

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

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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, fimbriate, 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 techniques 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, fimbriate, 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 fimbriate 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 fimbriate 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
<i>Anaphalis adnata</i>	Scorbiculate
<i>A. boissieri</i>	Scorbiculate
<i>A. busua</i>	Fimbriate
<i>A. contorta</i>	Sparsely ruminately fimbriate
<i>A. chitralensis</i>	Scorbiculate
<i>A. kashmiriana</i>	Scorbiculate
<i>A. margaritacea</i>	Scorbiculate
<i>A. nepalensis</i> var. <i>monocephala</i>	Scorbiculate
<i>A. nepalensis</i> var. <i>nepalensis</i>	Scorbiculate
<i>A. royleana</i> var. <i>cana</i>	Scorbiculate
<i>A. royleana</i> var. <i>concolor</i>	Scorbiculate
<i>A. royleana</i> var. <i>royleana</i>	Fimbriate
<i>A. staintonii</i>	Fimbriate
<i>A. triplinervis</i>	Fimbriate
<i>A. virgata</i>	Scorbiculate
<i>Cymbolaena griffithii</i>	Scorbiculate
<i>Filago arvensis</i>	Fimbriate
<i>F. hurdwarica</i>	Fimbriate
<i>F. paradoxa</i>	Fimbriate
<i>Gammochaeta pensylvanica</i>	Areolate
<i>Gnaphalium polycaulon</i>	Areolate
<i>G. stewartii</i>	Areolate
<i>G. thomsonii</i>	Areolate
<i>Homognaphalium pulvinatum</i>	Areolate
<i>Ifloga spicata</i>	Foveolate
<i>Lasiopogon muscoides</i>	Areolate
<i>Leontopodium brachyactis</i>	Areolate
<i>L. himalyanum</i>	Areolate
<i>L. jacotianum</i>	Areolate
<i>L. leontopodium</i>	Areolate
<i>L. nanum</i>	Fimbriate
<i>L. monocephalum</i>	Areolate
<i>L. pusillum</i>	Areolate
<i>Phagnalon acuminatum</i>	Areolate
<i>P. daravazicum</i>	Fimbriate
<i>P. niveum</i>	Areolate
<i>P. pycnophyllum</i>	Areolate
<i>P. schweinfurthii</i> var. <i>androssowii</i>	Areolate
<i>P. schweinfurthii</i> var. <i>lamondae</i>	Areolate
<i>Pseudognaphalium affine</i>	Fimbriate
<i>P. hypoleucum</i>	Fimbriate
<i>P. luteo-album</i>	Fimbriate

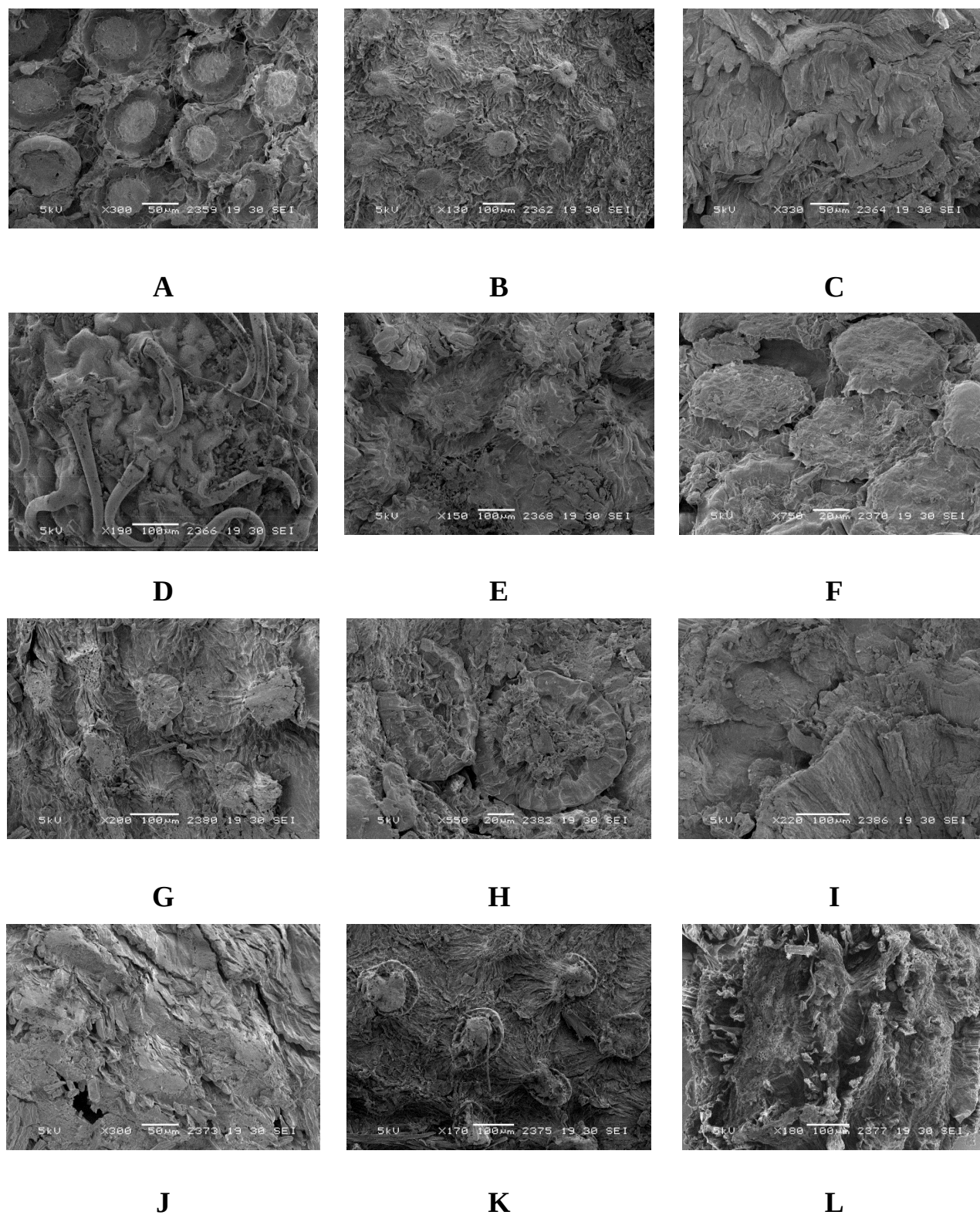


Fig. 1. Scanning electron micrographs (SEM) showing receptacle surface: A, *Anaphalis adnata*; B, *A. boissieri*; C, *A. busua*; D, *A. contorta*; E, *A. chitralensis*; F, *A. kashmiriana*; G, *A. margaritacea*; H, *A. nepalensis* var. *monocephala*; I, *A. nepalensis* var. *nepalensis*; J, *A. royleana* 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).

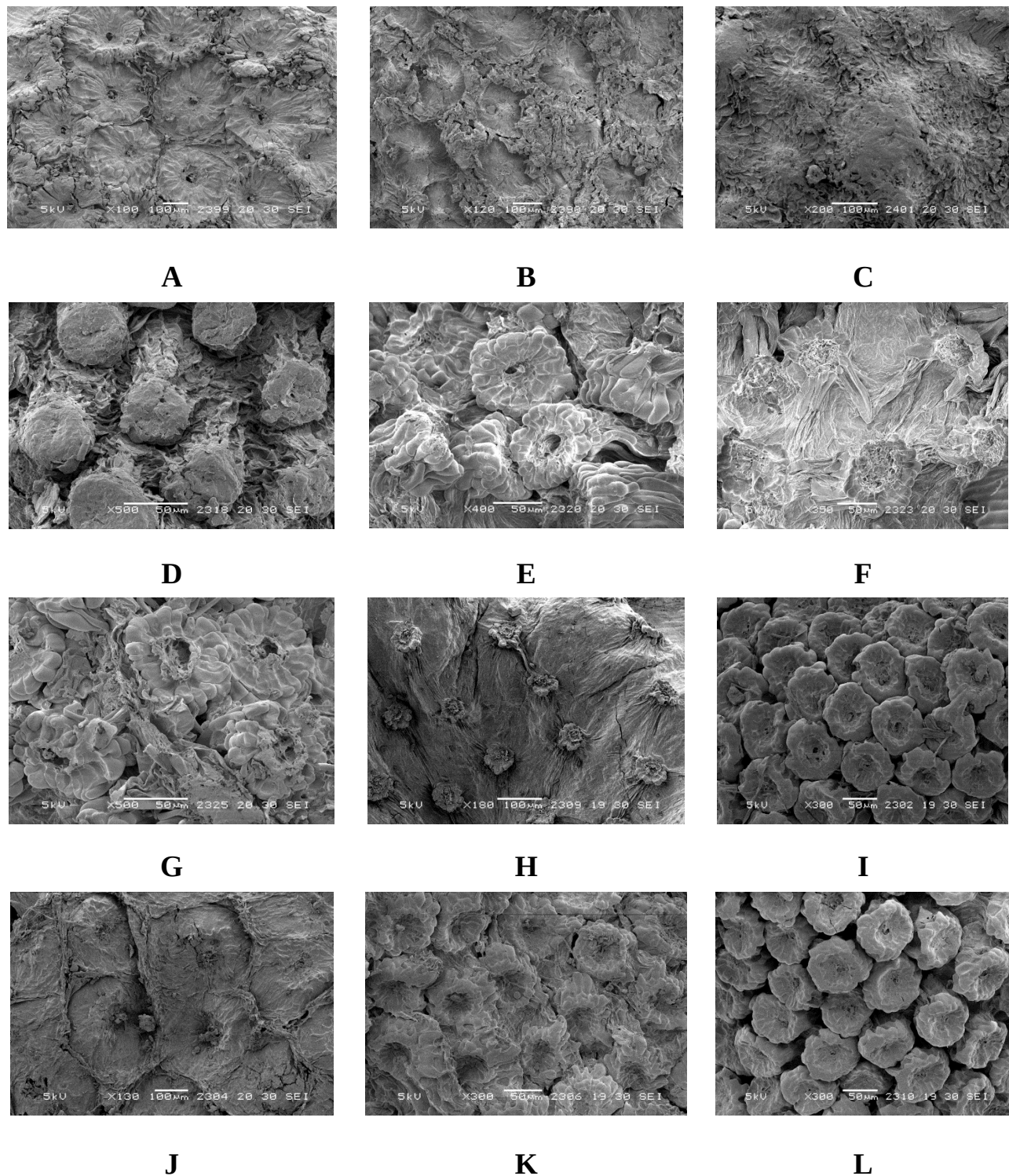


Fig. 2. Scanning electron micrographs (SEM) showing receptacle surface: A, *A. staintonii*; B, *A. triplinervis*; C, *A. virgata*; D, *Cymbolaena griffithii*; E, *Filago arvensis*; F, *F. hurdwara*; G, *Filago paradoxa*; H, *Gammochaeta pensylvanica*; I, *Gnaphalium polycaulon*; J, *G. stewartii*; K,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

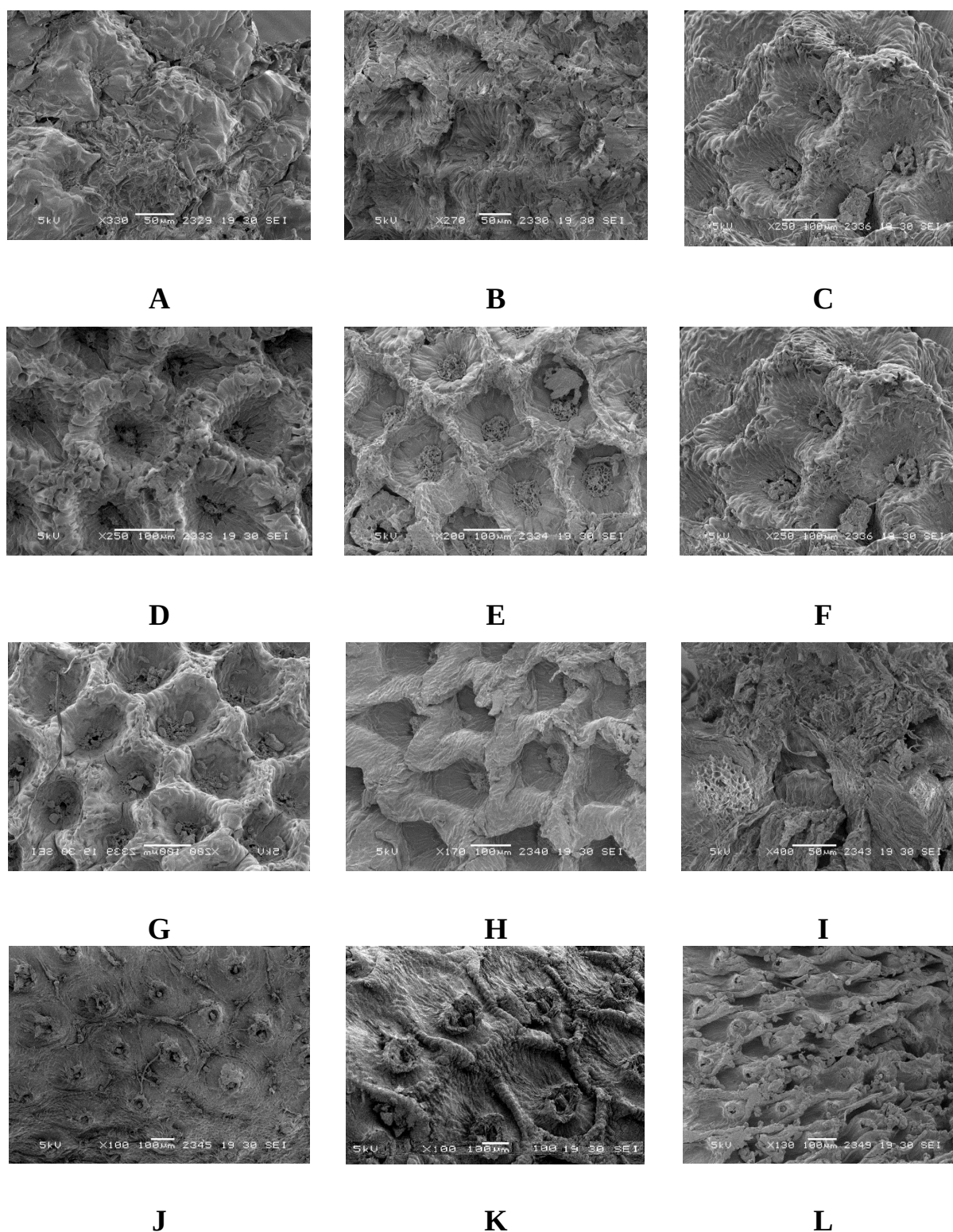


Fig. 3. Scanning electron micrographs (SEM) showing receptacle surface: A, B, *Iflago spicata*; C, *Lasiopogon muscoides*; D, *Leontopodium brachyactis*; E, *L. himalyanum*; F, *L. jacotianum*; G, *Leontopodium leontopodium*; H, *L. nanum*; I, *L. pusillum*; J, *L. monocephalum*; K, *Phagnalon acuminatum*;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

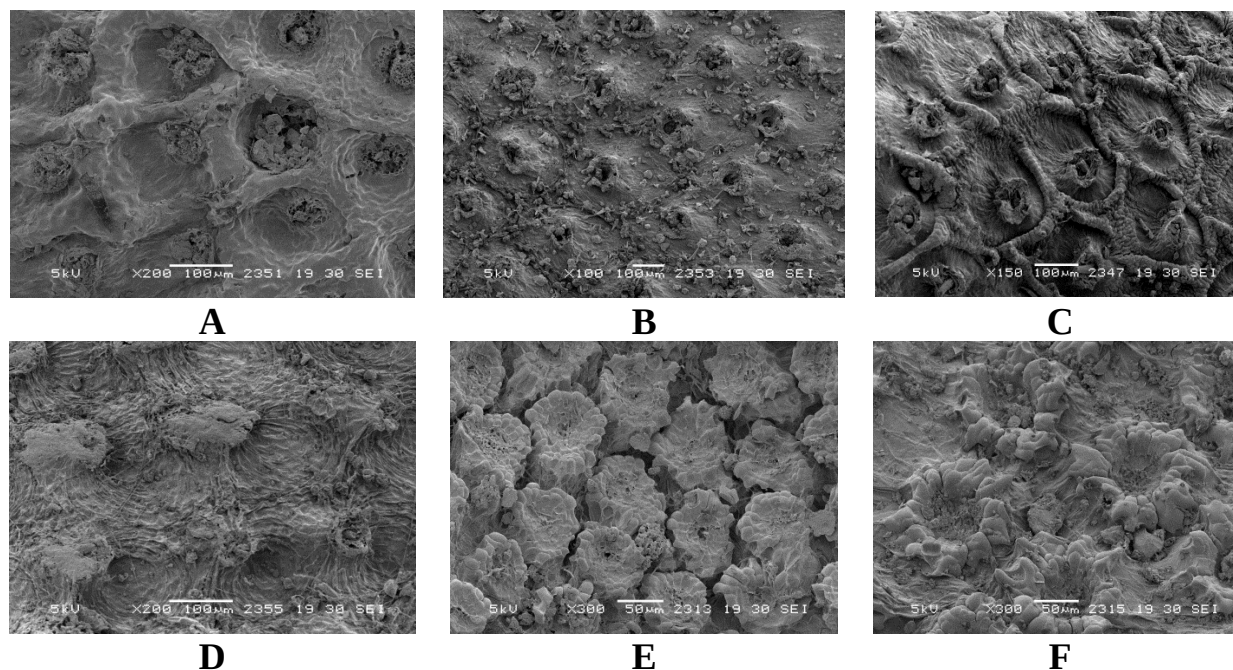


Fig. 4. Scanning electron micrographs (SEM) showing receptacle surface: A, *Phagnalon niveum*; B, *P. pycnophyllum*; C, *P. schweinfurthii* var. *androssowii*; D, *P. schweinfurthii* var. *lamondae*; E, *Pseudognaphalium affine*; F, *P. hypoleucum* (Scale bar: A,B,C,D=100µm; E,F=50µm).

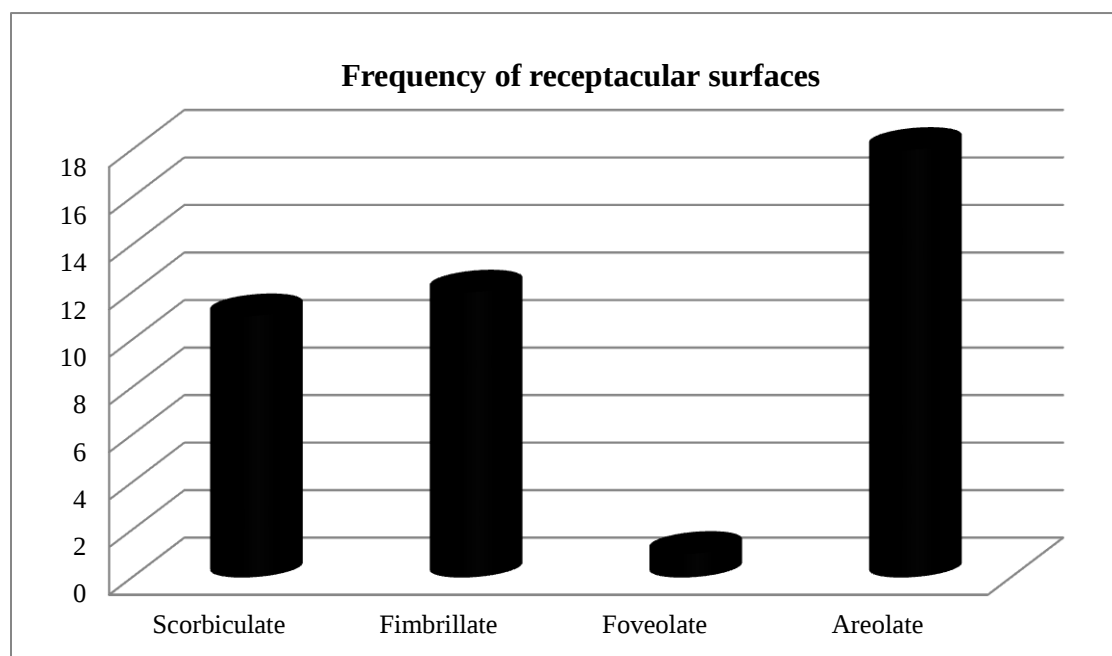


Fig. 5. Bar diagram showing the frequency in receptacular surface within the tribe Gnaphalieae (Asteraceae).

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Appendix I. List of voucher specimens.

Taxa	Collector, Numbers, Herbarium
<i>Anaphalis adnata</i>	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).
<i>A. boissieri</i>	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).
<i>A. busua</i>	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).
<i>A. contorta</i>	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).
<i>A. chitralensis</i>	K. M. A. Malik, S. Nazimuddin and Gohar Khan 1532 (KUH); Hakim Khan s.n. (RAW); Fazal Karim 2 (KUH).
<i>A. kashmiriana</i>	R. R. Stewart 10715 (K, RAW).
<i>A. margaritacea</i>	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).
<i>A. nepalensis</i> var. <i>monocephala</i>	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).
<i>A. nepalensis</i> var. <i>nepalensis</i>	S. Abedin and M. Qaiser 8987 (KUH); Y. Nasir 13338a (RAW); Nasir and Siddiqui 23313 (RAW); M. A. Siddiqui and A. Rehman 26807 (RAW).
<i>A. royleana</i> var. <i>cana</i>	R.R. Stewart 5852 (RAW); R.R. Stewart 8797 (RAW).
<i>A. royleana</i> var. <i>concolor</i>	J.F.Duthie s.n.(KUH); R.R. Stewart 713(RAW).
<i>A. royleana</i> var. <i>royleana</i>	O. Polunin 56/276 (BM); Evershed s.n. (BM); O. Polunin 56/742 (BM); M. K. Timins 175 (BM).
<i>A. staintonii</i>	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).
<i>A. triplinervis</i>	R. R. Stewart 24330 (RAW).
<i>A. virgata</i>	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).
<i>Cymbolaena griffithii</i>	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).
<i>Filago arvensis</i>	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).
<i>F. hurdwarica</i>	Y. Nasir and A. Siddiqui 8241(RAW); Omer and A. Wahid 2314 (KUH).
<i>F. paradoxa</i>	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).
<i>Gammochaeta pensylvenica</i>	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).
<i>Gnaphalium polycaulon</i>	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).
<i>G. stewartii</i>	Inayat 19742 (RAW); Mohindar Nath 441 (KUH). I. I. Choudhri 40 (RAW); Mohindar Nath 442 (RAW).
<i>G. thomsonii</i>	Tahir Ali, M. Qaiser and Ajmal Khan 644 (KUH); Walter Koelz 1244 (RAW); Jan Mohammad s.n. (KUH).
<i>Homognaphalium pulvinatum</i>	S. Abedin and Abrar Hussain 9509 (KUH); A. Ghafoor and M. Qaiser 190 (KUH); E. Nasir s.n. (RAW).

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

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