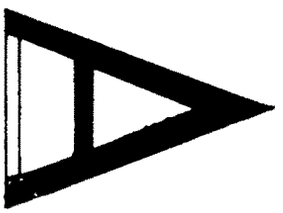


MICROMORPHOLOGY

MICROMORPHOLOGY

Besides other conventional disciplines viz cytology, palynology, anatomy etc, in recent times researchers have been attracted to study micromorphological characters of the leaf in particular. Quite a few number of angiospermic plant taxa have been studied for micromorphological characters. The information collected is metwith in research papers and text books such as Metcall & Chalk (1950, 1969, 1979), Esau (1950, 1965), Cutlar (1978), Cutlar & Bradham (1979), Johnson (1975), Levin (1973), Fahn (1974, 1983, 1986). The data gathered have been profitably used for understanding the relationships at various levels of plant taxonomy.

The observations pertaining to micromorphological features viz. epidermis, stomata, trichomes, veinislets and palisade ratio for the presently studied plant species belonging to families Capparidaceae, Malvaceae, Zygophyllaceae, Geraniaceae, Fabaceae, Asteraceae, Boraginaceae, Convolvulaceae, Scrophulariaceae and Verbenaceae have been presented below.

MICROMORPHOLOGY

Capparis cartilaginea

The matured leaves are glabrous, succulent and mostly hypostomatic. Epidermal study revealed the presence of polygonal, elongated, at times isodiametric epidermal cells, arranged in various directions. The calculated average values of epidermal cell frequency for abaxial and adaxial surfaces are 206 & 225 cells per mm^2. The recorded cell size for the lower and upper epidermal surfaces are 89 x 58 µm and 71 x 57 µm respectively (Pl. 36-a).

The leaves are mostly glabrous and totally covered with thin cuticle. The cuticular striations are flowing in various directions. (Pl.36-a).

Stomata are mostly present on lower surfaces. Usually stomata are evenly distributed and variously oriented. Only anomocytic stomata are observed and it is deeply sunken. Average guard cell size is 21 x 14 µm. The recorded stomatal frequency and stomatal index values are 64 & 32 per mm^2.

The determined values for palisade ratio and veinislets number are 18 and 13 respectively.

Abutilon pannosum

The fully grown up leaves are large, obovate, tomentose and amphistomatic. Epidermal cells are by and large isodiametric or at times elongated, having narrow sinuous anticlinal walls. 145 and 180 cells per mm^2 are the observed average cell frequency. 88 x 61 µm and 78 x 54 µm are the determined, cell size for the dorsal and ventral surfaces respectively (Pl. 36-b,c).

The leaves are totally covered with trichomes. Amidst the both types of trichomes, Eglandular - unicellular, conical; unicellular branched and stellate, short stalked (stalk unicellular) 7-9 armed (arms unicellular) type of trichomes are commonly noticed. However, Glandular - multicellular, uniseriate with capitate head and multicellular, stalked (stalk unicellular) with clavate head, trichomes are intermingled with eglandular type of trichomes (Pl.42-j,e; 43-l,i,j).

The mature stomata are distributed all over and arranged irregularly. The percentage distribution of stomatal types are 65% for anomocytic and 35% for anisocytic ones. The guard cell size of abaxial and adaxial surfaces are comparable.

The determined values for the stomatal frequency per unit area and stomatal index are 39 & 28 for the lower and 24 &

17 for the upper epidermal surfaces respectively.

Pavonia arabica

The fully developed leaves are amphistomatic and hairy. Epidermal peel study revealed the presence of isodiametric, polygonal or at times elongated cells with thin, sinuous or arched anticlinal walls. The epidermal cell frequency and size are about 245 per mm^2 and 270 per mm^2 and 60 x 57 µm and 49 x 52 µm for lower and upper epidermal surfaces respectively (Pl. 36-d,e).

Among the 7 type of trichomes observed, 4 are of eglandular and 3 of glandular types. Eglandular : unicellular, short conical; unicellular long, cylindrical; multicellular stellate short stalked 4-5 armed (arms multicellular); multicellular stellate, short stalked, many armed (arms unicellular) and Glandular: unicellular stalked with clavate head, unicellular stalked peltate scale and multicellular, uniseriate with capitate head have been recorded. Though, both types of trichomes are closely intermingled with each other, eglandular ones are more common than glandular ones (Pl. 43-j; 42-c; 43-i; 42-l; 43-g,a; 42-j).

In general, the stomata are variously oriented and distributed all over, except near the mid-vein. Anisocytic,

anomocytic, and paracytic are the 3 types of stomata with 75-80%, 12-17% and 4-10% frequency distribution respectively. The calculated length and breadth of guard cells are 28 x 15 µm for the lower and 20 x 12 µm for the upper surfaces. 39 & 24 and 24 & 18 are the numerical values for stomatal frequency per mm^2 and stomatal index for lower and upper epidermis respectively. Stomata with single guard cell and stomata with degenerated guard cells are the common irregularities observed on both the surfaces.

The numerical values determined for the veinislets number varies in between 20 and 24. The determined palisade ratio is as low as 4.5.

Pavonia zeylanica

The matured leaves are trilobed, hairy and amphistomatic. The epidermal cells are quite variable in shape and size. Cells are mostly polygonal, elongated or isodiametric in shape. The anticlinical walls of the epidermal cells are thin, with narrow sinuousites on lower surface and arched with loose sinuosites on upper surface. The cell fequency values for lower and upper surfaces are 198 and 240 mm^2. The average cell size for abaxial and adaxial surfaces are 71 x 60 µm and 62 x 49 µm respectively (Pl. 37-a,b).

Amidst the 5 types of trichomes observed, Eglandular: unicellular short, conical; uniseriate, multicellular, filiform; multicellular, stellate, short stalked, 3-5 armed (arms unicellular, thick walled); multicellular, stellate, short stalked, 4-armed (arm multicellular) are more common than Glandular: unicellular, stalked, with capitate head, multicellular, uniseriate, clavate headed. The infrequent occurrence of glandular, unicellular, peltate, scales was also recorded (Pl. 43-j,m,i; 42-k; 43-g; 42-j; 43-a,c,l).

On both the surfaces stomata are uniformly distributed and eccentrically oriented. Three types of stomata viz., anisocytic, anomocytic and paracytic are represented by 73%, 13% and 13% frequency distribution respectively. The guard cell size ranges in between 22 x 10 µm and 18 x 08 µm for abaxial and adaxial surfaces. The stomatal frequency per mm^2 and stomatal index values for dorsal and ventral surfaces are 42 & 25 per mm^2 and 32 & 16 per mm^2 respectively. The stoma with single guard cell and contiguous, obliguely oriented stomata were the recorded stomatal abnormalities (Pl. 37-a,b).).

The determined numerical values for veinislets number and palisade ratio are 22 and 6.9 respectively.

Pavonia grewioides

The fully mature leaves are large, glaucous, and amphistomatic. Epidermal cells are isodiometric, slightly elongated, polygonal and irregularly arranged. The anticlinal walls are thin, sinuate, now and then wavy to sinuate and rarely arched on both the surfaces. The recorded values for cell frequency fluctuates in between 185 and 225 cell/mm^2 having an average cell size 79 x 63 µm respectively (Pl. 37-c).

Both the leaf surfaces show presence of eglandular and glandular trichomes. Amongst the 5 types of trichomes noticed; Eglandular: unicellular short, conical; uniseriate, multicellular filiform; and multicellular, stellate, short stalked,3-5 armed (arms unicellular) are more common than Glandular: unicellular stalked, 1-celled,head, capitate; multicellular, uniseriate, with clavate head,types of trichomes (Pl. 43-j,m,i; 42-l,g,j).

Stomata are irregularly arranged and variously oriented except at midvein region. Anisocytic stomata are noticed more frequently with - 80% frequency distribution and anomocytic and paracytic share 15% and 5% frequency distribution on both the surfaces. The length and breadth of the guard cells are more or less comparable for both the

surfaces. Calculated values for stomatal index and stomatal frequency are 24 and 30 per mm^2 and 14 and 22 per mm^2 for abaxial and adaxial surfaces respectively.

No stomatal abnormality is noticed. 7.4 and 21 are the determined values for palisade ratio and veinislets number.

Senra incana

The adult leaf is trilobed and amphistomatic. The epidermal cells are polygonal, either isodiametric or elongated in various directions with thin, articulated and sinuous anticlinal walls. The epidermal cell frequency per mm^2 and size are 122 & 154 and 89 x 64 µm and 78 x 54 µm for lower and upper surfaces respectively (Pl. 37-d,e).

On both the surfaces, 4 types of eglandular and 3 types of glandular trichomes are noticed. These include Eglandular unicellular, short, conical; unicellular, long, cyllindrical; uniseriate, multicellular, filiform; multicellular stellate short stalked, 7-9 armed (arms unicellular) and Glandular: uniseriate, multicellular, head clavate, 2-4 celled; unicellular, stalk 1-celled head capitate; multicellular, stalk-bicellular, head capitate. Infrequent occurrence of glandular, unicellular, stalked, peltate trichome is also recorded. (Pl. 43-j; 42-c,e,l; 43-b,g,f; 42-b).

Stomata are uniformly distributed and irregularly oriented. Three types of stomata noticed on abaxial and adaxial surfaces are anomocytic, anisocytic and paracytic with 85%, 8% and 7% frequency distribution respectively. Very rarely stoma with single subsidiary cell is also recorded, however, its occurrence is insignificant. The average size of the guard cell for lower and upper surfaces are 34 x 18 µm and 27 x 14 µm. The recorded values for stomatal frequency per mm^2 and stomatal index are 42 & 28 per mm^2 for lower and 26 & 15 per mm^2 for upper surfaces. Stomata with single guard are also noticed infrequently (Pl. 37-d,e).

The veinslets number varies in between 23 and 27 and the palisade ratio ranges in between 7.4 and 10.5.

Tribulus rajasthanensis

The fully mature leaves are imparipinnately compound and leaflets are oblong, hairy and amphistomatic. Epidermal cells are usually polygonal, slightly elongated, and arranged irregularly or in vertical rows. The anticlinal walls are smooth, arched or at times sinuous. Sinuses usually broad giving wavy appearance. The calculated values for the epidermal cell size and frequency are 78 x 60 µm & 65 x 54 µm and 220 & 267 mm^2 for lower and upper leaf surfaces (Pl. 38-a,b).

Both the surfaces of the leaflets are completely clothed with both types of trichomes. Eglandular: unicellular, cylindrical; unicellular, hooked; multicellular, stellate, 3-5 armed (arms unicellular) and Glandular: unicellular, stalked, long with capitate head, are the observed trichome types. All types of trichomes are closely intermingled with each other forming a mat on leaflet surfaces (Pl.. 43-c,k;42-k,l).

Stomata are uniformly distributed and oriented in different directions. Among the 2 types of stomata, anomocytic is represented by 70% and anisocytic by 30% frequency distribution per mm^2. The average size of guard cells for the lower and upper epidermal surfaces are 44 & and 29 & respectively. Stomata with single guard cell are of infrequent occurrence.

The calculated values for veinislets number and palisade ratio, fluctuates in between 15 & 18 and 20 & 23 respectively.

Fagonia indica var. Schweinfurthii

The mature leaves are trifoliate, somewhat glabrous and amphistomatic. The epidermal peel study showed the cells are polygonal, slightly elongated,arranged irregularly or in vertical rows. The anticlinal walls are smooth, thick arched or at times sinuous. 165 and 218 are the respective

observed epidermal cell frequency for abaxial and adaxial surfaces. The cell size of lower and upper epidermis are 75 x 57 µm and 61 x 40 µm respectively (Pl. 38-c,d).

The leaves infrequently showed presence of eglandular unicellular short cylindrical trichomes on upper epidermis (Pl. 43-c).

The mature stomata are transversely or obliquely arranged and all over distributed, on both the surfaces. Two types of stomata recorded from both the surfaces are anomocytic and paracytic with about 85% and 15% frequency per mm^2. The size of the guard cells are 22 x 10 µm and 18 x 09 µm for abaxial and adaxial surfaces. 28 and 18 per mm^2 are the respective stomatal frequency and 15 & 09 per mm^2 are the stomatal index values for lower and upper surfaces. Occasionally stomata with arrested development and contiguous stomata are recorded, as stomatal abnormalities (Pl. 38-c,d).

The calculated numerical values for the palisade ratio and veinislets number are 8.5 and 20 respectively.

Zygophyllum simplex

The leaves are oblong, cylindrical and glabrous. Epidermal cells are mostly hexagonal, invariably polygonal and at times elongated in various directions. The anticlinal walls

are smooth, thin, and straight. The determined epidermal cell frequency and cell size for leaves are fluctuating in between 153 and 160 per mm^2 and 84 x 62 µm and 79 x 59 µm respectively (Pl.·38-e,f).

The leaves are mostly glabrous and show presence of glandular unicellular stalked peltate scale on epidermal surfaces (Pl. 43-g).

Stomata are variously oriented and scattered. Only anomocytic type of stomata observed on both the surfaces. The recorded size of guard cell is about 20 x 11 µm. Stomatal index and stomatal frequency per mm^2 are 22 and 14 respectively. At times, stoma . with single subsidiary cell was noticed (Pl.. 38-e). .

The calculated values for palisade ratio and veinislets number are 5.2 and 17 respectively.

Monsonia senegalensis

The leaves are shaggy and amphistomatic. Epidermal study revealed the presence of polygonal, elongated, at times isodiametric, irregularly arranged cells. 82 x 64 µm and 72 x 56 µm are the calculated values for the epidermal cell size. The recorded cell frequency for abaxial adaxial surfaces are 165 and 198 per mm^2 (Pl. 39-a,b).).

Both surfaces of the leaves show presence of tirchomes. Eglandular: unicellular, long, cylindrical; unicellular, conical; multicellular, tufted, 3-5 armed (arms multicellular). Glandular: unicellular, short stalked, peltate scale; uniseriate, multicellular, head capitate; multicellular, long stalked, stalk 2-celled, capitate headed trichomes are observed. Both types of trichomes are intermingled with each other (Pl. 42-c; 43-j; 42-f; 43-a,b,f; 42-b).

On both the leaf surfaces stomata are uniformly distributed and variously oriented. Anomocytic type of stomata are represented by 90% frequency distribution per mm^2 while, anisocytic and diacytic together show only 10%. Average size of guard cell for abaxial and adaxial surfaces are 30 x 18 µm and 26 x 12 µm respectively. The recorded values for stomatal frequency and stomatal index for lower and upper epidermis are 74 & 33.4 and 38 & 14.5 per mm^2 respectively. Abnormalities such as stomata with single subsidiary cell and twin stomata are occasionally observed (Pl. 39-a,b).

Values for palisade ratio and veinislets number fluctuates in between 12 and 14 and 21 & 25 respectively.

Indigofera argentea

The leaves are compound and hairy. The leaflets are oblong-elliptical and amphistomatic. Epidermal cells are usually isodiametric, sometimes elongated in various directions, appears polygonal in surface view. The anticlinal walls are thin, sinuos, sinuosites usually narrow giving wavy look. On an average 179 and 215 epidermal cells per mm^2 are noticed on lower and upper epidermis. The determined values of epidermal cell size for abaxial and adaxial surfaces are 77 x 64 µm and 68 x 51 µm respectively (Pl. 39-c).

Both the leaf surfaces are thickly covered with both types of trichomes. These includes Eglandular: unicellular cylindrical; unicellular filiform; multi-cellular, stellate 3-5 armed and Glandular: unicellular stalked, long with capitate head; unicellular stalked peltate scale; multicellular, uniseriate head capitate ones (Pl. 42-c,e,k; 43-d).

Stomata are homogeneously distributed except midveins region and irregularly oriented. Among the three types of stomata noticed; anomocytic one is represented by 78% while, paracytic and anisocytic by 12% and 10% frequency distribution per mm^2. The recorded guard cell size for both abaxial and adaxial surfaces are 24 x 15 µm and 19 x 18 µm respectively. 52 and 28 are the observed stomatal frequency

for lower and upper epidermis per mm^2. The respective numerical values for stomatal index are 21 and 11 for the lower and the upper epidermis. Stomata with single guard cell is the observed stomatal irregularity.

The palisade ratio value fluctuates in between 7 and 10 while, the value for veinislets number is 12.

Helichrysum cutchicum

The matured leaves are linear-lanceolate, woolly and amphistomatic. The epidermal cells are mostly elongated, polygonal and isodiametric; usually irregularly arranged, rarely arranged in rows near midvein. The anticlinal walls show mostly broad sinuosites, rarely arched or wavy. The observed epidermal cell frequency per mm^2 for abaxial and adaxial surfaces are 192 and 224 respectively. The epidermal cell size is greatly variable from 84 x 72 µm to 54 x 32 µm (Pl. 40-a,b).

Eglandular: unicellular, long, cylindrical, whiplike trichomes covers almost all the surface of the leaves. Eglandular, unicellular, filiform and Glandular unicellular, short talked, capitate headed trichomes are also infrequently noticed. Usually, unicellular, cylindrical trichomes forms a thick woolly covering, due to which stomata cannot be observed clearly. (Pl. 42-c,e; 43-g).

Stomata are uniformly distributed and irregularly arranged. Anomocytic, paracytic and diacytic type of stomata with 78%, 15% and 7% frequency distribution per mm^2, are noticed on abaxial and adaxial surfaces. The calculated guard cell size are 23 x 15 µm and 18 x 09 µm for lower and upper epidermis. The recorded stomatal frequency and stomatal index are 23 & 18.7 and 17 & 11.6 per mm^2 for the dorsal and ventral sides of the leaves (Pl. 40-a,b).).

The calculated values for the palisade ratio is 6.75 and determined veinislets number is 16.

Launaea resedifolia

The leaves are large hairy and amphistomatic. The epidermal cells are by and large isodiametric, variously elongated and polygonal in surface view. The anticlinal walls are mostly arched, loosely sinuate and rarely straight. The observed epidermal cell frequency per mm^2 and cell size are 204 and 235 and 78 x 60 x µm and 70 x 58 µm per mm^2 (Pl. 39-d). .

The leaves are sparingly covered with 6 types of trichomes, Eglandular: unicellular, long cylindrical; unicellular, stellate, 3-4 armed (arms unicelular). Glandular: unicellular stalked, head capitate; multicellular, uniseriate, head clavate 2-4 celled are recorded from both

the surfaces. Trichomes are noticed more abundantly on margin and mid vein region than the lamina. The unicellular, stalked, capitate headed trichomes are mostly present on upper epidermis (Pl. 42-c,k,l; 43-g; 42-g).

Stomata are well distributed and irregularly oriented. Three types of stomata noticed on abaxial and adaxial surfaces are anisocytic, anomocytic and diacytic with 74%,11% and 15% frequency distribution respectively. The guard cell size recorded for lower and upper surfaces are 22 x 14 µm and 18 x 10 µm respectively. For dorsal and ventral surfaces 26 & 54 and 16 & 37 per mm^2 are the calculated values for stomatal index and stomatal frequency respectively.

The palisade ratio value ranges in between 15 and 18 while, the value for veinislets number fluctuates in between 19 and 25.

Ipomoea kotschyana

The matured leaves are pinnatisect, glaucous and amphistomatic.The epidermal peel study revealed the presence of mostly isodiametric, at times elongated, polygonal and irregularly arranged cells. Epidermal cell have sinuous or distant sinuouses, and somewhat wavy anticlinal walls. The numerical values calculated for cell frequency per mm^2 and

cell size are 198 and 228 per mm^2 and 72 x 64 µm abd 65 X 54 µm per mm^2 respectively. (Pl. 40-d,e).

Both eglandular and glandular types of trichomes are noticed on leaf surfaces. Eglandular: unicellular, short cylindrical; unicellular, short, conical; multicellular, uniseriate, conical; and Glandular: unicellular, short stalked, pellate scale; multicellular stalk 2-celled, head capitate; have been observed. In addition, calcium oxalate crystals are also noticed from the upper leaf surfaces. (Pl. 42-c; 43-j,h,d,f).

Stomata are homogeneously distributed except at midvein region and irregularly oriented. The paracytic stomata has been consistently observed on both the leaf surfaces with 90-92% frequency distribution. Dicytic stomata represented by 6-8% and are observed interspread with paracytic one. The guard cell size ranges in between 24 x 15 µm and 20 x 09 µm for abaxial as well as adaxial surfaces. The values calculated per mm^2 for the lower and 41 and 23 per mm^2 for the upper surfaces.

The determined values for the palisade ratio and the veinislets number are 12.5 and 23.

Seddera latifolia

The matured leaves are hairy and amphistomatic. By and large elongated, polygonal and irregularly arranged epidermal cells are noticed on both the surfaces. The anticlinal walls are smooth, thin, mostly arched or minutely wavy. The observed cell frequency per mm^2 and cell size ranges in between 186 & 210 and 216 & 238 and 84 x 62 µm and 72 x 51 µm for lower and upper epidermal surfaces (Pl.. 41-a,b).

The leaves are totally clothed with shining silvery-grey hair . **Eglandular:** multicellular stellate unicellular 2 armed trichomes are most commonly observed. Eglandular unicellular, hooked trichomes are noticed interspered with above mentioned trichomes (Pl. 42-a; 43-a).

Stomata are homogemously distributed, irregularly arranged and variously oriented. The percentage distribution of anomocytic and paracytic type of stomata for abaxial and adaxial surfaces are 74% per mm^2 and 26% per mm^2. The recorded guard cell size for lower and upper surfaces are 28 x 15 µm and 24 x 12 µm respectively. The calculated stomatal index and stomatal frequency values are 18.2 & 36 and 11.2 & 27 per mm_2,for lower and upper leaf surfaces. Stomata with single guard cell and stomata with arrested development were also observed irregularly (Pl. 42-a,b).

The determined values for palisade ratio and veinislets number are 11.2 and 19 respectively.

Schweinfurthia pterosperma

The mature leaves are elliptic-oblong, glabrous, shiny and amphistomatic. The epidermal cells are more or less elongated with sinuous anticlinal walls, sinuosites are broad and giving wavy appearance. 136 and 178 per mm^2 are the recorded cell frequency for the lower and upper leaf surfaces. The determined cell size for dorsal and ventral surfaces are 82 x 65 µm and 68 x 57 µm respectively (. (Pl. 41-c,d).

Trichomes are totally absent in this taxon. Leaves are glabrous and show presence of thin cuticle.(Pl. 46-a).

On an average, stomata are distributed all over, irregularly arranged and oriented in various directions. The percentage distribution of stomatal types are 90% for anomocytic and 10% for diacytic type. The recorded guard cell size of abaxial and adaxial surfaces are 24 x 14 µm and 20 x 12 µm respectively. 44 &30 and 28 & 18 are the calculated values for stomatal frequency and stomatal index respectively.

10.6 and 17 are the respectively determined values for the

palisade ratio and veinislets number.

Chascanum marrubifolium

The leaves are generally rough and amphistomatic. Epidermal cells are usually isodiametric, polygonal or elongated and variously oriented. The anticlinal walls are mostly loosely/broadly sinuous, sometimes wavy and infrequently arched on adaxial surface. The recorded cell frequency and cell size for lower as well as upper surface per mm^2 are 197 and 225 and 78 x 64 µm and 70 x 52 µm (Pl. 41-e,f).

Both leaf surfaces are covered with 4 types of trichomes. Eglandular: unicellular, long, warty, cylindrical; unicellular, short, thick walled, warty, conical and Glandular: multicellular, uniseriate, head capitate. At times, eglandular short, thick walled, warty with swollen base, conical trichomes are also recorded
Former two types of trichomes present on both the surfaces of the leaf. (Pl. 42-d,h; 43-b).

Usually stomata are variously oriented and irregularly distributed. Three types of stomata anomocytic, anisocytic and paracytic are represented by 72%, 17% and 11% fequency distribution respectively. The recorded guard cell size for abaxial and adaxial surfaces are more or less similar (25 x 12 µm and 21 x 10 µm). The numerical values recorded for the

stomatal index and stomatal frequency per mm^2 are 18.6 & 11.7 and 62 & 46 for the lower and upper epidermis respectively (Pl. 41-e,f).

The numerical values for the palisade ratio is 16.75; while, that for the veinislets number is 14.

Premna resinosa

The matured leaves are somewhat glaucous and amphistomatic. The epidermal peel study revealed the presence of isodiametric, at times elongated and/or polygonal cells in surface view. The anticlinal walls are loosely sinuous, sinuoses, 'U' shaped, rarely straight to arched and thin. The epidermal cell frequency per mm^2 and cell size recorded for abaxial and adaxial surfaces are 167 and 205 per mm^2 and 78 x 64 μm and 59 x 48 μm (Pl..39-d).

Two types of trichomes are infrequently observed on both the surfaces. Eglandular unicellular, short, conical and Glandular, unicellular stalked, short, capitate. In addition upper leaf surface showed presence of multiceullular secretary glands, made up of 8-10 radially arranged cells (Pl. 43-j,f,g).

Generally stomata are distributed all over, variously oriented and irregularly arranged. Three types of stomata

are anomocytic, anisocytic and paracytic, represented by 72%, 16% and 12% fequency distribution per mm^2 respectively. The guard cell sizes are more or less comparable for both the surfaces (19 x 13 µm and 18 x 11 µm). The numerical values recorded for stomatal and index and stomatal frequency are 64 and 28.5 per mm^2 for abaxial and adaxial surfaces respectively (Fig.

The calculated values for palisade ratio and veinislets number are 12.5 and 16 respectively.

Heliotropium bacciferum

The fully grown leaves are linear - lanceolate, and hairy. Epidermal cells are by and large isodiametric or at times elongated having loosely sinuous anticlinal walls. 240 to 280 cells per mm^2 are the observed average cells frequency. 78 x 62 um and 67 x 51 um are the determined cell size for the adaxial and abaxial surfacer respectivelly. (Fig. Pl.).

The leaves are totally covered with trichomes. Amidst the both the types of trichomes.

Eglandular - unicellular conial, unicellular cylindrical uniseriate conial and multicellular tufted type of trichomes are commonly noticed. However, Glandular - multicellular,

uniseriate with capitate head are intermingled with the eglandular type of trichomes. (Pl. 42-j,e; 43-l)

The mature stomata are distributed all over and arranged iregularly. The percentage distribution of stomatal types are 68% anomocytic and 23% anisocytic and 9-10% paracytic type. The guard cell size of abaxial and adaxial surfaces are more or less comparable (18 x 10 um). The determined values for the stomatal index and stomatal frequency are 37 & 21 for the lower and 21 & 15 for the upper epidermal surfaces respectively.

The calculated values for the palisade ratio and veinislets no. are 25 and 10 respectively.

Plate No. 36 Epidermal peel showing:

Capparis cartilaginea

a - Smooth arched anticlinal walls cuticular striations and sunken anomocytic stomata.

Abutilon pannosum

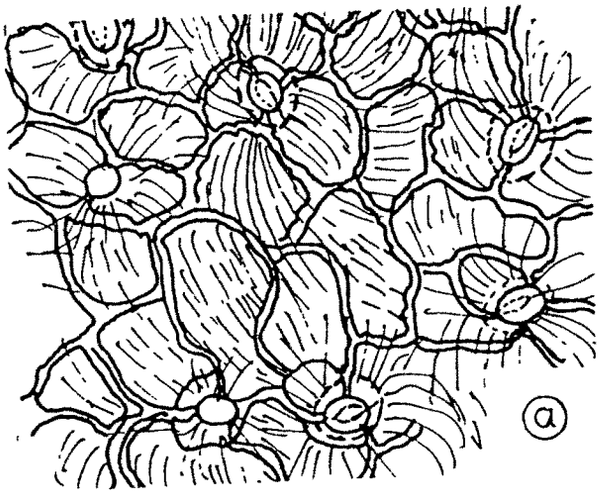
b (u.s.) Prominent sinuosites of anticlinal walls, paracytic, dicytic and anisocytic stomata.

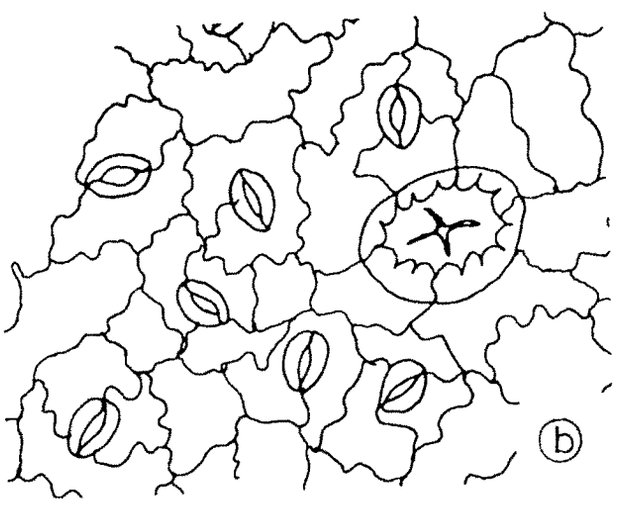
c (l.s.) Prominent sinuosites of anticlinal walls and anisocytic stomata and stomata with sigle guard cell.

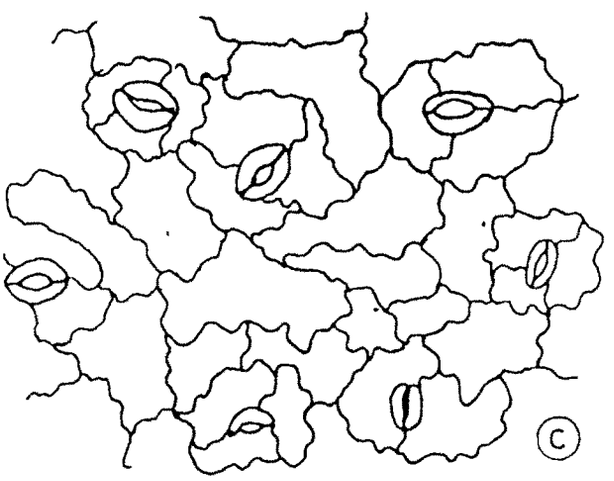
Pavonia arabica

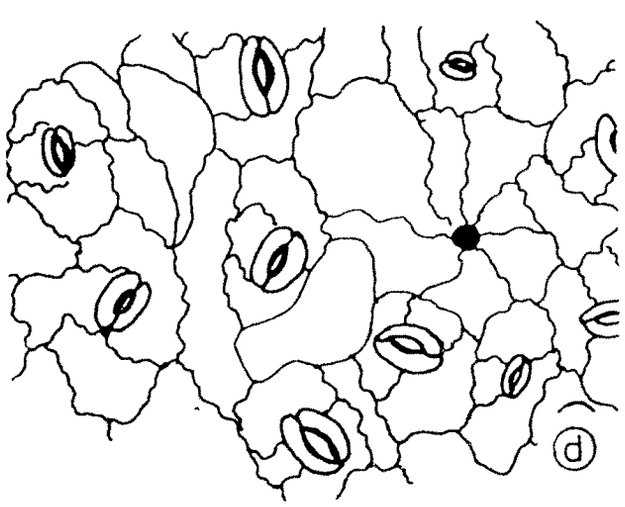
d (u.s.) Prominent sinuosites of anticlinal walls, stomata with cuticular thickenings, anisocytic and paracytic stomata.

e (l.s.) Stomata of different sizes and degenerated guard cells.









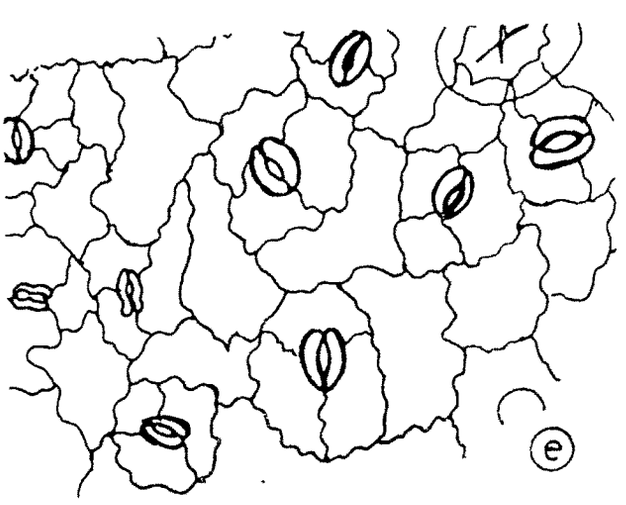


PLATE NO. 36

Plate No. 37 Epidermal peel showing:

Pavonia zeylanica

a (u.s.) - Prominent sinuosites of anticlinal walls and stomata with slightly cuticular thickenings.

b (l.s.) - Stomata with single subsidiary cell and paracytic, anisocytic stomata.

Pavonia grewioides

c (l.s.) - Regular sinuousites of anticlinal walls and anisocytic, di^{a}_{k}cytic and stomata with single guard cells.

Senra incana

d (u.s.) - Loosely regular sinuous anticlinal walls with anomocytic, anisocytic stomata.

e (l.s.) - Stomata with single guard cell and di^{a}_{k}cytic, anomocytic stomata.

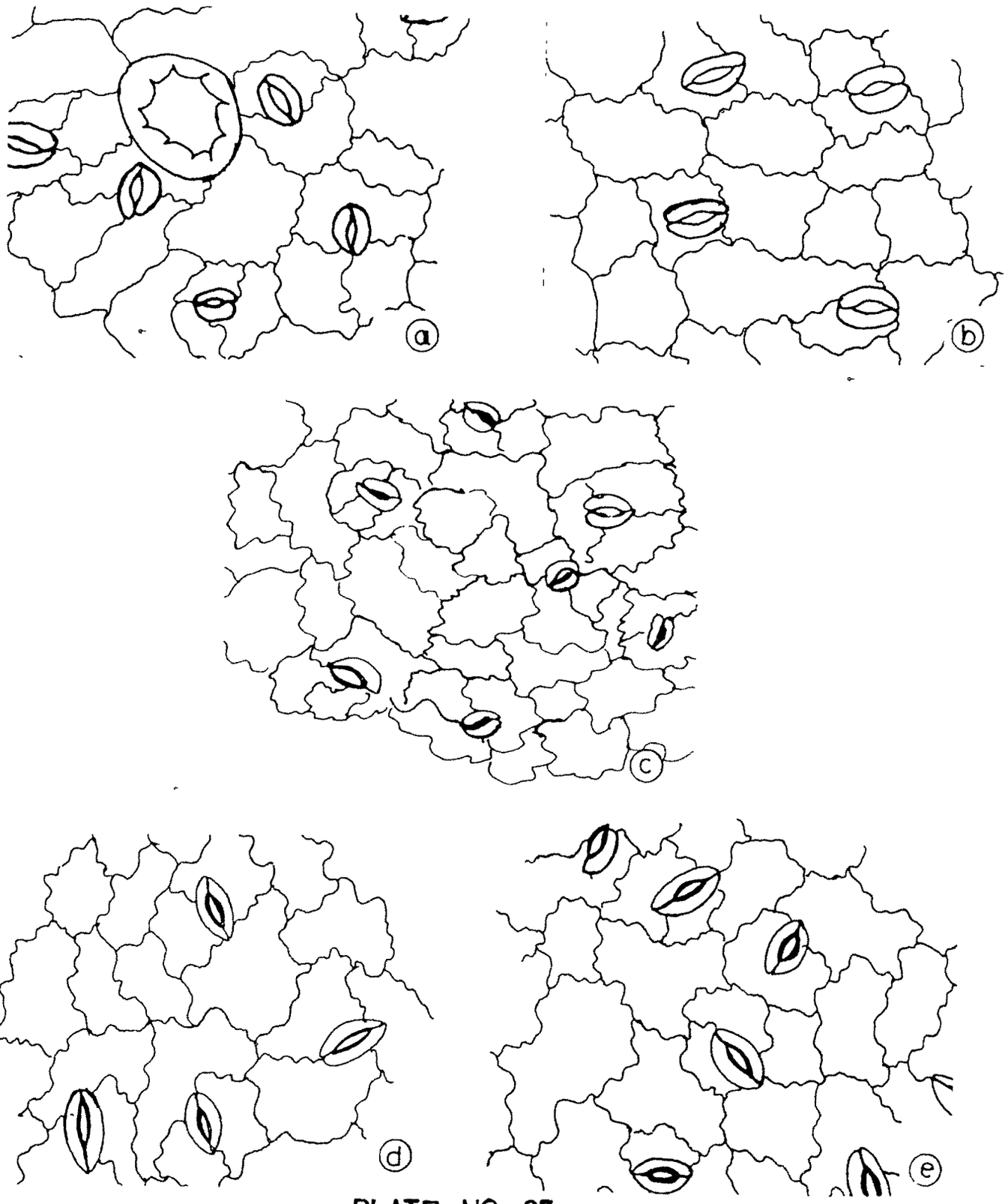


PLATE NO. 37

Plate No. 38 Epidermal peel showing:

Tribulus rajasthanensis

a (l.s.) - Smooth, arched to straight anticlinal walls and anomocytic and juxtaposed twin stomata.

b (u.s.) - Smooth arched anticlinal walls and anomocytic, paracytic and degenerated stomata.

Fagonia indica var. schweinfurthii

c (u.s.) - Smooth arched to straight anticlinal walls

d (l.s.) with thin cutical and anomocytic and paracytic stomata, stomata with degenerated guard cells.

Zygophyllum simplex

e (u.s.) - Smooth straight anticlinal walls and anomocytic

f (l.s.) stomata with cuticular thickening on l.s.

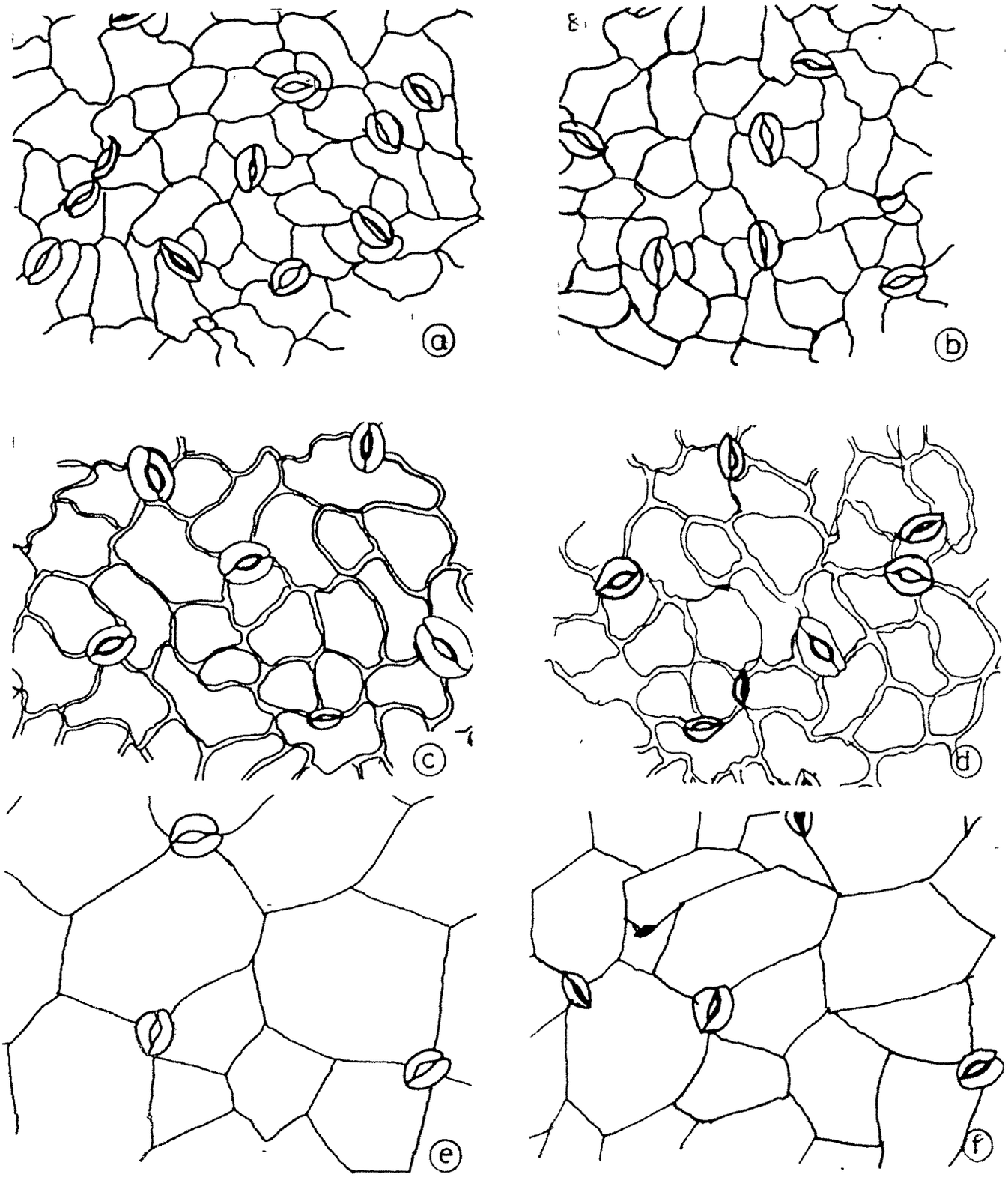


PLATE NO. 38

Plate No. 39 Epidermal peel showing:

Monsonia senegalensis

a (l.s.) - Loosely sinuous anticlinal walls and anomocytic paracytic, dicytic and degenerated guard cells stomata. Juxtaposed twin stomata also seen.

Indigofera argentea

b (l.s.) - Loosely sinuous to arched smooth anticlinal walls and paracytic, anomocytic and juxtaposed stomata.

Heliotropium bacciferum

c (l.s.) - Smooth arched to loosely sinuous anticlinal walls and anomocytic stomata.

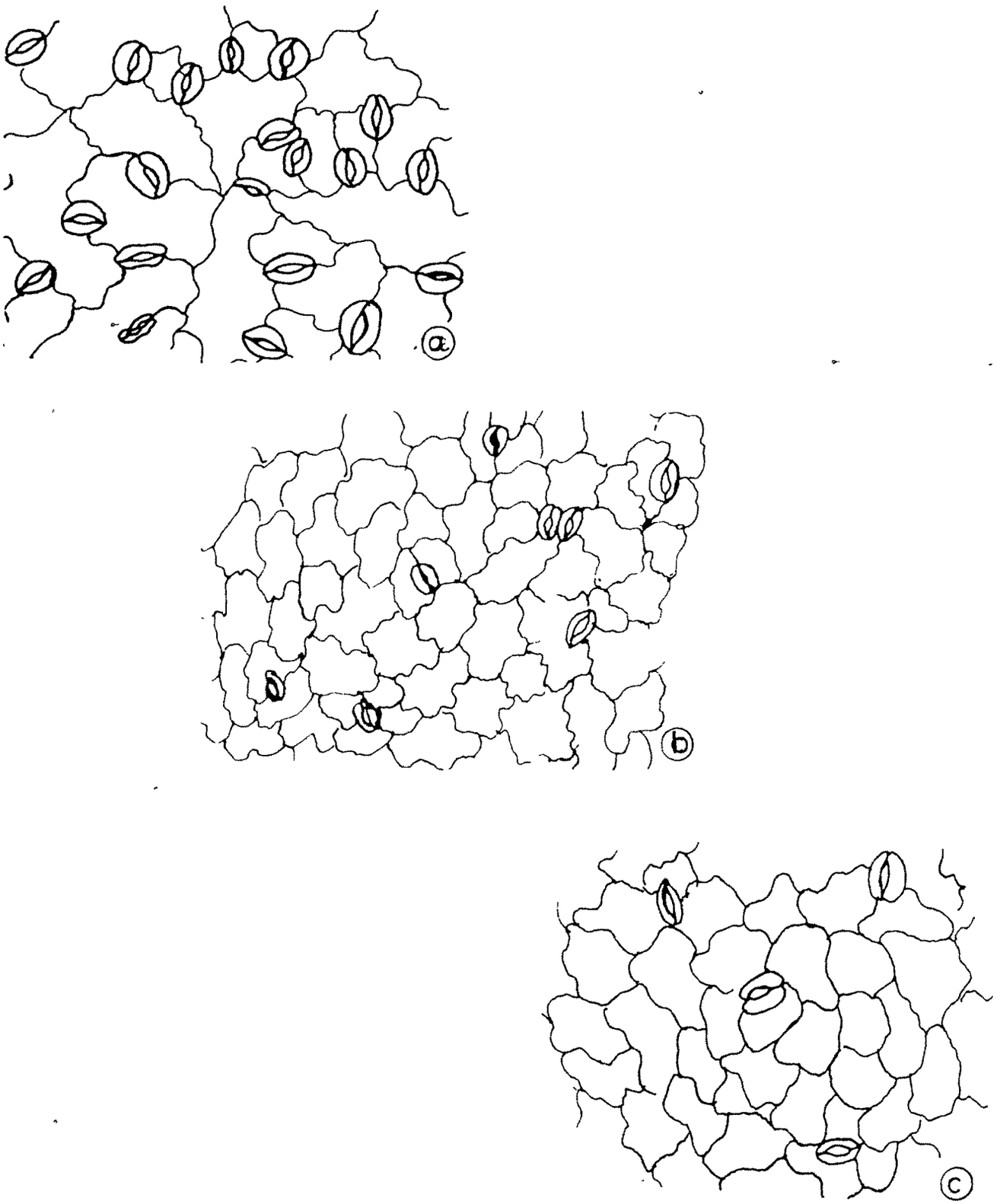


PLATE NO. 39

Plate No. 40 Epidermal peel showing:

Helichrysum cutchicum

a (u.s.) - Loosely sinuous and smooth arched anticlinal walls and anomocytic stomata.

b (l.s.) - Stomata with single guard cell and paracytic stomata.

Launaea resedifolia

c (l.s.) - Loosely sinuous anticlinal walls and anomocytic, contiguous paracytic stomata.

Ipomoea kotschyana

d (u.s.) - Loosely sinuous anticlinal walls and paracytic and anomocytic stomata.

e (l.s.) - Different sizes of stomata paracytic and stomata with single guard cell with calcium oxalate crystal.

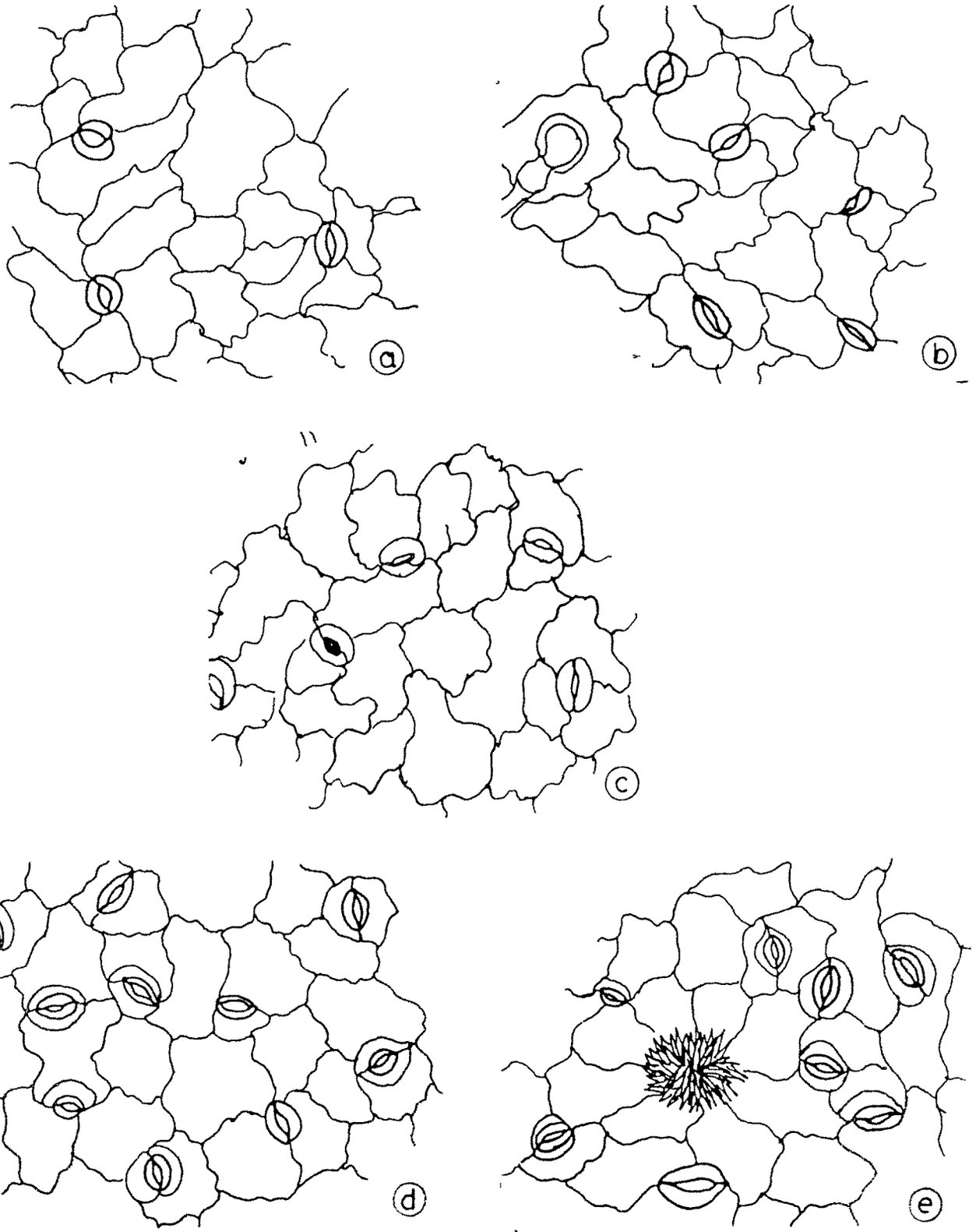


PLATE NO. 40

Plate No. 41 Epidermal peel showing:

Seddera latifolia

a (u.s.) - Smooth arched to straight anticlinal walls and anomocytic, stomata with single guard cell and degenerated guard cells.

b (l.s.) - Stomata with cuticular thickening and anomocytic, paracytic stomata.

Schweinfurthia pterosperma

c (u.s.) - Loosely sinuous anticlinal walls and anomocytic,

d (l.s.) paracytic and contiguous diacytic stomata.

Chascanum marrubifolium

e (u.s.) - Loose sinuous anticlinal walls, stomata with cuticular thickening and anomocytic, paracytic stomata.

f (l.s.) - Anomocytic and diacytic stomata of different sizes.

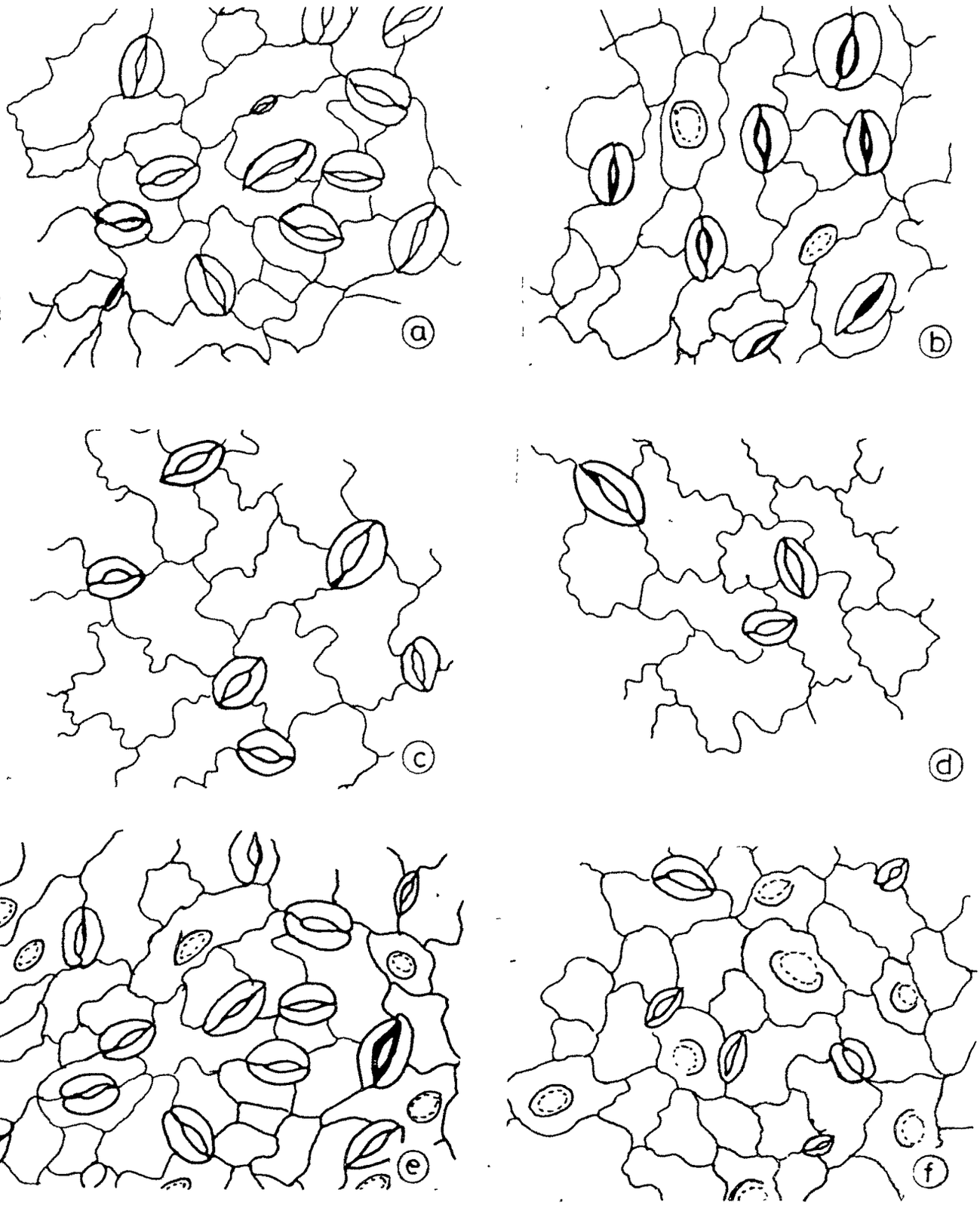


PLATE NO. 41

Plate No. 42 Various trichome types observed in the selected plant taxa.

a - Eglandular, multicellular, stellate - 2 armed.

b - Glandular, bicellular stalked, clavate (Long).

c - Eglandular, unicellular, cylindrical.

d - Eglandular, unicellular, conical with bristles.

e - Eglandular unicellular, filiform.

f - Eglandular, multicellular tufted.

g - Glandular, uniseriate, stalked, capitate.

h - Eglandular, unicellular, conical with thick walls.

i - Glandular uniseriate stalked with multicellular capitate head.

j - Glandular, uniseriate stalked clavate.

k - Eglandular, multicellular, stellate 4-armed.

l - Eglandular, multicellular, stellate with many arms.

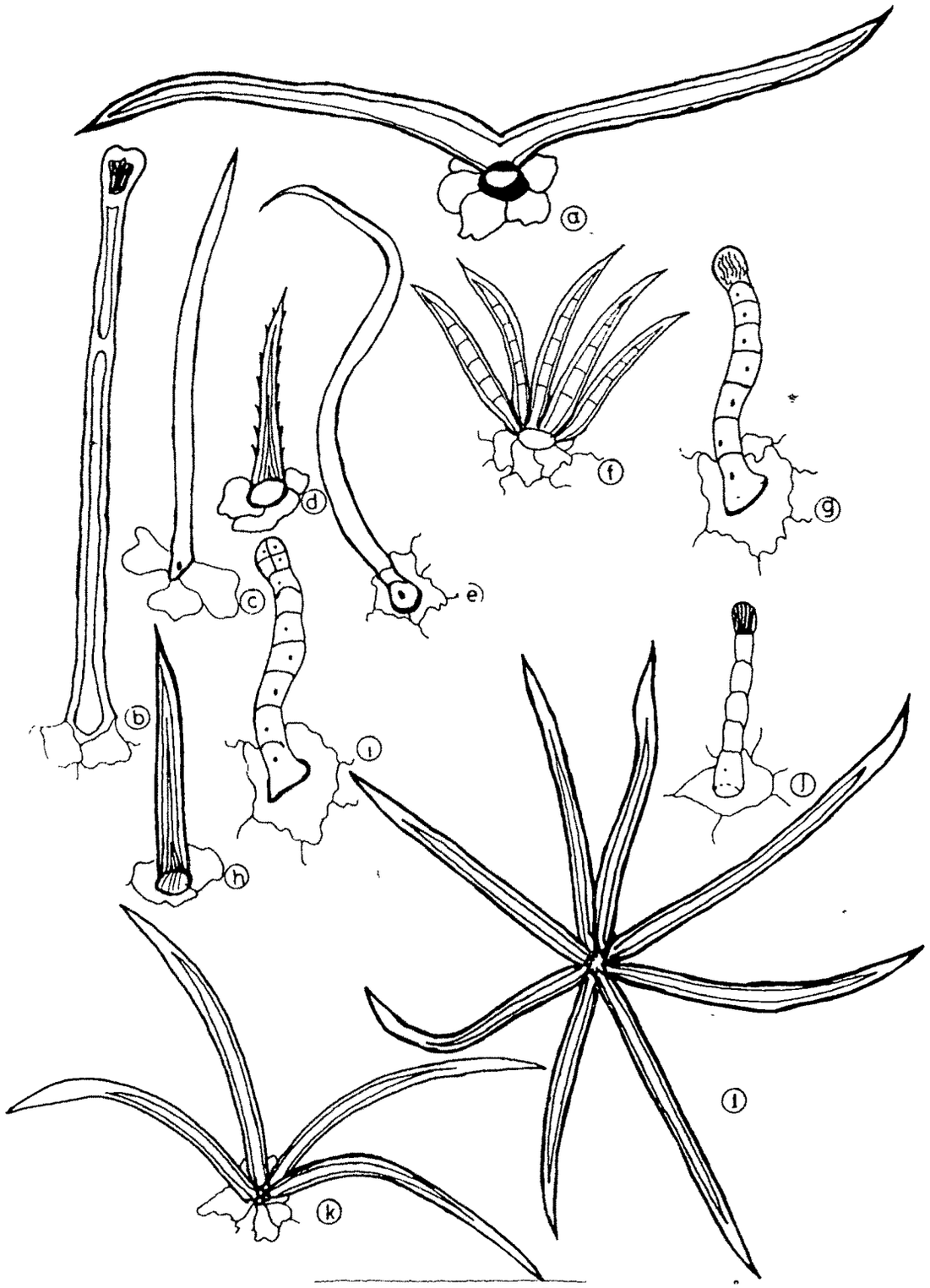


Plate No. 42

Plate No. 43 Various trichome types observed in the selected plant taxa.

a - Glandular, unicellular stalked peltate scale.

b - Glandular, uniseriate, stalked, clavate.

c - Glandular, uniseriate, stalked, capitate (Long).

d - Peltate scale.

e - Eglandular, unicellular, branched.

f - Glandular, bicellular stalked, bicellular capitate.

g - Glandular, unicellular, stalked capitate.

h - Eglandular uniseriate conical.

i - Eglandular, multicellular, stellate, 4-armed with thick walls.

j - Eglandular, unicellular, conical (Long).

k - Eglandular, unicellular, short, hooked.

l - Eglandular, multicellular, stellate, 3-armed with thick walls.

m - Eglandular, uniseriate conical (Small).

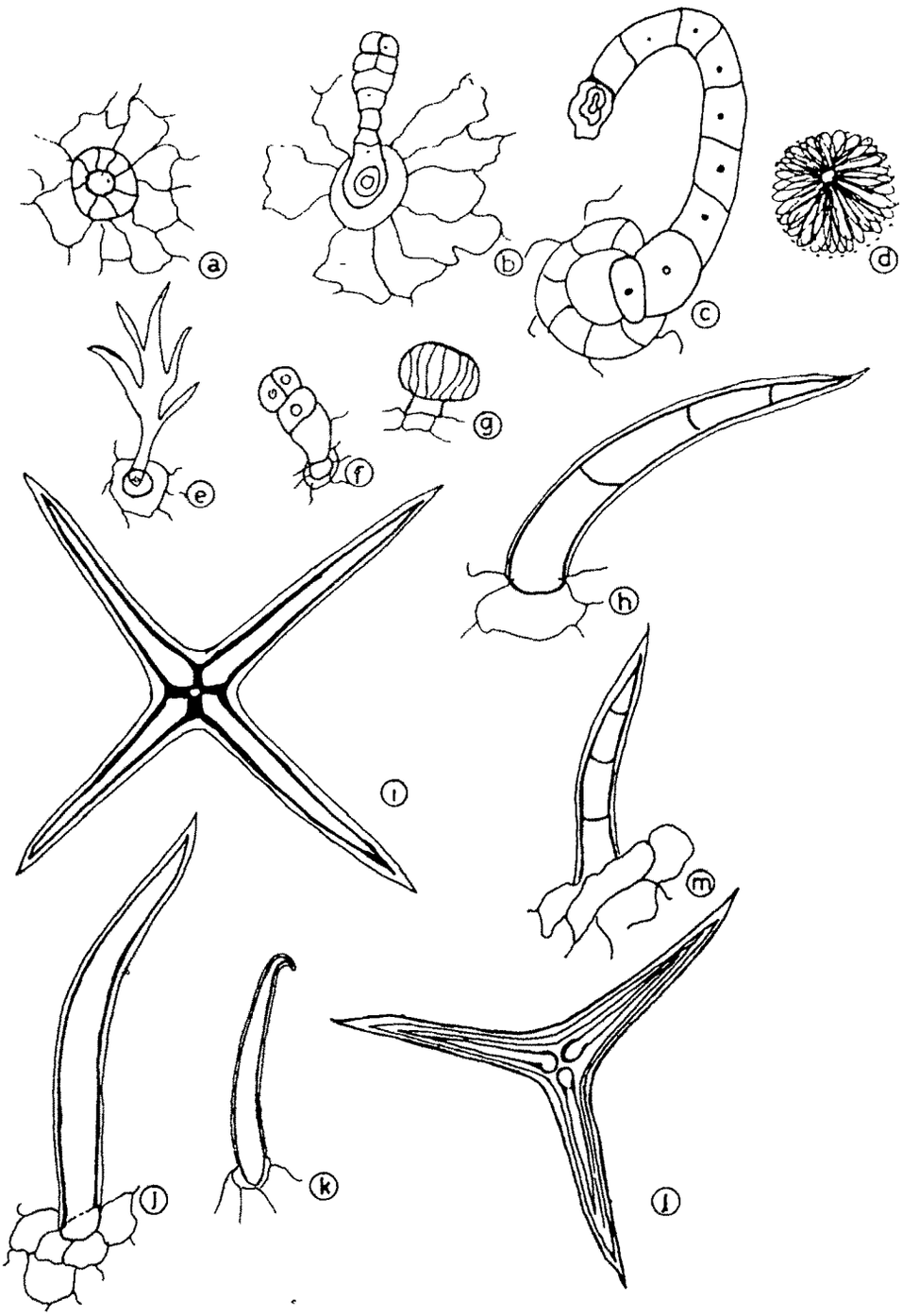


Plate No. 43

Plate No. 45 Trichomes

a - Senra incana : Glandular, bicellular, stalked, capitate trichome.

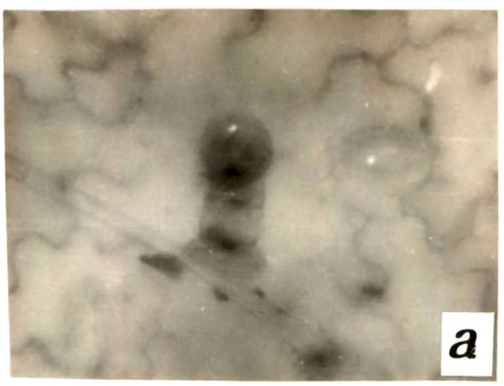
b - Abutilon pannosum : Eglandular, stellate multicellular, thick walled trichome.

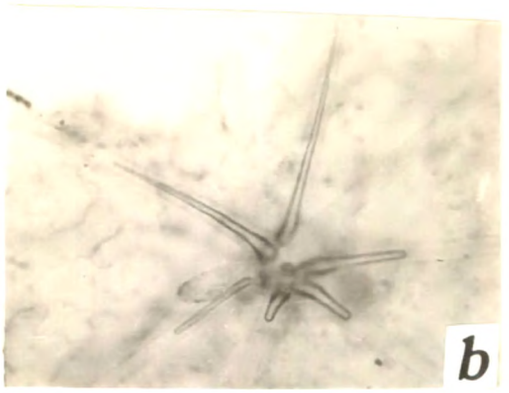
c - Pavonia zeylanica : Eglandular, stellate, trichome.

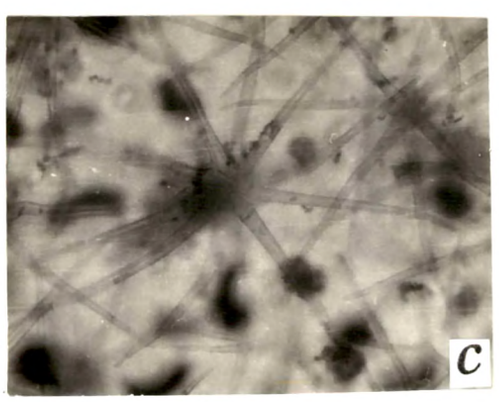
d - Chascanum marrubifolium : Eglandular, thick walled conical trichome.

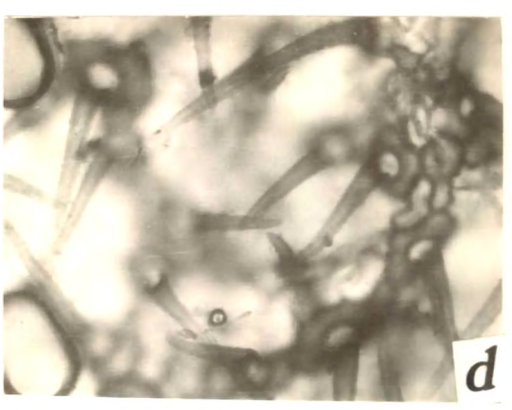
e - Seddera latifolia : Eglandular, stellate 2-armed 'T' shaped trichome.

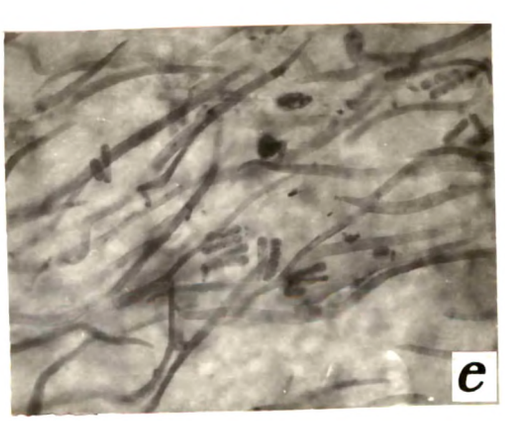
f - Senra incana : Eglandular, unicellular cylindrical trichome.











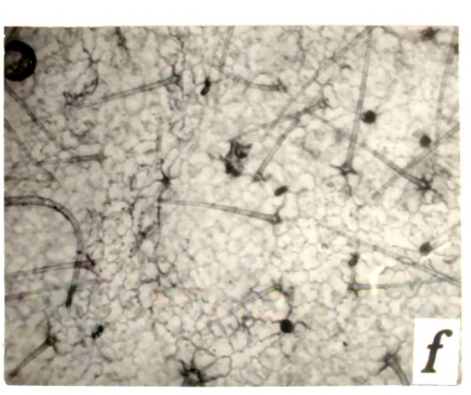


Plate No. 45

Plate No. 46

a - Schweinfurthia pterosperma : Showing cuticular striations.

b - Fagonia indica : Showing thin arched anticlinal walls and anomocytic, anisocytic stomata.

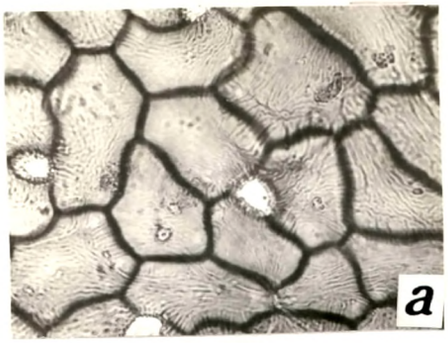
c - Premna resinosa : Twin contiguous stomata and arched smooth anticlinal walls.

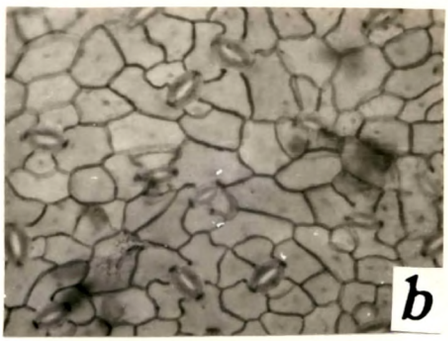
d - Monsonia senegalensis : Contiguous stomata and twin stomata stomata with single subsidiary cells.

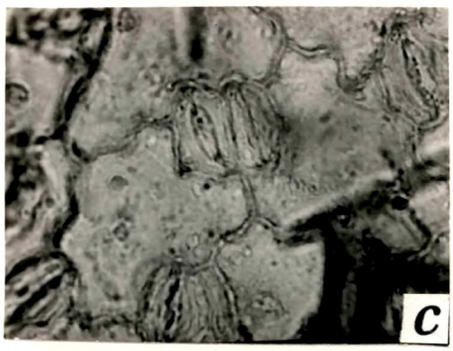
e - Pavonia zeylanica : Glandular, uniseriate multicellular capitate trichome.

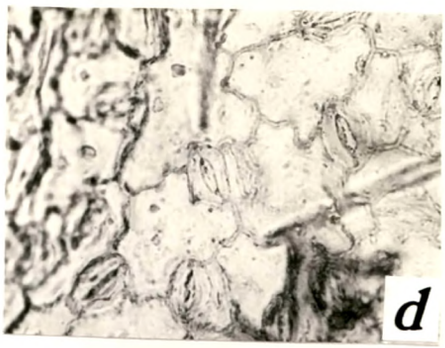
f - Capparis cartilaginea : Epidermal peel showing cuticular striations and sunken stomata.

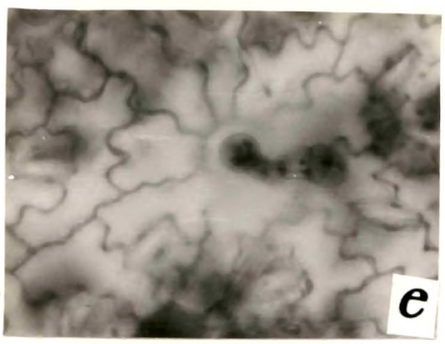
g - Senra incana : Eglandular, stellate, many armed trichome.

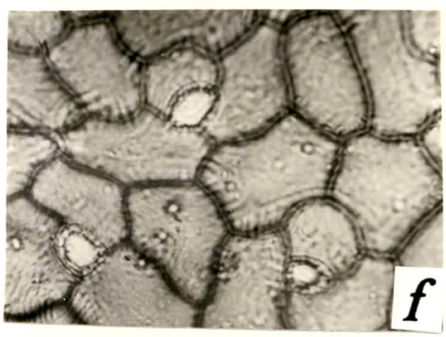












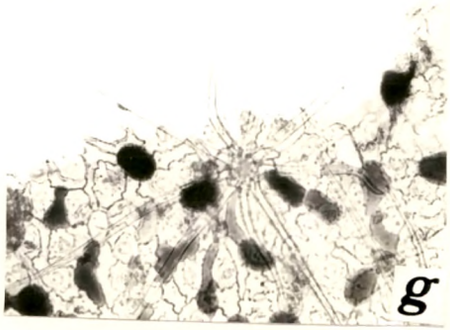


Plate No. 46

The present findings of Capparis cartilaginea grossly resembled with those of earlier findings for other species of the genus Capparis by Allekutty (1978) and Inamdar(1980). However, Capparis cartilaginea is not included in the above mentioned publications.

In past, quite a few taxa of the cohart Malvales have been worked out by Inamdar & Chouhan (1969,a,b) Inamdar et al (1983); Ramayya & Rao (1976, 1977, 1981); Yuldashev & Gareva (1984); A Sultanel (1990), for epidermal features including ontogeny of trichomes and stomata. Observations regarding the epidermal features for Abutilon pannosum and Pavonia zeylanica are more or less comparable to those of earlier workers. Inamdar et al (1983) have reported 5 types of trichomes in Senra incana while, in the present study 2 more types of trichomes viz.Eglandular: unicellular cylindrical and glandular: uniseriate stalked with clavate head have been recorded for the S. incana. The 2 species Pavonia arabica and Pavonia grewioides are not metwith in the earlier works. In all probability these two have been worked out for the first time for epidermal features.

Present observations regarding epidermal features for Fagonia indica var. schweinfurthii (Syn. Fagonia cretica) and earlier observations of Inamdar and Patel (1970) are more or less identical. Observations for Zygophyllum simplex and earlier observations of Cunnigham (1927) for Z.fabago

show resemblence in epidermal features. Observations regarding epidermal structures of Tribulus rajasthanensis and earlier observations of Inamdar (1969) for Tribulus terestris are more or less comparable in majority of features.

From the review of available literature it appears,that the species Monsonia senegalensis remained unexplored for micromorphological features. The present findings revealed the presence of anomocytic, anisocytic, and paracytic type of stomata and eglandular,unicellular,conical;unicellular cylindrical; multicellular,stellate, bicellular stalked capitate trichomes and unicellular stalked,peltate scale.

Previously, Kothari and Shah (1975); Jasbir Kaur and Trivedi (1984); Prabhakar et al (1985); Karatelaloya et al (1990) and others have scrutinised different genera of the family papilionaceae. However, species Indigofera argentea is altogether absent in these earlier reports. The present observations pertaining to epidermis, stomata and trichomes are by and large comparable with earlier works.

Information regarding micromorphological characters for the family Asteraceae is metwith in earlier works of Ramayya (1962,a,b; 1963); Ramayya et al (1969, 1972); Bhatt & Inamdar (1975); and Subramaniam (1983); wherein reference to Launaea nudicaulis and Helichrysum sp. is noticed,. In the

present work Leunaea resedifolia and Helichrysum cutchicum have been scrutinised for epidermal features, depcting grass resemblence to above mentioned taxa. In all probability this is the first report for the epidermal features for these two taxa.

Earlier, Patel and Inamdar (1971); Bhatia (1984); Nyuwane & Gill (1990) have studied different species of Heliotropium Sp. However, species Heliotropium bacciferum is conspicuous by its absence in the earlier works. In the species, anisocyctic and anomocytic type of stomata; Eglandulaer : unicellular conical (bristles);unicellular,cylindrical; uniceriate conical and glandular: unicellular stalked capitate trichomes have been recorded. The noteworthy feature of the species is the conspicuous presence of unicellular conical bristly trichomes.

Micromorphological studies for different species of family Convolvulaceae and Ipomoea have been carried out by Pant & Banerjee (1965); Shah (1967); Inamdar (1971, 1978) and Karatel & Gill (1985). The observations for the species I. kotschyana and those for the earlier worked out species showed resemblences regarding stomatal types, trichome types and other features. Mention may be made of the genus Seddera which is not included in earlier works mentioned above. Presence of anomocytic and paracytic stomata; Eglandular:

unicellular hooked; unicellular stellate 2 armed 'T' shaped trichomes have been recorded for Seddera latifolia.

The species Schweinfurthia pterosperma is altogether absent in the earlier works of Bhatt & Inamdar (1975) and Paliwal (1971) for the family scrophulariaceae. In the present work, anomocytic and paracytic stomata and cuticular striations have also been recorded for the species.

In the earlier works of Inamdar (1969) Shah & Mathews (1982, 1983) and Pailwal (1978) for the family verbenaceae both the genera Chascanum and Premna are not represented. However, in the works of Cantino (1990) 5 species of Premna have been worked out but Premna resinosa has remained unexplored from micromorphological viewpoint. Observations for Chascanum marrubifolium revealed the presence of anomocytic, anisocytic and paracytic type of stomata, Eglandular : unicellular conical, cylindrical, filiform and glandular uniseriate stalked,capitate,trichomes. The present findings for Premna resinosa are more or less comparable to those for the other species of Premna worked out earlier.

Table 4: Distribution of Trichomes in investigated taxa

	TAXA TRICHOMES	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Capparis cartilaginea																			
2	Abutilon pannosum	+	+	-	+	-	+	-	-	-	+	-	-	+	-	-	+	-	-	
3	Pavonia arabica	+	+	-	-	-	-	-	-	+	+	-	-	+	+	-	+	-	-	
4	Pavonia zeylanica	+	+	-	-	-	+	-	-	-	+	-	-	-	+	-	+	-	-	
5	Pavonia grewioides	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	+	-	-	
6	Senra incana	+	+	-	-	-	-	-	-	+	+	-	-	-	+	-	+	+	-	
7	Tribulus rajasthanensis	-	+	-	-	+	-	-	-	+	-	-	+	-	-	-	-	+	-	
8	Fagonia indica var. schweinfurthii	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
9	Zygophyllum simplex	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	
10	Monsonia senegalensis	+	+	-	-	-	-	-	-	+	-	-	-	-	+	+	-	+	-	
11	Indigofera argentea	+	-	+	-	-	-	-	-	+	-	-	+	-	+	-	+	-	-	
12	Helichrysum cutchicum	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	
13	Launaea resedifolia	-	+	-	-	+	-	-	-	+	-	-	-	+	-	+	-	-	-	
14	Heliotropium bacciferum	+	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	
15	Ipomoea kotschyana	+	+	-	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	
16	Seddera latifolia	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	

	TAXA	TRICHOMES	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
17	Schweinfurthia pterosperma																			
18	Chascanum marrubifolium		+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
19	Premna resinosa		+	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-

A Eglandular unicellular conical
B Eglandular unicellular cylindrical
C " " filiform
D " " branched
E " " Hooked
F " uniseriate conical
G Eglandular uniseriate filiform
H " multicellular stellate 2 armed
I " " " 4 armed
J " " " many-armed
K " " tufted
L " Glandular unicellular stalked capitate
M Glandular unicellular stalked clavate
N " " " stalked pellate
O " Bicellular staked capitate
P " uniseriate stalked capitate
Q " " " clavate
R " " " falcate