J. Indian bot. Soc. 63 : 129—147, 1984

CUTICULAR STUDIES OF ASCLEPIADACEAE[1]

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ABSTRACT

The paper describes the cuticular structures of eighteen genera and thirty species belonging to family Asclepiadaceae. Cuticular structures including their appendages have been studied in detail. Important characters of the investigated taxa have been noticed and efforts have been made to identify the species on the basis of these characters.

INTRODUCTION

Cuticular studies of the family Asclepiadaceae have received little attention so far. Stomatal pattern and trichome morphology have been discussed in some detail by Metcalfe & Chalk (1950), Krishnamurthy and Sundaram (1967) and Krishnamurthy & Kannabiran (1970). No published account of their structure and mode of development is available and therefore, authors thought it worth while to study the structure of stomata in some members of the family. Trichome morphology has also been studied in detail. Results of present investigation based on important cuticular characters of the leaves noticed during this study are mentioned here.

MATERIAL AND METHODS

Leaves of the following plants have been used for the present investigations: *Calotropis gigantea* (L.) R. Br., *C. procera* (Ait.) R. Br., *Leptadenia reticulata* Wight & Arn., *L. spartium* Wight, *Hemidesmus indicus* R. Br., *Asclepias curassavica* L., *Cryptostegia grandiflora* R. Br., *Gymnema sylvestre* R. Br. *Oxystelma secamone* (L.) K. Schum., *O. esculentum* R. Br., *O. callophylla* R. Br., *Cynanchum auriculatum* Roy, *C. clavsum* Roy., *Tylophora indica* (Burm. f.) Merr., *T. govanii* Dcne., *T. hirsuta* Wight, *Hoya longifolia* Wall., *Marsdenia Roylei* Wight., *M. tenacissima* Wight & Arn., *Geropegia bulbosa* Roxb., *C. longifolia* wall., *C. wallichii* Wight, *Gongronema nepalense* Dcne., *Pergularia extensa* Dcne., *P. pallida* Wight & Arn., *P. minor* Andr., *Dregea volubilis* Benth., *Stapelia* sp. *L.*, *Daemia extensa* R. Br. and *Sarcostemma brevistigma* Wight & Arn.

Cuticles were obtained by usual maceration methods. Sudan IV and Safranin were used to stain the cuticles which were mounted in glycerine jelly: the margins of coverslips were sealed with Canada Balsam.

DESCRIPTION

Cuticular structures including their appendages of the above mentioned taxa

1. Accepted for publication on April 23, 1983.

We are thankful to Director, National Botanical Research Institute, Lucknow, for providing the herbarium material and to the Director, Birbal Sahni Institute of Palaeobotany for Library facility. We are also thankful to University Grants Commission for financial assistance. Junior author is thankful to Dr. C. L. Verma for helpful suggestions.

have been investigated in detail. Important cuticular characters of these taxa are described below:

Epidermal cells · Upper epidermal cells are usually hexagonal (isodiametric), elongated on the venal region, cells are usually thick and with straight walls. Lower epidermal cells are variable in shape, they may be irregular, polygonal hexagonal. Lower epidermal cells are comparatively less thickened than the upper epidermal cells. Cell-wall may be straight or undulated (sinuous). Cells on the venal region are elongate and comparatively more thickened than the remaining cells. Upper and lower epidermal cells in all the species studied are alike except that the former have more thickened walls. In some, rare instances upper epidermal cells are slightly larger than the lower ones.

In some species of *Pergularia*, thick-walled cells in groups have been observed. Often, cells are arranged in a radiate manner not unlike a trichome base.

Marginal cells are usually much thickened and smaller in size than the cells of the rest of the lamina. The size of epidermal cells varies slightly; upper epidermal cells range between 10-18 × 15-25 μm to 25-30 × 40-50 μm and lower epidermal cells range from 15-20 × 10-25 μm to 30-35 × 40-45 μm.

Thickness of the cuticle: Macerated cuticles yield no detailed information about their thickness. Relative thickness can be judged by Sudan IV stain. It has been observed that stiff cuticles stain deeply, thin cuticles hardly take up any stain while cuticles intermediate in thickness are less stained. To determine the thickness of cuticles transverse sections of three grades of leaves, quite thick thin and intermediate between the two were obtained. The range of thickness varies from 4 to 30 μm for lower epidermis (thin 4 to 8 μm; medium, 6to 15μm thick 12 to 25 μm, very thick, over 25 μm). Similarly thickness for the upper epidermis ranges from 15 to 35 μm (thin 15-20μm, thick 20-30μm and very thick over 30μm).

Stomatal complex : Stomata are confined to lower foliar surface and usually have random distribution and orientation; rarely they are arranged in regular pattern and in clusters. Stomata occur on both the surfaces of leaves in some species of *Ceropegia*, *Marsdenia* and *Hoya*. They are generally absent from the midrib region, rarely however, they occur on midrib and smaller veins. Paracytic stomata are characteristic of the family but both paracytic and anomocytic stomata have been observed in *Leptadenia spartium*, *Cynanchum auriculatum* and *Oxystelma callophylla* and anisocytic type occur in some species of *Hoya* and *Stapelia*.

The guard cell pairs may be almost circular, oval or elongated. It has been observed in most species that cuticle is sometimes thicker over the guard cells and in rare instances over the subsidiary cells than on remaining cells. Guard cells and sometimes subsidiary cells are slightly sunken below the level of the epidermal cells. Guard cells sunken below the plane of epidermal cells are recorded in *Sacrostemma brevistigma*, in species of *Galotropis*, *Ceropegia*, *Hoya* and *Stapelia*. In some species, subsidiary cells divide parallel to the pore twice.

Stomatal abnormalities like degenerated guard cells, single guard cell and contiguous stomata are of common occurrence in the family Asclepiadaceae. Giant stomata commonly occur over small and large veins in some species.

Trichomes : Trichomes are commonly found on both the surfaces of the leaves in genera studied; rarely they occur

only on the lower surface or the marginal region of the leaf. They are irregularly distributed, but in some instances they have regular pattern. In few species they are absent, otherwise, they occur throughout this family. Different types of trichomes recorded here are—

(i) Papillae like
(ii) Unicellular small,
(iii) Unicellular long,
(iv) Uniseriate small, 2 to 4 celled,
(v) Uniseriate long, multicellular,
(vi) Glandular.

Papillae are infrequent but have been observed in some species of *Stapelia, Oxystelma, Pergularia* and *Leptadenia,* unicellular and uniseriate multicellular trichomes are commonly present throughout the family. Glandular trichomes are infrequent and occur mixed with other type of trichomes.

Walls of the trichomes are generally uniform in thickness. It has been observed that the wall of the lower cells is thicker than that of the apical cells of trichomes. Unicellular small trichomes have thin walls. Granular contents are present in the cells of some trichomes, small protuberances are also seen on the trichomes walls in some species.

Trichome bases are usually hexagonal and thickened, rarely rounded. sometimes two or more trichome bases are fused together as in *Calotropis.*

Cuticular striations : Cuticular striations are frequent throughout the family, in rare instances they may be absent. Cuticular striations are seen all over the foliar surfaces in most of the genera studied. In majority of the species they arise either from guard cells or subsidiary cells or from trichome bases. Striations occur in trichome cells also.

Domatia : These are infrequent throughout the family. They occur in both the surfaces of leaf in *Marsdenia tenacissima* and *Pergularia pallida* they are variable in shaped and size.

Hemidesmus indicus Br. (Figs. 1-6).

Stomata occur on the lower surface of the leaf, they are crowded and usually paracytic; upper epidermal cells are hexagonal with slightly thickened walls showing straitions, cells at the venal region are elongated and much thickened; lower epidermal cells are irregular, striaght walled, striations though rare can be seen originating from subsidiary cells of some stomata.

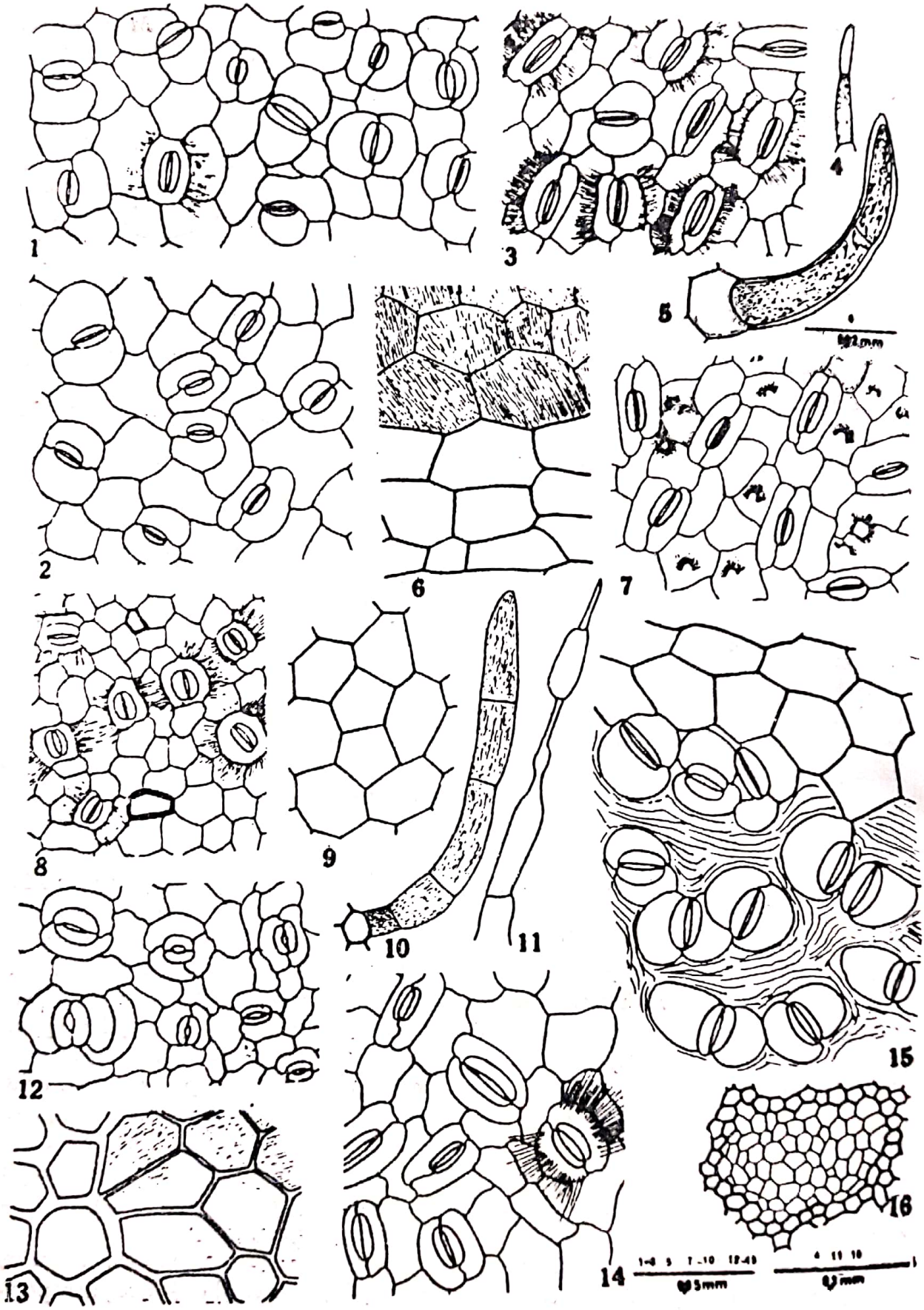
Cryptostegia grandiflora Br. (Figs. 13, 15, 16).

Stomata on the lower surface, much crowded, usually paracytic and striated. Stomata in groups seen in areolar regions only. On the venal regions, cells hexagonal, at places large giant stomata seen; upper epidermal cells hexagonal, thick walled, bounded by heavily thick-walled sclerenchymatous cells; cells in venal region double in thickness compared to the remaining upper epidermal cells; upper epidermal and lower epidermal cells heavely striated, trichomes absent on both the surfaces.

Oxystelma

Three species of this genus viz., *O. secamone, O. esculentum* and *O. callophylla* have been studied for their cuticular structures. *O. esculentum* (Figs. 14, 21, 22, 25). Stomata on lower surface, irregular in distribution, paracytic; upper epidermal cells polygonal, lower epidermal cells irregular or polygonal straight walled; trichomes unicellular long or small, bicelled, papillae like trichomes also seen; cuticular striations common; giant stomata on venal region. *O. secamone* (Figs. 7, 10).

Stomata on lower surface, irregular, paracytic; epidermal cells irregular, poly-



gonal, striaght walled; trichomes, long uniseriate, multicellular, small papillar outgrowth seen throughout the lower leaf surface; cuticular striations common.

O. callophylla (Figs. 12, 19, 20).

Stomata on lower surface, irregular, usually paracytic, rarely anisocytic; epidermal cells irregular with slightly sinuate walls; trichomes absent; cuticular striations rare; stomata of two distinct sizes; giant stomata seen on venal regions.

Calotropis Br.

Cuticular structures of the two species of this genus viz. *C. gigantea* and *C. procera* have been investigated.

C. gigantea (Figs. 17, 24, 30, 59, 63, 64).

Stomata on lower surface paracytic, upper epidermal cell hexagonal straight walled; lower epidermal cells irregular with slightly sinuate walls; trichomes present on both the surfaces, short unicellular or two to four celled; trichome bases hexagonal, sometimes two unite together, cuticular striations common throughout the foliar surface, contiguous and degenerated stomata commonly seen.

C. procera (Figs 41, 46).

Stomata on lower surface paracytic, much crowded; epidermal cells hexagonal or irregular with straight walled; trichomes, short two or four celled; cuticular striations common, contiguous and giant stomata frequently seen .

Daemia extensa Br. (Figs. 38, 47).

Stomata on lower surface, irregular, small, paracytic; epidermal cells hexagonal, straight walled; trichomes long, uniseriate, septate, trichome bases hexagonal, cuticular striations absent.

Asclepias curassavica L. (Figs. 2, 4, 23).

Stomata on lower surface paracytic; walls usually irregular on the lower surfaces, hexagonal on the upper surface, straight walled. Trichomes two-celled, usually long and narrow, occur throughout the foliar surface, basal cell of trichomes with granular contents, cuticular striations absent.

Cynanchum L.

Two species of this genus viz. *C. auriculatum* and *C. claysum* have been investigated.

C. claysum (Figs. 31, 32, 35, 48, 51, 53, 55.)

Stomata on lower surface, paracytic; epidermal cells hexagonal or irregular with straight walls, cells on venal regions, elongated; marginal cells small with thick walls, trichomes unicellular, rarely bicel-

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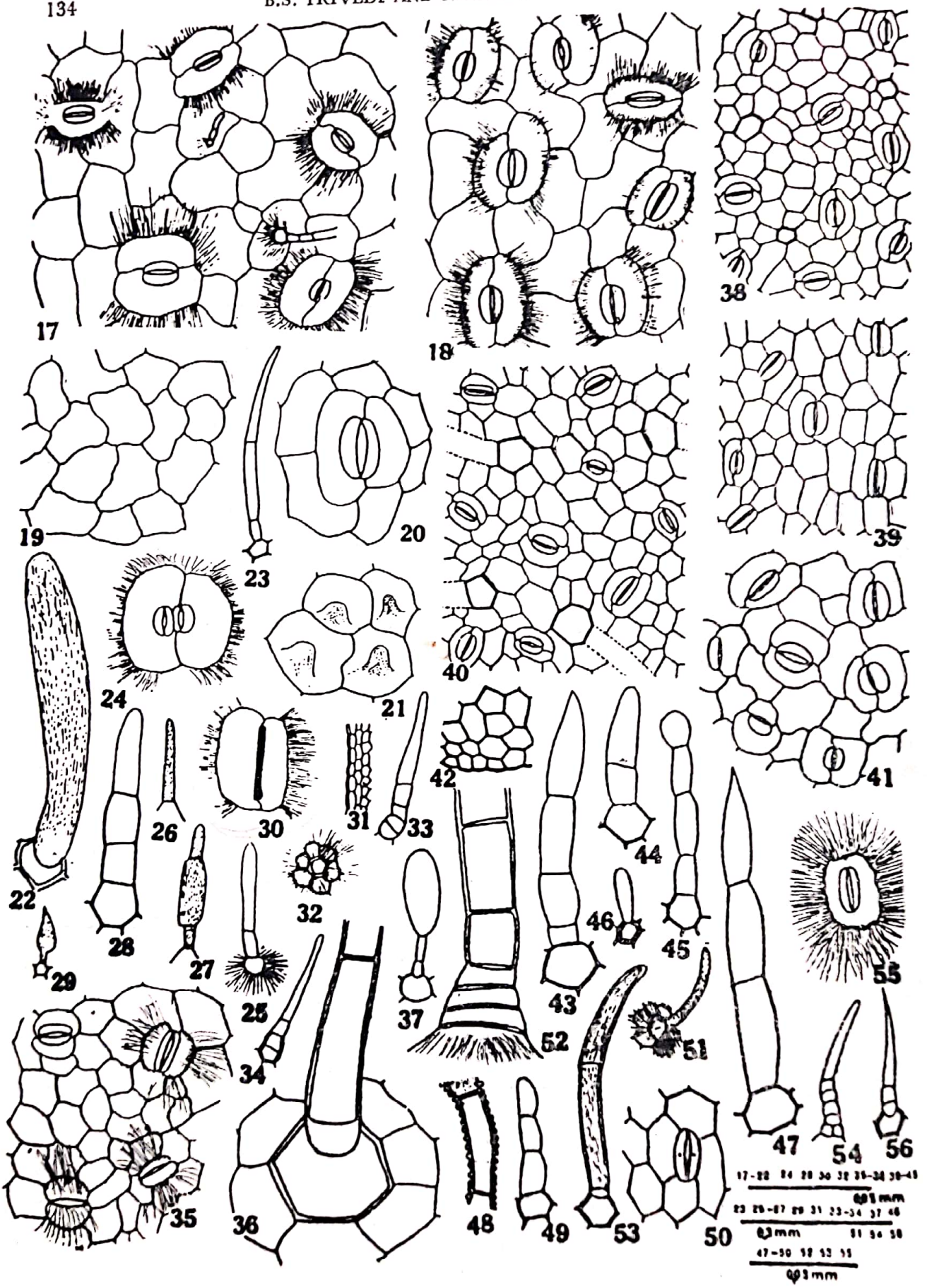
Figs. 1-16. Fig. 1. Lower epidermal cells showing striated stomata of *Hemidesmus indicus*. Fig. 2. Lower epidermal cells and stomata of *Asclepias curassavica*. Fig. 3. Lower epidermal cells and stomata with striations of *Gongronema nepalense*. Fig. 4. Tirchome of *A. curassavica*. Fig. 5. Trichomes of *Leptadenia reticulata*. Fig. 6. Upper epidermal cells of venal region, elongated, intercostal region; hexagonal showing striations of *Hemidesmus indicus*. Fig. 7. Lower epidermal cells and stomata of *Oxystelma secamone*. Epidermal cells showing small papillae. Fig. 8. Lower epidermal cells and stomata showing striations of *Leptadenia reticulata*. Fig. 9. Upper epidermal cells of *Leptadenia reticulata*. Fig. 10. Trichomes of *Oxystelma sucharose*. Fig. 11. Long septate trichome of *Tylophora hirsuta*. Fig. 12. Lower epidermal cells and stomata of *Oxystelma callophylla*. Fig. 13. Much thickened cells on venal region (costal region) showing striations of *Cryptostegia grandiflora*. Fig. 14. Lower epidermal cells and stomata of *Oxystelma esculentum*. Fig. 15. Lower epidermal cells of costal and intercostal region and stomata in groups of *Cryptostegia grandiflora*. Fig, 16. Upper epidermal cells of costal and intercostal region showing thick walled cells of *Cryptostegia grandiflora*.



led; trichome bases hexagonal, thickned; walls of trichomes usually show small protuberances, striations, common throughout the foliar surfaces.

C. auriculatum (Figs. 33, 34, 36, 37, 52, 54, 56).

Stomata on lower surfaces usually paracytic, rarely anomocytic; epidermal cells hexagonal (upper); irregular (lower) with straight walls; trichomes uniseriate, multicellular, terminal cells quite long, glandular trichomes also seen, basal cells show numerous small cells in series, various planes of division seen in trichome bases (Transverse, longitudinal and blique). Cuticular striations originating from subsidiary cells, guard cells and trichome bases occur commonly.

Sarcostemma brevistigma Wight & Arn. (Figs. 39, 45, 49, 50).

Plants leafless. Stomata on the stem, irregular, small, anomocytic rarely paracytic, guard cells at a lower level than the plane of epidermal cells; epidermal cells longer than broad, hexagonal, straight walled; trichomes, uniseriate, septate, glandular, trichome bases hexagonal, thickened; cuticular striations absent.

Gymnema sylvestre Br. (Figs. 57, 60, 106, 116).

Stomata on lower surface, small irregular, paracytic; epidermal cells hexagonal (upper) and irregular or polygonal (lower) with straight walls; trichomes in regular pattern, usually on large but also on small veins, rarely on areolar regions, trichomes, uniseriate multicellular; striations common, arise from subsidiary cells of stomata.

Gongronema nepalense Dene. (Figs. 3, 28).

Stomata on the lower surface, narrow, elongated, paracytic; epidermal cells variously shaped with undulated walls; trichomes distributed all over the leaf surface, uniseriate and multicellular, lower cells of trichomes show thickened walls, top cells remain thinwalled; cuticular striations arising either from guard cells or from subsidiary cells,

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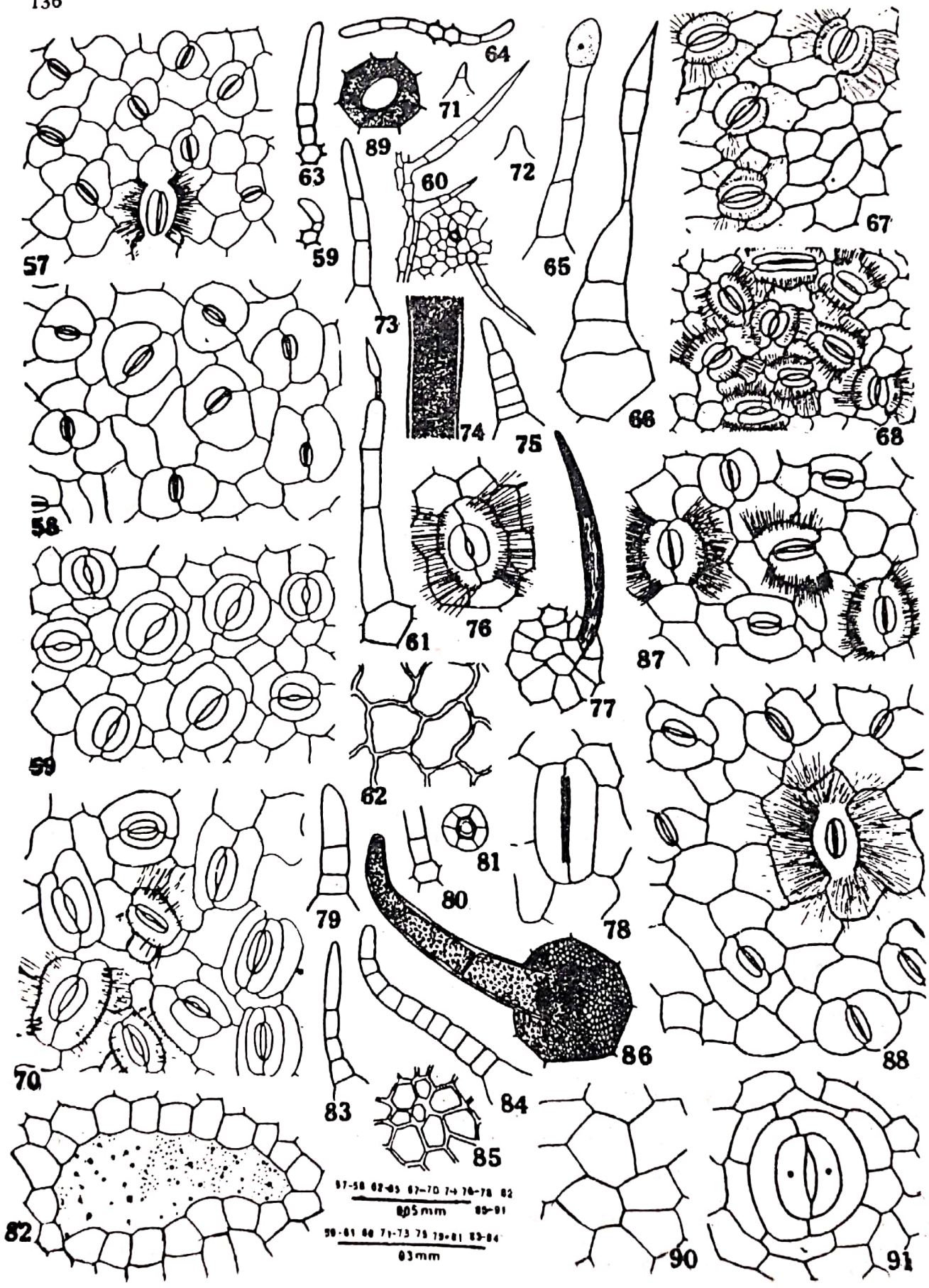
Fig. 17-56. Fig. 17. Lower epidermal cells and stomata showing striations of *Calotropis gigantea*. Fig. 18. Lower epidermal cells and stomata of *Tylophora hirsuta*. Fig. 19. Upper epidermal cells of *Oxystelma callophylla*. Fig. 20. Giant stomata of *O. callophylla*. Fig. 21. Upper epidermal cells showing papillae with striations (*O. esculentum*). Fig. 22, Unicellular trichome of *O. esculentum*. Fig. 23. Trichome of *Asclepias curassavica*. Fig. 24. Contiguous stomata of *Calotropis gigantea*. Fig. 25. Bicelled trichome showing striations of *O. esculentum*. Figs. 26, 27 & 29. Trichomes of *Leptadenia reticulata*. Fig. 29. Trichomes of *Gongronema nepalense*. Fig. 30. Degenerated stomata of *Calotropis gigantea*. Fig. 31. Marginal cells of *Cynanchum clavsum*. Fig. 32. Trichome base of *C. clavsum*. Fig. 33, 34. Basal cell of trichome showing division of *Cynanchum auriculatum*. Fig. 35. Lower epidermal cells and stomata showing striations of *C. clavsum*. Fig. 36. Trichome base of *C. auriculatum*. Fig. 37. Glandular trichome of *C. auriculatum*. Fig. 38. Lower epidermal cells and stomata of *Daemia extensa*. Fig. 39. Epidermal cells and stomata of *Sacrostemma brevistigma*. Fig 40. Epidermal cells and stomata of *Leptadenia spartium* Fig. 41. Lower epidermal cells and stomata of *Calotropis procera*. Fig. 42. Marginal cells of *Leptadenia spartium*. Figs. 43, 44. Trichomes of *L. spartium*. Fig. 45. Glandular trichome of *Sacrostemma brevistigma*. Fig. 46. Unicellular trichome of *Calotropis procera*. Fig. 47, Uniseriate trichome of *Daemia extensa*. Fig. 48. Cells of trichome showing, small protuberances on the surface of *C. clavsum*. Fig. 49. Trichome of *Sacrostemma brevistigma*. Fig. 50. Anomocytic stomata of *S. brevistigma*. Figs. 51, 53 Unicellular and septate trichomes of *C. clavsum*. Fig. 52. Basal cells of trichome showing small cells in series of *C. auriculatum*. Figs. 54, 56, Basal cells of trichomes showing division of various planes of *C. auriculatum*. Fig. 55. Stomata on costal region (venal region) showing striations of *C. clavsum*.



common; degenerated stomata also seen at places.

Marsdenia Br.

Two species of this genus viz. *M. Roylei* and *M. tenacissima* have been studied for their cuticular structures.

M. tenacissima (Figs. 67, 77, 90).

Stomata on lower surface paracytic; epidermal cells hexagonal and straight (upper), irregular with slightly sinuate walls (lower), elongated on the venal regions. Trichomes, unicellular, rarely septed, distributed on both the surfaces, regular on the upper surface; cuticular striations common ; domatia commonly present.

M. Roylei (Figs. 62, 68, 86, 89).

Stomata on the lower surface, rarely on the upper surface, paracytic; epidermal cells hexagonal (upper), irregular with highly sinuate walls, (lower), small, elongated on the margins; trichomes, on both the surfaces. They are regular on the upper surface, uniseriate, multicellular, trichome bases round with granular contents; granular conents also seen in the basal cells of trichomes; cuticular striations common.

Pergularia L.

Cuticular structures of three species of this genus viz. *P. extensa, P. pallida* and *P. minor* have been investigated.

P. pallida (Figs. 80-82, 83, 87).

Stomata on lower surfaces, irregular, paracytic; epidermal cells hexagonal, straight walled, upper epidermal cells quite thick; domatia seen on both the surfaces; cuticular striations common.

P. extensa (Figs. 70, 73, 75, 78).

Stomata on lower surface, irregular, paracytic; epidermal cells hexagonal (upper), irregular (lower) straight walled (upper), sinuate (lower); trichomes either unicellular small or uniseriate multicellular long; cuticular straiations common; stomata with degenerated guard cells frequent.

P. minor (Figs. 69, 76, 85, 91).

Stomata on lower surface, somewhat regular, paracytic; epidermal cells hexagonal, straight walls; trichomes ab-

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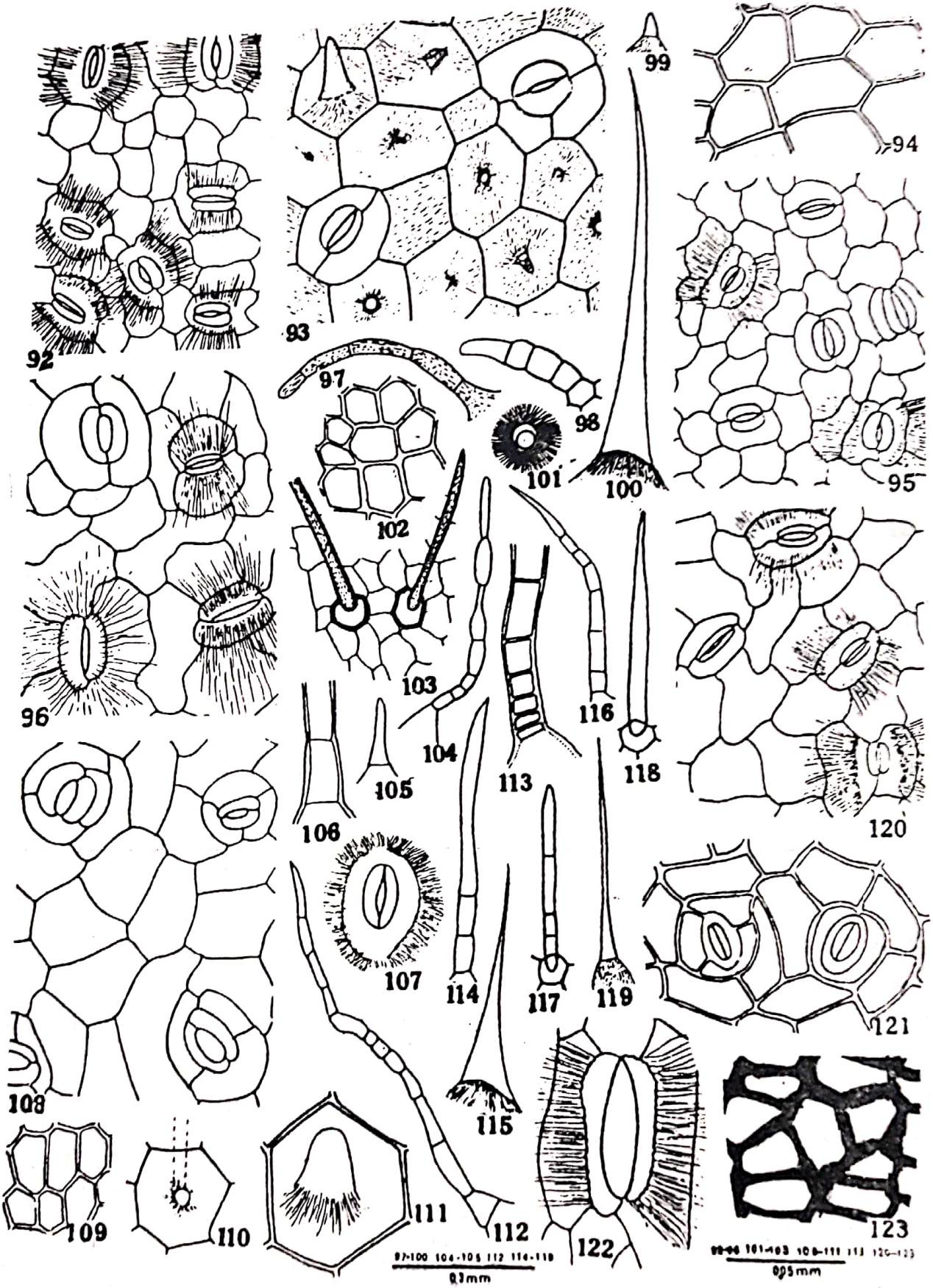
Fig. 57—91. Fig. 57. Lower epidermal cells and stomata of *Gymnema cylvestre*. 58. Lower epidermal cells and stomata of *Dregea vulbilis*. 59. Small trichome of *Calotropis gigantea*. 60. Upper epidermal cells showing striations of *Gymnema sylvestre*. 61. Septate trichome of *Tylophora hirsuta*. 62. Epidermal cells showing sinuate wall of *Marsdenia roylei*. 63. Large trichome of *Calotropis gigantea*. 64. Trichome bases united of *C. gigantea*. 65. Glandular trichome of *T. hirsuta*. 66. Broad basal cell of trichome of *T. hirsuta*. 67. Lower epidermal cells and stomata of *M. tenacissima*. 68. Lower epidermal cells and striated stomata of *M. roylei*. 69. Lower epidermal cells and stomata of *Pargularia minor*. 70. Lower epidermal cells and striated stomata of *Pergularia extensa*. 71,72. Small papillae like trichomes of *P. extensa*. 73,75. Large septate trichome of *P. extensa*. 74. Cells of trichome showing granular contents of *Tylophora hirsuta*. 76. Striated stomata of *Pergularia minor*. 77. Unicellular trichome of *Marsdenia tenacissima*. 78. Degenerated stomata of *Pergularia extensa*. 79. Trichome of *Ceropegia longifolia*. 80. Trichome base along with cells of *Pergularia pallida*. 81. Trichome base of *Pergularia pallida*. 82. Domatia of *Pergularia pallida*. 83. Trichome of *P. pallida*. 84. Trichome of *Ceropegia longifolia*. 85. Thick walled cells at group at places on the foliar surface of *P. minor*. 86. Trichome showing granular content of *M. roylei*. 87. Lower epidermal cells and striated stomata of *P. pallida*. 88. Lower epidermal cells and stomata of *Ceropegia longifolia*. 89. Trichome base with granular content of *Marsdenia roylei*. 90. Epidermal cells showing striaght walls of *Marsdenia tenacissima*. 91. Giant stomata of *Pergularia minor*.



sent, cuticular, striations rare, seen at places arising from subsidiary cells; giant stomata frequent; at places thick-walled cells seen in groups; marginal cells small much thickened.

Tylophora Br.

Three species of this genus viz. *T. hirsuta*, *T. govanii* and *T. indica* have been investigated for thier cuticular structrures.

T. hirsuta (Figs. 11, 18, 61, 65, 66, 74).

Stomata on lower surface, irregular, paracytic, upper epidermal cells hexagonal, thickened, straight walled (lower) irregular, slightly undulated; trichomes, uniseriate, multicellular with broad basal cells, some cells show granular texture; some trichomes glandular, trichome bases hexagonal, thickened, cuticular striations seen all over the surface.

T. govanii (Figs. 92, 101, 103, 117, 118).

Stomata on lower surface, irregular, paracytic; upper epidermal cells hexagonal, straight walled, polygonal or irregular (lower); trichomes long unicellular, or uniseriate, multicellular, crowded on the margins and on upper surface, trichome bases rounded; cuticular striations common and frequent all over the surfaces.

T. indica (Figs. 102, 112, 113, 114, 120).

Stomata on lower surface, irregular, narrow, paracytic; upper epidermal cells hexagonal, thick-walled, lower irregular or polygonal, straight walled; trichomes narrow, long, uniseriate, multicellular, basal cells show series of small cells, apical cells long and pointed, trichome bases hexagonal ; cuticular striations present all over the surface.

Dregea volubilis Benth. (Figs. 58, 98, 107).

Stomata only on the lower surface, paracytic, rounded, in appearance, crowded and irregular in distribution; epidermal cells irregular with undulating walls; trichomes distributed all over the surface, small uniseriate, sepatate, cells of the trichome thick-walled, except the terminal one; trichome base hexagonal, wall considerably thickened; striations present particularly on the venal regions.

Hoya Br.

Two species of the genus viz. *H. longifolia* and *H. parasitica* have been studied.

Fig. 92—123. Fig. 92. Lower epidermal cells and striated stomata of *Tylophora govanii*. 93. Lower epidermal cells and stomata of *Stapelia* sp. 94. Upper epidermal cells of *Hoya longifolia*. 95. Lower epidermal cells and stomata of *Ceropegia wallichii*. 96. Lower epidermal cells and striated stomata of *Ceropegia bulbosa*. 97. Trichome of *Ceropegia bulbosa*. 98. Trichome of *Dregea volubilis*. 99, 100, 105, 119. Small papillae and long unicellular trichomes of *Stapelia* sp 101. Rounded trichome base showing striations of *Tylophora govanii*. 102. Upper epidermal cell *Tylophora indica*. 103. Upper epidermal cells showing trichome of *T. govanii*. 104. Trichome of *Ceropgeia wallichii*. 106. Cell wall of trichome of *Gymnema sylvestre*. 107. Striated stomata of *Dregea volubilis*. 108. Lower epidermal cells and stomata of *Hoya longifolia*. 109. Upper epidermal cells of *Hoya parasitica*. 110. Trichome base showing striations of *Stapelia* sp. 111. Small papillae showing striations of *Stapelia* sp. 112. Septate long trichome of *T. dica*. 113. Basal cell showing small cells in series of *T. indica*. 114. Uniseriate, septate trichome of *T. indica*. 115. Unicellular long trichome of *Staopelia* sp. 116. Uniseriate, septated trichome of *Stapelia* sp. 116. Uniseriate, septated trichome of *Gymnema sylvestre*. 117. Septate trichome of *T. govanii*. 118. Unicellular trichome of *T. govanii*. 120. Lower epidermal cells and striated stomata of *T. indica*. 121. Lower epidermal cells and stomata of *Hoya parastica*. 122. Giant stomata of *Ceropegia bulbosa*. 123. Thi- Thickened cells of venal region of *H. parasitica*.

H. longifolia (Figs. 94, 108, 123).

Stomata on both the surfaces more on the lower surface; irregular anisocytic; epidermal cells hexagonal, thickened, striaght walled much thickened on the venal regions; trichomes absent; cuticular striations not seen.

H. parasitica (Figs. 109, 121).

Stomata on both the surfaces, less on the upper surface, irregular, anisocytic rarely paracytic; epidermal cells hexagonal, thickened, straight walled; trichomes absent; cuticular striations absent.

Leptadenia Br.

Two species of this genus have been studied.

L. reticulata (Figs. 5, 8, 9, 26, 27, 29).

Stomata on the lower surface, paracytic; upper and lower epidermal cells thickened; trichomes distributed all over the foliar surfaces, much frequent on the venal region, short, narrow, unicellular or two or three celled; thick-walled cells in group of 3 or 4 seen at places on the lower surface; cuticular striations common throughout the foliar surfaces.

L. spartium (Figs. 40, 42-44).

Plants leafless. Stomata on stem in depressions, formed by thickened outer epidermal cells, small, irregular, paracytic, epidermal cells hexagonal thickened, straight walled, small much thickened on the margins; trichomes all over the surfaces, uniseriate, two to multicellular, in some trichomes top cells show granular contents, trichome bases hexagonal; cuticular striations rare.

Ceropegia

Three species of this genus viz. *C. wallichii*, *C. longifolia* and *C. bulbosa* have been studied.

C. bulbosa (Figs. 96-97, 122).

Stomata on both the surfaces, higher frequency on the lower surface, irregular, quite large, paracytic; upper epidermal cells hexagonal, lower irregular or various shape, straight walled; trichome,uniseriate, multicellular confined to the margins and larger veins; cuticular striations frequent all over the surface; giant stomata present on the veins.

C. wallichii (Figs. 95, 104).

Stomata on both the surfaces, more frequent on the lower surface, irregular, small paracytic; epidermal cells hexagonal; upper epidermal cells straight walled with various shapes, while lower epidermal cells irregular, slightly sinuate; trichomes uniseriate, septate, all over the surface; cuticular striations confined to trichomes and stomata.

C. longifolia (Figs. 79, 84, 88).

Stomata on both the surfaces, less on the upper surface, small, irregular, paracytic; upper epidermal cells hexagonal, lower epidermal polygonal, straight walled; trichomes throughout the surface, uniseriate, multicellular, squarish cells; cuticular striations confined to stomata.

Stapelia sp. L. (Figs. 93, 99, 100, 105, 109, 110, 111, 115).

Stomata on the lower surface, usually paracytic rarely anisocytic, wall of guard cells quite thick; epidermal cells are usually hexagonal with straight and thick walls; trichomes distributed all over the foliar surface; small to quite long, usually unicellular; sometimes quite stiff, trichome small papillate; trichome bases

usually round; cuticular striations common throughout the foliar surfaces.

DISCUSSION

Plants belonging to the family Asclepiadaceae are mostly shrubs or herbs. This family is placed close to Apocynaceae with which it has many features in common. Leaves in all the taxa of this family are dorsiventral except in *Ceropegia*, *Hoya* and *Marsdenia* where they are isobilateral. Sabnis (1921) reported the occurrence of isobilateral levaves in *Leptadenia spartium* also. According to Metcalfe and Chalk (1950) stomata in this family are paracytic, but anisocytic type have been recorded in some species of *Hoya* and *St petia*. Anomocytic stomata have been observed in *Sacrostemma* by Sayeeduddin and Suxena (1940). "Tradescantia type" of stomata have been reported in *Stapelia* by Sayeeduddin and Suxena (1940). Trichomes are usually unicellular, small or long, uniseriate and multicellular in most of the species. Glandular trichomes are also recorded in some taxa (Metcalfe & Chalk, 1950).

In the present investigation we have studied cuticular structures of 18 genera and 30 species belonging to this family (Table I). Previous to this investigations Krishnamurthy and Sundaram (1967) studied foliar epidermis in the following five plants of this family *Calotropis gigantea* R. Br., *Leptadenia reticulata* Wight & Arn., *Daemia extensa* R. Br., *Hemidesmus indicus* R. Br. and *Telosoma minor* Graib. These authors investigated cuticular structures in relation to their pharmacognostic importance. Therefore, their observations are not very convincing.

The family Asclepiadaceae is divided into the following tribes by Bentham & Hooker (1876):

Tribe I. Periploceae —*Hemidesmus, Cryptostegia, Oxystelma* (*Periploca*)

Tribe II. Cynancheae —*Calotropis, Asclepias, Cynanchum, Sacrostemma, Daemia.*

Tribe III. Marsdenieae —*Gymnema, Gongronema, Tylophora, Marsdenia, Pergularia, Hoya, Dregea*

Tribe IV. Ceropegieae —*Leptadenia, Ceropegia*

Tribe V. Stapelieae —*Stapelia* sp.

Engler & Prantl (1897) divided the family Asclepiadaceae as under :

Sub-family-Periplocoideae

Tribe I Periploceae —*Hemidesmus, Cryptostegia, Oxystelma* (*Periploca*).

Sub-family II Cynanchoideae

Tribe 2 Asclepideae

Sub-tribe I Glossonematineae—*Oxystelma*

II Asclepiadineae—*Asclepias, Calotropis*

III Cynanchinae—*Cynanchum, Sarcostemma, Daemia*

Tribe 3 Tylophoreae

Sub-tribe I Ceropeginae—*Leptadenia, Ceropegia, Stapelia.*

Sub-tribe II—Marsdeniinae—*Gymnema, Tylophora, Marsdenia, Dregea, Pergularia, Hoya.*

Genera like *Calotropis, Asclepias* and *Cynanchum* are placed in the tribe Cynancheae by Bentham and Hooker (1876), but Engler and Prantl place the first two genera in the sub-tribe Asclepiadineae while the last genus is kept under subtribe Cynanchieae.

The three genera *Calotropis, Asclepias* and *Cynanchum* have generally paracytic stomata which are restricted to the

TABLE

SOME IMPORTANT MICROSCOPICAL EPIDERMAL

Name of Species	STOMATA						EPIDERMAL
	Upper	Lower	types	Stomatal size in µm.	Stomatal frequency per mm²	Stomatal index	Size of epidermal cells in µm
Hemidesmus indicus R. Br.	—	+	Pa	25–30 × 30–35	560	44	20 × 25
Cryptostegia grandiflora R. Br.	—	+	Pa	35 × 35	385	27	25 × 35
Oxystelma esculentum R. Br.	—	+	Pa	30 × 40	582	28	25 × 35
O. secamone (L) K. Schum	—	+	Pa	20 × 35	440	28	20 × 30
O. callophylla	—	+	Pa, Anis.	25 × 30	700	40	20 × 30
Calotropis gigantea (L.) R. Br.	—	+	Pa	35 × 40	275	22	20–30 × 20–35
C. procera (Ait) R.Br.	—	+	Pa	20 × 25	548	38	15 × 20
Daemia extensa R.Br.	—	+	Pa	15 × 20	440	26	10 × 20
Asclepias curassavica L.	—	+	Pa	25 × 25	405	27	20 × 30
Cynanchum claviun Jacq.	—	+	Pa	40 × 45	236	43	15 × 20
C. auriculatum Royle	—	+	Pa, An.	30 × 35	600	45	20 × 25
Sacrostemma brevistigma	—	+	Pa, An.	15 × 20	324	24	12 × 20
Gymnema sylvestre R. Br.	—	+	Pa	20 × 25	485	28	20 × 25
Gongronema nepalense Decne.	—	+	Pa	20 × 35	560	30	15 × 25
Marsdenia tenacissema Wight & Arn.	—	+	Pa	20 × 25	322	28	12 × 18
M. Roylii Wight.	Rarely +	+	Pa	15 × 20	600	38	15 × 20
Pergularia pallida Wight and Arn.	—	+	Pa	25 × 30	480	29	15 × 25

I

CHARACTERS OF THE FAMILY ASCLEPIADACEAE

CELLS				TRICHOMES	SPECIAL CHARACTER
Wall structure					
Straight wall	Slightly sinuate	Sinuous walls	Cuticular striations		
+	—	—	Rare	Absent	Absence of Trichomes throughout the foliar surface.
+	—	—	Common	—	Trichome absent Stomata in groups.
+	—	—	Common	Trichome long, unicellular or uniseriate 120-150 μm long.	Papillae small throughout the surface.
+	—	—	Common	Trichome long & septated 150-200 μm.	Small papillae throughout the surface.
—	+	—	Rare	—	Trichomes & Papillae absent.
Upp+	Low+	—	Common	15-50 μm long short septated.	Degenerated stomata, contiguous stomata common, trichome base united.
Upp+	Low+	—	Common	Unicelluar short, 20-25 μm long.	Stomata crowded, single guard cell stomata frequent.
+	—	—	—	Trichome septated 100-150 μm long.	Striations absent stomata small.
+	—	—	—	Narrow, uniseriate, septated 200-400 μm long.	Striations absent throughout.
+	—	—	Common	80 to 100 μm long, unicellular or septated.	Striated stomata common, trichome cells have small protuberances.
+	—	—	Common	Septated long, 300-400 μm long.	Basal cell of trichome shows small cells in series.
+	—	—	Rare	Septated 50 to 100 μm long.	Glandular trichome seen at places, guard cell below the plane of epidermal cell.
+	—	—	Common	Trichome long, septated 150-550 μm, smooth walled.	Trichomes in regular pattern.
+	—	—	Common	Septated short, 70-100 μm lower cells thick walled.	— —
Upp+	Low+	—	Common	Unicellular trichomes 80-100 μm long.	Domatia commonly present.
—	—	+	Common	Trichomes septated short 80-120 μm long granular content present.	Trichomes throughout, base rounded.
+	—	—	Common	Long septated 200-300 μm long.	Domatia present.

TABLE I

Name of Species	STOMATA						EPIDERMAL
	Upper	Lower	types	Stomatal size in µm.	Stomatal frequency per mm²	Stomatal index	Size of epidermal cells in µm
P. extinsa	—	+	Pa	30×35	460	28	15×30
P. minor Andr.	—	+	Pa	30×30	236	24	15×20
Tylophara hirsuta Wight	—	+	Pa	27×36	500	28	20×25
T. govanii Decne.	—	+	Pa	29×32	582	40	20×30
T. indica (Burmf) Merr.	—	+	Pa	25×25	305	25	20×35
Dregea volubilis Benth.	—	+	Pa	30×36	500	30	15×30
Hoya longifolia Wall.	+ rare	+	Anis	37×42	195	29	35×50
H. parasetica	+	+	Anis & Pa	35×40	152	33	20×35
Leptadenia reticulata Wight & Arn.	—	+	Pa	20×25	410	27	10×15
L. spartinum	—	+	Pa	10×15	513	38	15×20
Ceropegia bulbosa Roxb.	+	+	Pa	L.40×45 U.35×40	263	23	25×35
C. Wallichii Wight	+	+	Pa	L.25×35 U.20×30	250	27	20×25
C. longifolia Wall.	+	+	Pa	L.25×30 U.20×20	472	28	25×30
Stapelia sp.	—	+	Pa & Anis	40×50	168	16	30×40

—, absent; +, present; UPP, upper; Low, Lower; Pa, Paracytic; An, Anomocytic; Anis, Anisocytic.

—(*Contd.*)

CELLS				TRICHOMES	SPECIAL CHARACTER
Wall structure					
Straight wall	Slightly sinuate	Sinuous walls	Cuticular striations		
Upp+	Low+	—	Common	Small, unicellular, papillae like.	Degenerated guard cells stomata common, papillae also seen.
+	—	—	rare	—	Giant stomata seen at places thick walled cells also seen.
Upp+	Low+	—	Common	Trichomes quite long 700-950 μm septated basal cell of the trichome broad.	Glandular trichomes cells show granular contents.
+	—	—	Common	Trichome long, uniseriate septated 700-800 μm.	Basal cell of trichome shows series of cells.
+	—	—	Common	Trichomes unicellular or septated, short 100-120 μm long.	Trichome bases rounded.
—	+	—	Rare	Trichomes short, septated 50-70 μm long.	Striated stomata seen on venal region basal cell of trichome thickened.
+	—	—	—	—	Stomata anisocytic large, veins quite thick.
+	—	—	—	—	Cells uniformely thickened.
+	—	—	Common	Uniseriate, septated or unicellular small 100-180 μm long.	— —
+	—	—	rare	Septated 50-100 μm long	Marginal cells quite small & thickened.
+	—	—	Common	Trichomes only on the marginal region, 100-300 μm long.	Stomata large trichome marginal, giant stomata common.
Upp+	Low+	—	Common	Trichomes uniseriate long, septated, 500-600 μm	Trichomes throughout surface.
+	—	—	Less frequent	trichome septated cells squarish, 200-300 μm long	Striations rare, seen originating from subsidiary cells.
+	—	—	Common	Trichome small to long unicellular, 50-100 μm long, 1 to 1.5 μm.	Trichomes throughout surface spiny in appearance.

lower foliar surface. *Calotropis* and *Asclepias* have similar stomata and trichomes but cuticular striation seen in *Calotropis* are absent from *Asclepias*, though *Cynanchum* has distinct cuticular striations. Thus it has been observed that these three taxa have common cuticular characters and have been rightly placed by Bentham and Hooker (1876) under the tribe-Cynancheae.

Similarly, the genus *Stapelia* is kept in tribe Stapelieae by Bentham and Hooker (1876), while Engler and Prantl placed this taxon with *Leptadenia* and *Ceropegia* in the sub-tribe Ceropegiineae; the latter two genera are placed in a separate tribe, Ceropegieae by Bentham and Hooker (1876). Genus *Stapelia* can be easily separate from the other two genera on the basis of its cuticular characters, as it has paracytic and anisocytic stomata, trichomes are long; while the short ones are spiny. Papillae and cuticular striations occur throughout the foliar surface and the epidermal cells are much thickened. *Ceropegia* and *Leptedenia* have similar stomata, striations and trichome morphology, however, the former has amphistomatic leaf while the latter has hypostomatic leaf. As stated above, the genus *Stapelia* has distinctive cuticular characters and was rightly placed in separate tribe-Stapelieae by Bentham and Hooker. This classification thus gets support from cuticular studies.

Sub-family Periplocoideae has been treated as a separate family Periplocaceae by Hutchinson (1959). Santapau and Irani (1960). Mulary *et al.* (1965) supported the separation of Periplocoideae as a distinct family on the basis of floral anatomy and embryology. According to these authors the two sub-families Periplocaceae and Cynanchoideae on the basis of presence or absence of pollinium, floral morphology, anatomy and embryology, justify the separation into Periplocaceae, and Asclepiadaceae proper. Takhtajan (1969) places the family Asclepiadaceae under the order Gentianales and includes the newly created family Periplocaceae within Asclepiadaceae. Present author's observations based on cuticular characters confirm the retention of Periplocaceae under the family Asclepiadaceae. The cuticular structures of the two sub-families are very similar to each other and hardly show any distinctive features to merit separation.

The families Asclepiadaceae and Apocynaceae are closely placed and they share many features. Of these, the most important are the universal occurrence of lacticiferous tubes in stems and leaves and the presence of intraxylary phloem. Hairs are mostly simple, unicellular or multicellular uniseriate, infrequently glandular. Leaf is dorsiventral or isobilateral, stomata are frequently paracytic.

Our studies show that these two families which are otherwise very close to each other can be separated on the basis of cuticular characters (Trivedi & Upadhyay, 1973, 1974, & 1977) It. has been observed that Asclepiadaceae is characterised by thick cuticle, thick-walled epidermal cells, and cuticular striations which are commonly present in all the taxa studied except in a few species where they are less frequent while Apocynaceae is characterised by thin cuticule, walls of epidermal cells are either straight or sinuate with cuticular striations; rarely these can be seen originating from subsidiary or guard cells.

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