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RECEPTACLE MICRO-CHARACTERS AND THEIR TAXONOMIC SIGNIFICANCE FOR THE TRIBE GNAPHALIEAE (ASTERACEAE) FROM PAKISTAN AND KASHMIR

Rubina Abid and Afsheen Ather

Department of Botany, University of Karachi, Karachi-75270, Pakistan.
Corresponding author's e-mail: rubinaku@yahoo.com

ABSTRACT

Micro-characters of receptacle were studied for 42 taxa distributed in 11 genera viz., *Anaphalis* DC., *Cymbolaena* Smoljan, *Filago* L., *Gamochaeta* Wedd., *Gnaphalium* L., *Homognaphalium* Kirp., *Ifloga* Cass., *Lasiopogon* Cass., *Leontopodium* R.Br.ex Cass., *Phagnalon* Cass. and *Pseudognaphalium* Kirp. of the tribe Gnaphalieae (Asteraceae) by using light (LM) and scanning electron microscopy (SEM). A variety of receptacular surfaces viz., alveolate, areolate, fimbrillate, foveolate and scorbiculate are found which could be significantly used as an additional tool for the generic and specific delimitation within the tribe Gnaphalieae.

Key-words: Receptacle, Gnaphalieae, Asteraceae, Kashmir, Pakistan.

INTRODUCTION

Gnaphalieae is a tribe of the family Asteraceae. In Pakistan it is represented by 42 taxa distributed in 11 genera viz., *Anaphalis* DC., *Cymbolaena* Smoljan, *Filago* L., *Gamochaeta* Wedd., *Gnaphalium* L., *Homognaphalium* Kirp., *Ifloga* Cass., *Lasiopogon* Cass., *Leontopodium* R.Br.ex Cass. *Phagnalon* Cass. and *Pseudognaphalium* Kirp. The introduction of various micro-morphological characters has made positive impact for the identification and classification of various taxa of the family Asteraceae, such as the use of ligule micro-characters (Baagoe, 1978), palynology (Erdtman, 1952; Vincent and Norris,1989; Abid and Qaiser, 2002; Liu *et al.*,2002) and cypsela morphology (Haq and Godward, 1984; Abid and Ali, 2010). However, the receptacular characters did not receive due attention in spite of stability as important character, except some of the studies of Small (1919), Anderberg (1991), Bremer (1994) and Abid *et al.* (2014). The purpose of the present report is bifold firstly, there are no detailed information on receptacle features from the area under consideration. Secondly, to use these information as an additional tool for the recognition of various taxa belonging to the tribe Gnaphalieae from Pakistan and Kashmir.

MATERIALS AND METHODS

Capitula were collected from herbarium or fresh material (Appendix-I). After removing the florets empty capitula were boiled in aqueous NaOH for softening then fixed in Carnoy's solution (Glacial Acetic Acid: Distilled water=3:1). Receptacle were studied under stereo-microscope. For scanning electron microscopy receptacles were mounted on metallic stubs using double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber then observed under scanning electron microscope (JSM-6380A).

RESULT AND DISCUSSION

Receptacular studies have played an important role in the modern systematic tecqniques for the family Asteraceae (Small, 1919; Anderberg, 1991; Bremer, 1994). Receptacles of the tribe Gnaphalieae are flat or convex and generally epaleate or rarely paleate (Qaiser and Abid, 2003). The micro-characters of receptacles are variable like the tribe Senecioneae (Abid *et al.* 2014), such as a variety of receptacle surfaces viz., areolate, fimbrillate, foveolate and scorbiculate patterns are observed (Table 1; Figs. 1-5). To some extent these characters are found rewarding as an additional tool for the generic and specific delimitation within the tribe Gnaphalieae. Sometimes, this data could also be correlated to the cypsela morphological characters to provide a considerable strength, such as, the genus *Anaphalis* having papillose cypsela with ciliated barbellate bristles (Abid and Qaiser, 2007) also characterized by scorbiculate and fimbrillate receptacular surfaces. While, the genus *Gnaphalium* and its allied genera viz., *Gamochaeta* and *Homognaphalium* having exclusive cypsela characters(Abid and Qaiser, 2008a) but due to the presence of sharing receptacular surface pattern i.e., areolate receptacle they could not be separated.

Similarly, the genus *Pseudognaphalium* which could not be distinguished from *Gnaphalium* due to common cypsela features having fimbrillate receptacular surface pattern not found in *Gnaphalium* or either its allied genera. Moreover, amongst the remaining genera of this tribe viz., *Cymbolaena*, *Filago*, *Ifloga*, *Lasiopogon*, *Leontopodium* and *Phagnalon* with exclusive cypsela (Abid and Qaiser, 2008b), *Ifloga* is the only genus with foveolate receptacle surface.While rest of the genera shared a common receptacular surface pattern.

Table 1. Receptacle micro-characters for the taxa belonging to the tribe Gnaphalieae.

Taxa	**Receptacle**
Anaphalis adnata	Scorbiculate
A. boissieri	Scorbiculate
A. busua	Fimbrillate
A. contorta	Sparsely ruminately fimbrillate
A. chitralensis	Scorbiculate
A. kashmiriana	Scorbiculate
A. margaritacea	Scorbiculate
A. nepalensis var. *monocephala*	Scorbiculate
A. nepalensis var. *nepalensis*	Scorbiculate
A. royleana var. *cana*	Scorbiculate
A. royleana var. *concolor*	Scorbiculate
A. royleana var. *royleana*	Fimbrillate
A. staintonii	Fimbrillate
A. triplinervis	Fimbrillate
A. virgata	Scorbiculate
Cymbolaena griffithii	Scorbiculate
Filago arvensis	Fimbrillate
F. hurdwarica	Fimbrillate
F. paradoxa	Fimbrillate
Gammochaeta pensylvenica	Areolate
Gnaphalium polycaulon	Areolate
G. stewartii	Areolate
G. thomsonii	Areolate
Homognaphalium pulvinatum	Areolate
Iflago spicata	Foveolate
Lasiopogon muscoides	Areolate
Leontopodium brachyactis	Areolate
L. himalyanum	Areolate
L. jacotianum	Areolate
L. leontopodinum	Areolate
L. nanum	Fimbrillate
L. monocephalum	Areolate
L. pusillum	Areolate
Phagnalon acuminatum	Areolate
P. daravazicum	Fimbrillate
P. niveum	Areolate
P. pycnophyllon	Areolate
P. schweinfurthii var. *androssowii*	Areolate
P. schweinfurthii var. *lamondae*	Areolate
Pseudognaphalium affine	Fimbrillate
P. hypoleucum	Fimbrillate
P. luteo-album	Fimbrillate

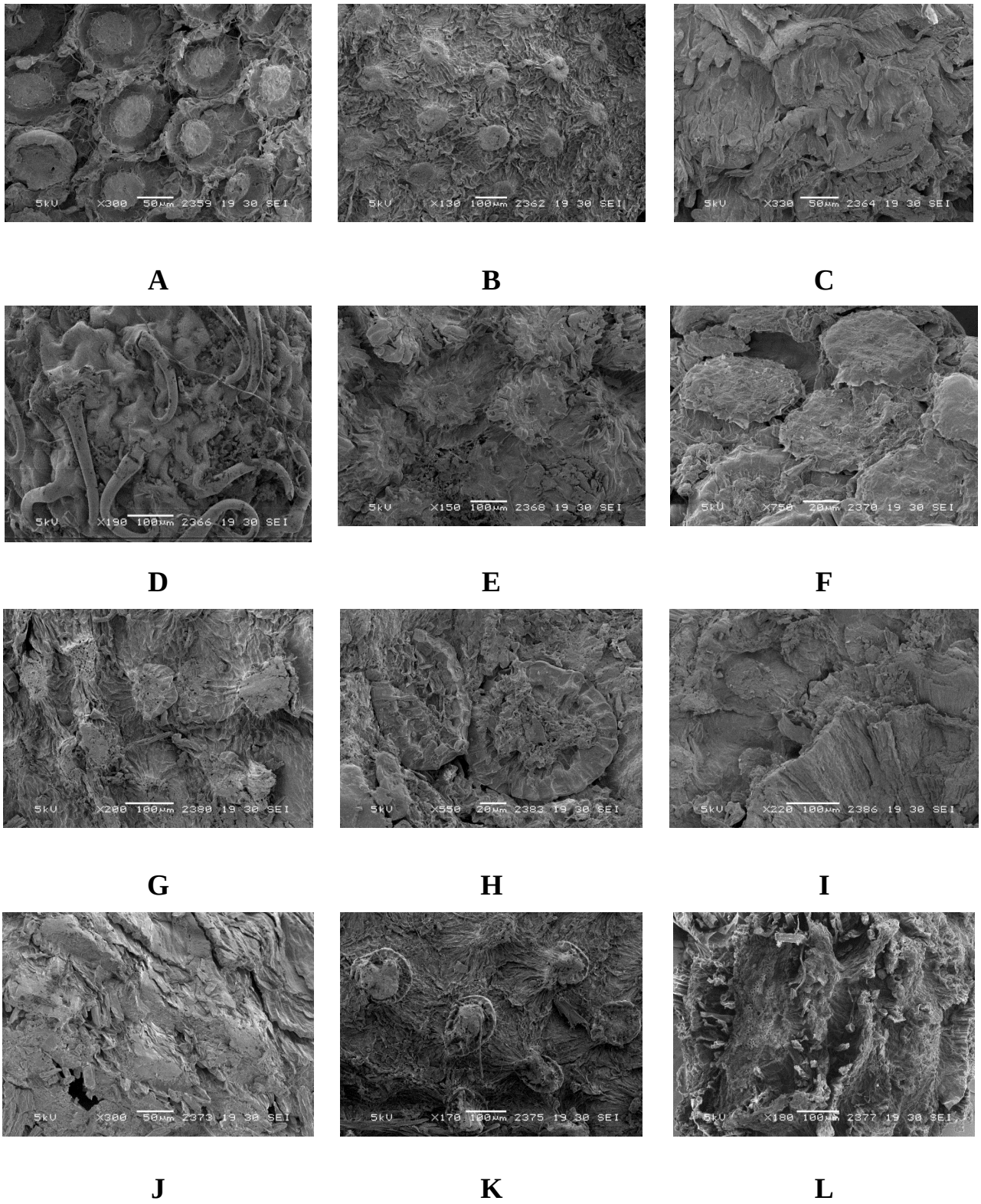

Fig. 1. Scanning electron micrographs (SEM) showing receptacle surface: A, *Anaphalis adnata*; B, *A. boissieri*; C, *A. busua*; D, *A. contorta*; E, *A. chitralensis*; F, *A.kashmiriana*; G, *A. margaritacea*; H, *A. nepalensis* var.*monocephala*; I, *A. nepalensis* var. *nepalensis*; J, *A. royleana* var.*cana*; K, *A. royleana* var. *concolor*; L, *A royleana* var.*royleana* (Scale bar: A,C,J=50µm; B,D,E,G,I,K,L= 100µm; F,H=20µm).

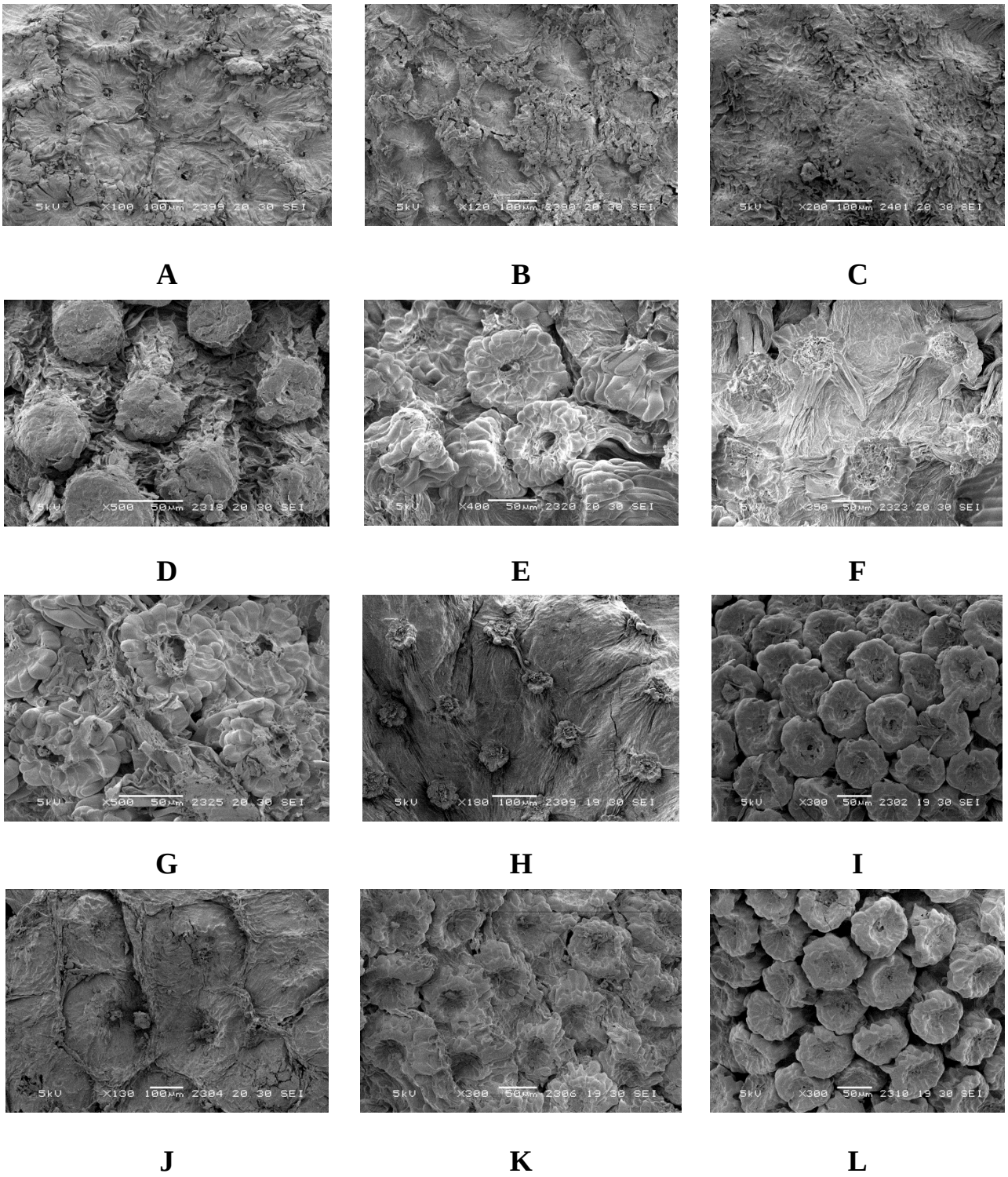

Fig. 2. Scanning electron micrographs (SEM) showing receptacle surface: A, *A. staintonii*; B, *A. triplinervis*; C, *A. virgata*; D, *Cymbolaena griffithii*; E, *Filago arvensis*; F, *F. hurdwarica*; G, *Filago paradoxa*; H, *Gammochaeta pensylvanica*; I, *Gnaphalium polycaulon*; J, *G. stewartii*; K, *G. thomsonii*; L, *Homognaphalium pulvinatum* (Scale bar: A,B,C,H,J= 100µm; D,E,F,G,I,K,L= 50µm).

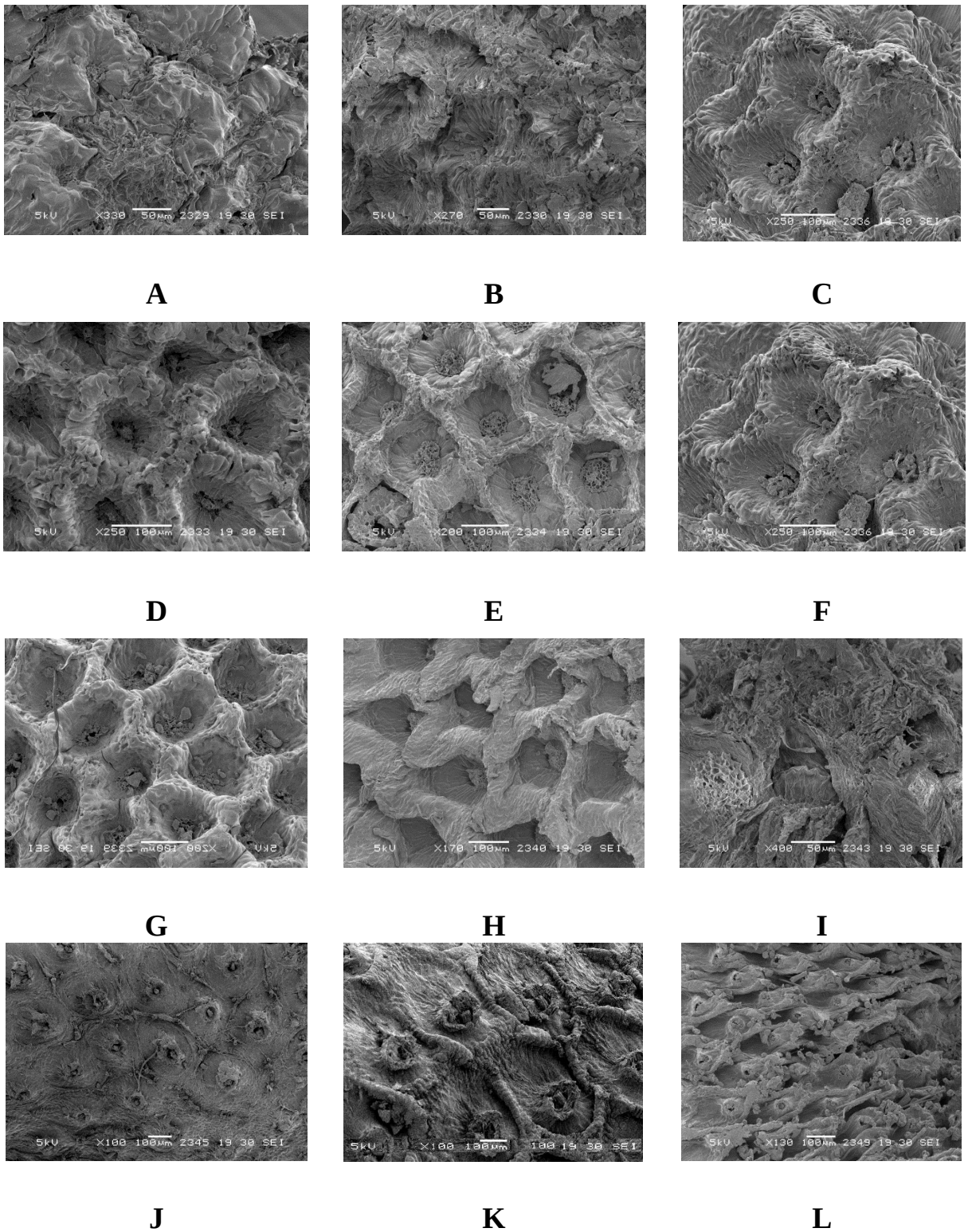

Fig. 3. Scanning electron micrographs (SEM) showing receptacle surface: A, B, *Iflago spicata*; C, *Lasiopogon muscoides*; D, *Leontopodium brachyactis*; E, *L. himalyanum*; F, *L. jacotianum*; G, *Leontopodium leontopodinum*; H, *L. nanum*; I, *L. pusillum*; J, *L. monocephalum*; K, *Phagnalon acuminatum*; L, *P. daravazicum* (Scale bar: A,B,I=50µm; C,D,E,F,G,H,J,K,L = 100µm).

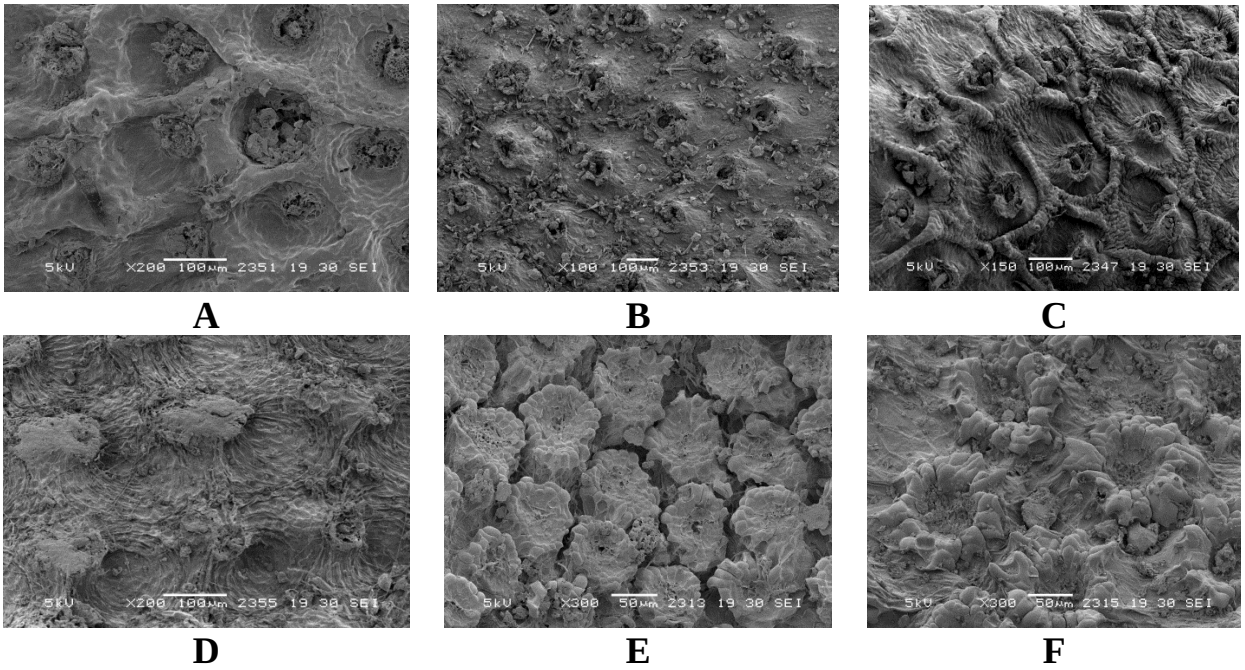

Fig. 4. Scanning electron micrographs (SEM) showing receptacle surface: A, *Phagnalon niveum*; B, *P. pycnophyllon;* C, *P. schweinfurthii* var.*androssowii*; D, *P. schweinfurthii* var. *lamondae*; E, *Pseudognaphalium affine*; F, *P. hypoleucum* (Scale bar: A,B,C,D=100µm; E,F=50µm).

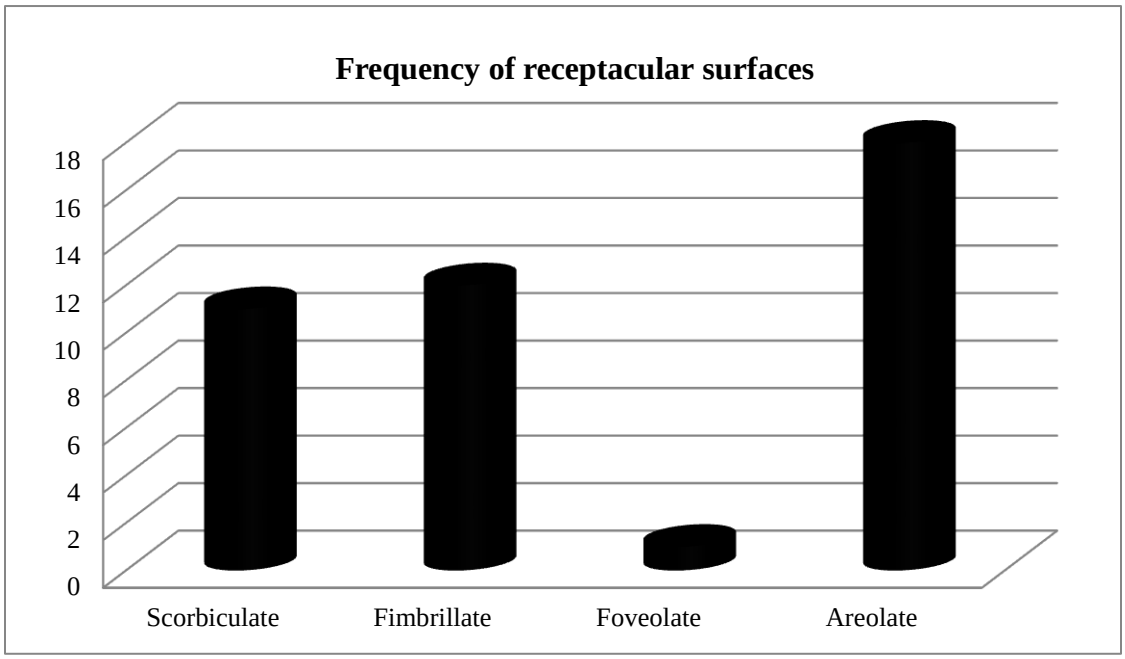

Fig. 5. Bar diagram showing the frequency in receptacular surface within the tribe Gnaphalieae (Asteraceae).

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Appendix I. List of voucher specimens.

Taxa	**Collector, Numbers, Herberium**
Anaphalis adnata	*Tahir Ali, M. Qaiser* and *M. Ajmal Khan* 284 (KUH); *S. M. A. Kazmi* 729 (KUH); *Y. Nasir and Zafar Ali* 7877 (RAW); *S. A. Farooqi and M. Qaiser* 3072 (KUH); *M. A. Siddiqui* 27684 (RAW); *R. R. Stewart* 15379 (RAW).
A. boissieri	*R. R. Stewart* 17902 (RAW); *Tahir Ali, M. Qaiser* and *M. Ajmal Khan* 545 (KUH); *Jan Alam* and *A. Aziz* 916 (KUH); *R. R. Stewart* 961 B (KUH); *Jan Alam Hunzai* 250 (KUH).
A. busua	*M. Qaiser* and *A. Ghafoor* 4803 (KUH); *S. Abedin* and *M. Qaiser* 9227 (KUH); *A. Ghafoor* and *students* 5386 (KUH); *R. R. Stewart* 21812 (RAW); *R. R. Stewart* 29137 (RAW).
A. contorta	*R. R. Stewart* 12617, 12619, 20986 (RAW); *M. Qaiser* and *Rizwan Yusuf* 7882 (KUH); *M. Qaiser* and *A. Ghafoor* 4810 (KUH); *J. Mohd.* s.n. (RAW).
A. chitralensis	*K. M. A. Malik, S. Nazimuddin* and *Gohar Khan* 1532 (KUH); *Hakim Khan* s.n. (RAW); *Fazal Karim* 2 (KUH).
A. kashmiriana	*R. R. Stewart* 10715 (K, RAW).
A. margaritacea	*M. Qaiser* and *Rizwan Yusuf* 7825, 7697 (KUH); *R. R. Stewart* 10526A, s.n. (KUH); *Tahir Ali, M. Ajmal Khan* and *M. Qaiser* 597, 608 (KUH).
A. nepalensis* var. *monocephala	*Raja Bashir* s.n. (RAW); *Kamal* and *M. Qaiser* 248 (KUH); *S. Abedin* and *M. Qaiser* 9022 (KUH); *Jan Alam* 179 (KUH); *Jan Alam* and *M. S. Islam* 343 (KUH); *R. R. Stewart* 29137 (RAW).
A. nepalensis* var. *nepalensis	*S. Abedin* and *M. Qaiser* 8987 (KUH); *Y. Nasir* 13338a (RAW); *Nasir* and *Siddiqui* 23313 (RAW); *M. A. Siddiqi* and *A. Rehman* 26807 (RAW).
A. royleana* var. *cana	*R.R. Stewart* 5852 (RAW); *R.*R. *Stewart* 8797 (RAW).
A. royleana* var. *concolor	*J.F.Duthie s.n.*(KUH); *R.R. Stewart* 713(RAW).
A. royleana* var. *royleana	*O. Polunin* 56/276 (BM); *Evershed* s.n. (BM); *O. Polunin* 56/742 (BM); *M. K. Timins* 175 (BM**).**
A. staintonii	*Tahir Ali, M. Qaiser* and M. *Ajmal Khan* 579 (KUH); *T. Ali* and *G. Ke* 3452(KUH); *A. Rashid* 1079 (KUH); *F. Schmid* 2188 (BM); *A. Ghafoor* and *S. Omer* 3221 (KUH).
A. triplinervis	*R. R. Stewart* 24330 (RAW).
A. virgata	*S, I. Ali et al* 3371 (KUH); *Jan Alam* 490 (KUH); *Niaz Mohammad* s.n. (KUH); *K. A. Malik* and *M. Qaiser* 565 (KUH); *Bowes Lyon* 1042 (KUH).
Cymbolaena griffithii	*S. Omer* 1192 (KUH); *S. Omer* 1265 (KUH); *S. M. H. Jafri* s.n. (KUH); *A. Ghafoor* and *Steve M. Goodman* 5063 (KUH); *M. Qaiser* and *S. Abedin* 5930 (KUH).
Filago arvensis	*A. Ghafoor* and *S. Omer* 3266 (KUH); *R. R. Stewart* and *A. Rahman* 25151 (RAW); *S. Omer* and *M. Qaiser* 2317 (KUH); *S. M. H. Jafri* and *Akbar* 2121 (KUH).
F. hurdwarica	*Y. Nasir* and *A. Siddiqui* 8241(RAW); *Omer* and *A. Wahid* 2314 (KUH).
F. paradoxa	*R. R. Stewart* 27293 (RAW); *S. Omer* and *M. Qaiser* 2703 (KUH); *A. Ghafoor* and *S. Omer* 3023 (KUH); *A. Ghafoor* and *Steve M. Goodman* 4587 (KUH).
Gammochaeta pensylvenica	*P. C. Joshi* 1 (RAW); *Surayya Khatoon* and *A. Ghafoor* 154 A (KUH); *Abrar Hussain* s.n. (KUH); *Surayya Khatoon* 324 (KUH); *Y. Nasir* s.n. (RAW), *R. R. Stewart* s.n. (RAW).
Gnaphalium polycaulon	*S. Abedin* and *Abrar Hussain* 9479 (KUH); *S. M. H. Jafri* 1571 (KUH); *S. I. Ali* 1636 (KUH); *S. I. Ali* s.n. (KUH); *A. Ghafoor* and *M. Qaiser* 463 (KUH).
G. stewartii	*Inayat* 19742 (RAW); *Mohindar Nath* 441 (KUH). *I. I. Choudhri* 40 (RAW); *Mohindar Nath* 442 (RAW).
G. thomsonii	*Tahir Ali, M. Qaiser* and *Ajmal Khan* 644 (KUH); *Walter Koelz* 1244 (RAW); *Jan Mohammad* s.n. (KUH).
Homognaphalium pulvinatum	*S. Abedin* and *Abrar Hussain* 9509 (KUH); *A. Ghafoor* and *M. Qaiser*190 (KUH); *E. Nasir* s.n. (RAW).

Iflago spicata	*M. Qaiser* and *A. Ghafoor* 7438 (KUH); *S. Abedin* and *Abrar Hussain* 7252 (KUH); *Malhotra* s.n. (RAW); *R. R. Stewart* 15311 (KUH); *A. Ghafoor* and *M. Qaiser* 62 (KUH); *A. Ghafoor* and *Steve M. Goodman* 4458 (KUH).
Lasiopogon muscoides	*A. Ghafoor* and *Steve M. Goodman* 5057 (KUH); *S. Omer, M. Qaiser and Y. Nasir* 2159 (KUH); *Kamal A. Malik et al*. 2380 (KUH).
Leontopodium brachyatis	*M. Qaiser* and *A. Ghafoor* 1833(KUH); *S. M. A. Kazmi* s.n. (KUH); *S. M. H. Jafri* and *Ali* 3173 (KUH); *S. Abedin* and *M. Qaiser* 9033 (KUH).
L. himalyanum	*R. R. Stewart* 6634 (RAW).
L. jacotianum	*S. Omer* and *M. Qaiser* 2640 (KUH); *R. R. Stewart* s.n. (KUH); *F. Schmid* 326 (RAW).
L. leontopodinum	*Jan Alam* and *Fazal Karim* 1303 (KUH); *Jan Alam* and *Aziz* 1068 (KUH); *R. R. Stewart* 12642 (RAW); *S. I. Ali, W. Sugong* and *Tahir Ali* 3389 (KUH).
L. nanum	*Jan Alam* and *A. Aziz* s.n. (KUH); *Walter Koelz*2179 (RAW).
L. monocephalum	Metz 171 (RAW).
L. pusillum	*Walter Koelz* 2689 (K).
Phagnalon acuminatum	*S. Omer* and *A. Ghafoor* 1824 (KUH); *Ulfat Hussain zargar* 495 (KUH); *Dick-Peddie* 26 (RAW); *M. A. Siddiqui* 27100 (RAW).
P. daravazicum	*S. Omer* and *A. Ghafoor* 1797 (KUH).
P. niveum	*M. Qaiser* and *S. Abedin* 5624 (KUH); *Ali* 1109 (KUH); *Sadruddin* s.n. (KUH); *A. Ghafoor* and *Tahir Ali* 3700 (KUH); *Tahir Ali* and *G. R. Sarwar* 2738 (KUH).
P. pycnophyllon	*S. M. A. Kazmi* 1698(RAW); *S. Nazimuddin* and *S. Abedin* 1071 (KUH); *R. R. Stewart* 570 (RAW); *S. Nazimuddin* and *S. Abedin*1071 (KUH).
P. schweinfurthii* var. *androssowii	*S. M. H. Jafri* and *Akbar* 2331B (KUH); *S. Omer* and *A. Ghafoor* 1381 (KUH); *S. M. H. Jafri* 2925 (KUH).
P. schweinfurthii* var. *lamondae	*S. M. A. Kazmi*1149 (RAW).
Pseudognaphalium affine	*M. Qaiser* and *A. Ghafoor* 7438 (KUH); *Y. Nasir* 6824 (KUH); *S. M. H. Jafri* 1637 (KUH); *M. A. Siddiqi* and *Y. J. Nasir* 7354 (RAW); *S. I. Ali* 1637 (KUH).
P. hypoleucum	*Gatarace* s.n. (RAW); *R. R. Stewart* s.n. (RAW).
P. luteo-album	*A. Ghafoor and S. Omer* 2503 (KUH); *R. R. Stewart* 9610 (KUH); *A. Ghafoor* and *S. Omer* 2487 (KUH); *Rasool Baksh* 96 (KUH); *S. Omer* 407 (KUH); *S. Abedin* and *Abrar Hussain* 9513 (KUH); *Tahir A*li and *G. R. Sarwar* 2746 (KUH).

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