



COMPARATIVE MORPHOLOGICAL STUDIES ON ACHENE OF SOME TAXA OF ASTERACEAE

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ABSTRACT

Morphological structure and different characters of achene is most important from the taxonomic point of view. In present study achene shape, colour, size, texture and pappus type were recorded for 20 taxa of Asteraceae by using light microscope (LM) and scanning electron microscope (SEM). Examination of pappus by SEM recorded 6 groups; (1- Scarious barbellate fine bristles and scarious barbellate bristles, 2- Scarious subulate scales free, 3- Scarious scales, 4- Paleaceous scales corona, 5- Plumose bristles and 6- Capillary barbellate). Also eight patterns were recognized based on surface sculpturing pattern: reticulate, with two subtypes, tuberculate, sulcate, punctulate, colliculate, aculeate, lineate and striate. The data proved useful in the construction of a dichotomous indented key to the studied taxa. Twenty-two characters with 85 characters stats were used to generate anatomical key using the DELTA key-generating programs.

INTRODUCTION

Asteraceae (Compositae) is one of the largest Angiosperm families, comprises of 1590 genera and around 23,600 known species (Bremer & Jansen, 1992 and Bremer, 1994). It is cosmopolitan in distribution, occurring in all continents except Antarctica (Hickey & King, 1997).

The subfamilial classification had minor revisions; Cronquist (1955) recognized two subfamily and 10 tribes; (Thorne, 1983) classified the family into two subfamily and 14 tribe, while (Bremer, 1994) divided it into four subfamilies and 17 tribes. More recently (Baldwin *et al* 2002 and Panero & Funk, 2002) divided the family into 10 subfamilies and 35 tribes.

The fruit of Asteraceae are technically called as cypsela or achene, which develops from bicarpellary, syncarpus, epigynous, one chambered, one ovuled ovary with basal placentation. Most achen have appendage called pappus; the most recent workers have adopted the view that the pappus is a modified calyx (Cronquist, 1977; Thorne, 1983 and Takhtajan, 1997). Cypselar features are very helpful, for the separation of taxa, when flowering stage is unavailable (Jana and Mukherjee, 2012). Morphological structure and different characters of cypsela is most important from the taxonomic point of view. Also the pappus is a taxonomically important and useful organ in Asteraceae (Cassini, 1827). Cypsela or achene study has been utilized by many authors successfully for the delimitation of genera and species within the family Asteraceae as (Bhar & Mukherjee, 2004; Chehregani & Mahanfar, 2007; Talukdar & Mukherjee, 2008; Jana & Mukherjee, 2012 & 2013; Bednorz & Podsiedlik 2013, Jana *et al* 2013 and Jana & Mukherjee, 2014). Most taxonomic affinity studies in Asteraceae (Compositae) in Egypt have focused mainly on a systematic revision as (Amin, 1978; Zareh, 1987, 1992 & 2005; Fayed, 1987 & 1991; Fayed and Zareh,

1987, 1988 & 1989; Fayed and M602ohamed, 1991a & b; El-Karemy and Zareh, 1991; Zareh and Osman, 2004 and Zareh, 2005). Little studies other than revision are don as (Abd El-Wahid *et al* 2009; Abd El-Twab & Zahran, 2010 and Osman, 2011 a & b). The scan of achene and pappus in Asteraceae taxa growing in Egypt is not yet correctly projected.

The aim of this study was to compare the achene morphological characters for some taxa of different Asteraceae tribes to evaluate the application of this character in the classification and finding some useful characters to delimit the taxa at species level.

MATERIAL AND METHODS

The present study included achen of 20 taxa of family Asteraceae belong to three sub-family and nine tribe according to Panero & Funk (2002), collected fresh from different localities in Egypt (Table 1). The materials studied were identified by means of comparison with specimens kept in the herbarium of the Agricultural Museum (CAIM). In addition, keys of (Täckholm, 1974; Davis, 1975; Boulos, 2000 and Bisby *et al* 2010). Reference herbarium specimens of studied species were prepared and kept in the herbarium of Botany and Microbiology Department, Faculty of Science (Girls Branch) Al-Azhar University. For fruit morphology, five to seven achen were investigated to record their dimensions, shape, color, size, pappus and surface texture. Details of achene sculpture were examined by a JEOL JSM – 5500 scanning electron microscope operated at an accelerated voltage of 20 kv and photographed. The terminology of (Bednorz & Podsiedlik, 2013) was adopted to describe the SEM aspects of the achene coat, and the terminology of (Mukherjee and Nordenstam, 2008) for pappus structure.

Numerical analysis

Various data obtained from the description of the achene morphology and pappus were subjected to automated key generation (Key 2) using version 4.12 of the DELTA suite of program (Dallwitz *et al* 2000).

RESULTS AND DISCUSSION

The achene morphological characters, pappus and achene sculpture of the studied taxa are summarized in Tables 2 & 3 and Plates 1, 2 and 3.

A. Pappus

Papuse were seen in different forms. The examination of pappus by scanning electron microscope divided the studied taxa into 6 groups:

- a- Group 1- Scarbous barbellate fine bristles and scarbous barbellate bristles; it is the main group which including 12 taxa; eg. *Pluchea dioscoridis* & *Sonchus oleraceus* (Plate 2 and Figs. 5 & 19)
- b- Group 2- Scarbous subulate scales free, including 3 taxa; eg. *Carduus pycnocephalus* (Plate 2 and Fig. 1)
- c- Group 3- Scarious scales specific for *Pulicaria undulate* (Plate 2, Fig. 9b)
- d- Group 4- Paleaceous scales corona for *Anthemis melampodina* subsp. *deserti* (Plate 2 and Fig. 10)
- e- Group 5- Plumose bristles for two taxa; eg. *Notobasis syriaca* (Plate 2, Fig. 2)
- f- Group 6- Capillary barbellate for *Phagnalon rupestre* (Plate 2, Fig. 7)

B. Achene

Data indicated that studied taxa were delineated on the following characteristics:

Length

Studied specimens were between 0.9 - 9 mm. Achene lengths were different in different specimens; in *Urospermum picroides* it was longer than 8 mm, in *Pluchea dioscoridis* less than 1 mm and in the reminders it was noted in a variety of sizes.

Shape

Achenes shape was also different in studied taxa. Shape of achene was Fusiform in *Senecio vulgaris*, Obovate in *Notobasis syriaca*, oblong in *Centaurea aegyptiaca* and Curved in *Calendula arvensis*.

Table 1. Collection data of the taxa included in the present study, sub-family & tribes according to Panero & Funk, 2002; all localities are in Egypt.

Sub-Family	Tribe	Taxa	Locality and date	
Carduoideae	Cynareae	<i>Carduus pycnocephalus</i> L.	Kafr AL dawar , 3/2014	
		<i>Notobasis syriaca</i> (L.) Cass.	Kafr AL dawar , 3/2014	
		<i>Silybum marianum</i> (L.) Gaertn. var. <i>albiflorum</i> Eig,second contr.	Wadi Hagol, 11/2013 Kafr AL dawar, 3/2014	
		<i>Centaurea aegyptiaca</i> L.	Cairo- Suez road, 3/2014	
Asteroideae	Pluceae	<i>Pluchea dioscoridis</i> (L.) DC.	Wadi Hagol, 11/2013 Al-Azhar University, 5/2014	
	Astereae	<i>Conyza bonariensis</i> (L.) Cronquist, Bull.	Wadi Hagol, 11/2013 Al-Azhar University, 5/2014	
		<i>Phagnalon rupestre</i> (L.) DC.	Kafr AL dawar , 3/2014	
		Gnaphalieae	<i>Pseudognaphalium lutedalbum</i> (L.) Hilliard & B.L. Burtt.	New Valley, 4/2004
	Inuleae	<i>Pulicaria undulate</i> (L.) C.A.Mey.	Wadi Hagol, 3/2010	
	Anthemideae	<i>Anthemis melampodina</i> Delile, subsp. <i>deserti</i> (Boiss) Eig.	Cairo- Suez road, 3/2014	
		Senecioneae	<i>Senecio glaucus</i> L. sub-sp. <i>corono-</i> <i>pifolius</i> (Maire) C.	Cairo- Suez road, 3/2014
			<i>Senecio vulgaris</i> L.	New Valley, 4/2010
	Calenduleae	<i>Calendula arvensis</i> L.	New Valley, 4/2004	
	Cichorioideae		<i>Urospermum picroides</i> (L.) F.W.	Cairo- Suez road, 3/2014
		<i>Launaea spinosa</i> (Forssk)Sch.	Wadi Hagol, 11/2013	
		<i>Launaea nudicaulis</i> (L.)Hook.	Wadi Hagol, 11/2013 Al-Azhar University, 5/2014	
Cichorieae		<i>Launaea mucronata</i> (Forssk) Mus- chi. sub-sp. <i>mucronata</i>	Cairo- Suez road, 3/2014	
		<i>Reichardia tingitana</i> (L.) Roth	Cairo- Suez road, 3/2014	
		<i>Sonchus maritimus</i> L.	New Valley, 4/2004	
		<i>Sonchus oleraceus</i> L.	Wadi Hagol, 11/2013	

Table 2. Comparative observations on achene morphology of the studied taxa of Asteraceae

Taxa	Characters				Achene Size					Pappus						
	Similarity	Colour	Shape	Texture	Length mm.	Width mm.	Ridges	Stylopodium	Beak	Persistence	Colour	Position	Number	Length mm.	Type	Connation at the base
<i>Carduus pycnocephalus</i>	1	2	1	1	4.5-5	2-2.1	1	1	2	2	3	1	2	10-15	3	1
<i>Notobasis syriaca</i>	1	1	2	1	5-6	3-3.5	2	2	2	2	1	2	2	12-15	6	2
<i>Silybum marianum</i> var. <i>albiflorum</i>	1	1	1	1	6-7	3	2	1	2	2	1	1	2	12-14	3	1
<i>Centaurea aegyptiaca</i>	1	1	1	4	1.5-2.	0.5-1	2	2	2	1	1	1	2	5-6	3	2
<i>Pluchea dioscoridis</i>	1	1	1	1	0.9-1	0.1-0.2	1	2	2	1	1	1	1	2.5-3	2	2
<i>Conyza bonariensis</i>	1	3	1	4	1.5-1.7	0.2	2	2	2	1	1	1	1	3.2-4	2	2
<i>Phagnalon rupestre</i>	1	1	1	4	1	0.1	2	2	2	1	1	1	1	6	7	1
<i>Pseudognaphalium lutedalbum</i>	1	1	1	6	0.5	0.2	2	2	2	2	1	1	2	2	2	1
<i>Pulicaria undulate</i>	1	1	3	4	1.1-1.5	0.3-0.5	2	2	2	2	1	1	1	3-6	4,2	1
<i>Anthemis melampodina</i> subsp. <i>deserti</i>	1	1	2	2	0.9-1.9	0.1	1	2	2	1	2	1	1	1.5-.8	5	1
<i>Senecio glaucus</i> sub-sp. <i>coronopifolius</i>	1	5	4	3	2-2.5	0.5	2	1	2	2	1	1	2	4.5	1	2
<i>Senecio vulgaris</i>	1	2	4	3	2.5-3	0.5	2	1	2	2	1	1	2	7-9	1	2
<i>Calendula arvensis</i>	2	2	6	5	2.3-5		2	2	2	3	-	-	-	-	-	-
<i>Urospermum picroides</i>	1	1	3	2	8-9	1.5	1	1	1	2	1	1	2	1-1.2	6	1
<i>Launaea spinosa</i>	1	4	2	2	2.8-3	1-1.2	1	1	2	1	1	1	2	4-5	1	2
<i>Launaea nudicaulis</i>	1	4	2	1	1.2-1.5	0.2-0.3	1	2	2	1	1	1	2	7-9	1	2
<i>Launaea mucronata</i> sup-sp. <i>mucronata</i>	1	1	4	2	3	0.4	1	1	2	1	1	1	2	7-8	1	2
<i>Reichardia tingitana</i>	1	1	5	2	1.3-1.9	0.3-0.4	2	2	2	2	1	1	2	9-10	2	1
<i>Sonchus maritimus</i>	1	4	1	2	2-2.3	0.4-1	1	1	2	2	1	1	2	8-9	1	2
<i>Sonchus oleraceus</i>	1	1	4	2	2.5-3	8.1	1	1	2	2	1	1	2	5-7	1	2

Achene similarity: 1= Homogenous; 2= Polymorphic.

Achene colour: 1= Brown; 2= Green; 3= Yellow; 4= Yellowish green; 5= Brownish green.

Achene shape: 1= Oblong; 2= Obvate; 3= Oblong-Obvate; 4= Fusiform; 5= Tetragonal; 6= Curved.

Achene texture: 1= Smooth; 2= Tuberculate; 3= Hairy; 4= Sparsely hairy; 5= Spiny; 6= Granulate.

Achene ridges: 1= Present; 2= Absent.

Achene stylopodium: 1= Conspicuous; 2= Inconspicuous.

Achene beak: 1= Present; 2= Absent.

Pappus persistence: 1= Persistent; 2= Deciduous; 3= Absent.

Pappus colour: 1= White; 2= Yellow; 3= Yellowish brown.

Pappus position: 1= Terminal; 2= Sub-terminal.

Pappus number: 1= Limited (less than 15); 2= Unlimited (more than 15).

Pappus types: 1= Scarious barbellate fine bristles; 2= Scarious barbellate bristles; 3= Scarious subulate scales free; 4= Scarious scales; 5= Paleaceous scales to form corona; 6= Plumose bristles; 7= Capillary barbellate.

Pappus connate at the base: 1= Connate; 2= Unconnate.

Table 3. Comparative observations on achene coat micrography of the studied taxa of Asteraceae

Taxa	Characters	Achene coat pattern sculpture	Anticinal wall			Periclinical wall	
			Shape	Thicknes	Level	Level	Texture
<i>Carduus pycnocephalus</i>		1	1	1	1	1	1
<i>Notobasis syriaca</i>		2	2	1	1	1	1
<i>Silybum marianum</i> var. <i>albiflorum</i>		3	2	1	3	1	1
<i>Centaurea aegyptiaca</i>		4	3	2	1	1	3
<i>Pluchea dioscoridis</i>		7	3	1	2	3	1
<i>Conyza bonariensis</i>		6	3	1	2	3	1
<i>Phagnalon rupestre</i>		3	2	1	2	3	3
<i>Pseudognaphalium lutedalbum</i>		3	2	1	2	3	1
<i>Pulicaria undulate</i>		5	2	1	1	1	1
<i>Anthemis melampodina</i> subsp. <i>deserti</i>		3	2	1	3	2	3
<i>Senecio glaucus</i> sub-sp. <i>Coronopifolius</i>		8	4	1	1	1	3
<i>Senecio vulgaris</i>		8	4	1	1	1	3
<i>Calendula arvensis</i>		9	4	1	3	2	4
<i>Urospermum picroides</i>		3	2	1	3	2	3
<i>Launaea spinosa</i>		3	2	1	3	2	1
<i>Launaea nudicaulis</i>		4	3	2	2	3	3
<i>Launaea mucronata</i> sup-sp. <i>mucronata</i>		8	4	1	1	1	2 *
<i>Reichardia tingitana</i>		8	4	1	1	1	3
<i>Sonchus maritimus</i>		3	4	1	3	2	1
<i>Sonchus oleraceus</i>		3	4	1	3	2	1

Achene coat pattern sculpture: 1= Puncticulate; 2= Colliculate; 3= Reticulate - rugose; 4= Sulcate; 5= Aculeate; 6= Lineate; 7= Striate; 8= Tuberculate; 9= Reticulate.

Anticinal wall shape: 1= Round; 2= Undulate; 3= Line; 4= Wavy.

Anticinal wall thicknes: 1= Thin; 2= Thick.

Anticinal wall level: 1= Grooved; 2= Convex; 3= Raised.

Periclinical wall level: 1= Convex; 2= Concave; 3= Grooved.

Periclinical wall texture: 1= Smooth; 2= Striated; 3= Warty; 4= Papillate.

*= Secondary roseate structure

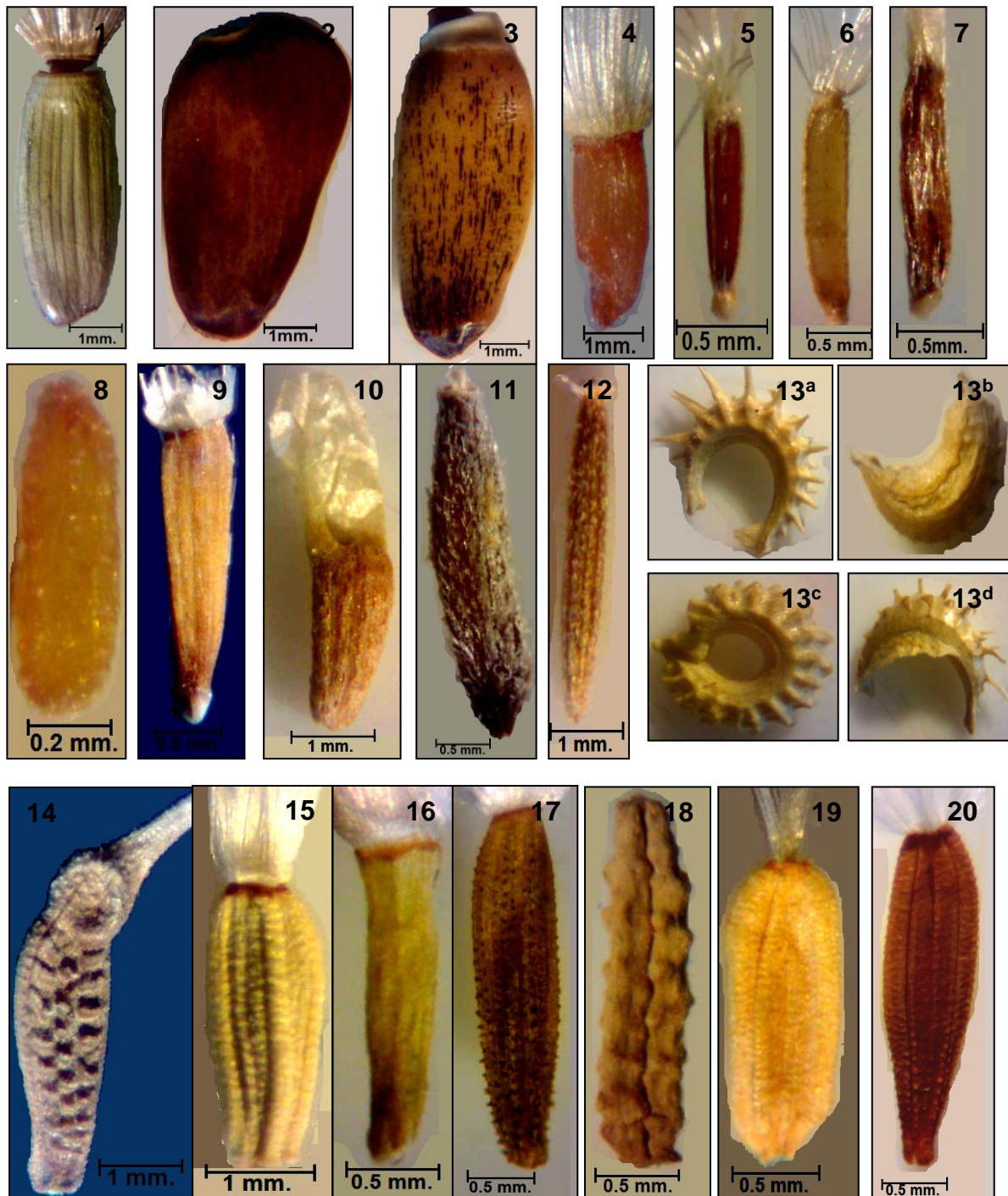


Plate 1. Achene morphology of 20 taxa of Asteraceae as revealed by light microscopy: 1. *Carduus pycnocephalus*; 2. *Notobasis syriaca*; 3. *Silybum marianum* var. *albiflorum*; 4. *Centaurea aegyptiaca*; 5. *Pluchea dioscoridis*; 6. *Conyza bonariensis*; 7. *Phagnalon rupestre*; 8. *Pseudognaphalium lutedalbus*; 9. *Pulicaria undulate*; 10. *Anthemis melampodina* subsp. *deserti*; 11. *Senecio glaucus* sub-sp. *Coronopifolius*; 12. *Senecio vulgaris*; 13. *Calendula arvensis*; 14. *Urospermum picroides*; 15. *Launaea spinosa*; 16. *Launaea nudicaulis*; 17. *Launaea mucronata* sub-sp. *mucronata*; 18. *Reichardia tingitana*; 19. *Sonchus maritimus*; 20. *Sonchus oleraceus*.

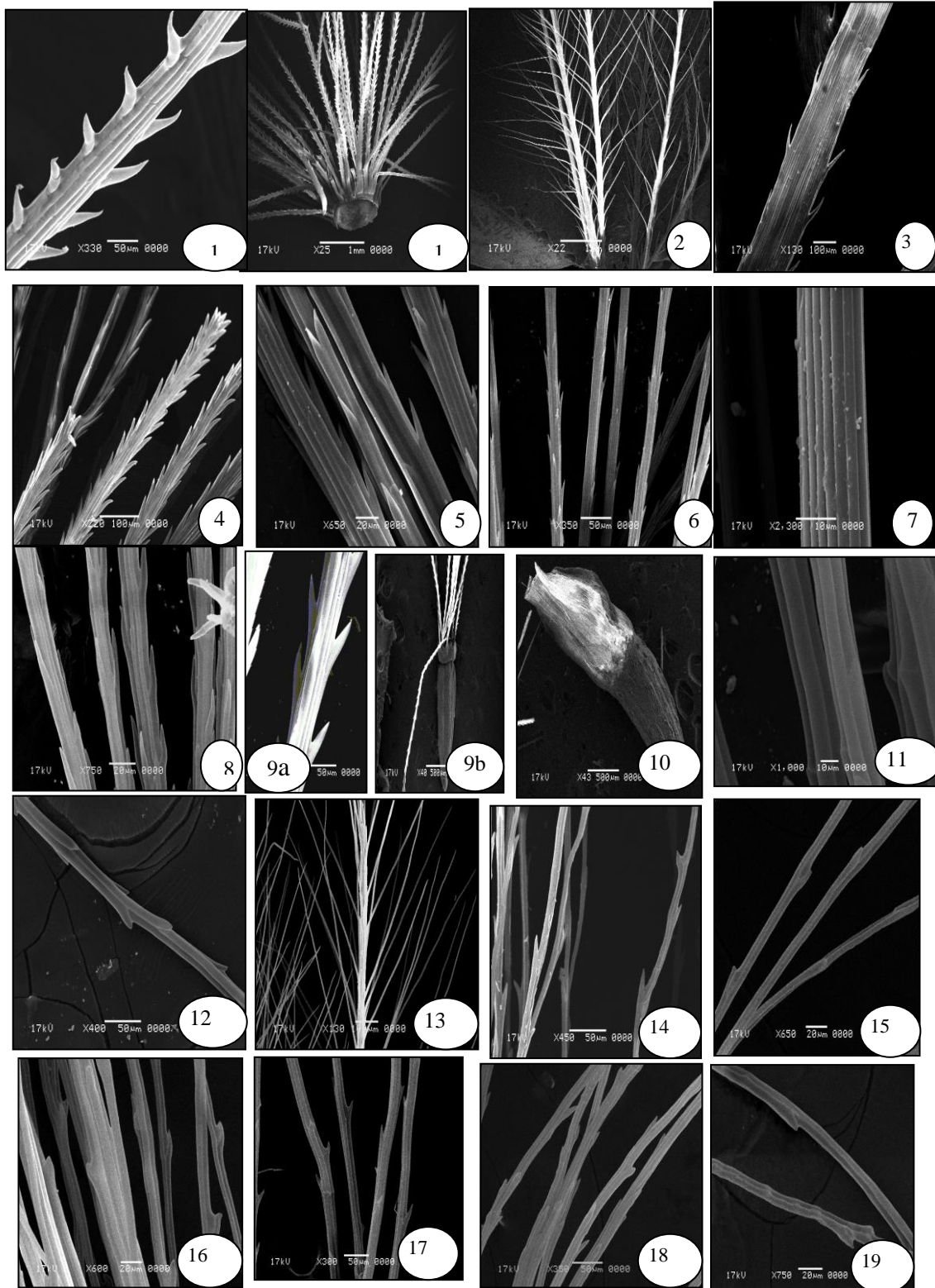


Plate 2. Pappus morphological types of 19 taxa of Asteraceae as revealed by SEM : 1. *Carduus pycnocephalus*; 2. *Notobasis syriaca*; 3. *Silybum marianum* var. *albiflorum*; 4. *Centaurea aegyptiaca*; 5. *Pluchea dioscoridis*; 6. *Coryza bonariensis*; 7. *Phagnalon rupestre*; 8. *Pseudognaphalium lutedalium*; 9. *Pulicaria undulate*; 10. *Anthemis melampodina* subsp. *deserti*; 11. *Senecio glaucus* sub-sp. *Coronopifolius*; 12. *Senecio vulgaris*; 13. *Urospermum picroides*; 14. *Launaea spinosa*; 15. *Launaea nudicaulis*; 16. *Launaea mucronata* sub-sp. *mucronata*; 17. *Reichardtitingitana*; 18. *Sonchus maritimus*; 19. *Sonchus oleraceus*

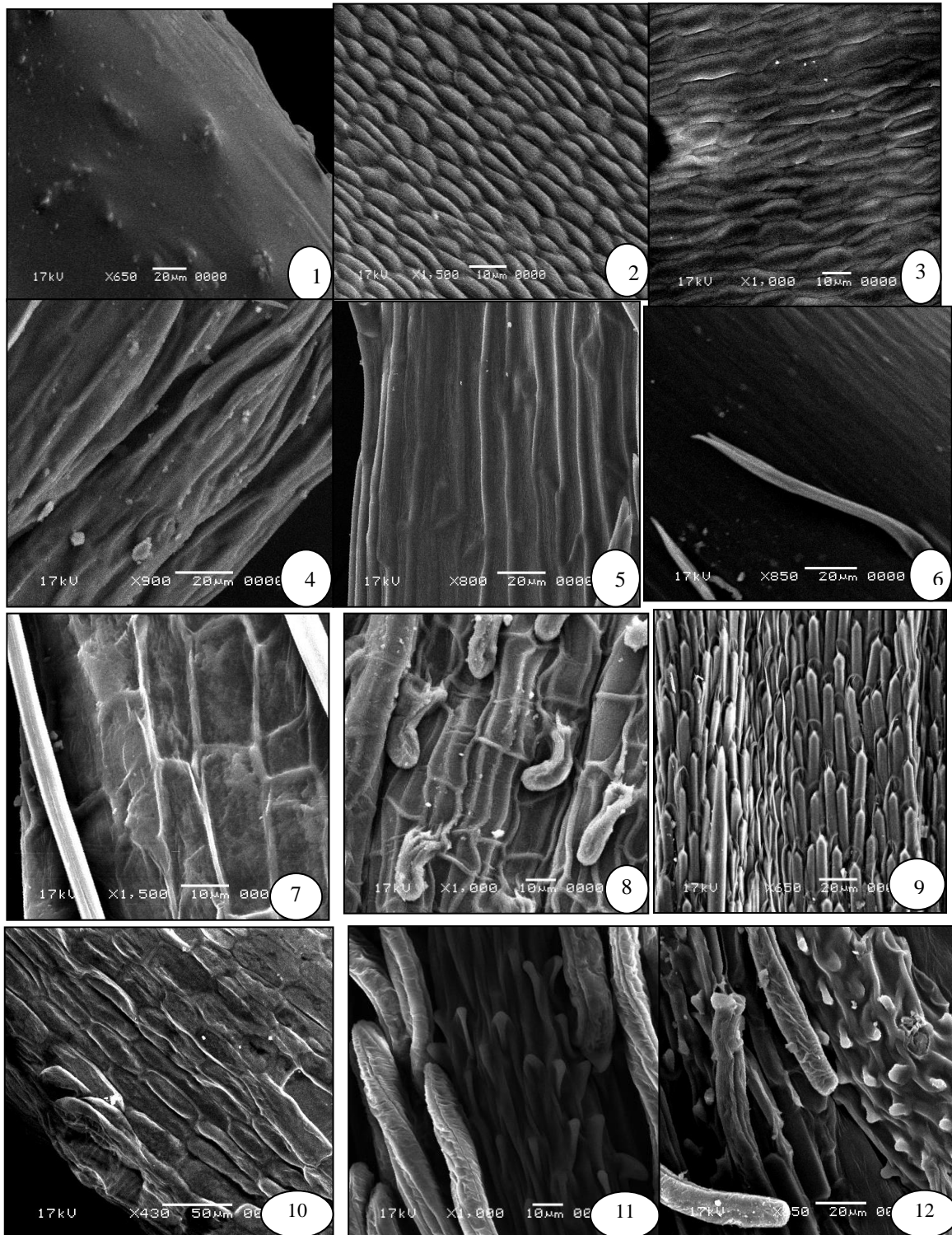


Plate 3. Achene surface sculpture for 20 taxa of Asteraceae as revealed by SEM: 1. *Carduus pycnocephalus*; 2. *Notobasis syriaca*; 3. *Silybum marianum* var. *albiflorum*; 4. *Centaurea aegyptiaca*; 5. *Pluchea dioscoridis*; 6. *Conyza bonariensis*; 7. *Phagnalon rupestre*; 8. *Pseudognaphalium lutedalbum*; 9. *Pulicaria undulate*; 10. *Anthemis melampodina* subsp. *deserti*; 11. *Senecio glaucus* sub-sp. *Coronopifolius*; 12. *Senecio vulgaris*

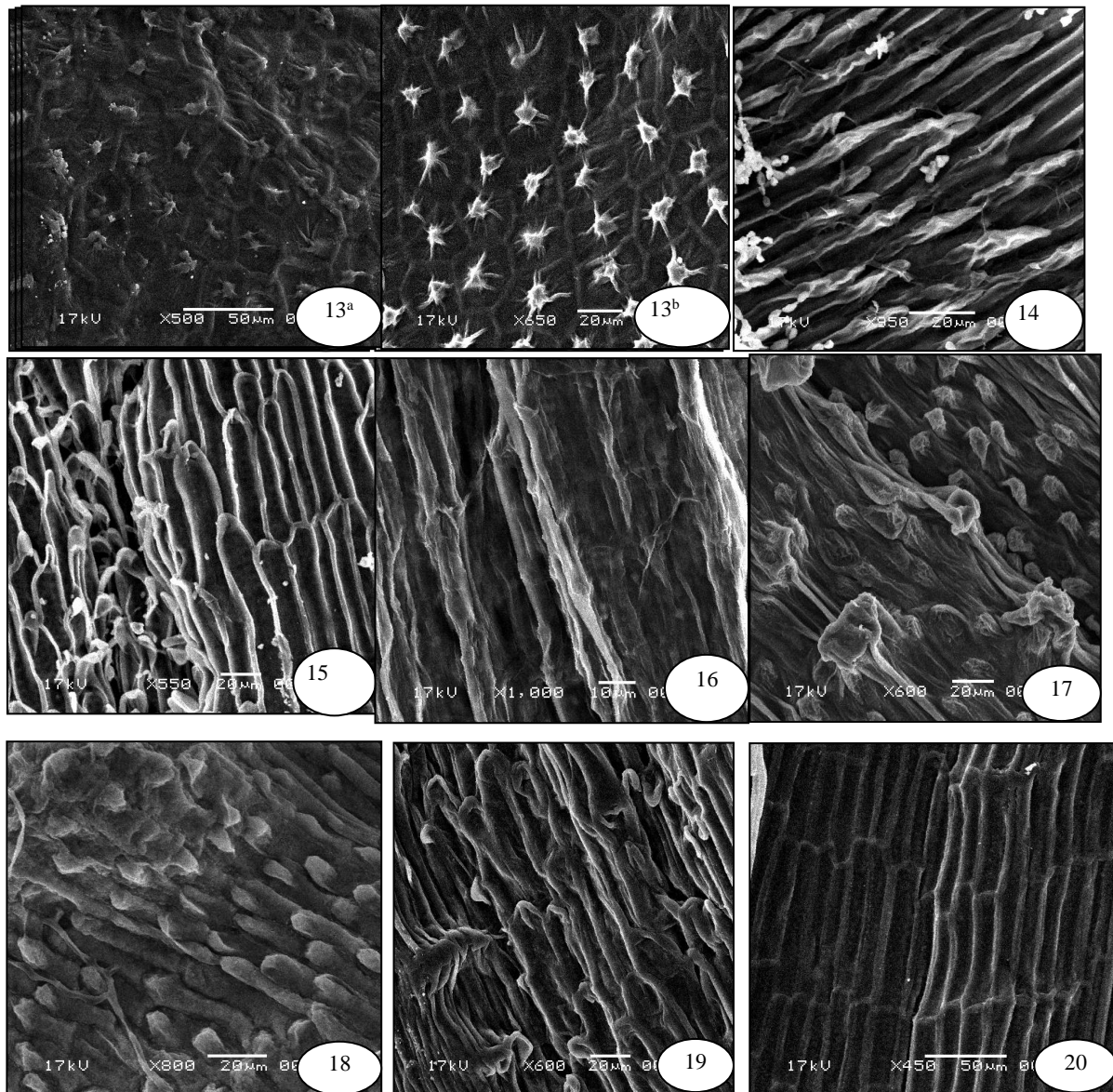


Plate 3con.. Achene surface sculpture for 20 taxa of Asteraceae as revealed by SEM: 13. *Callendula arvensis*; 14. *Urospermum picroides*; 15. *Launaea spinosa*; 16. *Launaea nudicaulis*; 17. *Launaea mucronata* sub-sp. *mucronata*; 18. *Reichardia tingitana*; 19. *Sonchus maritimus*; 20. *Sonchus oleraceus*.

Seed coat sculpture

The examination by scanning electron microscope on 20 taxa show differences in achene coat pattern which suggest its grouping into eight groups; the reticulate is the main types in which eight taxa belong to it:

The different types of achene coat pattern are summarized in **Table 3 & plate 3**.

- 1- Reticulate, with two subtypes
 - a- Regular reticulate; eg. *Calendula arvensis* (**Plate 3, Fig. 13**)
 - b- Reticulate-rugose; eg. *Sonchus oleraceus* (**Plate 3 and Fig. 20**)
- 2- Tuberculate achene coat recorded in four taxa; eg. *Senecio vulgaris* (Plate 3, Fig. 12)
- 3- Sulcate achene coat found in two taxa; eg. *Centaurea aegyptiaca* (Plate 3, Fig.4)
- 4- Punctulate achene coat for *Carduus pycnocephalus* (Plate 3 Fig.1)
- 5- Colliculate achene coat for *Notobasis syriaca* (Plate 3, Fig. 2)
- 6- Aculeate achene coat for *Pulicaria undulate* (Plate 3, Fig. 9)
- 7- Lineate achene coat for *Conyza bonariensis* (Plate 3, Fig. 6)
- 8- Striate achene coat for *Pluchea dioscoridis* (Plate 3, Fig. 5)

The key (1): The recorded data table 2&3 were used to construct the following indented key to the 20 taxa of Asteraceae that it might help in the confirmation of their identification.

- A- Achene polymorphic, spiny, curved, pappus absent and periclinical wall texture papillate ***Calendula arvensis***
 AA- Achene homomorphic, not spiny, pappus present and periclinical wall texture not papillate.
 B- Achene shape oblong or oblong obovate
 C- Achene shape oblong
 D- Achene colour brown
 E- Achene size 0.5 mm. with granulates texture.....***Pseudognaphalium lutedalbum***
 EE- Achene size more than 0.5 mm. and texture not granulate
 F- Achene texture smooth
 G- Ridges absent, pappus type scabrous subulate scales free and achene coat pattern reticulate-rugose
Silybum marianum var. albiflorum

GG- Ridges present, pappus type scabrous barbellate bristles and achene coat pattern striate..... ***Pluchea dioscoridis***

FF- Achene texture sparsely hairy

H- Pappus capillary barbellate with limited number & connate at the base and achene coat pattern reticulate-rugose

.....***Phagnalon rupestre***

HH- Pappus scabrous subulate scales free with unlimited number & not connate at the base and achene coat pattern sulcate

.....***Centaurea aegyptiaca***

DD- Achene colour not brown

I- Ridges present, stylopodium conspicuous, pappus deciduous with unlimited number and achene coat pattern punctulate or reticulate

J- Pappus type scabrous subulate scales free with yellowish brown colour and achene coat pattern punctulate.....

Carduus pycnocephalus

JJ-Pappus type scabrous barbellate bristles with white colour and achene coat pattern reticulate

Sonchus maritimus

II- Ridges absent, stylopodium inconspicuous, pappus persistent with limited number and achene coat pattern lineate.....

Conyza bonariensis

CC- Achene shape oblong obovate

K- Beak and ridges present with tuberculate texture, pappus homogenous and achene coat pattern reticulate

Urospermum picroides

KK- Beak and ridges absent with sparsely hairy texture, pappus heterogenous and achene coat pattern aculeate

.....***Pulicaria undulate***

BB- Achene shape obovate, fusiform or trigonal

L- Achene shape obovate

M- Achene texture smooth

N- Ridges absent, pappus sub-terminal, deciduous with plumose bristles type and achene coat pattern colliculate ***Notobasis syriaca***

NN- Ridges present, pappus terminal, persistent with scabrous barbellate fine bristles type achene coat pattern sulcate.....

Launaea nudicaulis

MM- Achene texture tuberculate

O- Pappus yellow, limited with paleaceous scales corona type

...***Anthemis melampodina subsp. Deserti***

OO- Pappus white, unlimited with scabrous barbellate fine bristles type.....

Launaea spinosa

LL- Achene shape fusiform or tetragonal

P- Achene shape fusiform and pappus type scabrous barbellate fine bristles

Q- Achene colour brown with tuberculate texture and ridges present

R- Pappus persistent and achene coat pattern tuberculate

.....***Launaea mucronata sub-sp. mucronata***

RR- Pappus deciduous and achene coat pattern reticulate-rugose...***Sonchus oleraceus***

QQ- Achene colour green or brownish green with hairy texture and ridges absent

S- Achene colour green.... ***Senecio vulgaris***

SS- Achene colour brownish green.....

Senecio glaucus sub-sp. coronopifolius

PP- Achene shape tetragonal and pappus type scabrous barbellate bristles.....

Reichardia tingitana

The key (2):

Characters: 22 indata, 22 included, 7 in key.

Items: 20 indata, 20 included, 20 in key.

Parameters: Rbase =1.40 Abase = 2.00 Reuse = 1.01 Varywt = 0.80

Charactersincluded: 1–22

Character reliabilities: 1–22,5

1. Coat pattern sculpture punctulate.....

Carduus pycnocephalus

Coat pattern sculpture colliculate.....

Notobasis syriaca

Coat pattern sculpture reticulate- rugose.....2

Coat pattern sculpture sulcate..... 4

Coat pattern sculpture aculeate.....

Pulicaria undulate

Coat pattern sculpture lineate.....

Conyza bonariensis

Coat pattern sculpture striate.....

Pluchea dioscoridis

Coat pattern sculpture tuberculate..... 5

Coat pattern sculpture reticulate.....

Caendula arvensis

2(1). Pappus type scarbous barbellatefine bristles..... 3

Pappus type scarbous barbellate bristles

Pseudognaphalium lutedalbum

Pappus type scabrous subulate scales free

.....***Silybum marianum***

Pappus type Paleaceous scales to form corona.. ***Anthemis melampodina subsp. deserti***

Pappus type Plumose bristles.....

Urospermum picroides

Pappus type Caillary barbellate.....

Phagnalonrupestre

3 (2). Seed shape oblong.....

Sonchus maritimus

Seed shape obovate.....

Launaea spinosa

Seed shape fusiform

4(1). Seed shape oblong; Pappus type scabrous subulate scales free; Seed color brown; Seed texture sparsely hairy

.....***Centaurea aegyptiaca***

Seed shape obovate; Pappus type scarbous barbellatefine bristles; Seed color green;

Seed texture smooth....***Launaea nudicaulis***

5(1). Seed color brown..... 6

Seed color green.....***Senecio vulgaris***

Seed color brownish green.....

Senecio glaucus sub-sp. coronopifolius

6(5). Seed shape fusiform; Pappus type scarbous barbellatefine bristles; Seed ridges present; Seed stylopodium conspicuous

.....***Launaea mucronata sub-sp. mucronata***

Seed shape tetragonal; Pappus type scarbous barbellate bristles; Seed ridges absent;

Seed stylopodium inconspicuous.....

Reichardia tingitana

To conclude, achene micro-morphological characters are important and could be helpful in the identification species and genera. Studies on the other taxa of this tribe may further invoke that micro-morphological characters of achene are truly valuable characters to classify the species.

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