

# TRICHOMES ON LEAVES OF SOME LAMIACEAE

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## ABSTRACT

The morphology and ontogeny of trichomes are described on the leaves of 33 species. They are of three major types—A. non-glandular ones are uniseriate (i) bi-celled, (ii) filiform-straight conical, falcate, hooked, lanceolate, (iii) simple conical, falcate, hooked, S-shape, flagellate and (iv) branched; B. glandular capitate trichomes are (v) sessile with (a) unicellular or (b) 2-4-more-celled head and (vi) stalked with (a) unicellular rarely (b) bi-celled head. (c) non-glandular-cum-glandular. Different types of trichomes develop from a single trichome-initial and the first division is usually periclinal. The use of trichomes in identification of species is suggested.

## INTRODUCTION

Foliar trichomes in Lamiaceae are described by METCALFE AND CHALK (1950), EL-GAZZAR AND WATSON (1970), SINGH *et al.* (1975), GUPTA AND BHAMBIE (1978), and RUDALL (1980) but these studies lack desired information on their ontogeny. Hence, our observations on thirty-three species embracing ten genera of the tribe Ocimoideae in Lamiaceae are presented.

## MATERIAL AND METHOD

Most of the material was collected and fixed in FAA during botanical explorations to the forests in Gujarat, Mahabaleshwar and Kerala. Seeds of some species, received from Berlin and raised in the botanical garden of the Sardar Patel University, Vallabh Vidyanagar, were also fixed in FAA for study. The trichomes were studied from free-hand and microtome transverse sections (6-8  $\mu\text{m}$  thick), stained with safranin-fast-green combination and made permanent.

## OBSERVATIONS

Trichomes are non-glandular and glandular; both the types often are found side by side (Fig. 12). The former generally have their cells without contents whereas the latter retain them in the head-cells and stalk-cells, or atleast in the former.

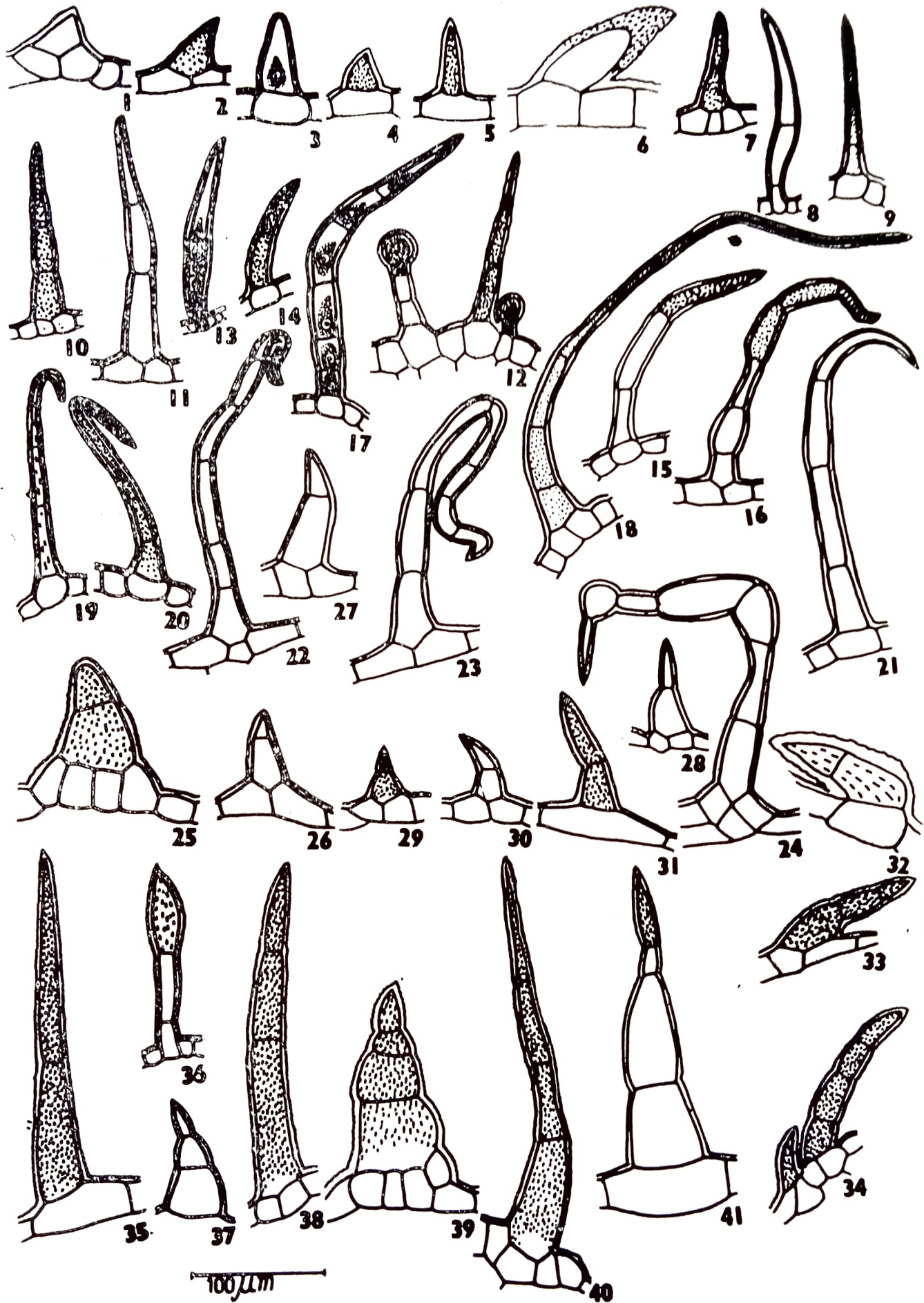
## MORPHOLOGY OF TRICHOMES

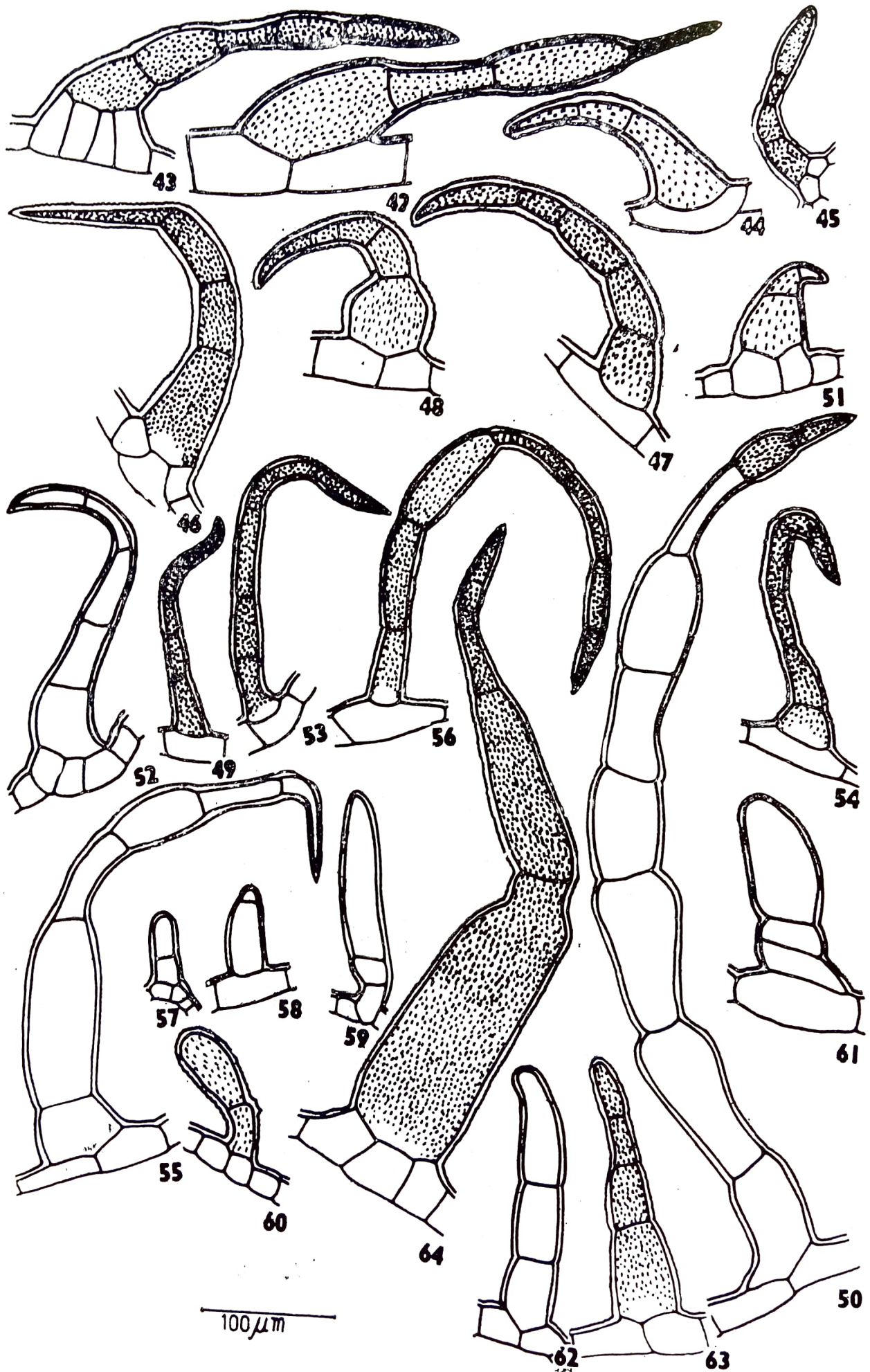
### *Type I : Non-glandular uniseriate bi-celled trichomes*

Foot-cells 1-2, thin-walled, rectangular, tubular, trapezoidal or polygonal, not projecting, without contents. Body unicellular, straight or bent, narrowly or broadly conical, trapezoidal, ovate-triangular or ovate-oblong, tapering and acute or rounded at apex thin- or thick-walled, with smooth or warty cuticle; lumen broad, seldom with very thin contents (Figs. 1-6, 34).

### *Type II : Non-glandular uniseriate filiform trichomes*

Foot-cells 1-2 as in Type I, rarely conical flask-shaped (Fig. 8), seldom with contents (cf. Fig. 13). Body 2-7-celled, thin-walled, smooth and evenly cuticularized





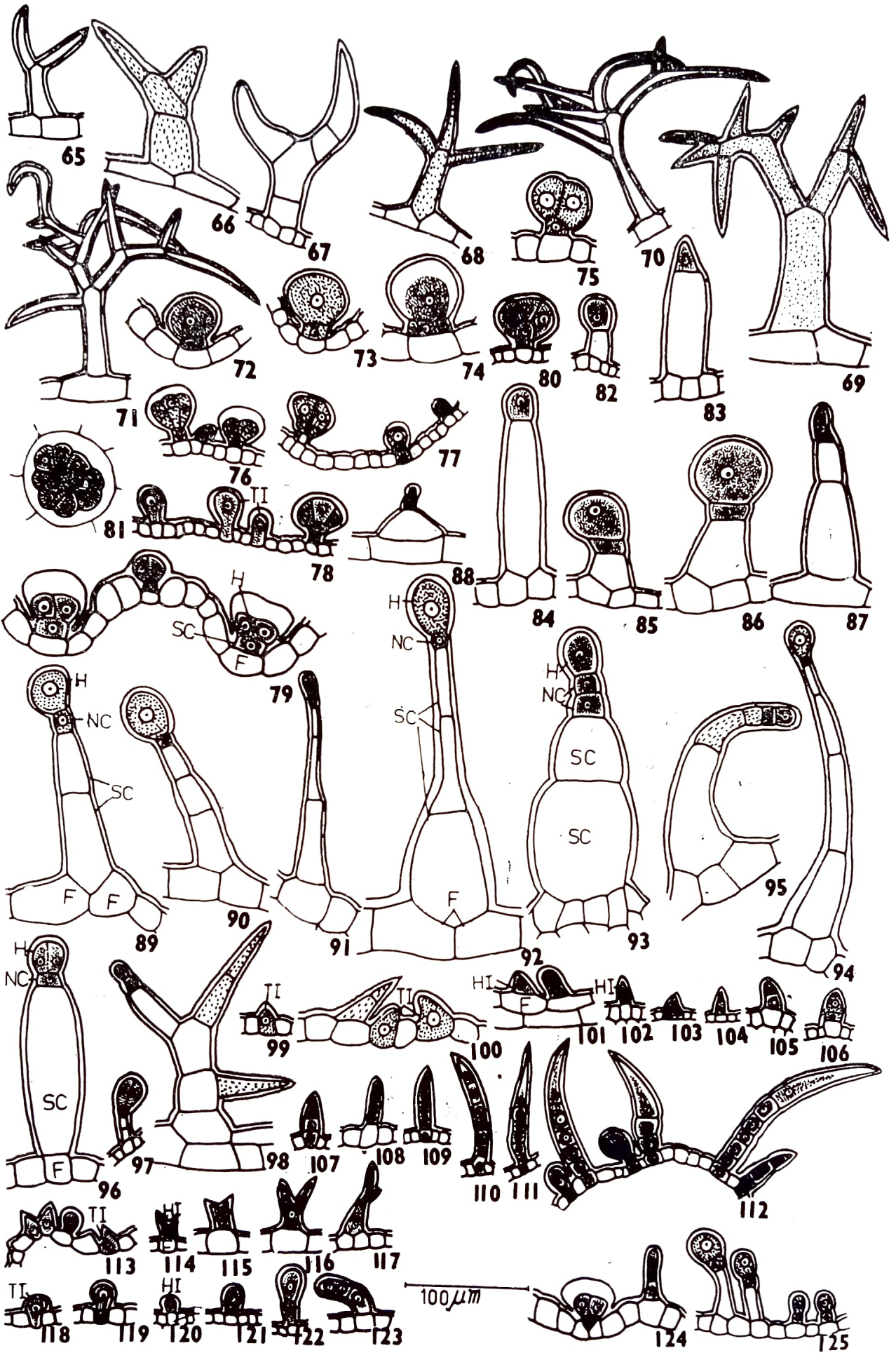


Table 1—Occurrence of different types of trichomes on the leaves of various species of tribe Ocimoideae studied.

Type I—bi-celled; Type II non-glandular uniseriate filiform (a) straight conical, (b) falcate, (c) hooked and (d) lanceolate; Type III non-glandular uniseriate simple (a) conical, (b) cylindrical, (c) falcate, (d) hooked, (e) S-shape and (f) flagellate; Type IV non-glandular branched; Type V-glandular capitate sessile with head (a) unicellular and (b) 2-4-more-celled; Type VI-glandular capitate stalked with head (a) unicellular (a) unicellular and (b) bicelled; Type VII-non-glandular-cum-glandular trichomes.

Name of plants	Non-glandular trichomes						Glandular trichomes							
	Type I		Type II		Type III		Type V		Type V		Type VI		Type VII	
	a	b	c	d	a	b	c	d	e	f	a	b	a	b
<i>Anisochilus carnosus</i> var. <i>eriocephalus</i> Bth.	—	—	—	—	+	—	+	+	—	—	+	—	+	—
<i>Coleus aromaticus</i> Bth.	—	—	—	+	+	—	+	+	—	—	+	—	+	—
<i>C. barbatus</i> Bth.	+	—	—	—	+	—	+	—	—	—	—	+	+	—
<i>C. blumei</i> Bth.	+	—	—	—	+	—	+	—	—	—	+	+	—	—
<i>C. forskohlii</i> Briq.	+	—	—	—	+	—	+	—	+	—	+	+	+	—
<i>C. malabaricus</i> Bth.	—	—	—	—	+	—	+	—	—	—	—	—	—	—
<i>Geniosporum tenuiflorum</i> Merr.	+	—	—	—	+	—	+	—	—	—	—	+	—	—
<i>Hyptis suaveolens</i> Poit.	+	+	+	—	+	—	—	—	—	+	—	+	+	—
<i>Lavandula bipinnata</i> O.K.	—	—	—	—	+	—	+	—	—	—	+	+	+	—
<i>Moschosma polystachyum</i> Bth.	—	—	—	—	+	—	—	—	—	—	—	—	+	—
<i>Ocimum adscendens</i> Willd.	—	—	—	—	+	—	+	—	—	—	—	+	—	—
<i>O. basilicum</i> L.	+	—	—	—	+	—	—	—	—	—	—	+	—	—
<i>O. canum</i> Sims.	+	—	—	—	+	—	—	—	—	—	—	—	+	—
<i>O. gratissimum</i> L.	—	—	—	—	+	—	+	—	+	—	—	—	+	—
<i>O. kilimandscharicum</i> Gurke.	+	—	—	—	+	—	+	—	—	—	—	+	—	—

<i>O. sanctum</i> L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Orthosiphon comosus</i> Wt.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+	+	—
<i>Or. diffusus</i> Bth.	+	+	—	+	+	+	—	—	—	—	—	—	—	+	+	—	—	—	—
<i>Or. glabratus</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Or. pallidus</i> Royle	+	+	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Or. rubicundus</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Or. stamineus</i> Bth.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Or. tomentosus</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Or. viscosus</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>Platystoma flaccidum</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Plectranthus coetsa</i> Buch.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
<i>P. incanus</i> Link.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. japonicus</i> Koidz.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. maddenii</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. rugosus</i> Wall.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. striatus</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. stocksii</i> Hk. f.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. wightii</i> Bth.	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

walled, lateral walls straight or bulging. Head unicellular or 2-4-more-celled, spherical, thin-walled, cuticularized, cuticle extending to stalk cell (s); stalk cell (s) and head cell (s) with denser cytoplasm and a nucleus (Figs. 72-81, 112, 124).

*Type VI : Glandular capitate stalked trichomes*

Foot-cells (F) 1-4, as in Type V. Stalk uniseriate, 1-4-celled (SC), smooth-walled, warty, straight or falcate, without contents, rarely one or two cells below the head with dense cytoplasm and nucleus. Such cells being called here as neck-cells (NC). Head mostly unicellular, rarely 2-celled, spherical, oblong or rarely triangular, smooth and thinly cuticularized, cuticle extending all over the surface of the stalk (Figs. 82-87, 89-97). Seldom, the head-cell and neck-cell very small and looking like a knob above a very broad bell-jar-like stalk-cell (Fig. 88).

*Type VII : Non-glandular-cum-glandular branched trichomes*

Foot one-celled; stalk uniseriate, 2-4-celled, cells squarish or polygonal, terminal one two branched, one branch non-glandular, warty, uniseriate, other smooth, glandular consisting of a long stalk, spherical head and trapezoidal neck cell; head cell and neck cell with dense cytoplasm and nucleus, observed on the leaves of *Pl. stocksii* (Fig. 98). BOKHARI AND HEDGE (1971) and RUDALL (1980) describe this type of hairs as branched glandular.

#### ONTOGENY

The trichome-initials are scattered in the epidermis. At times, two initials are adjacently placed (Fig. 113) and are distinguished by their denser contents and relatively larger nuclei. The initials which give rise to non-glandular trichomes have papillate or protruberant outer walls (Figs. 99, 113). (a) They increase in size and divide by a transverse wall into a lower foot-cell (F) and upper hair-initial (HI) (Figs. 100-104). The hair-initial increases in size and on maturation it is without contents, developing usual cuticular thickenings. This is non-glandular uniseriate bi-celled trichome. (b) Many a times the hair-initial divides by more than one transverse walls to give rise to an uniseriate trichome which on full development is generally without contents, and it may assume different forms with usual cuticular thickenings. The resultant trichomes may be non-glandular uniseriate filiform or simple trichomes (Figs. 105-112). (c) In a few cases, during the early stages of ontogeny the enlarged hair-initial shows a slight depression which becomes deeper producing a branched hair (Figs. 114-117).

The initial of a glandular trichome has a rounded outer wall (Figs. 78, 118). It increases in size (Fig. 78) and divides by a transverse wall, following a nuclear division (Fig. 119), to produce the lower foot cell (F) and the upper hair initial (HI) (Figs. 77, 112, 120). (d) The latter by a transverse division produces an upper head-cell and lower stalk-cell (Figs. 76, 113, 121, 122, 125). The head-cell may increase in size and develop cuticle so that a unicellular head is formed, or it may divide by one or two intersecting walls to produce a 2-4 celled head (Figs. 76-79, 112, 124), or by more divisions a multicellular head (cf. Fig. 81). These trichomes are glandular, capitate, sessile. (e) The hair-initial divides by more than one transverse walls to form a uniseriate structure (Figs. 123-125). The uppermost cell organizes into an unicellular or rarely bicellular head and rest the cells forming a stalk. One or all stalk cells, except one or two below the head become elongated and loose contents. These are glandular capitate stalked trichomes.

According to METCALFE AND CHALK (1950, p. 1043) the non-glandular trichomes are (i) uniseriate and (ii) multicellular branched or tufted. Glandular ones consist of variable number of head-cells (1-16 or more) and the stalk of variable length. EL-GAZZAR AND WATSON (1970) reported the trichomes in Labiatae to be (i) unicellular simple and T-shaped, (ii) multicellular simple and branched, (iii) dendroid (stalked and sessile) and stellate, (iv) simple multicellular eglandular and normal or marrubioid or glandular with 1-2-more-celled head. Subsequently, SINGH *et al.* (1975) and GUPTA AND BHAMBIE (1978) emphasized taxonomic significance of trichomes in this family based on a study of 12 species of *Salvia* and 10 species of *Ocimum*, respectively.

Our observations broadly agree with those in the published literature but none of these authors has traced the ontogeny of different types of trichomes, except for a short account by MATHUR (1961) in *Ocimum basilicum*.

The different types of trichomes develop from a single trichome initial (see also NETOLITZKY, 1932; UPHOF *et al.*, 1962; GUPTA & MURTY, 1977). The shape of the outer wall of the initial has been suggested a character in the development of glandular or non-glandular trichomes. The former type of trichome develops from the initial with a round outer wall and latter type of trichome from the initial with papillate or protruberant outer wall (UPHOF *et al.*, 1962). Our studies support the observations of these authors. In each type of ontogeny, the first wall is always periclinal.

From Table 1 it is evident that Types, I, IIIa, c, Va, b and VI a are met with in many of the species but other types (and their subtypes where present) have a restricted distribution; further, the smooth or warty ornamentation on non-glandular trichomes render a reliable character to delineate the species of *Coleus*, *Ocimum*, *Orthosiphon* and *Plectranthus*. Utilizing this information an attempt is made to provide an artificial key to the species, and thus indicate a value of trichomes in identification (see also CARLQUIST, 1961; RAMAYYA & RAJAGOPAL, 1971; RADFORD *et al.*, 1974; SINGH *et al.*, 1975; RAO & RAMAYYA, 1977; GUPTA & BHAMBIE, 1978; SHAH & PARABIA, 1979).

1. Trichomes non-glandular-cum-glandular.....*Pl. stocksii*
1. Trichomes non-glandular and glandular, if branched non-glandular
  2. Non-glandular trichomes branched :
    3. Non-glandular uniseriate bi-celled trichomes absent.....*C. aromaticus*
    3. Non-glandular uniseriate bi-celled trichomes present
      4. Non-glandular trichomes smooth-walled.....*Pl. wightii*
      4. Non-glandular trichomes warty.....*C. barbatus*,  
*Pl. rugosus*
2. Non-glandular trichomes unbranched :
  5. Non-glandular uniseriate simple cylindrical trichomes present
  6. Non-glandular uniseriate filiform and bi-celled trichomes absent
    7. Glandular capitate trichomes both sessile and stalked.....*Or. comosum*
    7. Glandular capitate trichomes sessile
    8. Non-glandular trichomes smooth walled.....*Oc. sanctum*



8. Non-glandular trichomes  
warty.....*Oc. adscendens*
6. Non-glandular uniseriate filiform  
trichomes absent; bi-celled ones  
present :
9. Non-glandular trichomes  
smooth.....*Oc. basilicum*,  
*Oc. canum*
9. Non-glandular trichomes warty.....*C. forskohlii*
6. Non-glandular uniseriate filiform  
trichomes present; bicelled ones  
may be present or not
10. Bi-celled trichomes absent;  
non-glandular trichomes  
smooth-walled or warty.....*Pl. coetsa*
10. Bi-celled trichomes present;  
non-glandular trichomes warty :
11. Some of the filiform trichomes  
hooked, rarely lanceolate.....*Or. viscosus*
11. Filiform hooked or lanceolate  
trichomes absent.....*Pl. striatus*
5. Non-glandular uniseriate simple cylindrical  
trichomes absent :
12. Non-glandular uniseriate filiform.  
trichomes present :
13. Glandular capitate trichomes  
sessile and stalked.....*Hyptis*
13. Glandular capitate trichomes  
sessile :
14. Non-glandular uniseriate  
filiform trichomes straight  
conical.....*Oc. kilimandscharicum*
14. Non-glandular uniseriate  
filiform trichome are falcate  
or hooked in addition to  
straight conical.....*Or. diffusus*
12. Non-glandular uniseriate filiform  
trichomes absent :
15. Glandular trichomes absent.....*C. malabaricus*
15. Glandular capitate trichomes  
only stalked.....*Pl. maddenii*
15. Glandular capitate trichomes both  
sessile and stalked :
16. Non-glandular uniseriate bi-celled  
trichomes absent :
17. Non-glandular uniseriate  
trichomes simple conical.....*Moschosma*
17. Non-glandular uniseriate  
trichomes also falcate in  
addition to simple conical.....*Lavandula*
17. Non-glandular uniseriate  
trichomes simple conical,  
falcate and hooked :

18. Glandular capitate sessile trichomes with unicellular head.....*Anisochilus*
18. Glandular capitate sessile trichomes with 2-4-more-celled head.....*Or. stamineus*
16. Non glandular uniseriate bi-celled trichomes present.....*Or. pallidus*,  
*Pl. japonicus*
15. Glandular capitate trichomes sessile :
19. Non-glandular uniseriate bi-celled trichomes absent.....*Oc. gratissimum*
19. Non-glandular uniseriate bicelled trichomes present :
20. Non-glandular uniseriate trichomes simple conical.....*Platystoma*,  
*Pl. incanus*
20. Non-glandular uniseriate trichomes simple conical and falcate :
21. Glandular capitate sessile trichomes with 2-4-more celled head.....*Geniosporum*
21. Glandular capitate sessile trichomes with 2-4-more-celled or 1-celled head :
22. Non-glandular uniseriate simple trichomes warty.....*Or. glabratus*,  
*Or. rubicundus*, *Or. tomentosus*
22. Atleast some non-glandular uniseriate simple trichomes smooth-walled..... *C. blumei*

## REFERENCES

- BOKHARI, M. H. & HEDGE, I. C. (1971). Observations on the tribe Meriandreae of the Labiatae. *Notes Roy Bot. Grdn Edinb.*, **31** : 53-67.
- CARLQUIST, S. (1961). *Comparative Plant Anatomy*.—Hall Rimchart and Winston Inc., New York.
- EL-GAZZAR, A. & WATSON, L. (1970). A taxonomic study of Labiate and related genera. *New Phytol.*, **69** : 451-486.
- GUPTA, M. L. & BHAMBIE, S. (1978). Studies in Lamiaceae-IV. Foliar appendages in *Ocimum* L. and their taxonomic significance. *Proc. Indian nat. Sci. Acad.*, **44** : 154-160.
- GUPTA, M. & MURTY, Y.S. (1977). Trichomes in Trifolieae. *Proc. Indian Acad. Sci.* 85B (2) : 77-89.
- MATHUR, S. L. (1961). Structure and ontogeny of epidermal appendages on the floral organs of *Ocimum basilicum* L. *Curr. Sci.*, **30** : 471-473.
- METCALFE, C. R. & CHALK, L. (1950). *Anatomy of the dicotyledons*. **2**. Clarendon Press, Oxford.
- NETOLTIZKY, F. (1932). Die Pflanzenhaare. In : *Handbuch der Pflanzenanatomie* (Ed. Lindsbaur), **4**, Berlin, : 1-253.
- RADFORD, A. E., DICKISON, W.C., MASSEY, J.R. & BELL, C. R. (1974). *Vascular Plant Systematics*. Harper and Row, New York.
- RAMAYYA, N. & RAJAGOPAL, T. (1971). Foliar dermatypes of the Indian Aizoaceae and their use in identification. *J. Indian bot. Soc.*, **50** : 355-362.
- RAO, R. S. & RAMAYYA, N. (1977). Structure, distribution and taxonomic importance of trichomes in the Indian species of *Malvastrum*. *Phytomorphology*, **27** : 40-44.
- RUDALL, P. (1980). Leaf anatomy of the subtribe Hyptidinae (Labiatae). *Bot. J. Linn. Soc.*, **80** : 319-340.

- SHAH, G. L. & PARABIA, M. H. (1979). Observations on the structure, organographic distribution and ontogeny of floral trichomes in some Cyperaceae with a note on their taxonomic significance. *J. Guj. Univ.*, **12** : 11-24.
- SINGH, V., SHARMA, M. & JAIN, D. K. (1975). Trichomes in *Salvia* (Labiatae) and their taxonomic significance. *Bull. bot. Surv. India*, **16** : 27-34.
- UPHOF, J. G. TH., HUMMEL, K. & STAESCHE, K. (1962). *Plant Hairs*. In : Encyclopedia of plant anatomy Berlin.