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STRUCTURE, DISTRIBUTION AND TAXONOMIC SIGNIFICANCE OF TRICHOMES IN SOME CUCURBITACEAE

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The present LM and SEM investigations deal with the structure, distribution and taxonomic importance of trichomes in 16 genera and 31 species of Cucurbitaceae. Of these, 13 genera and 23 species have been studied for the first time. Presently, nine trichomes types are recorded viz., unicellular conical, uniseriate filiform capitate, uniseriate filiform clavate, uniseriate filiform cylindric –clavate, uniseriate filiform branched, uniseriate macroform conical, uniseriate macroform curved, uniseriate macroform cylindrical and uniseriate macroform candelabra hair types. Of these, uniseriate filiform capitate and uniseriate macroform conical trichome types are present on both the vegetative and floral parts. These types are considered as trichome markers of the Cucurbits studied. Uniseriate filiform cylindric clavate hair is common to all tribes of the Cucurbitaceae excepting Joliffieae and Sicyeae. The genus Cucurbita is unique by the exclusive presence of uniseriate macroform candelabra hair and it is totally absent in the rest of other Cucurbits studied.

Key Words: Cucurbitaceae, trichomes, structure, distribution, taxonomic importance.

Cucurbitaceae with 2600 species in 109 or 110 genera is one among the economically most important plant families (Schaefer and Renner 2011) and Indian representation being 31 genera and 94 species (Renner and Pandey 2013, Shanmukha Rao and Srinivas Rao 2014).

The structure and distribution pattern of trichomes in the family Cucurbitaceae have received considerable attention of earlier workers (Inamdar *et al*. 1990, Ibrahim 2003, Kolb and Muller 2004, Inamdar and Gangadhara 2008, Ali and Fahad 2011, Abdulrahaman *et al.* 2011, Adebooye *et al.* 2012, Bibi and Okoli 2014). However, not much attention has been given to study the trichomes using SEM. Hence, present communication deals with trichome structure in 16 genera and 31 species of Cucurbitaceae. Of these, 13 genera and 23 species are studied for the first time (Table1).

MATERIALS AND METHODS

The material were collected/ obtained from different sources (Table 1). Leaves and petals were fixed in a mixture of aceto-alcohol (1:3) and transferred to 70% alcohol (Johansen, 1940). For SEM studies, dried leaves and petals were cut into small pieces and mounted on brass stubs with silver paint and then coated with a thin layer of gold palladium 200-300 Å. The materials were viewed under Hitachi S520 Scanning Electron Microscope at Indian Institute of Chemical Technology (IICT), Hyderabad.

OBSERVATIONS

In all nine trichome types have been observed in present study. Their structural details are as follows:

1. Unicellular Conical hair (Plate 2 I, Plate 4 A, C) **Foot :** Consisting of the basal end of the hair embedded in the epidermis sometimes surrounded by a rosette of epidermal cells. **Body :** Conical, representing the extension of the foot, apex pointed, wall moderately thick; contents scanty; surface smooth.

2. Uniseriate filiform capitate hair (Plate 2 A, C, Plate 4 D, E, F, H, L, U, W **Foot :** 1-celled, embedded; wall thin; content scanty. **Stalk :** 2 to 30-celled, linear. **Head :** Capitate, 1 to 5-tiered, each tier 1-4 celled; contents dense; surface smooth.

3.Uniseriate filiform clavate hair (Plate 2 D, Plate 4 Q) **Foot :** 1-celled, linear, **Stalk :** 4 to 10- celled, linear, **Head :** Clavate, multicellular, 3 to 4- tiered, each tier 1 to 4-celled, walls moderately thick, cells rectangular to linear ; contents dense.

4. Uniseriate filiform cylindric-clavate hair (Plate 2 G, M, Plate 4 R, S) **Foot :** 1-celled. **Stalk :** 4 to 10- celled, linear. **Head :** 4 to10-

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Table 1 : Organographic Distribution of Trichomes Types on the Vegetative and Floral Parts in the Cucurbitaceae

Name of the Taxon	Leaf			petiole	Stem	Tendril	Male Flower							§ Female Flower		
	Abaxial	adaxial	margin				Pedicel	Calyx			Corolla			Stamen	Gynoecium	
								Ab	Ad	M	Ab	Ad	M		Style	ovary
Tribe : Melothrieae																
Corallocarpus epigaeus(Rottl,) C.B.Clarke *	ABFG	ABFG	ABFG	BFG	BFG	F	*	*	*	*	*	*	*	*	*	*
Ctenolepsis garcinii (Burm.f.) C.B.Clarke*	ABF	ABF	ABF	BF	F	F	BF	ABCF	ABCF	ABCF	ABCF	ABCF	ABCF	--	BF	BF
Cucumis callosus * (Rottl.)Cogn.	ABF	ABF	ABF	ABF	BF	F	F	BFG	BFG	BFG	BCDE	BCDE	BCDE	--	F	F
											FGH	FGH	FGH			
C. melo L.*	ABFG	ABFG	ABFG	AFG	ABF	FG	BFG	BCFG	BCFG	BCFG	BCDE	BCDE	BCDE	BF	F	F
											FGH	FGH	FGH			
C. prophetarum L.*	ABCFG	FG	FG	F	F	BF	F	BEF	BEF	BEF	BCEF	BCEF	BCEF	--	F	F
								GH	GH	GH	GH	GH	GH			
C. sativus L.	ABF	ABF	ABF	F	F	BF	F	BF	BF	BF	BCDF	BCDF	BCDF	F	F	F
											GH	GH	GH			
Melothria maderaspatana (L.) Cogn.*	BF	BF	BF	BF	F	F	BF	BFG	BFG	BFG	BCFG	BCFG	BCFG	F	F	F
											H	H	H			
M. mucronata (Bl.) Cogn.*	ABFG	ABFG	ABFG	BFG	BFG	BFG	F	BCFG	BCFG	BCFG	ABCF	ABCF	ABCF	F	BFG	BFG
											GH	GH	GH			
Solena amplexicaulis (Lam.)Gandhi*	BF	BF	BF	BF	BF	F	*	*	*	*	*	*	*	*	*	*
Zehneria maysorensis * (W & A) Arn.	ABFG	ABF	ABFG	BF	BF	F	*	*	*	*	*	*	*	*	*	*
Tribe : Joliffieae																
Momordica charantia L.*var. Charantia* (Karala)*	ABCFGH	ABF	ABFGH	BF	FBG	BF	FG	ABCF	ABCF	ABCF	ABCF	ABCF	ABCF	F	F	F
								GH	GH	GH	GH	GH	GH			
M. Charantia L.*var. muricata* (Willd.) Uchchhe.*	ABCFGH	BCFGH	BCFG	BCFG	BFG	BFG	FG	ABCF	ABCF	ABCF	ABCF	ABCF	ABCF	F	F	F
								GH	GH	GH	GH	GH	GH			
M. dioica Roxb. Ex Willd.*	BF	BF	BF	BF	BF	BF	BF	BEF	BEF	BEF	BCEF	BCEF	BCEF	F	F	F

M. subangulata Bl.*	ABF	ABF	ABF	BF	BF	F	BEF	BCEF	BCEF	BCEF	BCEF	BCEF	BCEF	F	F	F
								G	G	G	GH	GH	GH			
Tribe: Trichosantheae																
Trichosanthes cucumerina L. *var. anguina* (L.) Haines*	ABFG	ABFG	ABFG	ABFG	BFG	F	BFG	ABCD	ABCD	ABCD	ABCD	ABCD	ABCD	F	F	F
								FGH	FGH	FGH	EFGH	EFGH	EFGH			
T. cucumerina L.* *var. cucumerina* L.	ABFG	ABFG	ABFG	BFG	BFG	F	BFG	ABCD	ABCD	ABCD	ABCD	ABCD	ABCD	F	F	F
								FGH	FGH	FGH	EFGH	EFGH	EFGH			
T. palmata Roxb.*	ABFG	ABFG	ABFG	BFG	ABFG	BFG	BFG	ABCF	ABCF	ABCF	ABCD	ABCD	ABCD	F	F	F
								GH	GH	GH	EFGH	EFGH	EFGH			
Tribe : Benincaseae																
Benincasa hispida * (Thunb.) Cogn.							BF	ABF	ABF	ABF	ABC	ABC	ABC	F	F	F
Citrullus colocynthis (L.) Schrad	ABFG	ABFG	ABFG	BFG	BFG	BFG	BFG	ABCF	ABCF	ABCF	ABCD	ABCD	ABCD	F	F	F
C. lanatus (Thunb.) Mats. & Nakai*	BFG	BF	BF	BF	BFG	F	BFG	BCFG	BCFG	BCFG	BCDE	BCDE	BCDE	F	F	F
								GH	GH	GH	GH	GH	GH			
Coccinia grandis (L.) Voigt	BF	BF	BF	BF	F	BF	F	BCDF	BCDF	BCDF	BCDF	BCDF	BCDF	F	F	F
Lagenaria siceraria (Mol.) Standl.*	ABF	ABF	ABF	ABF	ABF	F	BF	BFG	BFG	BFG	ABC	ABC	ABC	F	F	F
Luffa acutangula(L.)Roxb. *var. acutangula* L.*	ABCFG	BF	ABCFG	ABFG	ABFG	ABFG	BFG	ABCD	ABCD	ABCD	BCDE	BCDE	BCDE	F	F	F
								EFGH	EFGH	EFGH	FGH	FGH	FGH			
L. acutangula (L.)Roxb. *var. amara*(Roxb.) C.B.Cl*	ABCF	ABF	ABF	F	BF	F	F	BCFG	BCFG	BCFG	BCDE	BCDE	BCDE	F	F	F
											FG	FG	FG			
L. cylindrica (L.) Roen.	ABCFG	ABCFG	ABCFG	ABCFG	ABCFG	BFG	BCF	ABCE	ABCE	ABCE	ABCD	ABCD	ABCD	BF	F	F
							GH	FGH	FGH	FGH	EFGH	EFGH	EFGH			
L. tuberosa Roxb.*	BCFG	BCFG	BCFG	BCFG	BF	BCF	BCFG	BCEF	BCEF	BCEF	BCEF	BCEF	BCEF	BF	F	F
								GH	GH	GH	GH	GH	GH			

Tribe : Cucurbiteae																
Bryonopsis laciniosa (L.) Naud.*	BF	BF	BF	F	F	F	F	BCF	BCF	BCF	BCDE	BCDE	BCDE	F	F	F
								GH	GH	GH	FGH	FGH	FGH			
Cucurbita maxima Duch,ex Lam.	ABFG	ABCFG	ABFG	BFG	BFG	FG	F	ABF	ABF	ABF	ABCDE	ABCDE	ABCDE	F	F	F
								GH	GH	GH	FGHI	FGHI	FGHI			
C. moschata (Duch,ex Lam.) Duch.ex Poir.*	ABFGH	ABFGH	ABFGH	BFG	BFG	F	F	ABF	ABF	ABF	ABCDE	ABCDE	ABCDE	BF	F	F
											FGHI	FGHI	FGHI			
C. pepo L.*	ABFG	ABFG	ABFG	BFG	ABFG	BFG	F	ABFH	ABFH	ABFH	ABCDE	ABCDE	ABCDE	F	F	F
											FGHI	FGHI	FGHI			
Tribe : Sicyeae																
Sechium edule (Jacq.) Swartz.*	ABFG	ABFG	ABFG	BFG	BFG	*	BF	BF	BF	BF	BCE	BCE	BCE	F	F	F
											FGH	FGH	FGH			

* These taxa have been studied for the time

A=Unicellular conical hair; B= Uniseriate filiform hair; C= Uniseriate filiform clavate hair;

D= Uniseriate filiform cylindric-clavate hair; E=Unseriate filiform branched hair; F= Uniseriate macroform conical hair;

G= uniseriate macroform curved hair; H= uniseriate macroform cylindrical hair; I= Uniseriate macro form condelabra hair

§ = In Male and female flowers pedicel, calyx, corolla trichomes are similar

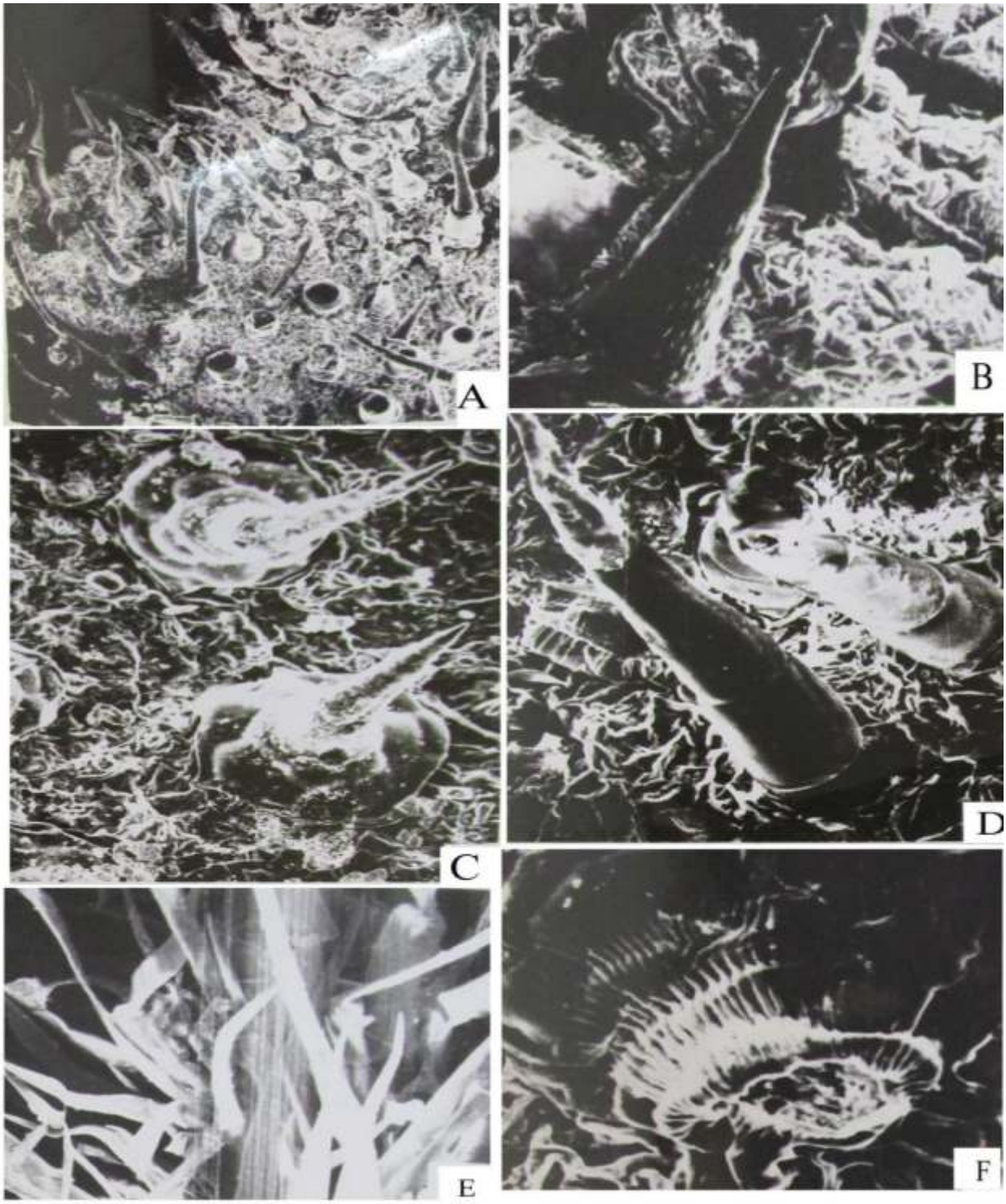

Plate 1 (A-F) Trichomes in Cucurbitaceae - SEM photographs **A**. ***Melothria maderaspatana*** Uniseriate macroform conical hairs from leaf margin X70. **B**. ***Cucumis melo*** Uniseriate macroform conical hair from leaf abaxial X 510. **C**. ***Luffa acutangula* var. *acutangula*** Uniseriate macroform conical hair and foot from leaf abaxial X 790. **D**. ***Trichosanthes cucumerina* var. *anguina*** Uniseriate macroform conical hair from leaf abaxial X600. **E**. ***Cucumis melo*** Uniseriate macrofrom conical hair from petal abaxial X 169. **F**. ***Momordica charantia* var. *charantia*** Trichome base in leaf abaxial X1000.

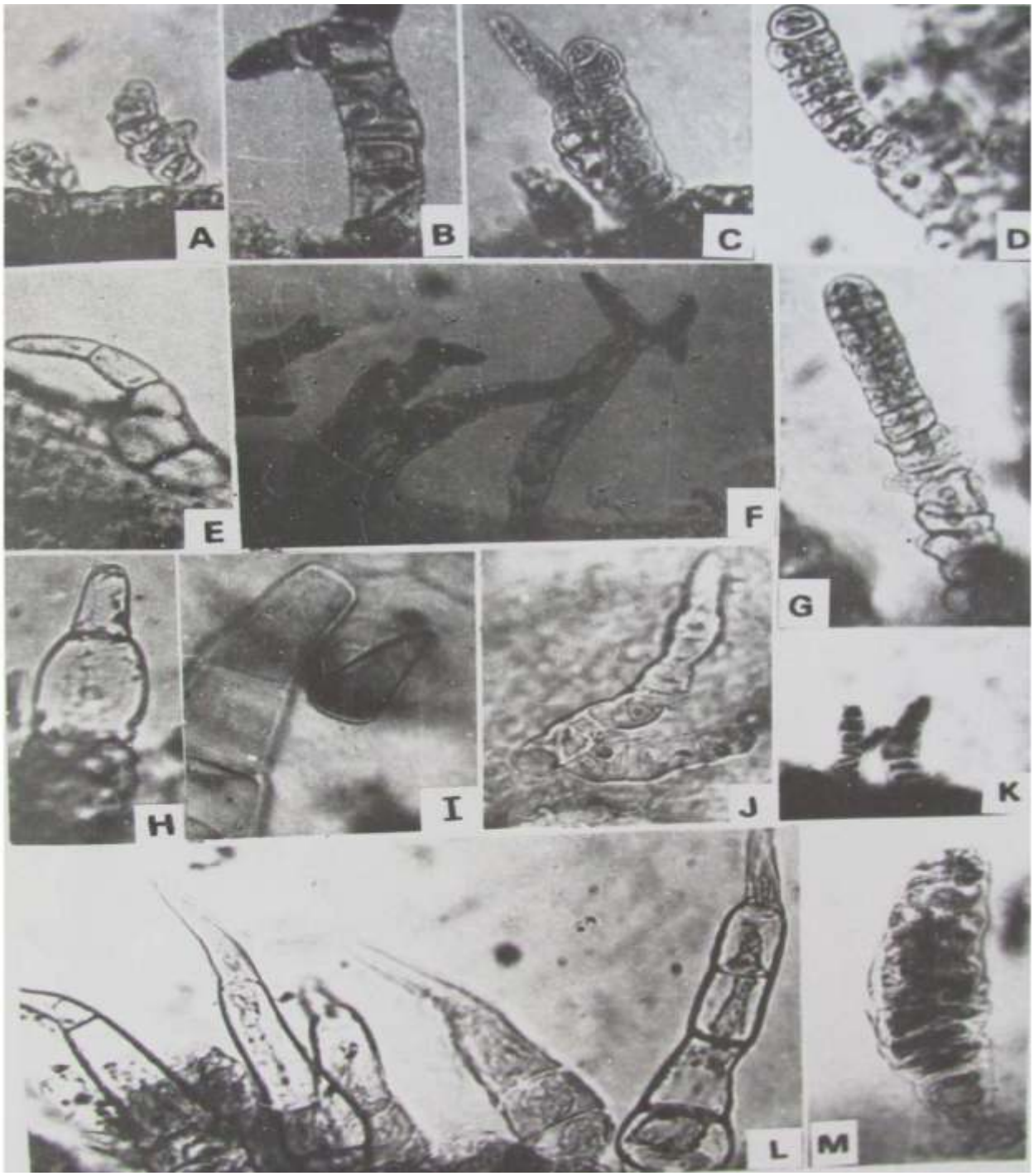

Plate 2 (A-M) Trichomes in Cucurbitaceae. **A, C, D, G, M** *Citrullus lanatus* **A**.Uniseriate filiform capitate hair from petal adaxial X 240, **C**. Uniseriate filiform capitate hair from petal margin X 301, **D**. Uniseriate filiform clavate hair from petal abxial X361, **G**. Uniseriate filiform cylindric - clavate hair from petal abaxial X500, **M**. Uniseriate filiform cylindric - clavate hair from petal adaxial X 450. **B**, **F** *Cucurbita pepo* **B**. Uniseriate filiform branched hair from petal abaxial X180, **F**. Uniseriate macro from candelabra hair from petal abaxid X210, **E**. *Momordica dioica* Uniseriate macroform conical hair from leaf margin X240, **H**. *Trichosanthes cucumerina* **var.** *anguina* Uniseriate macroform conical hair from petal abaxial X600, **I**. *Citrullus colocynthis* Unicellular conical hair from leaf abaxial X500, **J**. *Cucurbita moschata* Uniseriate filiform branched hair from petal abaxial X240, **K**. *Cucurbita moschata* Uniserate filiform branched hair from petal margin X 214, **L**. *Cucumis callosus* Uniseriate macroform conical hair from petal margin X 403.

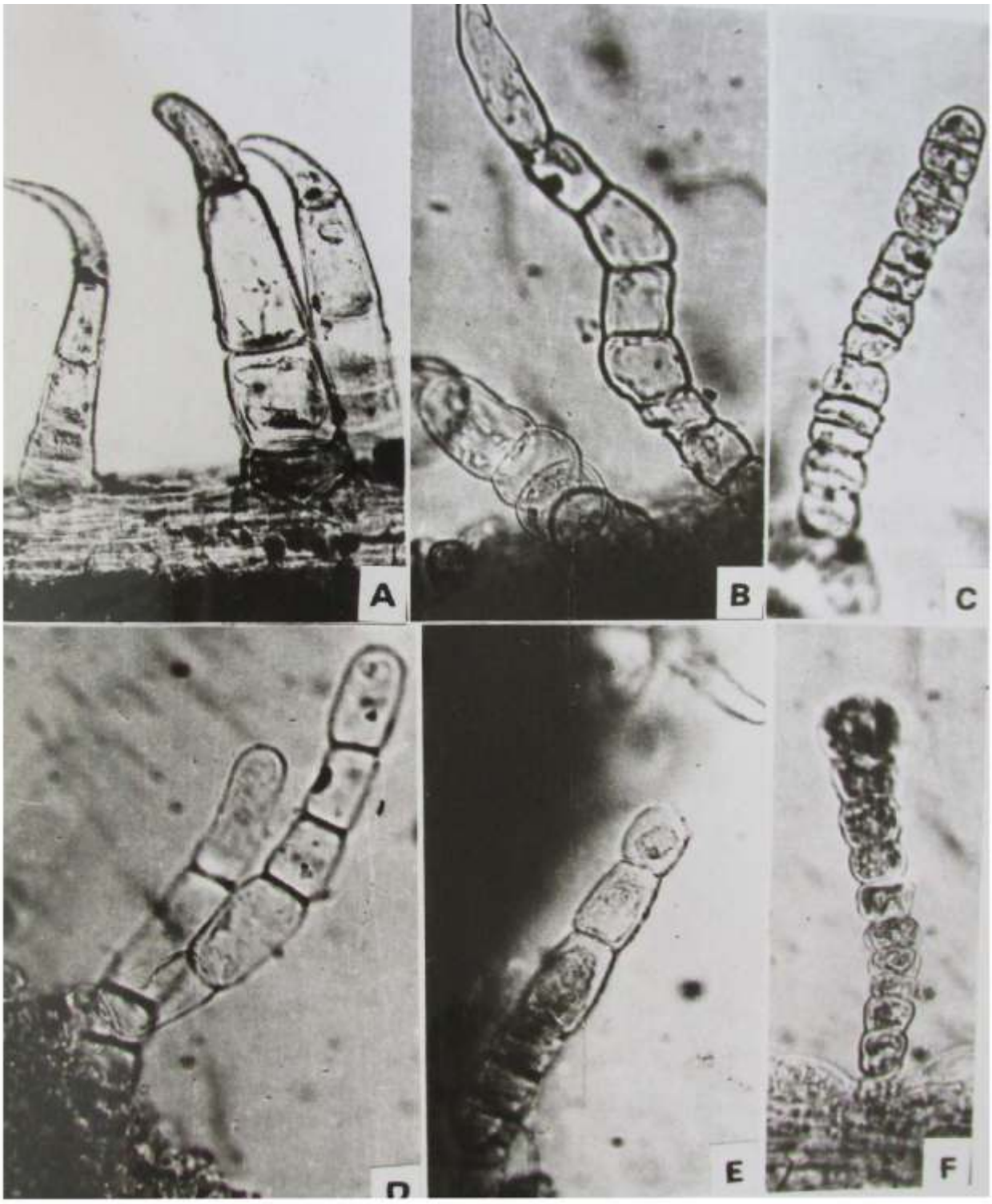

Plate 3 (A-J) Trichomes in Cucurbitaceae **A**. *Trichosanthes palmata* Uniseriate macroform curved hair from leaf adaxial X 204, **B, C, F** - *Luffa acutangula* **var.** *acutangula* **B**. Uniseriate macroform conical hair from corolla abaxial X 271, **C**. Uniseriate filiform clavate hair from petal abaxial X301, **F**. Uniseriate filiform capitate hair from petal margin X265, **D**. *Luffa acutangula* **var.** *amara* Uniseriate filiform clavate hair from petal margin X256, **E**. *Citrullus lanatus* Uniseriate filiform capitate hair from petal abaxial X313.

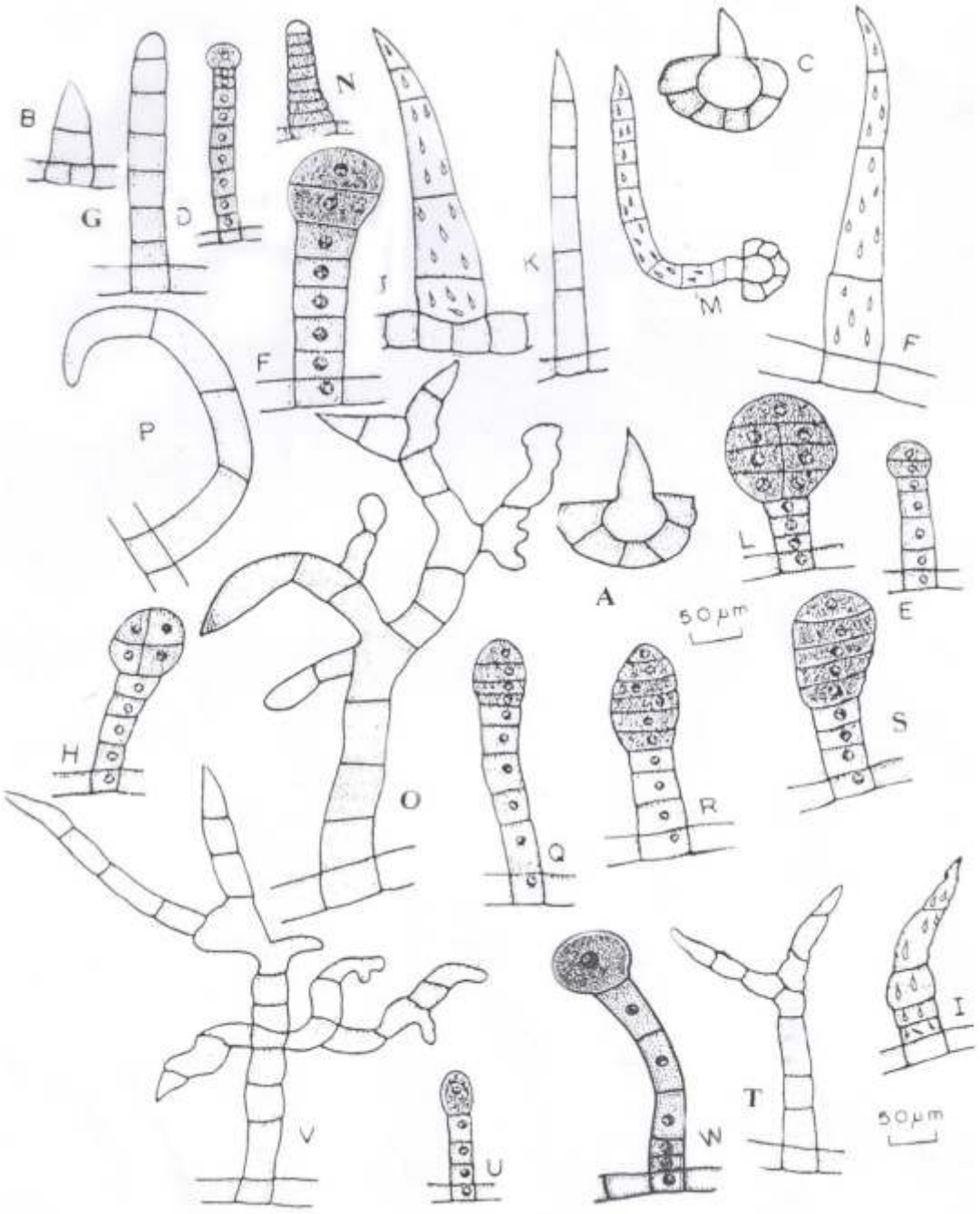

Plate 4 Trichomes in Cucurbitaceae **(A - V)**. **A**, **R**, **S**, **W** *Trichosanthes cucumerina* var. *cucumerina* **A**. Uniceullar conical hair from leaf abaxial. **R**. Uniseriate filiform cylindric clavate hair from petal margin. **S**. Uniseriate filiform cylindric clavate hair from petal adaxial. **W**. Uniseriate filiform capitates hair from leaf abaxial, **B, C**. *Sechium edule* **B**. Uniseriate macroform conical hair from leaf abaxial. **C**. Uniceullar conical hair from leaf abaxial. **D**. *Luffa acutangula* var. *amara* Uniseriate filiform capitate hair from petal margin. **E**. *Cucumis sativus* Uniseriate filiform capitate hair from petal margin. **F, L, M** *Citrullus colocynthis* **F**. Uniseriate filiform capitate hair from petal margin. **L**. Uniseriate filiform capitate hair from leaf adaxial. **M**. Uniseriate macro form conical hair from petal abaxial. **G, K** *Luffa tuberosa* **G**. Uniseriate marcoform cylindrical hair from sepal margin. **K**. Uniseriate macroform conical hair from sepal abaxial. **H**. *Coccinia grandis* Uniseriate filiform capitate hair from petal adaxial. **I**. *Lagenaria siceraria* Uniseriate macroform conical hair from petal abaxial. **J**. *Cucumis melo* Uniseriate macroform conical hair from petal margin. **N**. *Citrullus lanatus* Uniseriate macroform cylindrical hair from petal abaxial. **O**. *Cucurbita pepo* Uniseriate macroform candelabra hair from petal abaxial. **P**. *Cucumis prophetarum* Uniseriate macroform curved hair from leaf abaxial. **Q**. *Cucumis callosus* Uniseriate filiform clavate hair from petal margin. **T**, **U**, **V** *Cucurbita pepo* **T**. Uniseriate filiform branched hair from petal abaxial. **U**. Uniseriate filiform capitate hair from petal adaxial. **V**. Uniseriate marcoform candelabra hair from petal adaxial.

celled, broader than stalk; surface smooth; terminal cell rounded at the apex; wall thin; contents dense.

5. Uniseriate filiform branched hair (Plate 2 B, K, J Plate 4 T) : **Foot :** 1-celled. **Body :** Uniseriate 4 to 10- celled, branched, each branch 1 to 6- celled, walls moderately thick, surface smooth, contents scanty.

6. Uniseriate macroform conical hair (Plate 1 A-E Plate 2 E, H, L Plate 4 B, I , J, K, N) : **Foot :** Simple or compound 1 F, indistinct or subtended by multicellular pedestral forming rosette like structure at the base the trichome . Body: Conical, uniseriate 2 to 20 – celled; walls thick; content scanty; surface smooth or punctuate (Plate 1 B).

7. Uniseriate macroform curved hair (Plate 3 A Plate 4 P) : **Foot :** Simple, walls thick; content scanty. **Body :** Uniseriate, 4 to 10- celled; surface smooth; distally curved and pointed.

8. Uniseriate macroform cylindrical hair (Plate 4 G, N) **Foot :** Simple. **Body :** Cylindrical, uniseriate 4 to 8- celled, walls moderately thick; surface smooth.

9. Uniseriate macroform Candelabra hair (Plate 2 F Plate 4 O, V) : **Foot :** Simple, linear; wall thick; contents scanty; uniseriate, walls moderately thick; contents scanty; surface smooth. **Body :** Candelabra like, branches 3 to 8, each branch (arm) 1 to 6 celled, long, conical or rounded cells, straight or wavy; wall moderately thick; contents scanty; surface smooth.

DISCUSSION

The trichome types observed presently are either unicellular or uniseriate and they are in tune with the earlier reports (Inamdar and Gangadhara 2008, Ali and Fahad 2011, Abdulrahaman *et al.* 2011).

Inamdar and Gangadhara (2008) recorded a maximum 13 main and 26 sub types of trichomes in the Cucurbitaceae. However, a close scrutiny of trichomes of the Cucurbitaceae in this investigation, besides the survey of past works clearly indicates that about 9 types are recognizable, as the body of some of these trichome types shows much variation on one and same surface of the plant body. The trichome nomenclature presently adopted chose to highlight the gross morphological features of the body leading to the recognition of the above nine type of the trichomes.

Each trichome basically consists of two parts, the foot and the body. The former is mostly embedded in the epidermis (Plate 1 C) while the latter constitutes the emergent part (de Barry, 1884). In the present observations, the trichomes possess simple or compound foot (Plate 1C, F). The body may be entire or further differentiated into stalk and head. In all the cucurbits, the foot is embedded. Further, the body is entire in the unicellular conical, uniseriatefiliform branched, uniseriate macroform conical (Plate 1E, Plate 3B), uniseriate macroform curved (Plate 3 A), uniseriate macroform cylindrical, uniseriate macroform candelabra hair types whereas in the uniseriate filiform capitate (Plate 3 E,F), uniseriate filiform clavate (Plate 3 C,D), uniseriate filiform cylindric-clavate hair types, it is divided into stalk and head. In all trichome types, the protoplasmic contents are scanty in the foot and body whereas in the uniseriate filiform capitate, uniseriate filiform clavate and uniseriate filiform cylindric-clavate scanty in the foot and stalk.

In all the trichome types, the wall of the foot is thin, thick or moderately thick. The wall of the body is thin in uniseriate filiform capitate hair, uniseriate clavate hair and uniseriate filiform cylindric-clavate hair. In all the other trichome types, the wall of the body is moderately thin or thick. Functionally the uniseriate filiform capitate, uniseriate filiform clavate and uniseriate filiform cylindric-clavate hair types are glandular in nature. In all, the trichome types have uniformly smooth surface except in the uniseriate macroform conical hair where smooth as well as puncticulate ornamented surfaces are witnessed. Generally the vegetative parts possess 1 to 6 trichome types, whereas the floral parts 1 to 9 trichome types (Table 1).

Taxonomic Importance

Family Level : The present investigation reveals that uniseriate filiform capitate and uniseriate macroform conical hair types are common to all taxa studied. Therefore, these are considered as trichome markers of the family.

Tribe Level : Uniseriate filiform cylindric-clavate hair type is common to all the tribes of the Cucurbitaceae excepting tribes Joliffieae and Sicyoeae which are characterized by the absence of this particular trichome type.

Sub-tribe Level : Of the two sub-tribes recognized in the tribe Benincaseae, viz., Luffinae and Benincasinae, the former is characterized by the uniseriate filiform clavate hair on vegetative parts whereas it is absent in the latter.

Generic Level : The genus Cucurbita is unique by the exclusive presence of uniseriate macroform candelabra hair in the entire family. This trichome is totally absent in all the other taxa of the Cucurbitaceae presently studied.

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