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FLORAL MICRO-MORPHOLOGICAL CHARACTERS AND THEIR TAXONOMIC SIGNIFICANCE FOR THE TRIBE SENECIONEAE (ASTERACEAE) FROM PAKISTAN AND KASHMIR

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Abstract

The micro-morphological characters viz., receptacular surface and endothecial tissues of 26 species distributed in 9 genera of the tribe Senecioneae were examined using light and scanning electron microscopy (SEM). The endothecial tissues found to be significant for the generic delimitation within the tribe Senecioneae. However, a variety of receptacle surfaces i.e., alveolate, areolate, fimbrillate, foveolate and scorbiculate was observed and to some extent they may be used for specific delimitation.

Key words: Asteraceae, Senecioneae, Receptacle, Endothecial tissues.

Introduction

The tribe Senecioneae is one of the largest tribe of the Asteraceae with c. 3000 species and 150 genera, distributed in central and south America, south eastern Africa, central and east Asia but not common in Mediterranean type areas (Bremer, 1994; Nordenstam, 2007). In Pakistan the tribe Senecioneae is represented by 39 species distributed in 9 genera viz., *Crementhodium* Benth., *Doronicum* L., *Hertia* Less., *Ligularia* Cass., *Parasenecio* W.W. Sm. & J. Small., *Petasites* Miller., *Senecio* L., *Synotis* (C.B.Clark) C. Jeffery & L. Chen and *Tussilago* L. (Qaiser & Abid, 2011). The generic and specific delimitation of the tribe Senecioneae have ever been problematic, for solving this problem most of the workers gave the attention to various micro-morphological characters viz., pollen (Vincent & Norris, 1989; Liu *et al*., 2002), endothecial pattern (Dormer, 1962, Nordenstan, 1978; Wetter, 1983; Jeffery & Chen, 1984; Sundberg, 1985; Vincent & Getliffe, 1988; Bremer, 1994; Pelser *et al*., 2007; Riva *et al*., 2009; Liu & Yang, 2011) and seed micro-morphological features (Abid& Ali, 2010). While, the receptacle characters for the various taxa of the family Asteraceae were studied by Small (1919) where he recognised six different forms of receptacle. Apart from the above information, there are no exclusive and detailed reports available on micro-morphological characters for the taxonomic delimitation of various taxa of the tribe Senecioneae from the area under consideration. In view of this an attempt is made to provide the detailed floral micro-morphological characters as an additional tool to strengthen the recognition of various taxa belonging to the tribe Senecioneae from Pakistan and Kashmir.

Material and Methods

Micro-morphological characters viz., receptacular surface and endothecial tissues were studied under compound microscope (Nikon type102) and scanning electron microscope (JSM-6380A). Capitula were taken from herbarium specimens. A list of voucher specimen is given in Table 1. Anthers were dissected and cleared by heating in 50% lactic acid and mounted in a drop of distilled water and endothecial tissues were observed under compound microscope. Whereas, receptacles were mounted on metallic stubs using double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber and observed under scanning electron microscope.

Results and Discussion

Micro-morphological characters have found to be very rewarding for taxonomic delimitation for the various taxa of the tribe Senecioneae (Table 1). The receptacles are flat-convex or rarely conical. Similar to the previous findings on the tribe Inuleae (Abid & Qaiser, 2004) and Senecioneae (Small, 1919) great variation is observed for receptacle surface, as smooth or slightly-highly ridged receptacles with five distinct forms such as alveolate, areolate, fimbrillate, foveolate and scorbiculate receptacles are irregularly observed in all genera of the tribe Senecioneae (Fig. 2a) and to some extent they may also be used for specific delimitation (Fig. 1 A-U). Regarding to the endothecial tissues generally three types were recognized i.e. polar, radial and transitional (Abid & Qaiser, 2004; Dormer, 1962). However, in the present studies only two types of endothecial tissues *viz*., polar and radial (Fig. 2b) are observed which is in agreement with the finding of Nordenstam (1978) in the genus *Senecio*. It is also worth mentioning that these two types may be used to delimit the various genera such as polar endothecial tissues are exclusively present within the species of *Crementhodium*, *Doronicum*, *Parasenecio*, *Petasites* and *Tussilago*. However, radial endothecial tissues are observed throughout the species of *Hertia*, *Ligularia*, *Senecio* and *Synotis* (Fig. 3A-M).

Table 1. Micro-morphological characters of the taxa belonging to the tribe Senecioneae.

Taxa	Endothecial tissues	Receptacle surface	Voucher specimen collector, number, herbarium
Cremanthodium arnicoides	Polar	Scorbiculate	*M. Qaiser& Jan Alam*2129 (KUH); *R.R. Stewart* 5777 (KUH); *R.R. Stewart* 9381 (KUH*); coll. ignot*. 786375 (KUH).
C. decaisnei	Polar	Areolate	*R.R. Stewart* 6570 (KUH); *M. Qaiser& Jan Alam*2127 (KUH); *J.F. Duthie*s.n. (KUH); *Jan Alam & M. Qaiser* 2179 (KUH); *R.R. Stewart*s n. (RAW).
C. ellisii	Polar	Scorbiculate	*Jan Alam & Noor Din* 2876 (KUH); *M. Qaiser & Jan Alam* 2179 (KUH); *M. Qaiser& Jan Alam* 2128 (KUH).
Doronicum falconeri	Radial	Fimbrillate	*Sher Wali Khan & Shabbir Hussain* 644-A (KUH); *coll. ignot.* 1525(KUH).
D. kamaonense	Radial	Scorbiculate	*Tahir Ali* 1505 (KUH); *Mohindar Nath* 6025 (KUH).
Hertia intermedia	Radial	Areolate	*JanAlam & Saleem* 3787 (KUH*); Jan Alam & Saleem* 3632 (KUH); *A. Ghafoor & Rizwan Yousuf* 1534 (KUH); *Saood Omer & A. Ghafoor* 1197 (KUH).
Ligularia fischeri	Radial	Areolate	*R.R. & I.D. Stewart* 17670 (RAW); R.R. & *I.D. Stewart* 50088 (KUH); *U.H. Zargar* 786372 (KUH).
L. jacquemontiana	Radial	Alveolate	*R.R. & I.D. Stewart* 4617 (RAW); *R.R.* Stewart 12701 (RAW*); Jan Muhammad* J12 (RAW*); L.D. Kapoor*s. n. (RAW*); R.R. Stewart* 6628 (RAW).
L. sibirica	Radial	Alveolate	*R.R.* Stewart 19279 (RAW).
L. thomsonii	Radial	Fimbrillate	*Kamal Akhtar & M. Qaiser* 591 (KUH); *Jan Alam & Karim Madad* 1838-C (KUH*); A. Ghafoor & Z.C. Butt* 819 (KUH*); R.R.* & *I.D. Stewart* 7195 (KUH).
Parasenecio levingei	Polar	Scorbiculate	*R.R. Stewart* 6715 (RAW*); U.H. Zargar* 786474 (KUH).
Petasites tricholobus	Polar	Fimbrillate	*Saood* Omer, *S. Nazimuddin & A. Wahid* 621 (KUH); *Saood* Omer, *S. Nazimuddin & A. Wahid* 662 (KUH); *Saood Omer, S. Nazimuddin & A. Wahid* 666 (KUH).
Senecio analogus	Radial	Fimbrillate	*Sultan-ul-Abedin & M. Qaiser* 6912 (KUH); *Tahir Al*i 2494 (KUH); *S. Abedin* 6964 (KUH); *A. Ghafoor & students* 5379 (KUH); *Mohindar Nath*s. n. (KUH); *A. Rashid* s.n. (KUH*); M. Qaiser & A. Ghafoor* 4997 (KUH).
S. dubitabilis	Radial	Fimbrillate	*Saood Omer & A. Ghafoor* 1860-A(KUH); *Ved Parkash* 16422 (RAW).
S. flavus	Radial	Scorbiculate	*S.M. A. Kazmi* 1846 (North regional Lab. Peshawar); *J. Leonard* 5937 (KUH); *Tahir Ali* 939 (KUH); *M. Qaiser & Abrar Hussain* 1075 (KUH).
S. glaucus	Radial	Foveolate	*Sultan-ul-Abedin* 2928 (KUH); S. Omer & M. Qaiser 2436 (KUH); *A. Ghafoor & S. Ome*r 2489 (KUH); *A. Ghafoor & Rizwan Yousuf* 1369 (KUH); *M. Rabbi* 2828 (KUH*); Abdul* Ghafoor & Rizwan Yousuf 1544 (KUH); *Sher Wall Khan &ShabbirHussain*557 (KUH*);A. Ghafoor*& *S.* Omer 3010 (KUH).
S. graciliflorus	Radial	Areolate	*Mohindar Nath* 4350 (KUH); *A. Rashid khan* s.n. (RAW); *Mohindar Nath*s. n. (KUH); *N.L. Burtt* 15581 (RAW).
S. korshinskyi	Radial	Fimbrillate	*Kamal Akhtar Malik & S. Nazimuddin* 1790 (KUH*); Kamal Akhtar Malik & S. Nazimuddin* 1694 (KUH*); S. Omer & M. Qaiser* 2486 (KUH); *R.R.* & I.D. *Stewart* 212815 (RAW).
S. krascheninnikovii	Radial	Areolate	*M. Qaiser & A. Ghafoor* 5293 (KUH*); Sher Wali Khan & Mushtaq Hussain*761 (KUH*); Mohindar Nath* 2888 (KUH); *Kamal Akhtar& S.Nazimuddin* 723 (KUH*); Kamal Akhtar& M. Qaiser*392 (KUH*); S. Omer & M. Qaise r*2631 (KUH); *S. Omer & M. Qaiser*2520 (KUH);*Kamal Akhtar Malik & S. Nazimuddin*1791 (KUH); *Sultan-ul-Abedin& M. Qaise*r 8947 (KUH).
S. nudicaulis	Radial	Areolate	*Sultan-ul-Abedin* 2089 (KUH); *A. Ghafoor& Tahir Ali* 4039 (KUH).
S. paulsenii	Radial	Fimbrillate	*S. M.Toppin* 272 (KEW); *A.P. Young* s.n. (BM).
S. royaleanus	Radial	Fimbrillate	*Jan Alam& A. Hamee*d 1617 (KUH); *Jan Alam&Sher Salman Baig* 3398 (KUH).
S. tibeticus	Radial	Fimbrillate	*Mohindar Nath* 1 707 (KUH); *R.R. & I.D. Stewart* s.n. (RAW); *Saida Qureshi*s. n. (KUH).
S. vulgaris	Radial	Alveolate	*M. Qaiser* s.n. (KUH); *Ajit Singh* 12 (KUH); *Mohindar Nath* 4267 (KUH).
Synotis rufinervis	Radial	Alveolate	*R.R. Stewart* 15774 (KUH); *coll. ignot.* 1742 (KUH); *R.A. Sharma*s.n. (KUH).
Tussilago farfara	Polar	Areolate	*Saood Omer, S. Nazimuddin & A. Wahid* 621(KUH).

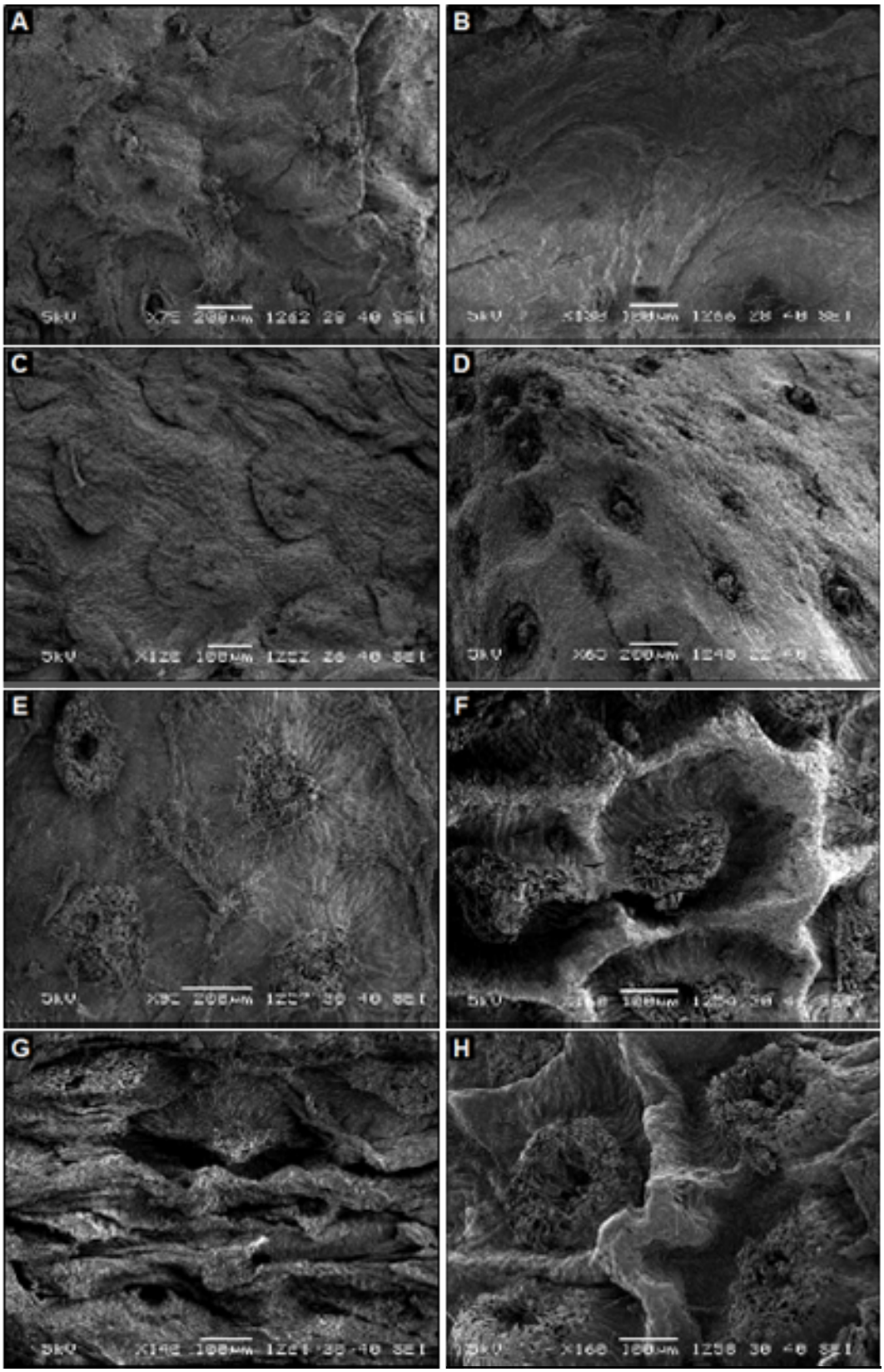

Fig. 1 (A-H). Scanning electron micrographs (SEM) showing receptacular surface: A, *Cremanthodium arnicoides*; B, *C. decaisnei*; C, *Doronicum falconeri*; D, *Hertia intermedia*; E, *Ligularia fischeri*; F, *L. jacquemontiana*; G, *L. sibirica*; H, *L. thomsonii* (Scale bar: A, D, E =200; B, C, F, G, H =100µm).

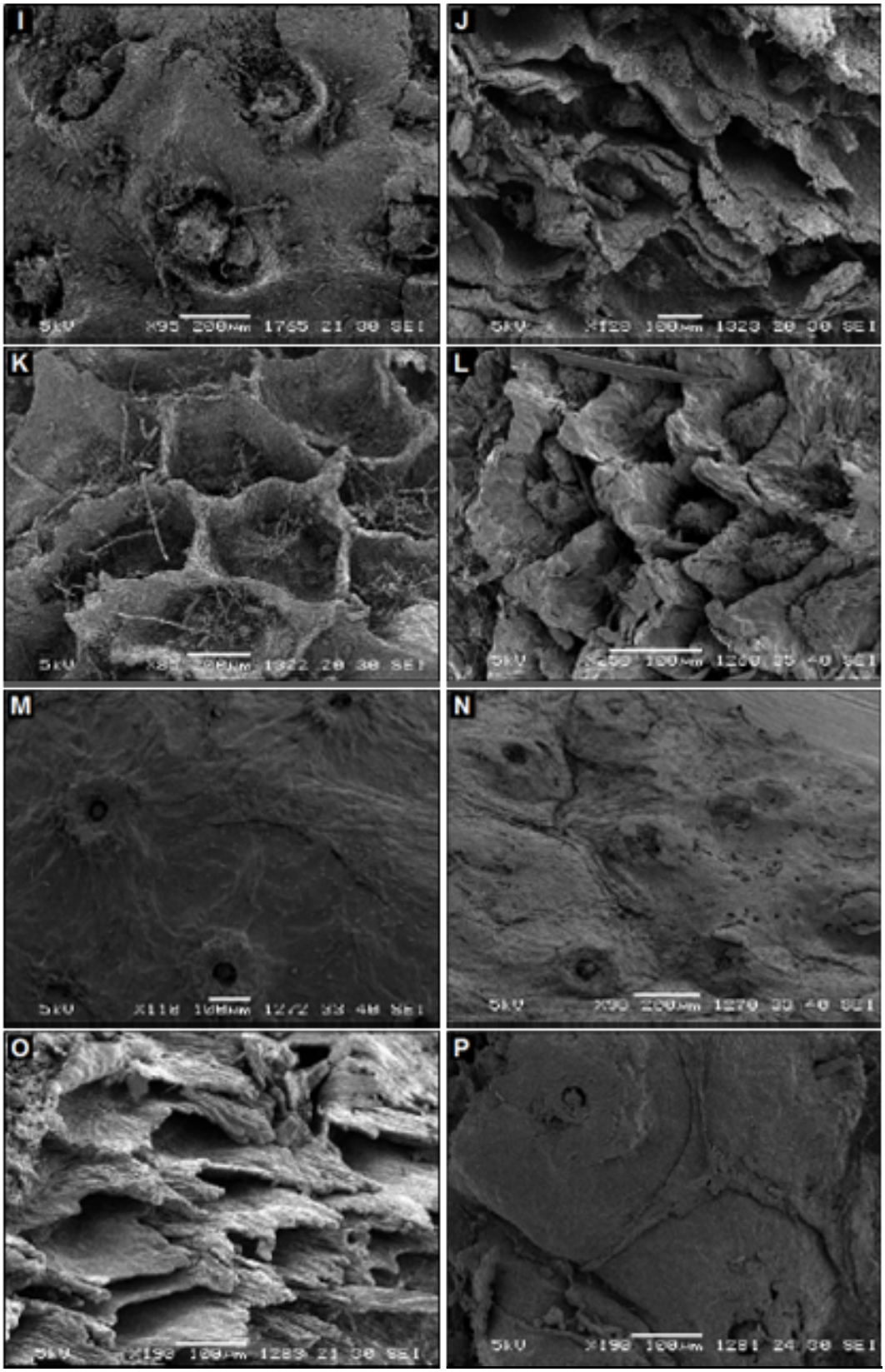

Fig. 1 (I-P). Scanning electron micrographs (SEM) showing receptacular surface: I, *Parasenecio levingei*; J, *Petasites tricholobus*; K, *Senecio analogus*; L, *S. dubitabilis*; M, *S. flavus*; N, *S. glaucus*; O, *S. korshinskyi*; P, *S. krascheninnikovii* (Scale bar: K, N=200; J, L, M, O, P = 100µm; I=20 µm).

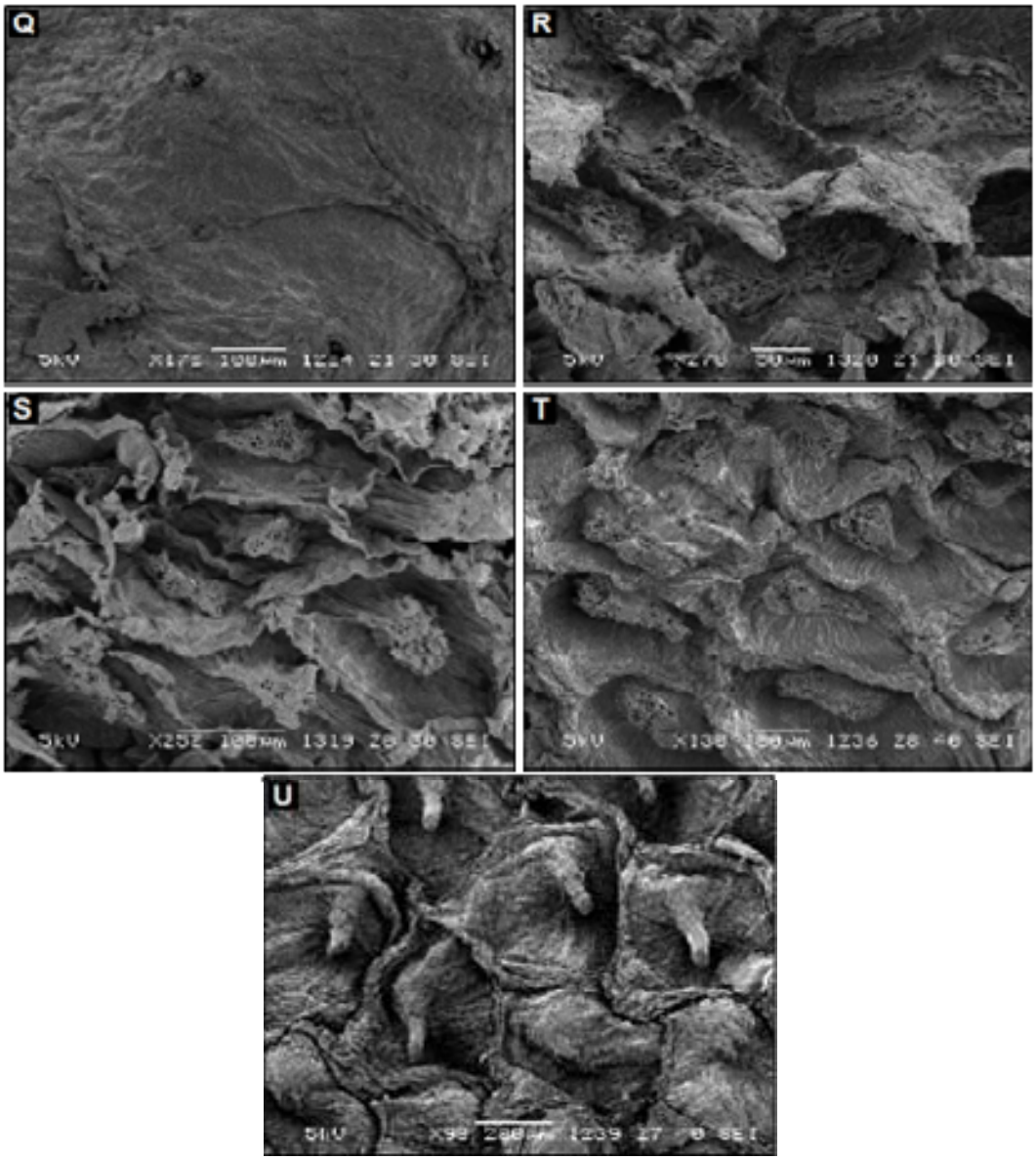

Fig. 1 (Q-U). Scanning electron micrographs (SEM) showing receptacular surface: Q, *S. nudicaulis*; R, *S. royaleanus*; S, *S. vulgaris*; T, *Synotis rufinervis*; U, *Tussilago farfara*(Scale bar: U = 200; Q, S, T = 100µm; R=50 µm).

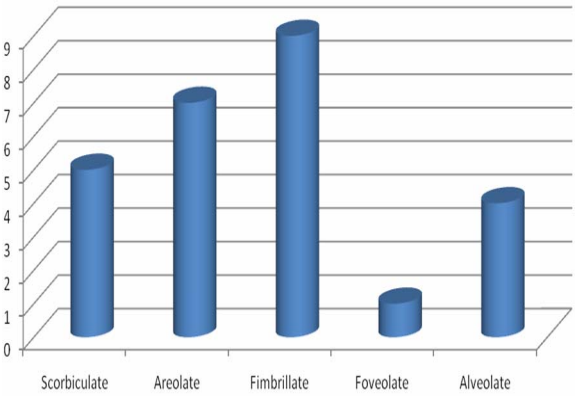

Fig. 2a. Bar diagram showing the variation in receptacle surface within the taxa of the tribe Senecioneae.

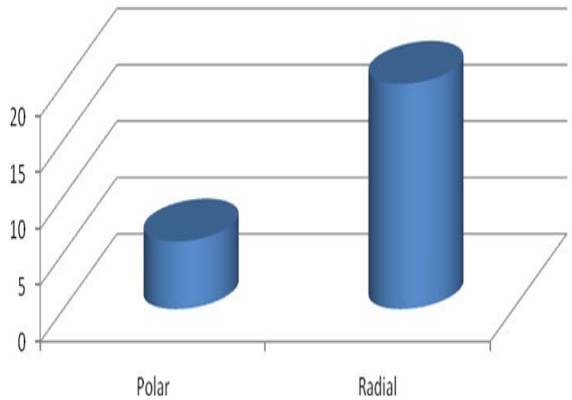

Fig. 2b. Bar diagram showing the variation in endothecial tissues within the taxa of the tribe Senecioneae.

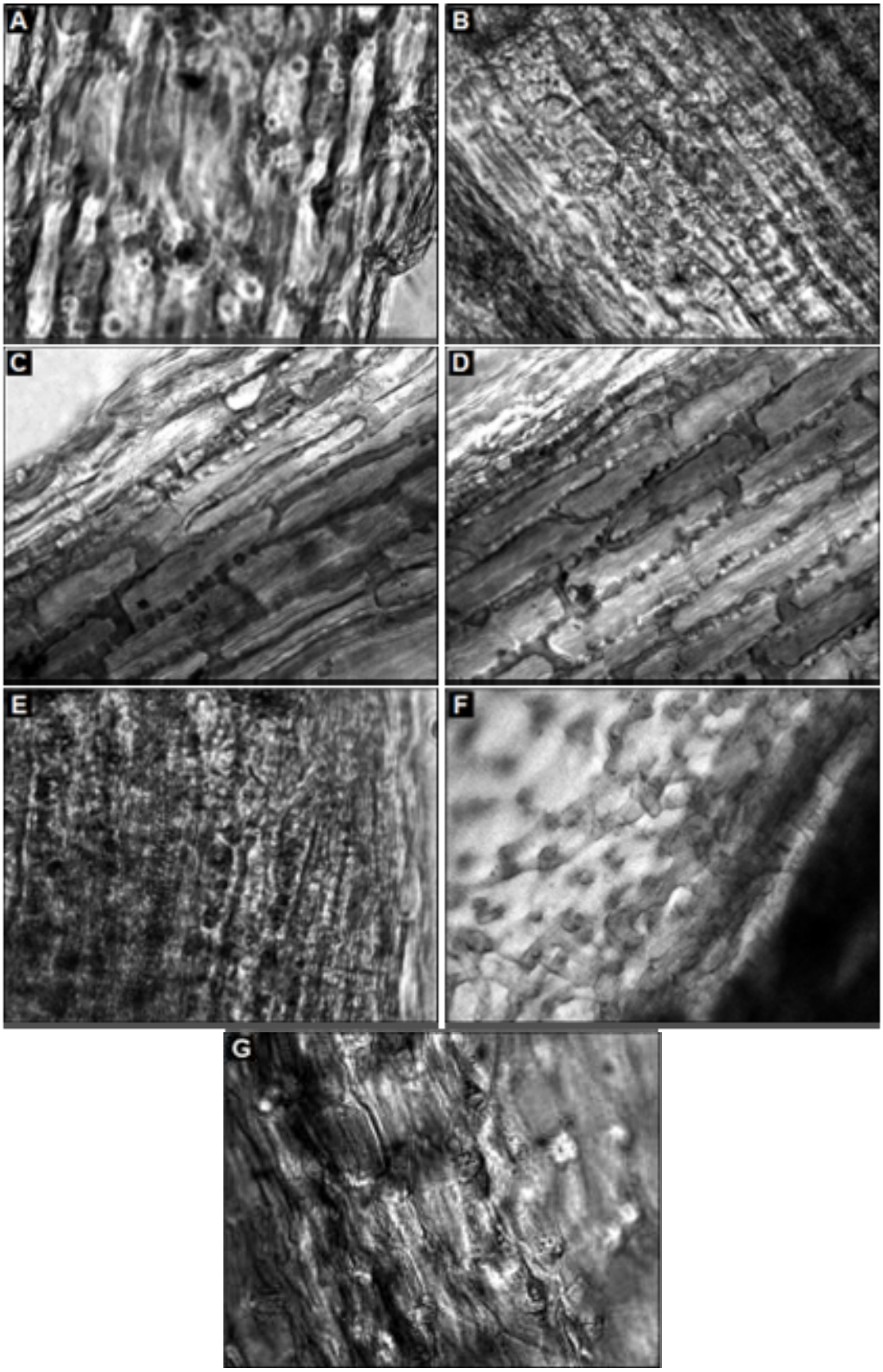

Fig. 3 (A-G). Light micrographs (LM) showing Endothecial tissues: A, *Cremanthodium decaisnei*; B, *Doronicum falconeri*; C, *Hertia intermedia*; D, *Ligularia fischeri*; E, *L. thomsonii*; F, *Parasenecio levingei*; G, *Petasites tricholobus* (Scale bar: 100X).

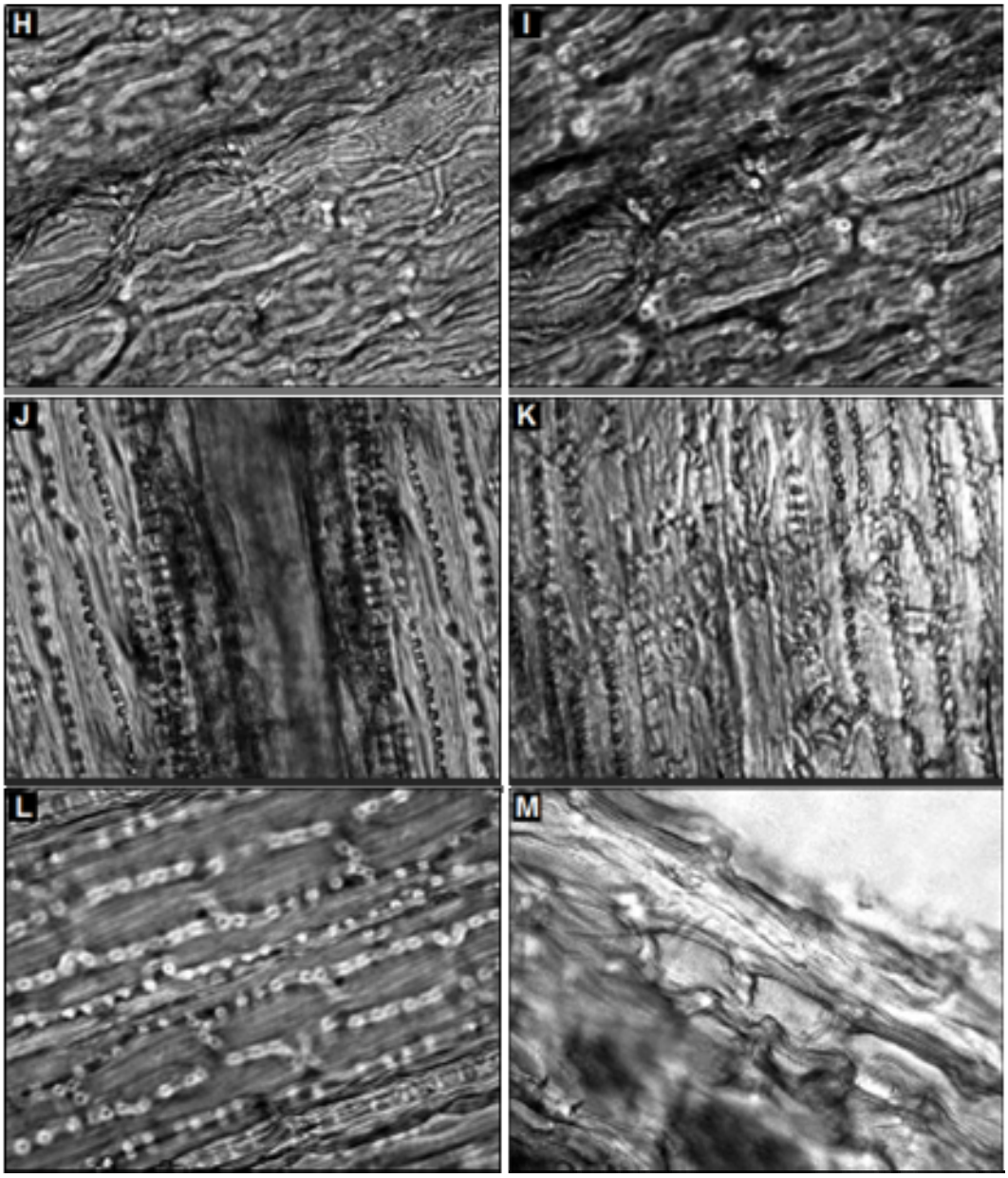

Fig. 3 (H-M). Light micrographs (LM) showing Endothecial tissues: H, *Senecio analogus*; I. *S. flavus*; J, *S. paulsenii*; K, *S. vulgaris*; L., *Synotis rufinervis*; M, *Tussilago farfara* (Scale bar: 100X).

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