

TRICHOME STUDIES OF PLANT IN FAMILY STERCULIACEAE***A.S PARIHAR AND VAIBHAV MISHRA**

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Received : 18.08.2018; Accepted : 01.10.2018**ABSTRACT**

The present study is aimed to examine the significance of trichome structure and their organographic distribution for taxonomic delimitation in the taxa of family sterculiaceae. Ten species belonging to 8 genera viz. *Buettneriaherbacea*, *Erioleanahokkeriana*, *Helicteresisora*, *Melhaniahiltoniana*, *Melhaniafuttyporensis*, *Melhaniatometa*, *Melochiacorchorifolia*, *Pterospermumacerifolium*, *Sterculiaurens*, *Waltheria indica* were selected. Total 29 trichomes types recognized during present investigation. Out of which, 27 belong to non-glandular and to glandular once. Some type are common and found in most of the taxa viz. unicellular flagellate, uniseriate conical and stellate multi-radiate whereas unicellular papillose, unicellular cylindrical, bi-cellular filiform, bi-cellular aseptate flagellate, uniseriate conical, uniseriate hooked, uniseriate curved, uniseriate aseptate flagellate, peltate, glandular flagellate and uniseriate glandular capitate appeared quite significant to a particular species for taxonomic delimitation in Sterculiaceae.

Figures : 97

References : 36

Tables : 02

KEY WORDS : Organographic distribution, Sterculiaceae, Taxonomic significance, Trichome

Introduction

Angiosperm show diverse epidermal characters, particularly trichomes after co-related with Taxonomic delimitation. The use of the trichome in taxonomy is well known and it has been suggested by several investigators that the trichomes can be utilized as an effective taxonomic tool in distinguishing between Genera and species workers^{13,31,32}.

A worker⁶ has used precise terminology for the first time during the studies of trichomes in *Rhododendrone*. Another worker²⁷ gave the polynominal names to the trichomes. Recently a stress on need to use of precise terminology in describing the trichome is being given by taxonomists³¹.

Of the several classification of mature trichome available in the literature, the one presented²⁷ in connection with the trichomes of compositae, is the most natural one as it is also close to ontogenic classification of trichomes presented by the same author. First and the most concise publication on the hair terminology is given²⁴.

It has already been established that trichomes often play very significant role in taxonomic consideration. They show very significant role in taxonomic consideration. They show wide range of variations in their shape, size and base structure within a genus. But when they are of characteristic form and restricted to a species, they can serve as a means of distinction among the

species. A considerable interest seems to have been created in studying the plant. Trichomes lead to accumulation of much data in many groups or families of the angiosperms viz. compositae²⁵, Aizoaceae²⁶, Gesneriaceae³⁰, Capparidaceae^{3,8}, Labiatae³⁶, Tiliaceae²⁹, Tiliaceae³⁴, Bombacaceae³³, Solanaceae¹, Bombacaceae⁷, Bombacaceae³⁵, Astraceae¹⁶, compositae¹⁴, Astraceae⁴

Although trichome vary in structure within larger and smaller group of plant, they are remarkably uniform and may be used for taxonomic purpose⁶. In view of this, workers⁹ have emphasized the great need for detailed study of trichome on different organs in various plant groups to establish homology.

Order Malvales is a large group comprising families of tremendous diversity in their taxa. Hence, in present study taxa of one of the family of order Malvales, Sterculiaceae are taken in to consideration for their trichome significance in relation to taxonomy. Sterculiaceae is a family of tropical and sub-tropical plant of large and small trees, shrubs and climbers.

Earlier a worker¹⁷ reported 8 genera and 12 species, whereas other²³ reported only 6 genus and 6 species from central India. Later on, other worker²¹ in his extensive survey reported 11 genus and 15 species from central India.

A comparative study was undertaken on trichome structure and distribution in order to assess their role in

TABLE-1: Species wise distribution of trichomes in the family sterculiaceae

TAXA													
OUTS No.	Names of Trichomes	Code	<i>Buettheria herbacea</i>	<i>Erioleana Hokkeriana</i>	<i>Helicteres isora</i>	<i>Melhania futtyporensis</i>	<i>Melhania hamiltonia</i>	<i>Melhania tometoa</i>	<i>Melochia corchorifolia</i>	<i>Pterospermum acerifolium</i>	<i>Sterculia-urens</i>	<i>Waltheria indica</i>	Occurrence %
1	Unicellular filiform	A			+		+				+	+	40
2	Unicellular flagellate	B			+	+	+	+	+	+	+	+	80
3	Unicellular conical	C	+	+	+	+	+	+	+		+		80
4	Unicellular Curved	D		+	+				+	+			40
5	Unicellular Dentate	E										+	10
6	Unicellular Hooked	F					+		+	+	+		40
7	Unicellular acerate	H			+	+				+		+	40
8	Unicellular Papillose	I		+									10
9	Unicellular cylindrical	J		+									10
10	Bi-cellular filiform	NI							+	+			20
11	Bi-cellular curved	NII	+		+			+					30
12	Bi-cellular conical	NV				+				+	+		30
13	Bi-cellular hooked	NVI					+	+		+			30
14	Bi-cellular aseptate flagellate	NVIII					+						10

species identification and to evaluate their taxonomic significance in 10 species belonging to 8 genera.

Material and Methods

In present study, total 10 species belonging to 8 genera were collected from central India. Hence, these 8 genera were considered for the study of trichome structure, distribution and taxonomic significance at species level.

Trichomes were studied in epidermal peels of different plant parts. Mature trichomes were taken into consideration for their types and distribution. Epidermal peels of both fresh as well as herbarium materials were taken out for trichome study- following the standard method¹⁵. Both vegetative and floral parts of each species were initially boiled for a minute in 20% glacial acetic acid followed by 5%NaOH. After cooling, the materials were washed in water to free it from alkali.

Trichome structure were studied under the compound microscope and camera Lucida diagrams were drawn. Nomenclature of trichome types were studies²³.

Result and Discussion

In the Malvales, foliar epidermal characters of the sterculiaceae are little known²⁰. Recently, a few papers have dealt with trichomes of certain taxa of sterculiaceae^{5,10,11,12,18,19,22,29}

A worker²⁹ established the structure and organographic distribution of trichome in eleven species of the sterculiaceae. He recognised 21 types of trichome and clustered them into five categories viz. unicellular trichome, uni-seriate filiform trichome, uni-seriate macroform trichome, bi-seriate trichome and multi-seriate trichome. In present study 10 species belonging to 8 taxa of sterculiaceae are taken into consideration. They are *Buettneriaherbacea*, *Erioleanahokeriana*, *Helicteresisora*, *Melhaniahamiltoniana*, *Melhaniafuttyporensis*, *Melhaniatometa*, *Melochiacorchorifolia*, *Pterospermumacerifolium*, *Sterculiaurens*, *Waltheriaindica*.

In all 29 trichome types were recorded during the investigation. Basically they are distinguishable into unicellular, bi-cellular, uni-seriate, peltate. Stellate and glandular hairs. Out of twenty nine types, 27 belong to non-glandular categories.

In present study not only unicellular form, but many bicellular, uniseriate, stalked, stellate, peltate, among non-glandular and glandular capitate, bi-cellular glandular capitate, uniseriate glandular tipped and bi-seriate glandular forms among glandular types have also been observed as taxonomic markers²⁴.

The perusal of the Tables (1-2) reveals that some types are common and found in most of the taxa, viz.

Unicellular flagellate, unicellular conical and stellate multi-radiate (80% occurrence). Whereas others are, less common on certain vegetative and floral parts, proved their taxonomic value at inter-generic and inter-specific level.

The number of trichomes types observed in a species range between seven and eleven. *Buttheriaherbacea*, bearing minimum number of trichome, can readily be distinguished from rest genera investigated. Presence of trichome complex C, NI, OIV, QI, QII and QIV on stem; C, NII, QI on stipule; C, NII on petals and C, NII, OIV on fruit wall provide it taxonomic identity. (Figs:1-6)

A worker²⁹ recognized six types of trichomes in *Eriolaenahookeriana*. Stellate multiradiate hairs further categories into septate tufted and aseptate. But presently these two types are considered to represent a single type^{2,25}.

In the present study total eleven types of trichomes were recorded both on vegetative and floral parts of *Eriolaenahookeriana*. Among these unicellular cylindrical, uniseriate hooked, unicellular papillose, unicellular curved and uniseriate glandular capitate are new record, not only for this taxa but also Sterculiaceae. (Figs:7-17). Moreover, restricted occurrence and identical organographic distribution of trichome I, J, OIV and W give it separate taxonomic status in present study and stand quite distinct in having four unicellular types viz. unicellular filiform, unicellular conical, unicellular curved, unicellular flagellate, unicellular and four stellate types viz. bi-radiate, tri-radiate; tetra radiate and multi radiate hairs. (Figs:18-28)

Three species of *Melhania* i.e. *M.futtyporensis*, *M.hamiltonia* and *M.tomentosa* clearly differ from rest of the studied taxa as well as from each other in trichome complements and their organographic distribution.

M.futtyporensis shows varying distribution of unicellular acerate, bi-cellular conical, uniseriate curved and uniseriate aseptate flagellate types on stem, leaf, bract, petal and even fruit wall. These are not recorded from rest two species. *M.hamiltoniana* and *M.tomentosa* both share bi-cellular hooked, uniseriate cylindrical, uniseriate septate flagellate and stellate multiradiate as common trichome types. However former species stand quite identical having restricted occurrence of bicellule aseptate flagellate and peltate trichome among all considered taxa. (Figs:29-59)

Frequent occurrence of a trichome complex eight types of non-glandular hairs i.e. unicellular flagellate, unicellular conical, unicellular curved unicellular hooked, bi-cellular filiform, stellate multi radiate in tetra-radiate and stellate multi radiate in *Melochiacorchorifolia*, and ten types viz. B, D, F, H, NI, NV, NVI, OII, QIII, QIV In *pterospurmacerifolium*, make them quite distinct from the other taxa. (Figs:60-79)

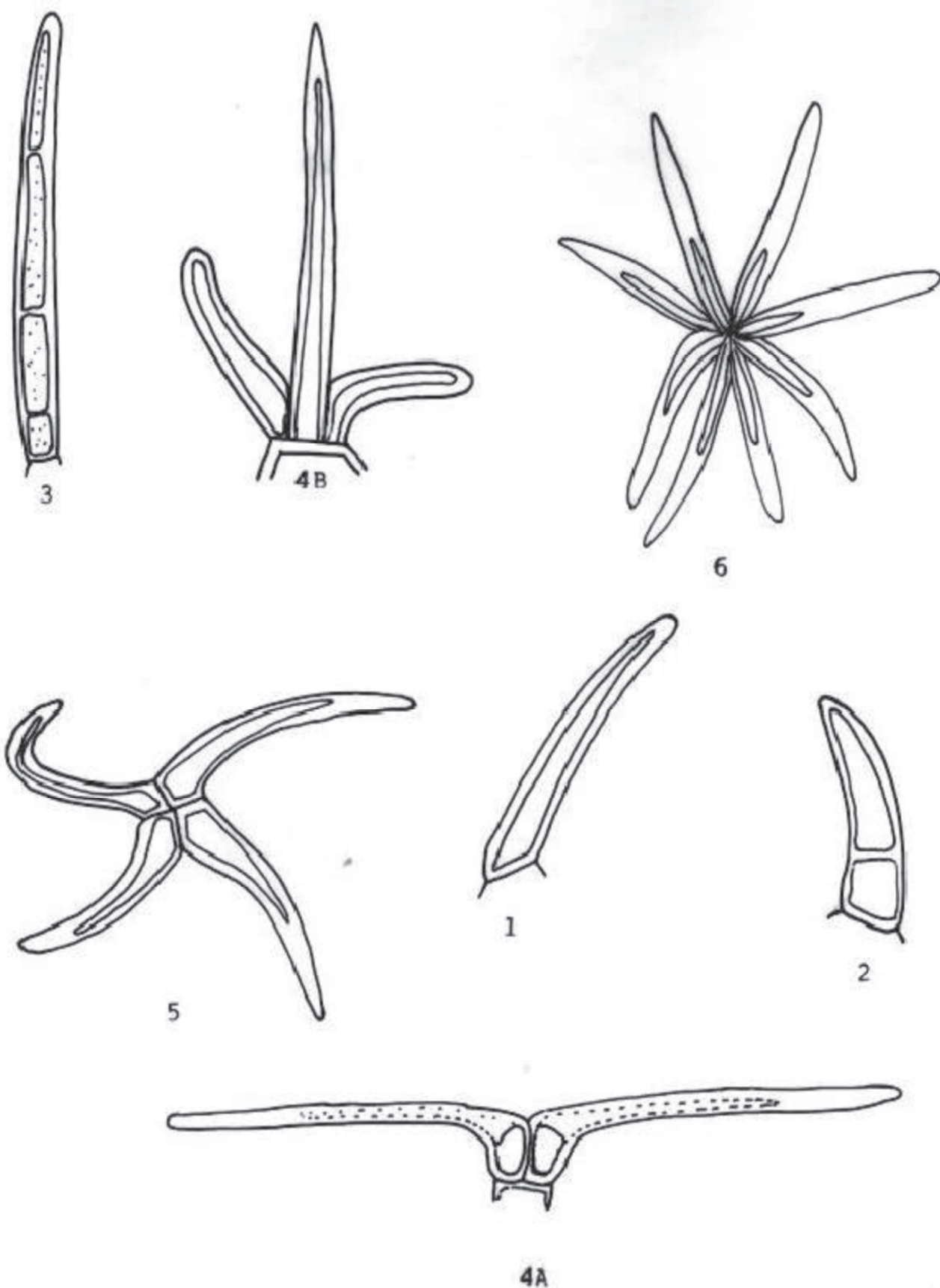


Plate – 1

Buettneria herbacea (Figs: 1-6) : 1. Unicellular conical, 2. Bicellular curred, 3. Uniseriate filiform, 4. (a) Stellate Bi-radiate, 4. (b) Stellate Tri-radiate, 5. Stellate – Tetra radiate, 6. Stellate Multi radiate

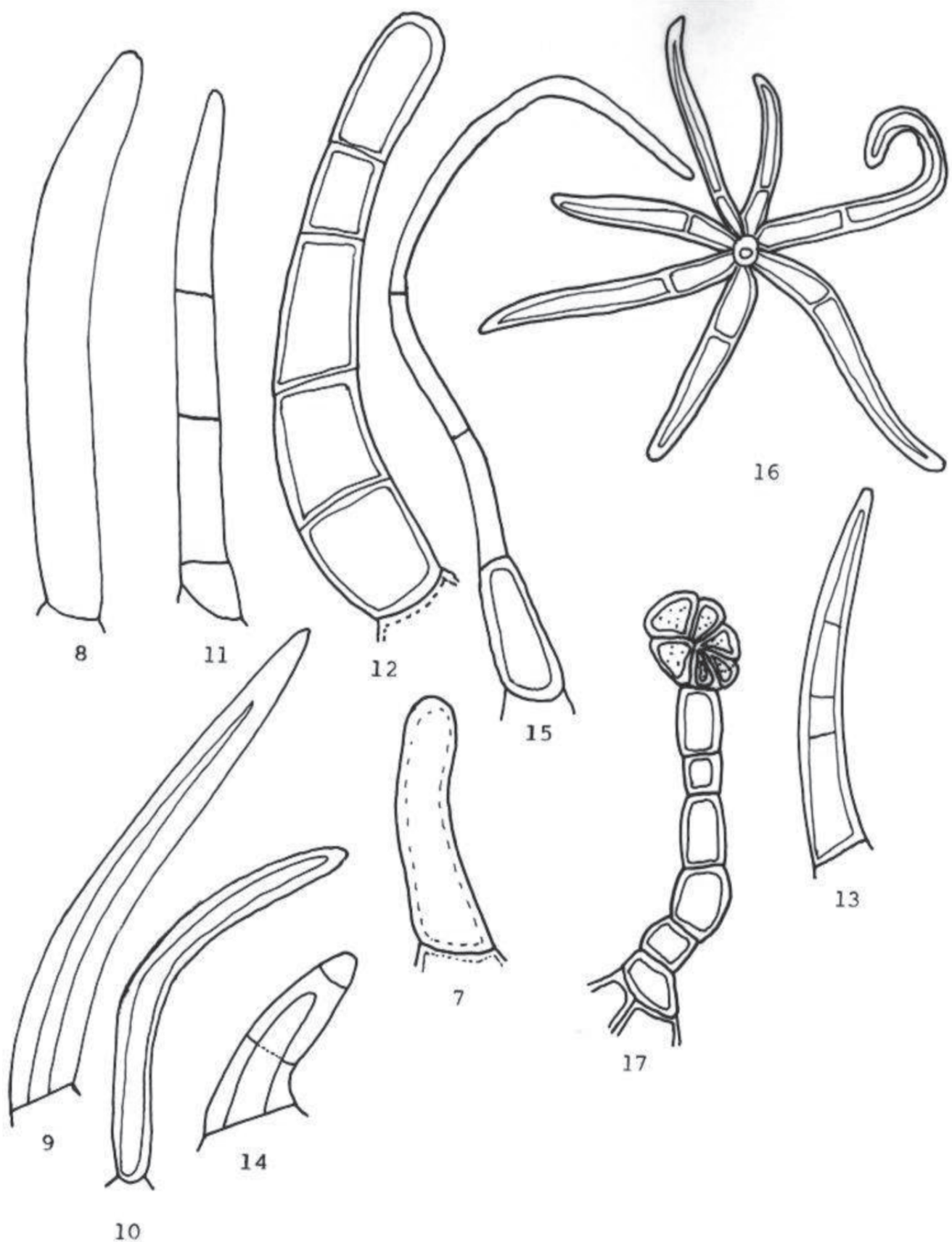


Plate – 2

Eriolaenahookeriana. (Figs: 7-17): 7. Unicellular Papillose, 8. Unicellular cylindrical, 9. Unicellular conical, 10. Unicellular curved, 11. Uni-seriate filiform, 12. Uni-seriate cylindrical, 13. Uni-seriate curved, 14. Uni-seriate hooked, 15. Uni-seriate septate flagellate, 16. Stellate multi-radiate, 17. uni-seriate glandular capitata

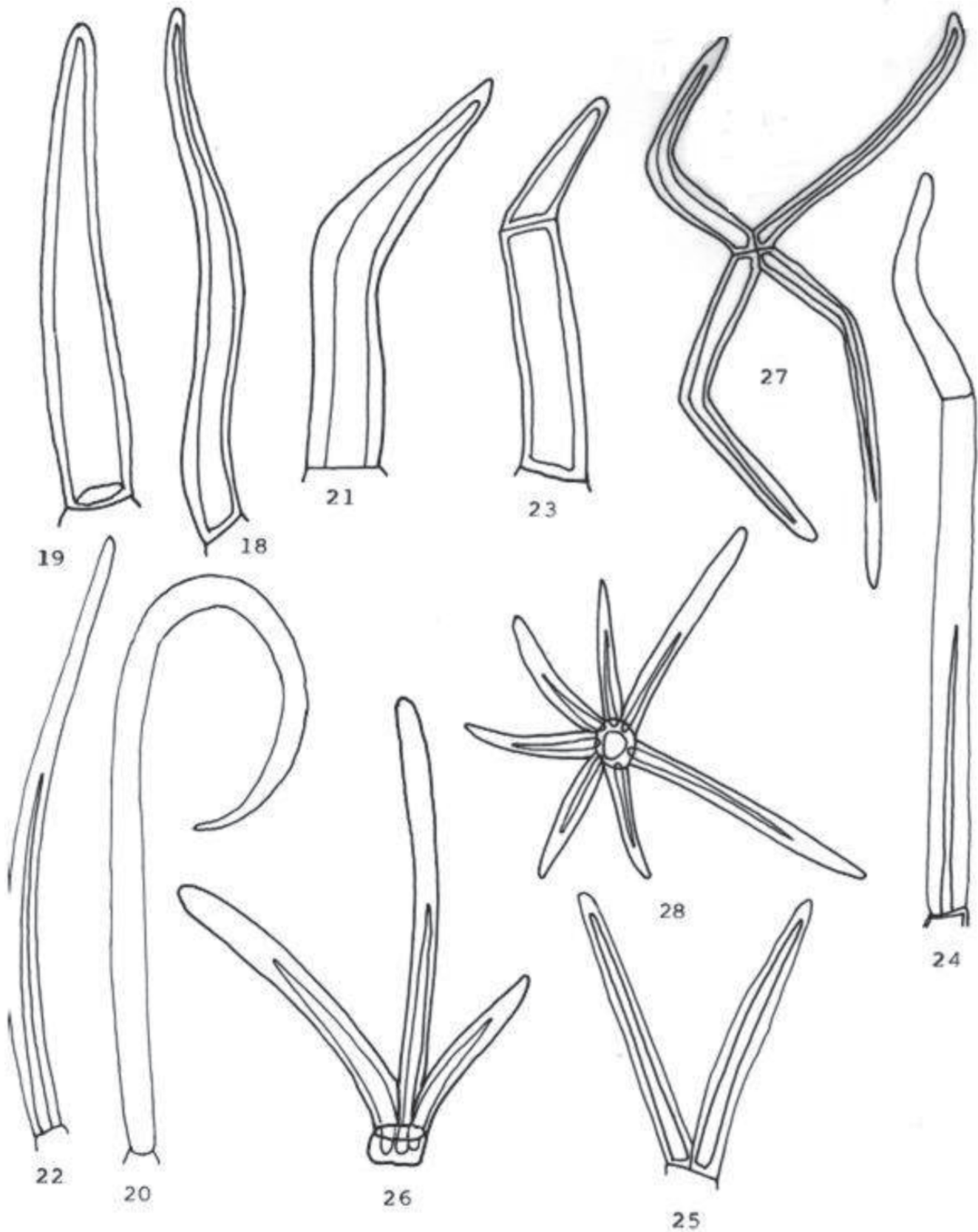


Plate -3

Helicteres isora. (Figs: 18-28): 18. Unicellular filiform, 19. Unicellular conical, 20. Unicellular flagellate, 21. Unicellular curved, 22. Unicellular acerate, 23. Bi-cellular curved, 24. Bi-cellular septate flagellate, 25. Stellate Bi-radiate, 26. Stellate tri-radiate, 27. stellate tetra-radiate, 28. Stellate multi-radiate.

TABLE-2 :Organographic distribution of trihomes in family sterculiaceae

Taxa	OUT'S	Stem	Petiole	Leaf Lamina		Stipule	Bract	Pedicle	Calyx(Sepal)		Corolla		Stamen	Ovary	Fruit wall
				Lower	Lower				upper	Inner	Upper	Inner			
<i>Buttneria herbacea</i>	1	C,NII,OVI,QI QI,QII,QIII,QIV	C,NII,OVI QII,QIII,QIV			C,NII,QI	C,OVI	C,OVI,QII			C,NII			C,	C,NII,OVI,QIII
<i>Eriolaena hockeriana</i>	2	I,OIV,D,QIV	D,OII,OVI, OIX,QIV	J,C,OII,OVI OIX,QIV	D,OII,OVI QIV	I,OVOIX QI,W	D,OVI, QI,QII	C,OVI,OIX QIV,W			C,I,OIX, W	C,D,J	C,J	C,J,OIX W	J,OIV,OVI,QI
<i>Helicteres sisora</i>	3	A,B,C,D,NII, NIX,QI,QII, QIII	A,B,C,H,NII, NIX,QI,QII, QIII,QIV	A,B,C,NII, NIX,QI,QII	A,B,NII,QI NIX,QII,QIV QIII	A,NII,QII QIII	B,D,H,NIX, QI,QIV	C,D,NII,NIX QIII,QIV	A,C,D,NII QIII,QIV	C,D,H, QIII	A,B,H, NII	C,D	A,B	B,C,NIX	B,C,QI,QII, QIII,QIV
<i>Melhaniafuffy- porensis</i>	4	B,H,NIX,OVI, OVI,OX	B,H,NV,NIX, OVI,OX	B,C,NV,NIX OVI,OX	C,H,NV,NIX OVI	B,NV,NIX OX	C,H,NV, OVI	B,H,NIX,OX	B,H,NIX OVI,OX	B,H,NIX, B,OVI, OVI,OX	B,NIX, OVI,OX	B,H,NIX, B,OVI, OVI,OX	B	B,NV, NIX	B,H,NV,NIX OV
<i>Melhania hamiltonia</i>	5	A,C,F,OII,P, NVI,QIV	C,F,OII,QIII, OIX,NVI,QIV	C,OIX,P,QIV	P,OIX,P	A,F,OIII QIV	C,F,OIX QIV	B,C,F,NVIII NVI,QII,OIII OIX,QIV,P	A,B,NVI, NVIII,OIX QIV	A,B,F,NVI, NVIII,OIII, QIV	A,B,F, NVI,OIX, NVIII	A,NVIII, QIV	OIX,A	NVIII	A,B,C,F,NVIII, NVI,QII,QIII
<i>Melhania tomentosa</i>	6	B,C,NII,NVI, OII,QIV	B,C,NVI,OII, OVI,OIX,QIV	C,OII,QIV	B,QIV	B,NII,NVI QIV	C,NVI,QIV	B,C,OVI,QIV	B,NVI,QIV	B,C,NII,NV OIX,QIV	NIX,OVI	NIX	B,NII	B,C,NVI	C,NII,OIX
<i>Melochia corchorifolia</i>	7	C,D	F,QI	C	D	C,F	C,D,QI	QII,QIV	D,F,QI	D,F,QI	D,F,NI	D,F	B,F,NI		D,F,NI,QI
<i>Pterospermuma cerifolium</i>	8	B,F,H,OII, QIV	D,H,NI	B,D,F,Q, OIV	B,H,NVI, QIV	B,D,F,NV	B,NII,QIII	D,F,OII,QIV	B,D,F,H, NI,QIII,QIV	B,D,F,H,NI QIII	B,F	NVI		B	B,F,H
<i>Sterculia urens</i>	9	A,C,F,QI	C,F,OII,NV, QI	A,C,F,QI	A,QI	A,C,QI,R	C,F,NV,QI	A,B,C,F,NV, OIII,OX,QI,R	A,C,F,NV, OIII,QIV	A,F,QI	A,B,C,F, NV,QIII OX,QI,R	A,B,NV OIII,OX, OIX,R	A,NV,R OIII	A,B,QI	A,C,F,OIII, OIX,OX,QI,R
<i>Waltheria indica</i>	10	B,E,H,OVI, QI,QIV,Q, Q, QIV	H,OVI,QI, QIV	J,QIV	H,OVI,QIV	B,E,QIV	A,B,E,H, QVI,QI, QIV	A,B,E,QI,QIV W	A,B,H,OVI, QI,QIV,W	A,B,H,OVI QI,QIV	A,B,OVI QI,W	A,B,OVI QI			A,B,H,QI

Sterculiaurens is a taxa which showed dense silky reddish pale hairs on almost all the young parts and flower. Total ten types, nine non glandular viz. A, B, C, F, NV, OIII, OX, OIX, QI and one glandular flagellate were recorded from vegetative and floral parts. Besides abundant distribution of all the recorded nine non-glandular types, restricted occurrence and distribution of glandular flagellate on stipule, pedicle, petals and fruit wall put it quite significant from others. (Figs:80-89)

Waltheriaindica, considered 10th taxa of Sterculiaceae was recorded second one bearing uniseriate glandular capitate trichome (TABLE-02). It is found distributed on stem, pedicle, calyx and petal. This glandular hair along with another trichome of restricted occurrence *i.e.* unicellular dentate provide taxonomic value of trichome complex in taxa delimitation. (Figs:90-97).

Over all observation of trichome types was recorded in Sterculiaceae. It is evident that some types are common whereas others appeared quite significant in taxonomic delimitation of taxa at generic and inter-specific level. Thus, they are useful in distinguishing the species and some time even their corresponding organs and may be of much interest to parmacognosists, archeobotanists, paleobotanists and agronomists.

Total Trichome Types Observed in the Family Sterculiaceae

1.UNICELLULAR FILIFORM

Foot: simple. Body: entire, elongated, filiform; wall thick and smooth; lumen narrow; content translucent. (Figs. 18,39,80,90)

2. UNICELLULAR FLAGELLATE

Foot: simple. Body: hyaline, very long, narrow; wall thin and smooth; lumen wide; content translucent. (Figs. 2,29,38,50,51,62,69,70,81,92)

3.UNICELLULAR CONICAL

Foot: simple. Body: elongated conical; tip rounded; wall thick and smooth; lumen wide; content translucent. (Figs. 19,30,37,52,63,81)

4. UNICELLULAR CURVED

Foot: simple. Body: stout, curved; base wide pointed; wall thick and smooth; lumen wide; content translucent. (Figs.10,21,60,61,71)

5. UNICELLULAR DENTATE

Foot: compound. Body: short erect: tip pointed; wall thick and smooth lumen narrow; content yellow. (Fig. 93)

6. UNICELLULAR HOOKED

Foot: simple. Body: differentiated; lower part short, straight; upper part long; tip rounded; wall thin and smooth; lumen narrow; content yellow. (Figs.40,64,72,83)

7. UNICELLULAR ACERATE

Foot: simple. Body: very elongated, acuminate acerate; tip acute; wall thin and smooth; lumen narrow; content translucent. (Figs.22,31,73,91)

8.UNICELLULAR PAPILLOSE

Foot: simple. Body: very small, papillose; wall thin and smooth; lumen wide; content translucent. (Fig.7)

9. UNICELLULAR CYLINDRICAL

Foot: simple. Body: long, smooth and cylindrical; tip rounde; wall thin and smooth; lumen wide; content translucent. (Fig.8)

10. BICELLULAR FILIFORM

Foot: simple. Body: two-ceiled, filiform; tip rounded; lateral wall thick and smooth; cross walls thin; lumen wide; content translucent. (Figs.65,72)

11. BICELLULAR CURVED

Foot: simple. Body: short, two-celled; basal cell small, wide; distal cell tapering and curved; lateral wall thick and smooth; cross walls thick; lumen wide; content yellow. (Figs.2,23,53)

12.BICELLULAR CONICAL

Foot: simple. Body: entire, two-celled; lower cell very long, flagellate; tip pointed; lateral and cross wall thin and smooth; lumen wide; content translucent. (Figs.32, 75,82)

13.BICELLULAR HOOKED

Foot: simple. Body: two-celled; lower cell long, straight, upper cell small and hooked; tip rounded; lateral wall thick and smooth; cross wall thin; lumen wide; content translucent. (Figs.54,76)

14.BICELLULAR ASEPTATE FLAGELLATE

Foot: simple. Body: differentiate; lower cell small; upper cell long flagellate; tip rounded; lateral and cross wall thick; lumen narrow; content translucent. (Fig.42)

15.BICELLULAR SEPTATE FLAGELLATE

Foot: simple. Body: entire, two-celled; lower cell small; upper cell very long, flagellate; tip pointed; lateral and cross wall thin and smooth; lumen wide; content translucent. (Figs.24,33,55)

16.UNISERiate CYLINDRICAL

Foot: simple. Body: very wider, cylindrical, cells rectangular; tip rounded; lateral and cross wall thick; joints distinct; lumen wide; content yellow. (Figs.12,43,57,77)

17.UNISERiate CONICAL

Foot: simple. Body: long arrect. Conical; tip pointed; lateral and cross wall thick smooth; lumen wide; content opaque. (Figs.45,85)

18.UNISERiate HOOKED

Foot: simple. Body: short curved; tip pointed; cells of

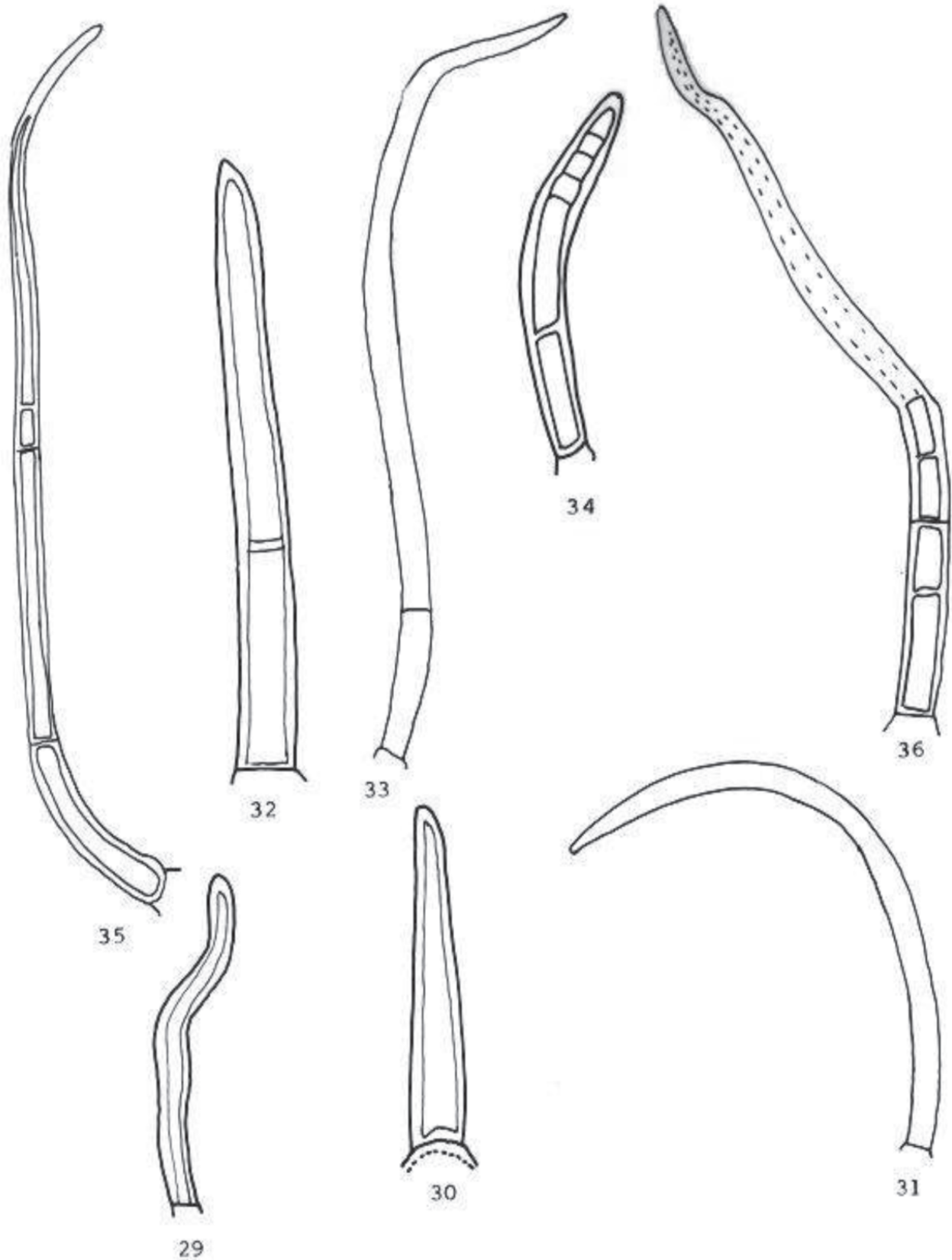


Plate – 4

Melhaniafuttyporensis. (Figs:29-36): 29. Unicellular flagellate, 30.unicellular conical, 31.Unicellular conical, 32. Unicellular acerate, 32.Bi-cellular conical, 33. Bi-cellular septate flagellate, 34. Uni-seriate curved, 35. Uni-seriate filiform 36. Uni- seriate aseptate flagellate.

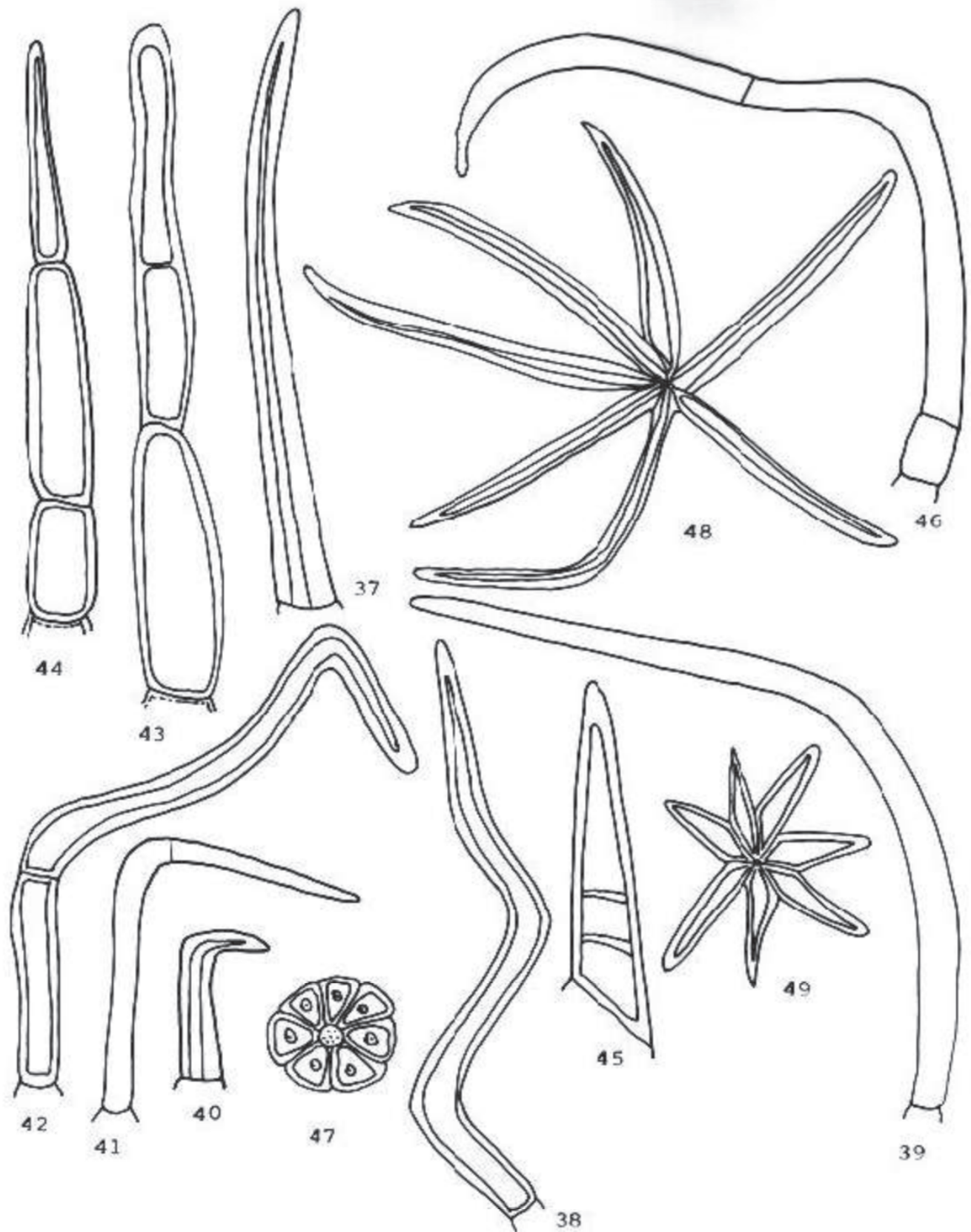


Plate – 5

Melhania hamiltoniana. (Figs: 37-49): 37. Unicellular conical, 38. Unicellular flagellate, 39. Unicellular filiform, 40. Unicellular hooked, 41. Bi-cellular hooked, 42. Bi-cellular aseptate flagellate, 43. Uni-seriate cylindrical, 44. Uni-seriate conical, 45. Uni-seriate conical, 46. Uni-seriate septate flagellate, 47. Pellate, 48. Stellate multi-radiate, 49. Stellate multi-radiate.

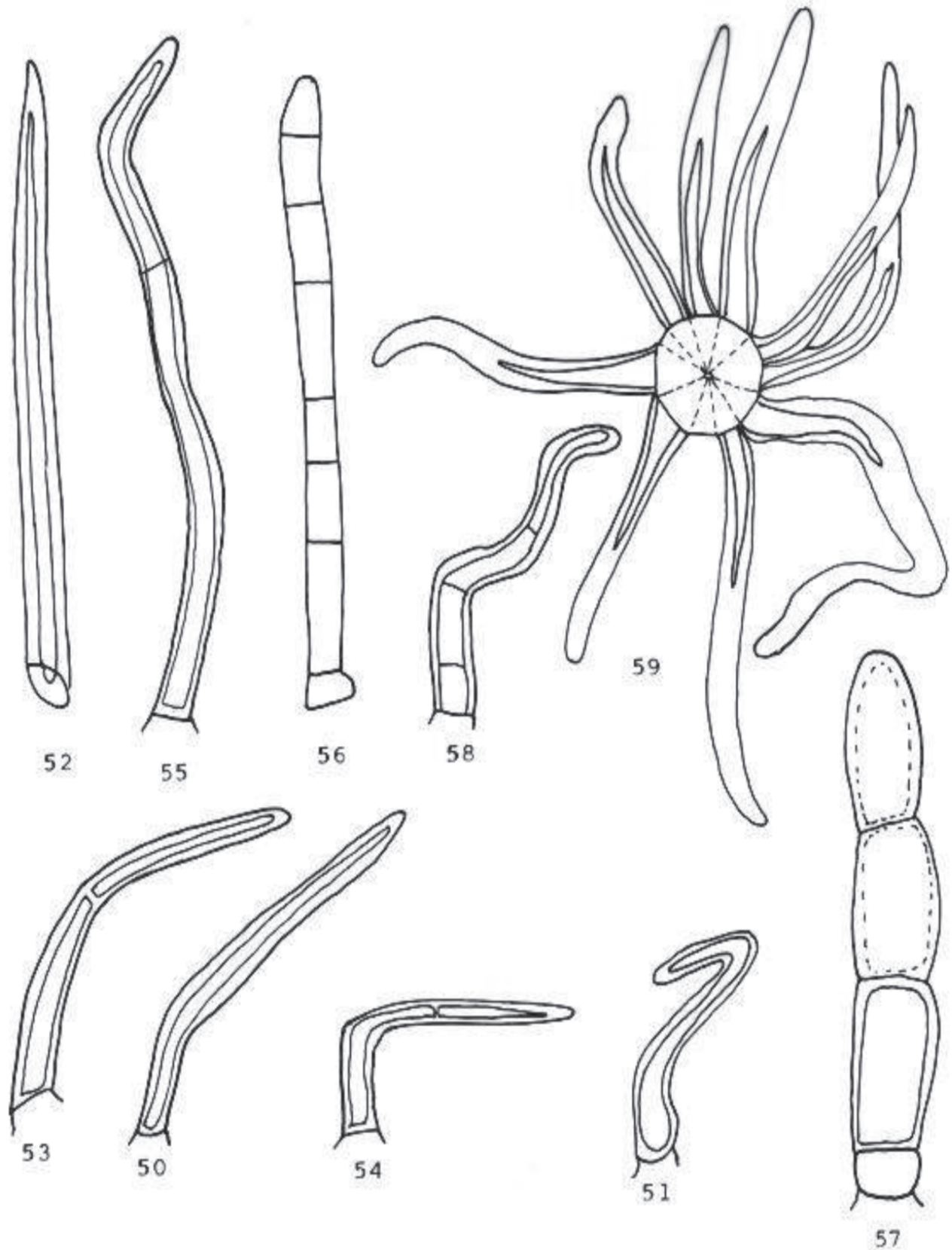


Plate – 6

Melhania tomentosa. (Figs: 50-59): 50. Uni-cellular flagellate, 51. Uni-cellular flagellate, 52. Unicellular conical, 53. Bi-cellular curved, 54. Bi-cellular hooked, 55. Bi-cellular septate flagellate, 56. Uni-seriate filiform, 57. uni-seriate cylindrical 58. Uniseriate septate flagellate, 59. Stellate multi-radiate

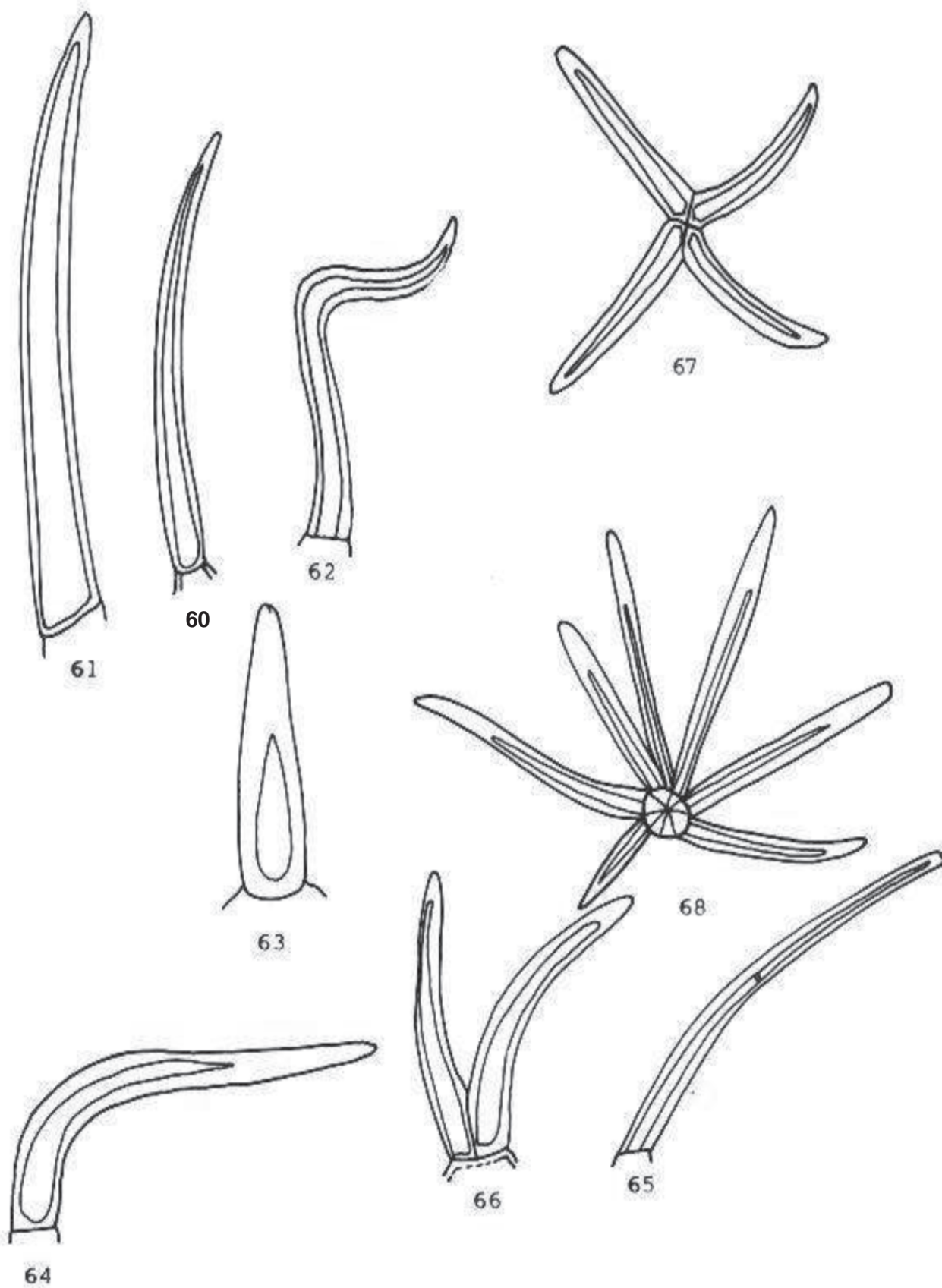


Plate – 7

Melochiacorchorifolia. (Figs: 60-68): 60. Uni-cellular curved, 61. uni-cellular curved, 62. Uni-cellular flagellate, 63. Unicellular conical, 64. Unicellular hooked, 65. Bi-cellular filiform, 66. Stellate bi-radiate, 67. Stellate tetra-radiate, 68. Stellate multi-radiate.

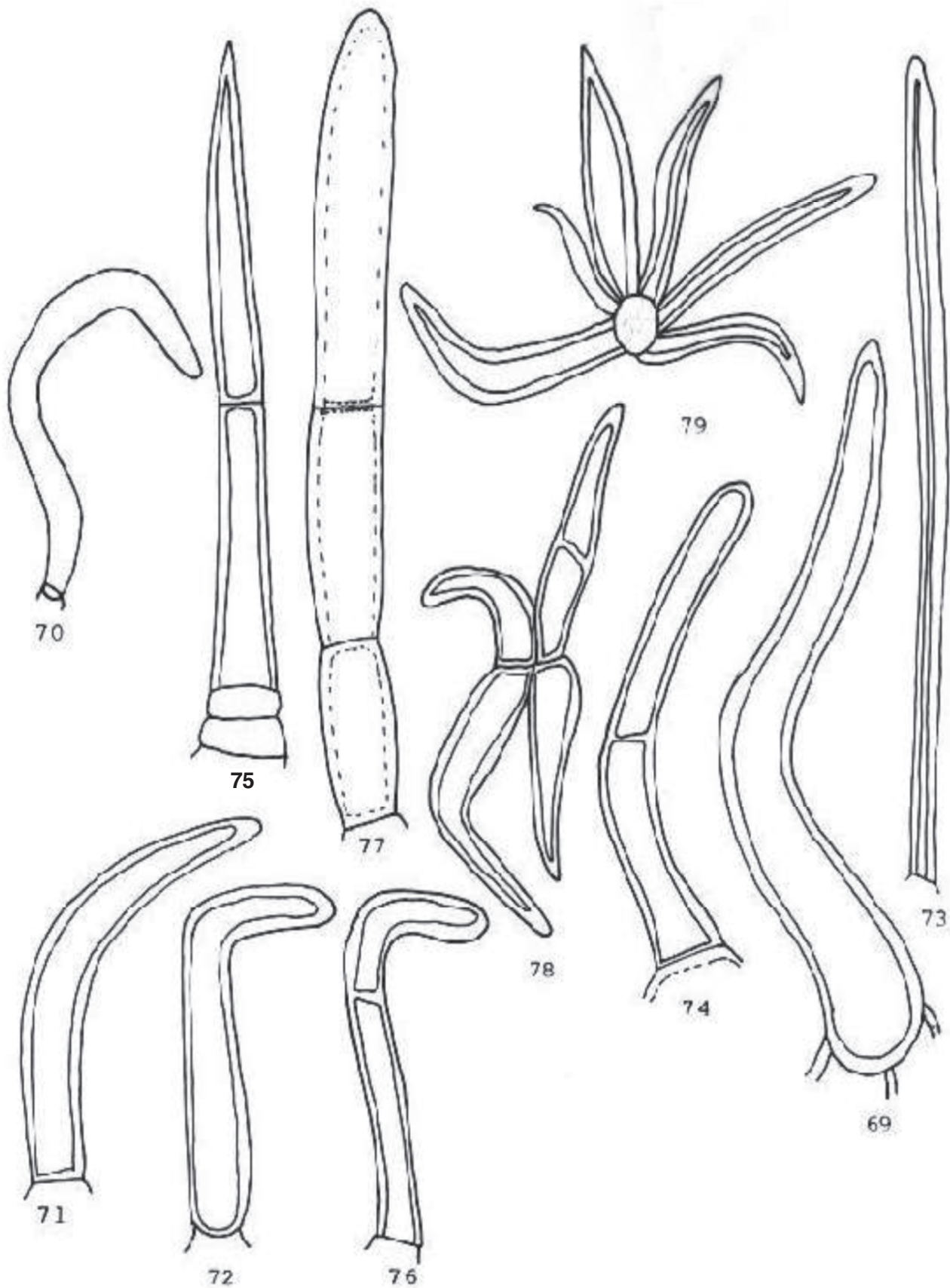


Plate -8

Pterospermum acerilifolium. (Figs: 69-79): 69. Uni-cellular flagellate, 70. Uni-cellular flagellate, 71. Uni-cellular curved, 72. Uni-cellular hooked, 73. Unicellular acerate, 74. Bi-cellular filiform, 75. Bi-cellular conical, 76. Bi-cellular hooked, 77. Uni-seriate cylindrical 78. Stellate tetra-radiate, 79. Stellate multi-radiate

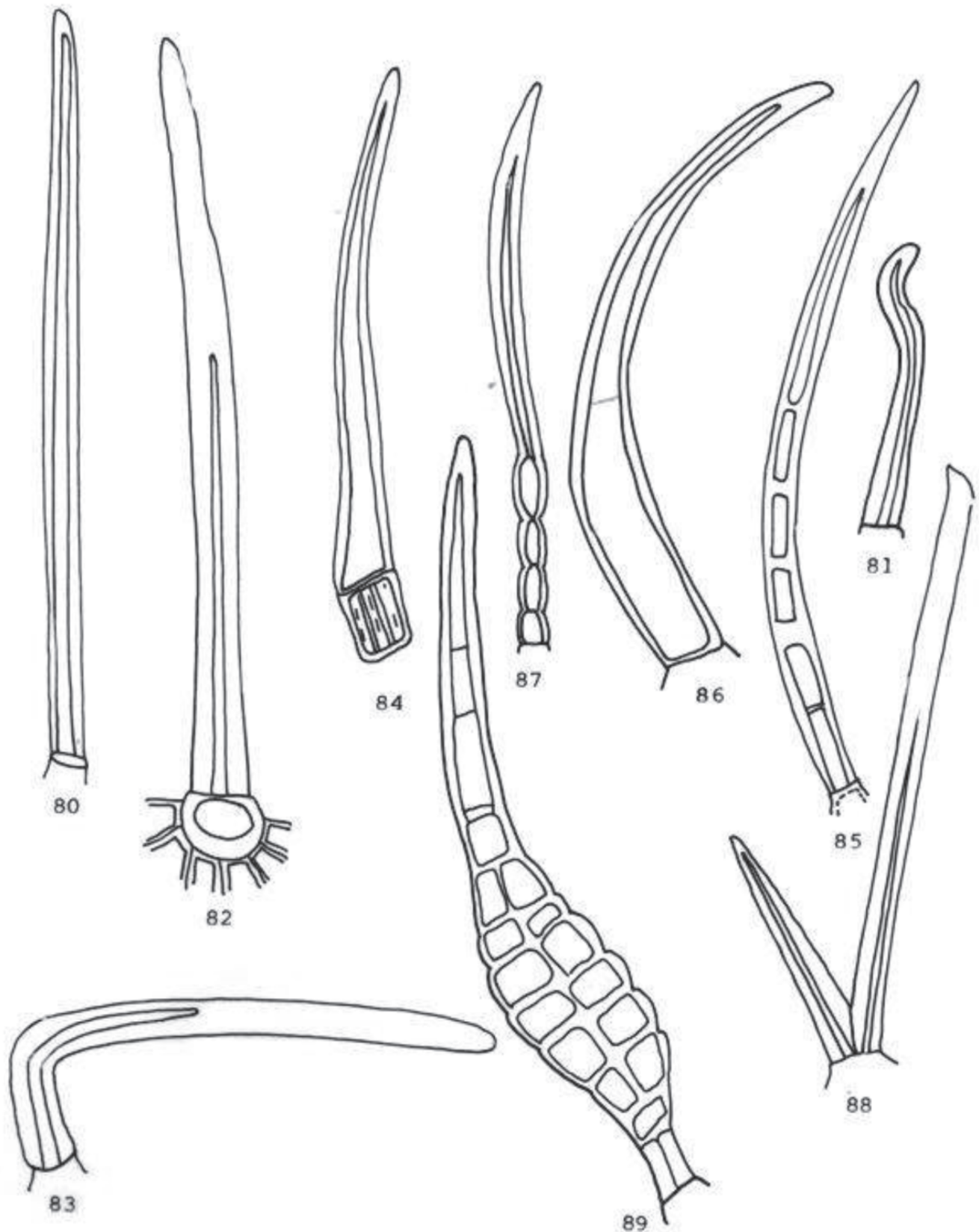


Plate – 9

Sterculiaurens. (Figs: 80-89): 80. Unicellular filiform, 81. Unicellular flagellate, 82. Unicellular conical, 83. Unicellular hooked, 84. Bi-cellular conical, 85. Uni-seriate conical, 86. Uni-seriate septate flagellate, 87. Uni-seriate aseptate flagellate, 88. Stellate bi-radiate, 89. Gladular flagellate.

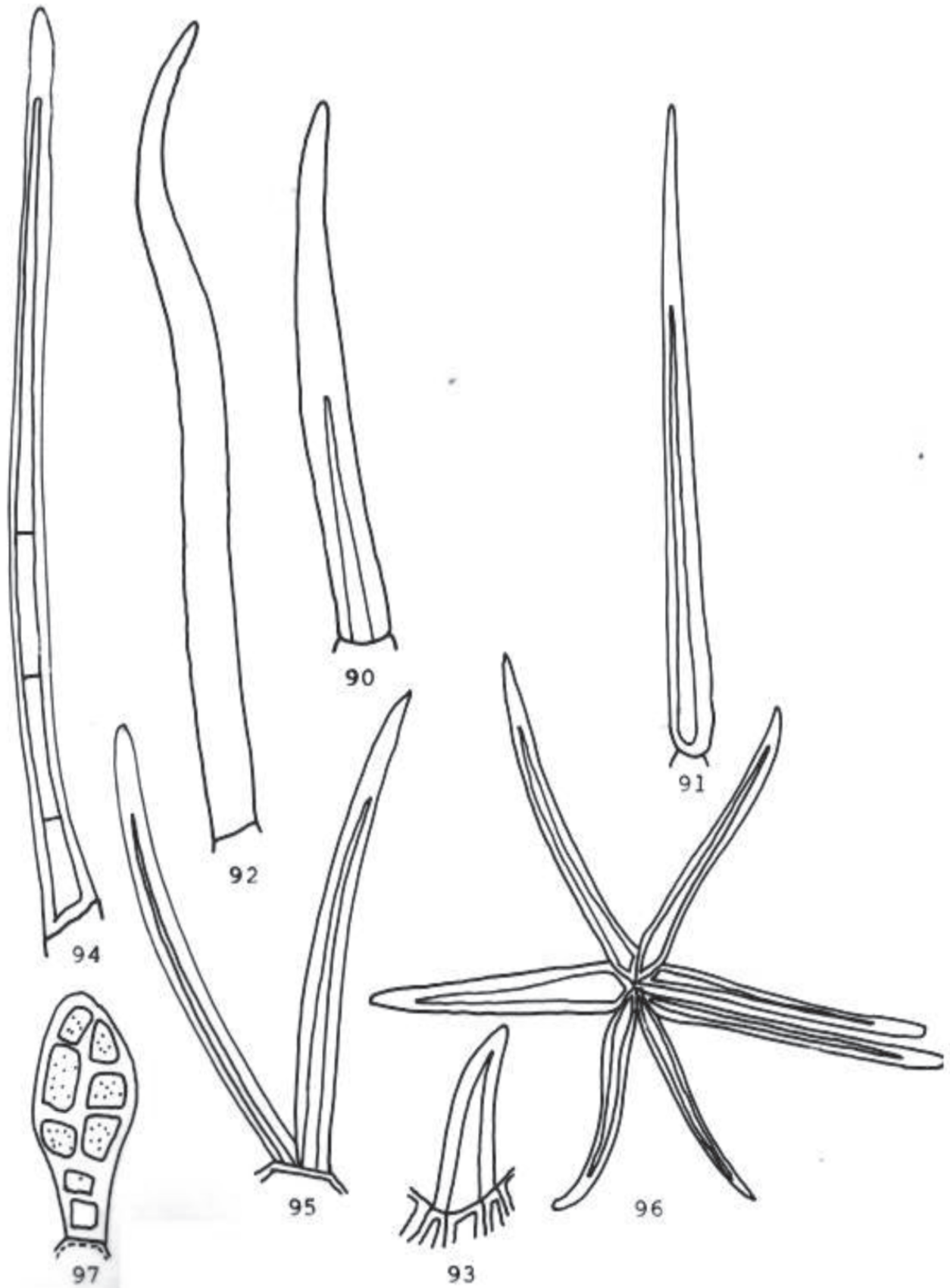


Plate -10

Waltheria indica (Figs: 90-97): 90. Unicellular filiform, 91. Unicellular acerate, 92. Unicellular flagellate, 93. Unicellular dentate, 94. Uni-seriate filiform, 95. Stellate bi-radiate, 96. Stellate multi-radiate, 97. Uni-seriate glandular capitate.

varied length; lateral wall thick and smooth; cross wall thin and cortex; lumen wide; content translucent. (Fig.14)

19.UNISERiate CURVED

Foot: simple. Body: short curved; tip pointed; cells of varied length; lateral wall thick and smooth; cross wall thin; content opaque. (Figs.13,34)

20. UNISERiate FILIFORM

Foot: simple. Body: entire long, filiform; tip rounded; lateral wall thick and smooth, cross wall thin and smooth; lumen narrowing to tip; content yellow granulated. (Fig.3,11,35,56,94)

21.UNISERiate SEPTATE FLAGELLATE

Foot: simple. Body: differentiate flagellate; basal cell wide and distinct; lateral wall thick and smooth; rest body very long, narrow flagellate; content translucent. (Figs.15,46,58,86)

22.UNISERiate ASEPTATE FLAGELLATE

Foot: simple. Body: uniseriate differentiate; lower cell small; distal cell longest, flagellate; tip pointed, lateral wall thin; cross wall thin; lumen wide; content translucent. (Figs.36,87)

23.PELTATE

Foot: not visible. Body: peltate, multi cellular, shield like sessile, one celled thick; parallel to epidermis; cell radiating from centre; radial wall thin; content light granulated. (Fig.47)

24.STELLATE BI-RADIATE

Foot: compound. Body: two rayed: ray unicellular, straight, conical, tip pointed; wall thick and smooth; lumen narrow; content yellow. (Figs.4A,25,66,88,95)

25.STELLATE TRI-RADIATE

Foot: compound. Body: three rayed; rays unicellular filiform; varying in length; tip rounded; lumen narrow; content yellow. (Figs.4B,26)

26.STELLATE TETRA-RADIATE

Foot: not visible. Body: four rayed; cruciform; rays unicellular very long, parallel to epidermis; wall thin and smooth; lumen narrow; content yellow. (Figs.5,27,67,78)

27.STELLATE MULTI-RADIATE

Foot: not visible. Body: multi-radiate; rays bicellular filiform or curved; varying length; parallel to epidermis; lower small, upper cell long; lateral and cross wall thick and smooth, content. (Figs.6,16,28,48,49,59,68,79,96)

28. GLANDULAR FLAGELLATE

Foot: simple. Body: differentiated; basal region barrel shaped, multicellular, cells arranged in biseriate manner, glandular; upper part uniseriate, flagellate; cells varied in length content granulated yellow. (Fig.89)

29.UNISERiate GLANDULAR CAPITATE

Foot: compound. Body: differentiated; stalk multi-cellular, uniseriate; cells rectangular of varied size and jointed; lateral and cross wall thick; head multi-cellular, peltate, capitate; content granulated dense. (Figs.17,97)

References

1. Adedeji O, Ajuwon OY, Babawale O. Foliar epidermal studies, organographic distribution and taxonomic importance of trichomes in the family Solanaceae. *International Journal of Botany*. 2007; **3** (3) : 276-282
2. Ahmad B. A study of the trichome structure and its taxonomic significance in the family Scrophulariaceae Ph.D. Thesis Bundelkhand university Jhansi. 1998.
3. Aleykutty KM, Inamdar JA. Structure, ontogeny and taxonomic significance of trichomes and stomata in some caparidaceae. *Feddes Repert*. 1978; **89** : 19-30
4. Anetasulbborska. Structure and Distribution of glandular and non- glandular trichomes on above-ground organs in *Inula helenium* L.Astraceae. *Acta Agronomica*. 2013; **66** (4) : 25-34
5. Chukwuma EC. Luke Temitope soyewo, Tolulopefisayookanlawon and omakafealabugbogu; *Anales de Biogia*. 2017; **39** :103-109
6. Cowan JM. The Rhododendron leaf , a study of epidermal appendages. Oliver and Boyd, *Edinburgh*, UK. 1950.
7. Folorunso AE, Jayeola AA, Olaleye-Otunla OJ. Comparative study of leaf Architectural and epidermal features in some Nigerian species of Bombacaceae. *Nigerian Journal of Botany*. 2009; **22** (2) : 263-277.
8. Gupta M, Murtey YS. Trifolieae. *Proc. Indian Acad .sci*. sect B. 1977; **85** : 77-89
9. Hummel K, Staesche K. Die verbreitung der Haartypem in den naturtichenverwandtschaftsgruppen. *Hand buchdirPflanzenanatomie*. 1962; **4** : 207-250
10. Hussain K, Saini ZM. Comprative leaf anatomical studies of some Sterculia.L. species (Sterculiaceae). *Botanical .Journal of Linnean society*. 1998; **127** : 159-174

11. Jain DK, Singh V. Structure and ontogeny of trichomes in *Dombeya. Matalensis* Sond. *J. Indian Bot. Soc.* 1973A; 235-241
12. Khatijah HN, Zaharina MS. comparative leaf anatomy of some *Sterculia*. L species *Sterculiaceae*. *Botanical journal of Linnean society*. 1998; **127** : 159-174
13. King RM, Robinson H. *Eupatorium*, A *compositae* genus of arctotertiary distribution. *Taxon*. 1970; **19** : 769-774
14. Kumar Sobhan, Birtlordenstam. Diversity of trichome from mature cypselar surface of some taxa from the basal tribe of *Compositae*. *Comp. newsl.* 2012; **50** : 78-125
15. Leelavathi A, Ramayya N. Structure, distribution and classification of plant trichomes in relation to taxonomy II. *Caesalpinoideae*. *Indian. J. forestry*. 1983; **6** : 43-56
16. Lipka Saha Sobhan, Mukherjee K. Morphological variation Trichomes in some common species of *Astraceae*. *International. Journal of Pharmaceutical Research and Bio-science*. 2012; **1** (6) : 408-425
17. Maheshwari JK. The Flora of Delhi. C.S.I.R., New Delhi. 1963:1-445
18. Maity D. Foliar architecture of Indian member of the family *sterculiceae* and systematic relevance. 2011; UGC. MRP: F.no. 40 327/2011.
19. Mandal M. Foliar architectural pattern of Indian members of *Malvaceae*, Ph.D. Thesis. University of Kalyani, West Bengal India. 2010; 10.
20. Metcalfe CR, Chalk L. Anatomy of the dicotyledons vol. I *Clarendon press. Oxford*. 1950; **1** : 243-245
21. Mishra OP. Comparative study of floristic component of Bundelkhand and Baghelkhand region PhD. thesis, Awadhesh Pratap Singh University, Rewa, M.P. 1982.
22. Mitra S, Maity D. Nodal and petiolar anatomy of Indian *Melochia griseb* (*Sterculiaceae*) and there taxonomic significance. *Journal of Botanical society of Bengal*. 2013; **67** (1) : 49-54.
23. Oomanchan M. The flora of Bhopal (Angiosperms) J.K. Jain Brothers, Motia Park, Bhopal. 1977; 1-474
24. Pyne WW. A glossary of plant hair terminology. *Brittania*. 1978; **30** : 239-255.
25. Ramayya N. Studies on the trichomes of some *compositae* I. General structure. *B. Bull. Bot. Surv. India*. 1962; **4** : 177-188
26. Ramayya N, Rajgopal T. Foliar dermatypes of the *Aizoaceae* and their use in identification. *J. Indian Bot. Soc.* 1971; **50** : 355-362
27. Ramayya N. Studies on the trichomes of some *compositae* II Phyllogeny and classification. *Ibide*. 1962; **4** : 189-192
28. Roe K. The terminology of hairs in the genus *Solanum*. 1971; **20** : 501-508
29. Rao S. Structure and distribution and classification of plant trichome and relation to taxonomy *Sterculiaceae*; *Feddes Reportorium*. 1987; **98** : 127-135
30. Saharsrabudhe S, Stace CA. Development and structural variation in the trichome and stomata of *Gesneriaceae*. *New bot.* 1974; **1** : 46-62
31. Sahu TR. Studies on the trichome in *Helianthoideae* (*Asteraceae*). *J. Econ. Tax. Bot.* 1982; **3** : 517-521
32. Sahu TR. Taxonomic implication of trichome complements to *Vernonia* (*Compositae*) in India. *Feddes report.* 1984; **95** : 239-249
33. Salma I. The taxonomic significance of the trichome morphology in the genus *Durio* (*Bombacaceae*) *Gardens Bulletin Singapore*. 1999; **51** : 55-70.
34. Sharma Rajeshwari. Trichomes in some *Tiliaceae*; *J. Indian. Bot. Soc.* 1990; **69** : 11-14.
35. Solhani SN, Norani T, Chung RCK. Morphologic trikomo chromalogopusswartz *Bombacaceae*. *Proceeding of the 11th symposium for the Malaysian Society of Applied Biology*. 2010; 140-145
36. Werker E, Ravid U, Putievsky E. Glandular hairs on their secretion in the vegetative and reproductive organs of *Salvia sclarea* and *Salvia dominica*. *Israel Journal of Botany*. 1985; **34** : 239-252.