulate grains.

During the study of the aperture system of the family with ultraviolet LM it was found that it consists of an ecto- and endoaperture with the apertural membrane formed by nexine 2 (STIX 1960). This author also presented a general survey of the structure of the exine in

* Corresponding address, e-mail: ahmosman2000@yahoo.com

the Compositae and this was subsequently expanded by ERDTMAN (1966a, b) who described the pollen as having composite apertures, usually 3-colporate, with lalongate ora.

There are three characteristics of Compositae pollen: (1) a structured tectum, (2) the presence of moderately long spines, and (3) a tripartite apertural system consisting of an outer aperture involving the foot layer and an inner or endoaperture limited to the endexine (DIMON 1971).

The using of the prefixes ecto-, meso- and endo- to indicate the relative location of each of the apertures was suggested by VASANTHY (1978).

It was found that the pollen grains of both the subtribe Hypochoeridinae and the subtribe Scolyminae (Lactuceae) have the apertural system as a colpus with two perpendicularly oriented ora. At the ultrastructural level it was pointed out that »the aperture is differentiated into (a) an outer creating the very thin part of the foot layer,(b) a middle comprising the distal surface of the endexine, and (c) an inner...comprising the inner part of the endexine«. Also it was noticed that the pollen grains of *Rhagadiolus* and *Garhadiolus* differ from those of other Hypochoeridinae because they have small polar areas. The pollen grains of *Scolymus hispanicus* (subtribe Scolyminae) differ completely from other species of Lactuceae (EL-GHAZALY 1980).

In SEM and TEM study of the tribe Lactuceae, it was claimed that the mesoaperture is located in the foot layer and has the form of a short lolongate colpus or pore (BLACKMORE 1981, 1982). This author studied the pollen grains of the subtribe Hyoseridinae (Lactuceae) and found that echinate and echinolophate pollen types with four patterns of exine stratification occur in this subtribe. Pollen of genus *Koelpinia* reveals a close affinity to *Tragopogon* (in the subtribe Scorzonerinae), but he also distinguished seven pollen types among the investigated species of the subtribe Scorzonerinae (Lactuceae) based on the number and position of their lacunae.

After numerous studies on Compositae pollen, palynologists separated the 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 Cichorieae; and the tubuliflorae-type, which is found in many other tribes (MULLER 1981). There are three pollen types were recognized in Compositae i.e., psilate (this type can not be easily recognized), echinate, and lophate pollen (SKVARLA and TURNER 1966, SKVARLA et al. 1977). Based on pollen wall ultrastructure, they 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.

There are four categories of pollen grains in the genus *Sonchus*, based on the size of polar area and polar lacunae (SAAD 1961). The tribe Lactuceae contains two basic pollen types, echinolophate and echinate and most taxa have echinolophate, tricolporate pollen (TOMB 1975). Five pollen groups among the studied species of *Sonchus*, *Reichardia* and *Aetheorhiza* were distinguished by ABU EL-NAGA (1990). Also five pollen morphological types in pollen grains of the subtribe Crepidinae (Lactuceae) were distinguished by BLACKMORE and PERSON (1996) based on five characters: overall form, spine length, width of the interlacunar gaps, the shape of ectoapertures and the shape of spines.

This paper considers pollen grains of the tribe Lactuceae in the flora of Egypt, which may prove of value in systematic treatments. Pollen types that show all the possible charac-

teristic 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.

Materials and methods

Pollen materials (buds or anthers) were removed from living specimens collected in the field, or from herbarium specimens identified according to TÄCKHOLM (1974); EL HADIDI and FAYED (1995); BOULOS (1995, 2002). The specimens were kept in Cairo University Herbarium (CAI), Egypt; or in the Herbarium of the Systematic Botany Institute (MSB), Ludwig Maximilians University, Munich, Germany (Tab. 1). The species investigated represent all the taxa of tribe Lactuceae (subfamily Cichorioideae-Compositae) kept in Cairo and Munich herbaria and are represented in the flora of Egypt. Light microscopy (LM) observations were carried out on acetolysed pollen and prepared according to the method of ERDTMAN (1960). SEM observations were made on acetolysed grains ERDTMAN (1969) coated with a thin layer of gold/palladium for 3 minutes using an EMITECH K550 sputter coater. Pollen grains were examined with a JEOL-6300 SEM of Systematic botany Institute, Ludwig Maximilians University, Munich, Germany. The terminology and main morphological concepts are based on PUNT et al. 1994. Certain points regarding the measurements should be noted. The measurements are based on 15–25 readings and in all cases the range of size is represented in parentheses and the mean value located in between. The exine thickness is measured at the centre of mesocolpium of the pollen grain as observed in polar view where echinae are included.

Tab. 1. Herbarium samples and collectors. s.n. – collecting number is missing.

Species	Collector	Sheet Number	Herbarium
VI-Tribe Lactuceae Cass.			
1.Unassigned Lactuceae			
Cichorium pumilum	E. Dörr	7930 / 3	M
Scolymus hispanicus	C. & J. Poelt	*s.n.*	M
S. maculatus	M. Gandoger	*s.n.*	M
2.Subtribe Catananchinae			
Thrincia tripolitana	H. Merxmüller & W. Lippert	*s.n.*	M
3.Subtribe Crepidinae			
Crepis dioscorides	A. K. Osman	*s.n.*	CAI
Lagoseris sancta	A. K. Osman	*s.n.*	CAI
Taraxacum. turcicum	K. P. Buttler & J. E. Krach	23389	M
4.Subtribe Hypochoeridinae			
Garhadiolus hedypnois	D. Podlech	20672	MSB
Hedypnois cretica	A. K. Osman	*s.n.*	CAI
Helminthotheca echioides	Ruppert & Ludwig	3427	M

Tab. 1. – continued

Species	Collector	Sheet Number	Herbarium
Hyoseris lucida	H. Kalheber	93– 120	M
H. scarba	S. Snogerup & M. Gustafsson	*s.n.*	M
Leontodon hispidulus	M. T. Tietz	T 99	M
L. laciniatus	H. Roessler	4840	M
Picris sprengeriana	H. W. Lack	*s.n.*	M
P. strigosa	K. H. Rechinger	42990	M
P. sulphurea	H. Förther	4332	M
Rhagadiolus stellatus	J. Matos & A. Matos	*s.n.*	M
Urospermum picroides	J. Sellmair	*s.n.*	M
5.Subtribe Lactucinae			
Lactuca orientalis	Davis	55407	MSB
L. saligna	J. Merkl	VIII– 1976	M
L. serriola	K. Werner	*s.n.*	M
L. undulata	K. H. Rechinger	52930	M
6.Subtribe Scorzonerinae			
Geropogon glabrum	M. Hirmer	*s.n.*	M
Koelpinia linearis	D. Podlech	50947	MSB
Scorzonera alexandrina	A. Faure	*s.n.*	M
S. mollis	Doppelbaur	16122	M
Tragopogon collinus	K. H. Rechinger	52241	M
T. longirostris	F. Förster	135	M
7.Subtribe Sonchinae			
Aetheorhiza bulbosa	Borja, Mansanet & Monasterio	*s.n.*	M
Launaea angustifolia	Ullmann	*s.n.*	MSB
L. capitata	D. Podlech	67266	MSB
L. cassiniana	D. Podlech	48558	MSB
L. goraeensis	H.-C. Friedrich	6040	M
L. massauensis	Schimper	1045	M
L. mucronata	D. Podlech	48754	MSB
L. nudicaulis	I. Ullmann & D. Podlech	*s.n.*	MSB
L. resedifolia	A. K. Osman	*s.n.*	CAI
L. spinosa	W. Schimper	78–89 / 318	M
Reichardia tingitana	H. Hertel	34645	M
Sonchus asper	O. Angerer	*s.n.*	M
S. asper ssp.glaucescens	A. K. Osman	*s.n.*	CAI
S. macrocarpus	L. Bonlo	*s.n.*	M
S. maritimus	Porta & Rigo	33441	M
S. oleraceaus	D. Podlech	4590	M
S. tenerrimus	D. Podlech	53976	MSB

Results

The subtribes, genera and species of tribe Lactuceae (according to BREMER 1994) 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 EL-HADIDI and FAYED (1994/1995) and BOULOS (1995, 2002).

A careful examination of the available pollen material of the Egyptian species of the tribe Lactuceae revealed the presence of 7 pollen types, which can be distinguished through the following key.

Key to the pollen types

1.a. Pollen grains 3-zonoporate . . . . . *Scolymus* type
b. Pollen grains 3-zonocolporate (sometimes 4-zonocolporate). 2
2.a. Pollen grains without distinct lacunae (depressions at equator between apertures.) . . . . . *Koelpinia* type
b. Pollen grains with distinct lacunae 3
3.a. Number of lacunae 15 4
b. Number of lacunae 17–21 5
4.a. Lacunae: 3 poral + 6 abporal + 6 paraporal 6
b. Lacunae: 6 abporal + 3 equatorial + 6 interporal . . . . . *Geropogon* type
5.a. Number of lacunae 17 : 6 abporal + 3 equatorial + 6 interporal + 2 polar lacunae . . . . . *Scorzonera* type
b. Number of lacunae 21: 3 poral + 6 abporal + 6 paraporal + 6 polar lacunae (in 4-zonocolporate pollen grains lacunae will be 4 + 8 + 8 + 8 respectively) . . . . . *Rhagadiolus* type
6.a. Polar area reduced to be a triradiate ridge without or with little echinae . . . *Lactuca* type
b. Polar area wide with isolated echinae . . . . . *Launaea* type

The following pollen types are recorded among the taxa of tribe Lactuceae in the flora of Egypt (Table 2).

Main characters of pollen types

1. Scolymus pollen type, LM (Plate 1, Fig. 1), SEM (Plate 2, Figs. 1–2).

Pollen grains 3-zonoporate, oblate-spheroidal (P/E = 0.91–0.94), 51.0 (50–53)–53.0 (50–55) × 54.0 (50–55) μm and echinolophate, with 15 lacunae (3 poral, 6 abporal and 6 paraporal). Depressions pentagonal, larger than the lacunae. The equatorial ridges have one to three echinae which project into each depression. The pore is ± round, surrounded by a thin tectum and is subtended by an endexinous, membranous, circular-lalongate os 11.0 (10–13)–12.0 (10–15) μm in diameter. The ora membrane appears partially ruptured. Poral lacuna has circular shape. Abporal lacunae small, surrounded by a microreticulate floor and with granulate margins. Polar area generally absent (EL-GHAZALY, 1980). The grains

Tab. 2. Taxa of Lactuceae and their representative pollen types. Number of genera = 23, number of species = 46.

Tribe and subtribe	Genus	No. of Species	Pollen Type
I. Tribe Lactuceae			
1. Unassigned Lactuceae			
	Cichorium	1	Launaea
	Scolymus	2	Scolymus
2. Subtribe Catananchinae			
	Thrincia	1	Launaea
3. Subtribe Crepidinae			
	Crepis	1	Launaea
	Lagoseris	1	Launaea
	Taraxacum	1	Launaea
4. Subtribe Hypochoeridinae			
	Garhadiolus	1	Lactuca
	Hedypnois	1	Launaea
	Helminthotheca	1	Launaea
	Hyoseris	2	Launaea
	Leontodon	2	Launaea
	Picris	3	Launaea
	Rhagadiolus	1	Rhagadiolus
	Urospermum	1	Launaea
5. Subtribe Lactucinae			
	Lactuca	4	Lactuca
6. Subtribe Scorzonerinae			
	Geropogon	1	Geropogon
	Koelpinia	1	Koelpinia
	Scorzonera	2	Scorzonera
	Tragopogon	2	Geropogon
7. Subtribe Sonchinae			
	Aetheorhiza	1	Rhagadiolus
	Launaea	9	Launaea
	Reichardia	1	Lactuca
	Sonchus	6	Rhagadiolus

are subcircular in equatorial outline pentagonal in polar outline. Exine is 10.0 (8–13) µm thick at centre of mesocolpia (spines included); sexine thicker than nexine, nexine 4.0 (2–6) µm thick. The infratectum and the tectum columellate. The ornamentation sculpture echinate with perforate-microreticulate, long, pointed spines of 3.0 (2–4)–4.0 (3–5) µm high and 2.0 (1–4)–3.0 (2–4) µm apart. The following taxa belong to this type:

Tribe Lactuceae

I. Unassigned Lactuceae

Genus *Scolymus* (2 species).

1. ***S. hispanicus*** L., Sp. Pl., ed. 1: 813 (1753).
2. ***S. maculatus*** L., Sp. Pl., ed. 1: 813 (1753).

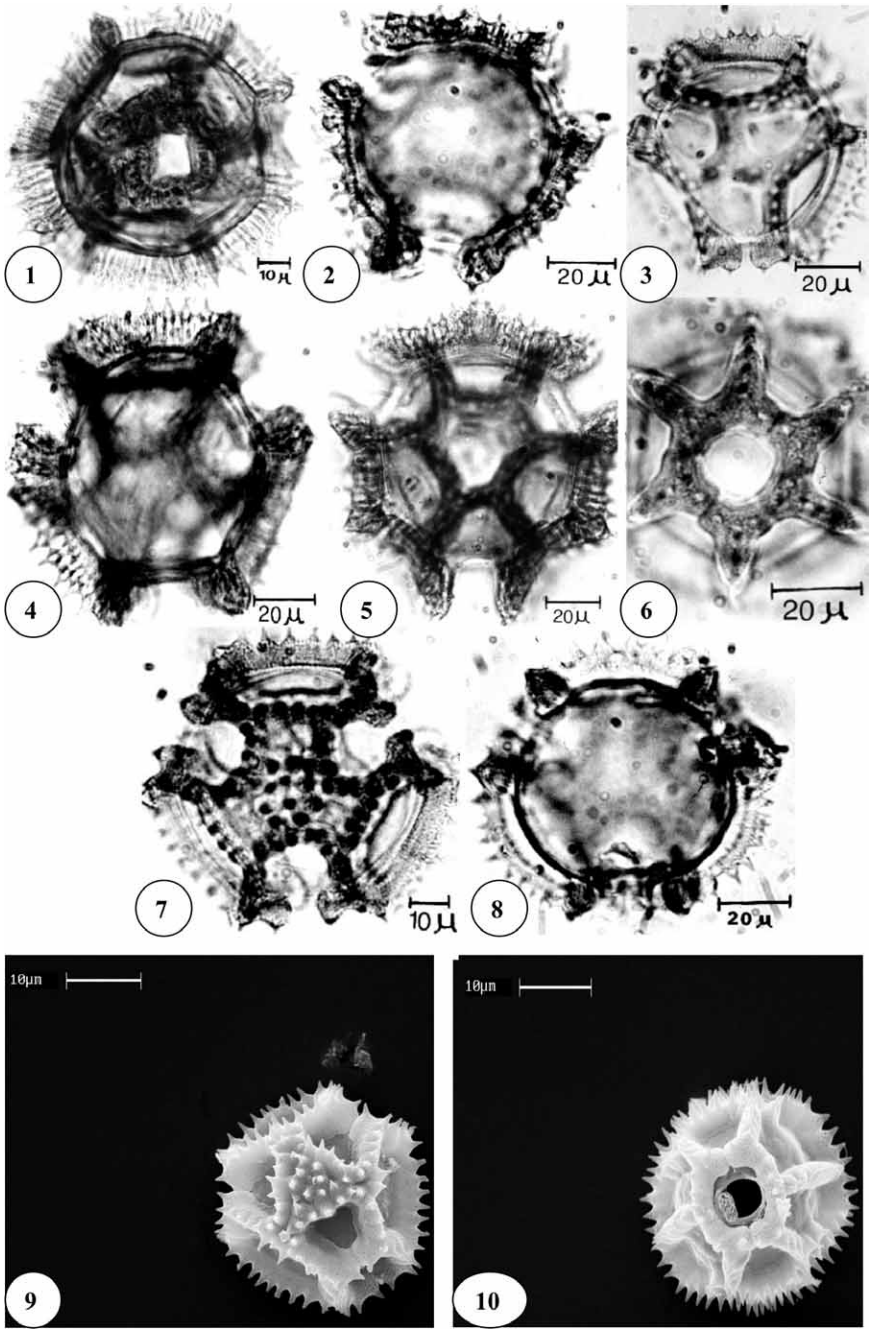

Plate 1. LM and SEM observations of acetolysed pollen grains. Fig.1 – *Scolymus hispanicus*, equatorial view. Fig. 2 – *Koelpinia linearis,* polar view. Figs. 3 and 6 – *Lactuca serriola*, polar view (3) and equatorial view (6). Fig. 4 – *Geropogon glabrum*, polar view. Fig. 5 – *Scorzonera mollis*, polar view. Fig. 7 – *Rhagadiolus stellatus*, polar view. Fig. 8 – *Launaea capitata*, polar view. Figs. 9–10 – *Launaea nudicaulis*, polar view (9), equatorial view (10).

2. Koelpinia pollen type, LM (Plate 1, Fig. 2), SEM (Plate 2, Figs. 3–4).

Pollen grains are 3-zonocolpororate, rarely 4-colpororate, oblate-spheroidal (P/E = 0.93), 39 (35–40) × 42 (40–45) μm and echinate. The pollen has distinct equatorial depressions between the apertures and without distinct lacunae. Apertures compound, each one consists of ectoaperture, which is a meridionally elongated colpus with rounded ends narrow at the equator, mesoaperture with the lowermost elongation of 10 (7–13) μm in diameter and the high endoaperture with triangular lateral extensions. The grains are ovate-shaped in equatorial outline and triangular, obtuse-hexagonal in polar outline (quadrangular in 4-colpororate pollen). The exine is 9 (7–10) μm thick (spines included) at centre of mesocolpia; sexine thicker than nexine, nexine 3 (1–4) μm thick. The infratectum and the tectum columellate. Ornamentation is echinate with perforate, long, pointed spines of 4 (2–5) μm high and 3 (2–4) μm apart. The following taxa belong to this type:
Tribe Lactuceae
I. Subtribe Scorzonerinae
Genus *Koelpinia* (1 species).
1. ***K. linearis*** Pallas, Reise, 3, 2: 755 (1776).

3. Scorzonera pollen type, LM (Plate 1, Fig. 5), SEM (Plate 2, Figs. 5–6).

Pollen grains are 3-zonocolpororate, spheroidal to prolate-spheroidal (P/E = 1.00–1.04), 57.0 (55–60)–61.0 (55–75) × 55.0 (50–60)–61.0 (55–65) μm and echinolophate, with 17 lacunae (6 abporal, 3 equatorial, 6 interporal and 1 lacuna at each pole). Aperture compound consists of ectoaperture, which is a meridionally elongated colpus with rounded ends narrow at the equator, divided by a central constriction into two abporal lacunae, mesoaperture which is a lowermost lolongate os 10.0 (8–12) μm in diameter and endoaperture which is a higher os with triangular lateral extensions. Polar area equipped with a large, hexagonal, with unequal (in *S. alexandrina*) or equal (in *S. mollis*) ridges lacuna. Interporal lacuna is pentagonal. The grains are subcircular in equatorial outline and triangular, obtuse-hexagonal in polar outline. The exine is 12.0 (10–13)–13.0 (10–15) μm thick (spines included) at centre of mesocolpia; sexine thicker than nexine, nexine 3.0 (2–4)–4.0 (2–5) μm thick. The infratectum and the tectum columellate. The ornamentation is echinate with perforate to microreticulate, pointed spines of 3.0 (2–4) μm high and 3.0–4.0 (2–5) μm apart. The following taxa belong to this type:
Tribe Lactuceae
I. Subtribe Scorzonerinae
Genus *Scorzonera* (2 species).
1. ***S. alexandrina*** Boiss., Fl. Orient. 3: 760 (1875).
(= *S. undulata* Vahl, Symb. Bot. 2: 86 (1791)).
2. ***S. mollis*** M. Bieb. var. *longifolia* Boiss., Fl. Orient. 3: 762 (1875).
(= *S. syriaca* Boiss., et Blanche, Diagn. Pl. Orient., ser. 2,3: 93 (1856)).

4. Rhagadiolus pollen type, LM (Plate 1, Fig. 7), SEM (Plate 2, Figs. 7–8).

Pollen grains are 3-zonocolpororate to 4-zonocolpororate, oblate-spheroidal to spheroidal (P/E = 0.95–1.00), 34.0 (32–35)–45.0 (35–50) × 34.0 (30–35)– 46.0 (42–51) μm and echinolophate, with 21–28 lacunae (21 lacunae in 3-zonocolpororate pollen; 3 poral, 6 abporal, 6 paraporal and 3 lacunae at each pole and 28 lacunae in 4-zonocolpororate pollen; 4 poral, 8 abporal, 8 paraporal and 4 lacunae at each pole). Apertures compound, each one

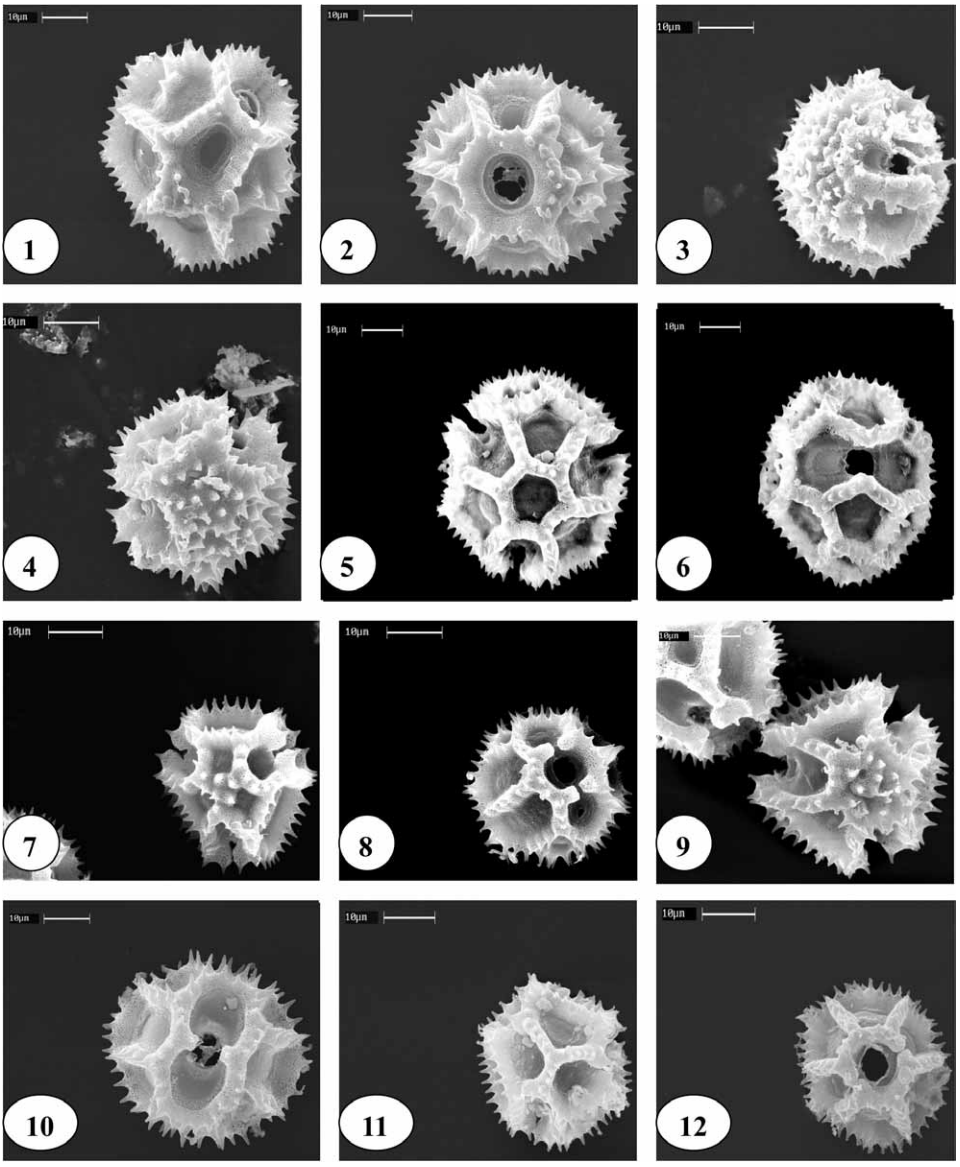

Plate 2. SEM observations of acetolysed pollen grains. Figs. 1, 2 – *Scolymus maculates*, oblique polar view (1), equatorial view (2). Figs. 3, 4 – *Koelpinia linearis*, oblique equatorial view (3), oblique polar view (4). Figs. 5, 6 – *Scorzonera mollis*, polar view (5), equatorial view (6). Figs. 7, 8 – *Rhagadiolus stellatus*, polar view (7), oblique equatorial view (8). Figs. 9, 10 – *Geropogon glabrum*, polar view (9), equatorial view (10). Figs. 11, 12 – *Lactuca orientalis*, polar view (11), equatorial view (12).

comprises ectoaperture which is a meriditionally elongated colpus with rounded ends wide at the equator, divided by a central constriction into two abporal lacunae, a mesoaperture which is lowermost lolongate, circular or lalongate os 6.0 (5–7)–8.0 (7–10) μm in diameters and endoaperture which is a higher os with triangular lateral extensions. Polar area wide with long axis 3.0 (2–5)–18.0 (16–20) μm provided with distinct lacunae and 4 (3–7)–20 (14–25) isolated echinae. The grains are subcircular-ovate or octagonal in equatorial outline, triangular-obtuse to hexagonal or quadrangular-octagonal in polar outline. The exine is 5.0 (4–6)–8.0 (7–9) μm thick at centre of mesocolpia (spines included); sexine thicker than nexine, nexine 1.0 (1–2)–2.0 (1–3) μm thick. The infratectum and the tectum columellate. Ornamentation is echinate or echinulate with perforate to microreticulate, pointed spines or spinules of 2.0 (1–3)–3.0 (2–4) μm high and 2.0 (1–3)–3.0 (2–5) μm apart. The following taxa belong to this type:

Tribe Lactuceae

I. Subtribe Hypochoeridinae

Genus *Rhagadiolus* Scop**.** (1 species).

1. *R. stellatus* (L.) Gaertn., Fruct. Sem. Pl. 2: 354, t. 157 (1791).

II. Subtribe Sonchinae

Genus *Aetheorhiza* Cass. (1 species).

2. *A. bulbosa* (L.) Cass.

Genus *Sonchus* (6 species).

3. *S. asper* (L.) Hill, Herb. Brit. 47, t. 34 (1769).

4. *S. asper* ssp. *glaucescens* (Jord.) Ball in J. Linn. Soc. London (Bot.) 16: 548 (1878).

5. *S. macrocarpus* Boulos et C. Jeffrey in Taxon 18: 349 (1969).

6. *S. maritimus* L., Syst. Nat., ed. 10, 2: 1192 (1759).

7. *S. oleraceus* L., Sp. Pl., ed. 1: 794 (1753).

8. *S. tenerrimus* L., Sp. Pl., ed. 1: 794 (1753).

Key to genera of Rhagadiolus pollen type

1.a. Polar area long axis 3.0 (2–5) μm . . . . . *Rhagadiolus*

b. Polar area long axis median 10.0–18.0 μm 2

2.a. Polar lacunae three, shallow and without distinct shape . . . . . *Aetheorhiza*

b. Polar lacunae four, deep in 4-colpororate pollen; three in 3-colpororate pollen, quadrangular in shape . . . . . *Sonchus*

5. Geropogon pollen type, LM (Plate 1, Fig. 4), SEM (Plate 2, Figs. 9–10).

Pollen grains are 3-zonocolpororate, oblate-spheroidal (P/E = 0.96), 47.0 (45–48)–51.0 (50–53) × 49.0 (47–50)–53.0 (50–55) μm and echinolophate, with 15 lacunae (6 abporal, 3 equatorial and 6 interporal). Apertures compound, each one consists of ectoaperture, which is a meriditionally elongated colpus with rounded ends narrow at the equator, divided by a central constriction into two abporal lacunae, mesoaperture which is a lowermost lolongate to circular os 11.0 (10–13)–12.0 (10–13) μm in diameter and endoaperture which is higher os with triangular lateral extensions. Long axis of polar area 13.0 (12–15)–23.0 (19–26) μm and provided with 9 (7–12)–10 (8–16) isolated, central echinae and may be also many, small, shallow concavities. The grains are ovate-shaped to subcircular in equatorial outline and triangular, obtuse-hexagonal in polar outline. The exine is 8.0 (7–9)–10.0 (8–11) μm thick (spines included) at centre of mesocolpia; sexine thicker than nexine, nexine 1.0

Tab. 3. Tabular summary showing pollen grain dimensions (μm). P – polar axis; E – equatorial diameter; Ech. Len. – echinae length; Echin. Apart – echinae apart; Ex. Th. inc. echin. – exine thick includes echinae; Nex. Th. – nexine thick; No. echin. polar area – number of echinae on polar area; Ora. diam. – ora diameter

Species	P.	E.	P/E	Ex. th. inc. echin.	Ech. len.	Echin. apart.	Ora. diam.	Nex. th.	long axis Polar area	No.echin. polar area.
VI-Tribe Lactuceae Cass.										
1. Unassigned Lactuceae										
Cichorium pumilum	59(52–62)	58(50–65)	1.02	12(10–15)	5(4–6)	4(3–5)	11(10–13)	2(1–3)	27(25–30)	2(1–3)
Scolymus hispanicus	53(50–55)	54(50–55)	0.91	10(8–13)	4(3–5)	3(2–4)	11(10–13)	4(2–6)	—	—
S. maculatus	51(50–53)	54(50–55)	0.94	10(8–12)	3(2–4)	2(1–4)	12(10–15)	4(2–6)	—	—
2. Subtribe Catananchinae										
Thrincia tripolitana	32(25–40)	33(26–40)	0.97	7(5–8)	2(2–3)	2(2–3)	6(5–8)	2(1–3)	15(14–16)	2(1–4)
3. Subtribe Crepidinae										
Crepis dioscorides	33(32–35)	34(32–35)	0.97	7(5–8)	3(2–4)	2(2–3)	8(7–10)	2(1–3)	11(9–14)	6(3–10)
Lagoseris sancta	27(25–30)	27(25–30)	1.00	5(4–6)	2(1–3)	3(2–3)	6(5–8)	1(1–2)	10(8–11)	5(3–10)
Taraxacum turcicum	34(32–35)	37(35–43)	0.92	6(5–7)	2(1–3)	3(2–4)	6(5–7)	2(1–3)	20(13–22)	7(3–8)
4. Subtribe Hypochoeridinae										
Garhadiolus hedypnois	27(25–30)	30(25–33)	0.90	7(5–8)	3(2–4)	3(2–5)	7(6–8)	2(1–3)	3(0–8)	4(3–5)
Hedypnois cretica	34(30–38)	40(35–43)	0.85	8(7–10)	3(2–4)	1(1–2)	8(7–10)	2(1–3)	14(12–15)	11(8–13)
Helminthotheca echioides	41(40–43)	43(40–45)	0.95	8(7–10)	3(2–4)	3(2–4)	8(7–9)	1(1–2)	19(18–20)	4(2–7)
Hyoseris lucida	40(37–43)	41(40–48)	0.98	8(7–10)	3(2–4)	2(1–3)	9(7–10)	2(1–3)	12(10–13)	8(6–11)
H. scarba	34(30–38)	34(30–40)	1.00	7(5–8)	3(2–4)	2(1–3)	8(7–9)	1(1–2)	12(10–13)	8(6–12)
Leontodon hispidulus	44(40–48)	43(40–48)	1.00	8(7–10)	4(2–5)	3(1–5)	10(8–12)	2(1–3)	18(15–23)	5(4–8)
L. laciniatus	35(32–38)	36(35–38)	0.97	7(6–8)	3(2–4)	1(1–2)	7(5–8)	2(1–3)	13(7–15)	6(6–8)
Picris sprengeriana	38(37–40)	39(37–40)	0.97	7(5–8)	2(2–3)	1(1–2)	9(7–10)	2(1–3)	17(15–18)	3(2–5)
P. strigosa	40(37–43)	43(37–43)	0.93	7(5–8)	3(2–4)	2(1–3)	8(7–10)	1(1–2)	20(18–22)	4(3–6)
P. sulphurea	33(32–35)	34(30–38)	0.97	5(5–6)	2(1–3)	2(1–3)	7(6–8)	1(1–2)	14(12–15)	9(7–12)
Rhagadiolus stellatus	34(32–38)	34(30–38)	1.00	7(5–8)	3(2–4)	2(1–3)	6(5–7)	2(1–3)	3(2–5)	4(3–7)
Urospermum picroides	35(32–38)	36(35–38)	0.97	6(5–7)	2(2–3)	3(2–4)	6(5–7)	1(1–2)	18(16–20)	7(4–10)

Tab. 3. – continued

Species	P.	E.	P/E	Ex. th. inc. echin.	Ech. len.	Echin. apart.	Ora. diam.	Nex. th.	long axis Polar area	No.echin. polar area.
5. Subtribe Lactucinae										
Lactuca orientalis	34(32–35)	37(35–40)	0.92	8(7–9)	3(2–4)	2(2–3)	9(7–10)	2(1–3)	—	—
L. saligna	35(32–38)	35(32–38)	1.00	7(7–8)	2(1–3)	2(2)	8(7–9)	2(1–3)	—	—
L. serriola	35(32–38)	35(32–38)	1.00	7(6–8)	3(2–4)	2(1–3)	9(7–10)	1(1–2)	—	—
L. undulata	32(30–35)	32(30–35)	1.00	7(5–8)	2(1–3)	2(2–3)	7(6–8)	1(1–2)	—	—
6. Subtribe Scorzonerinae										
Geropogon glabrum	48(45–50)	50(47–55)	0.96	10(8–11)	4(2–5)	3(2–4)	11(10–13)	3(2–4)	13(12–15)	10(7–13)
Koelpinia linearis	39(35–40)	42(40–45)	0.93	9(7–10)	4(2–5)	3(2–5)	10(7–13)	3(1–4)	—	—
Scorzonera alexandrina	61(55–75)	61(55–65)	1.00	13(10–15)	3(2–4)	4(3–5)	10(8–12)	4(2–5)	—	—
S. mollis	57(55–60)	55(50–60)	1.04	12(10–13)	3(2–4)	3(2–4)	10(8–12)	3(2–4)	—	—
Tragopogon collinus	51(50–53)	53(50–55)	0.96	9(7–10)	3(2–4)	4(3–5)	12(10–13)	2(1–3)	23(19–26)	10(8–16)
T. longirostris	47(45–48)	49(47–50)	0.96	8(7–9)	3(2–4)	3(2–4)	12(10–13)	1(1–2)	23(19–26)	9(7–12)
7. Subtribe Sonchinae										
Aetheorhiza bulbosa	40(35–43)	41(37–45)	0.98	7(6–8)	3(2–4)	2(1–3)	8(7–10)	2(1–3)	10(8–15)	15(10–18)
Launaea angustifolia	36(32–40)	37(32–40)	0.97	7(6–8)	3(2–4)	2(2–3)	8(7–10)	2(1–3)	17(14–20)	6(4–12)
L. capitata	35(32–38)	35(32–38)	1.00	7(5–8)	3(2–4)	2(2–3)	8(7–10)	2(1–3)	15(13–17)	16(11–20)
L. cassiniana	34(32–38)	36(35–38)	0.94	7(6–8)	3(2–4)	2(2–3)	9(7–10)	2(1–3)	16(14–18)	6(1–9)
L. goraeensis	33(30–38)	33(30–38)	1.00	7(6–8)	2(1–3)	2(2–3)	8(7–9)	2(1–3)	13(10–15)	2(0–5)
L. massauensis	32(30–33)	32(30–33)	1.00	6(5–8)	2(1–3)	2(2–3)	8(7–9)	2(1–3)	15(13–17)	8(4–10)
L. mucronata	35(32–38)	35(32–38)	1.00	8(7–8)	3(2–4)	2(2–3)	8(7–9)	2(1–3)	15(13–17)	9(6–10)
L. nudicaulis	36(32–40)	36(32–40)	1.00	7(5–8)	2(1–3)	2(2–3)	9(7–10)	2(1–3)	16(15–17)	9(5–10)
L. resedifolia	39(35–43)	39(35–43)	1.00	8(7–9)	3(2–5)	2(2–3)	8(7–10)	2(1–3)	19(15–21)	9(5–10)
L. spinosa	35(32–38)	35(32–38)	1.00	7(5–8)	3(2–5)	2(2–3)	9(7–10)	2(1–3)	14(13–15)	6(4–10)
Reichardia tingitana	31(27–33)	33(32–35)	0.94	7(5–8)	3(2–4)	2(2–3)	7(6–8)	2(1–3)	—	—
Sonchus asper	41(37–45)	43(37–45)	0.95	8(7–9)	2(1–3)	3(2–4)	7(5–8)	3(1–4)	10(9–12)	12(10–14)
S. asper ssp. glaucescens	36(35–38)	37(35–40)	0.97	7(5–8)	3(2–4)	3(2–4)	8(7–9)	2(1–3)	11(9–12)	7(4–10)
S. macrocarpus	41(40–43)	43(40–45)	0.95	8(7–9)	3(2–4)	3(2–5)	8(6–10)	2(1–3)	18(16–20)	20(14–25)
S. maritimus	34(32–35)	34(32–35)	1.00	5(4–6)	2(1–3)	3(2–4)	6(5–7)	1(1–2)	10(8–11)	7(3–8)
S. oleraceaus	45(35–50)	46(42–51)	0.98	6(5–7)	2(1–3)	3(2–5)	6(5–8)	2(1–3)	12(10–16)	20(15–25)
S. tenerrimus	38(37–40)	38(37–40)	1.00	8(7–9)	3(2–4)	3(2–4)	7(5–8)	1(1–2)	10(7–11)	6(3–9)

(1–2)–3.0 (2–4) μm thick. The infratectum and the tectum columellate. The ornamentation is echinate with perforate to Microreticulate, long, pointed spines of 3.0 (2–4)–4.0 (2–5) μm high and 3.0 (2–4)–4.0 (3–5) μm apart.
The following taxa belong to this type:
Tribe Lactuceae
I. Subtribe Scorzonerinae
Genus *Geropogon* L. (1 species).
1. *G. glabrum* L., Sp. Pl., ed. 2: 1109 (1763).
(= *G. hybridus* (L.) Schultz Bip. in Webb et Berth., Phytogr. Canar., 2: 472 (1850)).
Genus *Tragopogon* L. (2 species).
2. *T. collinus* DC., Prodr. 7(1): 115 (1838).
3. *T. longirostris* Bisch. ex Schultz Bip. in Webb et Berth., Phytogr. Canar., 2: 469 (1850).
(= *T. coelesyriacus* Boiss., Diagn. Pl. Orient., ser. 1, 11: 47 (1849)).

Key to genera of Geropogon pollen type

1.a. Polar area long axis 13.0 (12–15) μm . . . . . *Geropogon*
b. Polar area long axis 23.0 (19–26) μm. . . . . *Tragopogon*

6. Lactuca pollen type, LM (Plate 1, Figs. 3, 6), SEM (Plate 2, Figs. 11–12).

Pollen grains are 3-zonocolporate, oblate-spheroidal to spheroidal (P/E = 0.90–1.00), 27.0 (25–30)–35.0 (32–38) × 30.0 (25–33)–37.0 (35–40) μm and echinolophate, with 15 Lacunae, (3 poral, 6 abporal and 6 paraporal). Each compound aperture consists of ectoaperture which is a meridionally elongated colpus with rounded ends, wide at the equator, divided by a central constriction into two abporal lacunae, mesoaperture which is lowermost lolongate, lalongate or circular os 7.0 (6–8)–9.0 (7–10) μm in diameter and endoaperture which is a higher os with triangular lateral extensions. Polar area reduced, with axis 3.0 (0–8) μm in length and provided with 4 (3–5) echinae only in *Garhadiolus*, but in both *Lactuca* and *Reichardia* polar area is reduced to be a triradiate ridge, abporal and paraporal lacunae extending almost to the poles. The grains are ovate-shaped to subcircular in equatorial outline, hexagonal to triangular, obtuse in polar outline. Exine is 7.0 (5–8)–8.0 (7–9) μm thick at centre of mesocolpia (spines included); sexine thicker than nexine, nexine 1.0 (1–2)–2.0 (1–3) μm thick. Infratectum and tectum columellate. Ornamentation is echinate to echinulate with perforate, rarely Microreticulate, pointed spines or spinules of 2.0 (1–3)–3.0 (2–4) μm high and 2.0 (1–3)–3.0 (2–5) μm apart. The following taxa belong to this type:
Tribe Lactuceae
I. Subtribe Hypochoeridinae.
Genus *Garhadiolus* Jaub. and Spach. (1 species).
1. ***G. hedypnois*** (Fisch. et Mey.) Jaub. et Spach, I11. Pl. Orient. 3: 120, t. 184 (1850).
(= *G. angulosus* Jaub. et Spach, I11. Pl. Orient. 3: 122, t. 285 (1850)).
II. Subtribe Lactucinae.
Genus *Lactuca* L. (4 species).
2. ***L. orientalis.*** (Boiss.) Boiss., Fl. Orient. 3: 819 (1830).
3. ***L. saligna*** L., Sp. Pl., ed. 1: 796 (1756).
4. ***L. serriola*** L., Cent. Pl. 2: 29, no. 189 (1756).
5. ***L. undulata*** Ledeb., Icones Pl. Fl. Ross. 2: t. 129 (1830).

Tab. 4. Tabular summary showing description of LM and SEM samples. Cir. – circular; C. w. at eq. -colpi width at equator; Ech. scul. – echinae sculpture; Ech. type – echinae type; Echinul. – echinulate Lac. – lacunae; Lac. No. – lacunae number; La. = lalongate; Lo. – lolongate; Mret. – microreticulate; O. – oblate; Per. – perforate; P. A. conc. – polar area concavities; P. – provate; Red. – reduced; Ret. – reticulate; Sculp. type – sculpture type; Sha. – shallow; Sh. – spheroidal; Subob. – suboblate; II – pollen 3-zonocolporate; III – pollen 3-zonoporate; V – pollen 4-zonocolporate; * – SEM micrograph.

Species	Pollen Class	Pollen Shape	Ora Shape	Ech. Type	Sculp. Type	Ech. Scul.	Lac. No.	C. w. at eq.	Polar Area with	P. A. conc.
VI-Tribe Lactuceae Cass.										
1.Unassigned Lactuceae										
*Cichorium pumilum	II	P.-Sh.	Lo.	Spines	Echinate	Per.	15 (3,6,6)	Wide	Wide, little echinae	–
Scolymus hispanicus	III	O.-Sh.	La	Spines	Echinate	Per.-Mret.	15 (3,6,6)	–	–	–
S. maculatus	III	O.-Sh.	Cir.	Spines	Echinate	Per.	15 (3,6,6)	–	Absent	–
2.Subtribe Catananchinae										
*Thrincia tripolitana	II	O.-Sh.	Cir.	Spinules	Echinul.	Ret.	15 (3,6,6)	Wide	Wide, little echinae	–
3.Subtribe Crepidinae										
*Crepis dioscorides	II	O.-Sh.	La.	Spines	Echinate	Per.-ret.	15 (3,6,6)	Wide	Wide, little echinae	One, sha.
*Lagoseris sancta	II	Sh.	La.	Spinules	Echinul.	Mret.	15 (3,6,6)	Wide	Wide, echinate	Many, sha.
*Taraxacum turcicum	II, rar.V	O.-Sh.	Lo.	Spinules	Echinul.	Mret.	15 (3,6,6)	Wide	Wide, echinate	–
4.Subtribe Hypochoeridinae										
*Garhadiolus hedypnois	II	O.-Sh.	Cir.	Spines	Echinate	Per.	15 (3,6,6)	Wide	Red., little echinae	–
*Hedypnois cretica	II, rar.V	Subob.	La.	Spines	Echinate	Per.	15 (3, 6, 6)	Wide	Isolated echinae	–
*Helminthotheca echioides	II	O.-Sh.	Lo.	Spines	Echinate	Per.	15 (3,6,6)	Wide	Isolated echinae	Many, sha.
*Hyoseris lucida	II, rar.V	O.-Sh.	La.	Spines	Echinate	Mret.	15 (3,6,6)	Wide	Isolated echinae	Many, sha.
H. scarba	II, rar.V	Sh.	La.	Spines	Echinate	Per.	15 (3, 6, 6)	–	–	–
**Leontodon hispidulus*	II	Sh.	La.	Spines	Echinate	Ret.	15 (3,6,6)	Wide	Wide, echinate	Many, sha.
L. laciniatus	II	O.-Sh.	La.	Spines	Echinate	Per.	15 (3,6,6)	–	–	–
Picris sprengeriana	II	O.-Sh.	La.	Spinules	Echinul.	Per.	15 (3,6,6)	–	–	–
**P. strigosa*	II	O.-Sh.	La.	Spines	Echinate	Per.	15 (3,6,6)	Wide	Isolated echinae	Many, sha.
**P. sulphurea*	II	O.-Sh.	La.	Spinules	Echinul.	Mret.	15 (3,6,6)	Wide	Isolated echinae	–
**Rhagadiolus stellatus*	II	Sh.	Lo.	Spines	Echinate	Per.-Mret.	21(3,6,6,6)	Wide	Isolated echinae	3 deep lac.
**Urospermum picroides*	II, rar.V	O.-Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	Wide	Isolated echinae	–

Tab. 4. – continued

Species	Pollen Class	Pollen Shape	Ora Shape	Ech. Type	Sculp. Type	Ech. Scul.	Lac. No.	C. w. at eq.	Polar Area with	P. A. conc.
5.Subtribe Lactucinae										
**Lactuca orientalis*	II	O.-Sh.	La.	Spines	Echinate	Per.	15 (3,6,6)	Wide	Reduced	–
L. saligna	II	Sh.	La.	Spinules	Echinul.	Per.	15 (3,6,6)	–	–	–
L. serriola	II	Sh.	La.	Spines	Echinate	Per.	15 (3,6,6)	–	–	–
**L. undulata*	II	Sh.	Lo.	Spinules	Echinul.	Per.	15 (3,6,6)	Wide	Reduced	–
6.Subtribe Scorzonerinae										
**Geropogon glabrum*	II	O.-Sh.	Lo.	Spines	Echinate	Mret.	15 (6,3,6)	Narrow	Isolated echinae	Many, small
**Koelpinia linearis*	II, rar.V	O.-Sh.	Lo.	Spines	Echinate	Per.	–	Narrow	–	–
**Scorzonera alexandrina*	II	Sh.	Lo.	Spines	Echinate	Mret.	17 (6,3,6,2)	Narrow	Absent	Large lac.
**S. mollis*	II	P.-Sh.	Lo.	Spines	Echinate	Per.	17 (6,3,6,2)	Narrow	Absent	Large lac.
**Tragopogon collinus*	II	O.-Sh.	Cir.	Spines	Echinate	Per.	15 (6,3,6)	Narrow	Isolated echinae	–
**T. longirostris*	II	O.-Sh.	Lo.	Spines	Echinate	Mret.	15 (6,3,6)	Narrow	Isolated echinae	Narrow
7.Subtribe Sonchinae										
**Aetheorhiza bulbosa*	II	O.-Sh.	Lo.	Spines	Echinate	Per.	21 (3,6,6,6)	Wide	Isolated echinae	3 deep lac.
**Launaea angustifolia*	II	O.-Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	Wide	Isolated Eehinae	Many, sha.
L. capitata	II	Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	–	–	–
**L. cassiniana*	II	O.-Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	Wide	Isolated Eehinae	–
**L. goraeensis*	II	Sh.	La.	Spinules	Echinul.	Per.-Mret.	15 (3,6,6)	Wide	Without Eehinae	–
L. massauensis	II	Sh.	La.	Spinules	Echinul.	Per.-Mret.	15 (3,6,6)	–	–	–
L. mucronata	II	Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	–	–	–
**L. nudicaulis*	II	Sh.	La.	Spinules	Echinul.	Per.	15 (3,6,6)	Wide	Isolated Eehinae	Many, sha.
L. resedifolia	II	Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	–	–	–
L. spinosa	II	Sh.	Cir.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	–	–	–
**Reichardia tingitana*	II	O.-Sh.	La.	Spines	Echinate	Per.-Mret.	15 (3,6,6)	Wide	Red.	–
**Sonchus asper*	V, rar.II	O.-Sh.	Cir.	Spinules	Echinul.	Per.	21 (3,6,6,6)	Wide	Isolated Eehinae	3 or 4 lac.
S. asper ssp. *glaucescens*	II	O.-Sh.	Cir.	Spines	Echinate	Per.	21 (3,6,6,6)	–	–	–
**S. macrocarpus*	V, rar.II	O.-Sh.	La.	Spines	Echinate	Per.	21 (3,6,6,6)	Wide	Isolated Eehinae	3 or 4 lac.
S. maritimus	II	Sh.	Lo.	Spinules	Echinul.	Per.	21 (3,6,6,6)	–	–	–
**S. oleraceaus*	V, rar.II	O.-Sh.	Lo.	Spinules	Echinul.	Per.-Mret	21 (3,6,6,6)	Wide	Isolated Eehinae	3 or 4 lac.
**S. tenerrimus*	II	Sh.	Cir.	Spines	Echinate	Mret.	21 (3,6,6,6)	Wide	Isolated Eehinae	3 deep lac.

II. Subtribe Sonchinae.
Genus *Reichardia* Roth. (1 species).
6. ***R. tingitana*** (L.) Roth. Bot. Abh.: 35 (1787).

Key to genera of Lactuca pollen type

1.a. Polar view long axis 27.0 (25–30) µm . . . . . *Garhadiolus*
b. Polar view long axis median 31.0–35.0 µm 2
2.a. Polar view long axis 31.0 µm . . . . . *Reichardia*
b. Polar view long axis median 32.0–35.0 µm . . . . . *Lactuca*

7. Launaea pollen type, LM (Plate 1, Fig. 8), SEM (Plate 1, Figs. 9–10).

Pollen grains are 3-zonocolporate, rarely 4-zonocolporate, spheroidal to oblate--spheroidal, occasionally prolate-spheroidal or suboblate (P/E = 0.85–1.02), 27.0 (25–30) –59.0 (52–62) × 27.0 (25–30)–58.0 (50–65) µm and echinolophate, with 15 Lacunae (3 poral, 6 abporal and 6 paraporal). Each compound aperture consists of ectoaperture which is a meridionally elongated colpus with rounded ends, wide at the equator, divided by a central constriction into two abporal lacunae, mesoaperture which is lowermost lolongate, lalongate to circular os 6.0 (5–7)–11.0 (10–13) µm in diameter and endoaperture which is a higher os with triangular lateral extensions. Long axis of polar area 10.0(8–11)–27.0 (25–30) µm, provided with 2 (1–3)–16 (11–20) isolated echinae and small, shallow concavities. The grains are subcircular to ovate-shaped in equatorial outline hexagonal, triangular, obtuse to hexagonal or hexagonal-octagonal in polar outline. Exine is 5.0 (4–6)–12.0 (10–15) µm thick at centre of mesocolpia (spines included); sexine thicker than nexine, nexine 1.0 (1–2)–2.0 (1–3) µm thick. Infratectum and tectum columellate. Ornamentation echinate or echinulate with perforate to perforate-microreticulate, pointed spines or spinules of 2.0 (1–3)–5.0 (4–6) µm high and 1.0 (1–2)–4.0 (3–5) µm apart. The following taxa belong to this type:
Tribe Lactuceae
I. Unassigned Lactuceae
Genus *Cichorium* L. (1 species).
1. ***C. pumilum*** Jacq., Obs. Bot. 4: 3 (1771).
(= *C. endivia* L., Sp. Pl., ed. 1: 813 (1753). subsp. *pumilum* (Jacq.) Cout., Fl. Port.: 662 (1913)).
II. Subtribe Catananchinae
Genus *Thrincia* Roth. (1 species).
2. ***T. tripolitana*** Sch.-Bip.
III. Subtribe Crepidinae
Genus *Crepis* L. (1 species).
3. ***C. dioscorides*** L.
Genus *Lagoseris* M. Bieb. (1 species).
4. ***L. sancta*** (L.) K. Maly.
(= ***Crepis sancta*** (L.) Bornm. in Mitt. Thür. Bot. Ver., nov. ser., 30: 79 (1913)).
Genus *Taraxacum* Weber in F. H. Wigg. (1 species).
5. ***T. turcicum*** van. Soest
IV. Subtribe Hypochoeridinae
Genus *Hedypnois* Mill. (1 species).

6. ***H. cretica*** L., Sp. Pl., ed. 1: 810 (1753).
Genus *Helminthotheca* Vaill. ex Zinn. (= Helminthia) (1 species).
7. ***H. echioides*** (L.) Holub in Folia Geobot. Phytotax. (Praha) 8: 176 (1973).
(= *Picris echioides* L., Sp. Pl., ed 1: 792 (1753).
Genus *Hyoseris* L. (2 species).
8. ***H. lucida*** L. Mant. Pl.: 103 (1767).
(= *H. radiata* L., Sp. Pl., ed. 1: 808 (1753).
9. ***H. scarba*** L., Sp. Pl., ed. 1: 809 (1753).
Genus *Leontodon* L. (2 species).
10. ***L. hispidulus*** (Delile) Boiss., Fl. Orient. 3: 727 (1875).
(= *Crepis hispidula* Delile, Descr. Egypte, Hist. Nat. 117, t. 42 (1814).
11. ***L. laciniatus*** (Bertol.) Widder in Bornm., Iter Pers.-Turc., Beih. Bot. Centr. 60: 217 (1939).
(= *L. hispidulus* (Delile) Boiss. var. *tenuiloba* Boiss., Fl. Orient. 3: 728 (1875).
Genus *Picris* L. (3 species).
12. ***P. sprengeriana*** (L.) Chaix in Vill., Hist. Pl. Dauph. 1: 369 (1786).
13. ***P. strigosa*** M. Bieb.
14. ***P. sulphurea*** Delile, Descr. Egypte, Hist. Nat. 258 (1814).
Genus *Urospermum* Scop. (1 species).
15. ***U. picroides*** (L.) F.W. Schmidt, Samml. Phys.-Ökon. Aufs. 1: 275 (1795).
(= *Tragopogon picroides* L., Sp. Pl., ed. 1: 790 (1753).
V. Subtribe Sonchinae
Genus *Launaea* Cass. (9 species).
16. ***L. angustifolia*** (Desf.) O. Kuntze, Revis. Gen. 1: 350 (1891).
17. ***L. capitata*** (Spreng.) Dandy in F.W. Andrews, Fl. Pl. Sudan 3: 40 (1956).
18. ***L. cassiniana*** (Boiss.) O. Kuntze, Revis. Gen. 1: 350 (1891).
19. ***L. goraeensis*** (Lam.) Schultz Bip. in Flora 25: 422 (1842).
(= *L. intybacea* (Jacq.) Beauverd in Bull. Soc. Bot. Geneve, ser. 2, 2: 114 (1910)).
20. ***L. massauensis*** (Fresen.) Schultz Bip. ex O. Kuntze, Revis. Gen. 1: 350 (1891).
21. ***L. mucronata*** (Forssk.) Mushl, Man. Fl. Egypt, 1057 (1912).
22. ***L. nudicaulis*** (L.) Hook. fil. Brit. Ind. 3: 416 (1881).
23. ***L. resedifolia*** (L.) O. Kuntze, Revis. Gen. 1: 351 (1891).
24. ***L. spinosa*** (Forssk.) Schultz Bip. ex O. Kuntze, Revis. Gen. 1: 350 (1891).

Key to genera of Launaea pollen type

1.a. Polar view long axis 59.0 (52–60) µm . . . . . *Cichorium*
b. Polar view long axis median 27.0–44.0 µm 2
2.a. Polar view long axis 27.0 (25–30) µm . . . . . *Lagoseris*
b. Polar view long axis median 32.0–44.0 µm . . . . . *Thrincia, Crepis, Taraxacum, Hedypnois, Helminthotheca, Hyoseris, Leontodon, Picris, Urospermum, Launaea.*

Discussion

The results show that the pollen grains of the tribe Lactuceae with composite apertures are usually 3-zonocolpororate, occasionally 3-zonopororate, and rarely 4-zonocolpororate, which usually consist of a meridionally elongated colpus with rounded ends, divided by a

central constriction into two abporal lacunae; a porate mesoaperture which is lowermost lolongate-lalongate or occasionally circular ora, 6–12 µm in diameter, and an endoaperture which is a higher one with triangular lateral extensions.

During our study of the subtribes, genera and species of the tribe Lactuceae we distinguished seven morphological types of pollen which differ in the following five characters: the nature of the pollen class, the nature of lacunae in echinolophate pollen grains, the number of lacunae, the method of lacunae distribution on the pollen grain surface and the size of the polar area. These types are as follows:

1. **Scolymus pollen type**, in which the pollen grains are oblate-spheroidal, trizonopororate and echinolophate with 15 lacunae (3 poral, 6 abporal and 6 paraporal). This type is found only in Scolymus *hispanicus* and *S. maculatus*.
2. **Koelpinia pollen type**, in which the pollen grains are oblate-spheroidal, trizonocolpororate and without distinct lacunae. This type is represented only by *Koelpinia linearis*.
3. **Scorzonera pollen type**, in which the pollen grains are oblate-spheroidal, trizonocolpororate and echinolophate with 17 lacunae (6 abporal, 3 equatorial, 6 interporal and one lacuna at each pole). This type is represented only by *Scorzonera alexandrina* and *S. mollis*.
4. **Rhagadiolus pollen type**, in which the pollen grains are oblate-spheroidal to spheroidal, trizonocolpororate to tetrazonocolpororate and echinolophate, with 21–28 lacunae (21 lacunae in 3-zonocolpororate pollen grains; 3 poral, 6 abporal, 8 paraporal and 3 lacunae at each pole and 28 lacunae in 4-zonocolpororate pollen grains; 4 poral, 8 abporal, 8 paraporal and 4 lacunae at each pole). Genera of *Rhagadiolus* (1 species) *Aetheorhiza* (1 species) and *Sonchus* (6 species) belong to Rhagadiolus pollen type. In *Rhagadiolus* pollen grains long axis of polar area 3 (2–5) µm, while in both *Aetheorhiza* and *Sonchus* the median for long axis of polar area was 10–18 µm. On the other hand, in *Aetheorhiza* pollen grains, there are polar areas with three shallow lacunae without any distinct shape, while in *Sonchus* pollen grains, there is a polar area with four (in 4-zonocolpororate pollen) or three (in 3-zonocolpororate pollen) deep and quadrangular in shape lacunae.
5. **Geropogon pollen type**, in which the pollen grains are oblate-spheroidal, trizonocolpororate, and echinolophate with 15 lacunae (6 abporal, 3 equatorial and 6 interporal). The genus *Geropogon* (1 species) and the genus *Tragopogon* (2 species) represent the Geropogon pollen type. In *Geropogon* pollen grains, the long axis of the polar area was 13 (12–15) µm, while in *Tragopogon* pollen grains the long axis of the polar area was 23 (19–26) µm.
6. **Lactuca pollen type**, in which the pollen grains are spheroidal to oblate-spheroidal, trizonocolpororate and echinolophate with 15 lacunae (3 poral, 6 abporal and 6 paraporal). The pollen grain polar area in this pollen type is reduced to a triradiate ridge without any or with few echinae. Genera of *Garhadiolus* (1 species) *Reichardia* (1 species) and *Lactuca* (4 species) represent the Lactuca pollen type. In pollen grains of *Garhadiolus hedypnois*, the long axis of the polar view was 27 (25–30) µm, while the median for the polar view long axis in both *Lactuca* and *Reichardia* was 31–35 µm. On the other side, in *Reichardia*, the long axis of the polar view was 31 µm but in studied species of genus *Lactuca,* the median for the polar view long axis was 32–35 µm.

7. **Launaea pollen type**, in which the pollen grains are oblate-spheroidal to spheroidal, occasionally prolate-spheroidal, trizonocolporate and echinolophate with 15 lacunae (3 poral, 6 abporal and 6 paraporal). The pollen grain polar area is wide with isolated echinae. In addition to unassigned Lactuceae taxa, there are four subtribes comprising 11 genera representing the Launaea pollen type. These genera are *Cichorium* (1 species) *Thrincia* (1 species) *Crepis* (1 species) *Lagoseris* (1 species) *Taraxacum* (1 species) *Hedypnois* (1 species) *Helminthotheca* (1 species) *Hyoseris* (2 species) *Leontodon* (2 species) *Picris* (3 species) *Urospermum* (1 species) and *Launaea* (9 species). In *Cichorium pumilum* pollen grains, the long axis of the polar area was 59 (52–60) μm, but in the other genera, the median for the polar view long axis was 27–44 μm. On the other hand, the long axis of the polar view for *Lagoseris sancta* pollen grains was 27 (25–30) μm, while the remaining 10 genera have pollen grains with a polar view long axis median from 32 to 44 μm.

The size of the pollen grains is usually (P/E = 0.85–1.04) 27–61 × 27–61 μm. The longest axis (sexine included) from 27 μm (slightly less in *Lagoseris sancta* and *Garhadiolus hedypnois*) to 61 μm (slightly more in *Scorzonera alexandrina*), and the pollen size of other taxa ranged between 32.0–59 μm. Exine 5–13 μm thick at centre of mesocolpia (spines included). Sexine thicker than nexine. Tectum has pointed spines or spinules with broad base, 2–5 μm high, perforate microreticulate or reticulate.

In Egyptian flora of tribe Lactuceae there are in addition to unassigned Lactuceae six subtribes (Bremer 1994). These subtribes are Catananchinae, Crepidinae, Hypochoeridinae, Lactucinae, Scorzonerinae and Sonchinae. In these seven sections of tribe Lactuceae we distinguished seven pollen types.

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