STUDIES ON THE TRICHOMES OF SOME OLEACEAE, STRUCTURE AND ONTOGENY

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ABSTRACT

Some twelve types of trichomes are described for four species of Jasminum and Nyctanthes arbor-tristis L. They fall under two main categories, the eglandular and the glandular trichomes. The systematic position of Nyctanthes seems to be quite natural in the family Oleaceae.

INTRODUCTION

The family Oleaceae has received considerable attention of the botanists particularly with reference to the systematic position of Nyctanthes and the monotypic genus Dimetra. Airy Shaw (1952) transferred these genera to the Verbenaceae on morphological grounds. Stant (1952) has supported Airy Shaw on anatomical grounds. Johnson (1957) in a review of the family Oleaceae opined that Nyctanthes should be excluded from Oleaceae based on the cytological findings of Taylor (1945). On the other hand the embryological data (Patel, 1963; Kapil, 1967) suggests that Nyctanthes should be retained in the Oleaceae.

Several workers (De Bary, 1884; Cowan, 1950; Goodspeed, 1954; Carlquist, 1958, 1959 a, 1959 b, 1959 c, 1961; Mathur, 1961; Ramayya, 1962 a, 1962 b, 1963) have described the structure and development of trichomes and glands in several angiosperm families. The present investigation was carried out to find if the trichomes and glands could be of any help in settling the doubtful systematic position of Oleaceous genera. The present paper deals with the study of eglandular and glandular (glands) trichomes on the vegetative organs of four species of Jasminum, viz., J. auriculatum L., J. flexile Vahl, J. officinale L., J. sambac Ait. and Nyctanthes arbor-tristis L.

The information on the trichomes of Oleaceae is still meagre as it is clear from Solereder's (1908, p. 521) account who described only three types
of trichomes in Oleaceae. They are, peltate, unicellular and simple uniseriate trichomes. Metcalfe and Chalk (1950, p. 895) have followed Solereder.

**MATERIALS AND METHODS**

The vegetative shoots were fixed in FAA and the customary methods of dehydration, infiltration and embedding were followed. Sections were cut at the thickness of 8 microns and stained with Regaud's haematoxylin and fast green. Temporary whole mounts cleared in warm 2·5 % NaOH and stained in aqueous safranine were also used.

**OBSERVATIONS**

In the present investigation of 5 species of Oleaceae 12 types of eglandular and glandular trichomes have been observed. They are: (i) Simple unicellular, (ii) Simple uniseriate filiform, (iii) Conical, (iv) Cylindrical, (v) Truncate, (vi) Fusiform eglandular, (vii) Cylindrical glandular, (viii) Peltate glandular, (ix) Capitate glandular, (x) Fusiform glandular, (xi) Clavate glandular, (xii) Capitate filiform glandular trichomes.

(i) **Simple Unicellular Trichomes** (Fig. 1: 2, Fig. 4: 1-3, 5: 8)

Simple unicellular trichome originates from a papillose protodermal cell which becomes delimited from the adjoining cells by its larger size, prominent nucleus and dense cytoplasm. This hair initial (Fig. 4: 1) gradually elongates and becomes vacuolated (Fig. 4: 2). This becomes more and more vacuolated as the hair undergoes elongation (Fig. 4: 3, Fig. 5: 8). Ultimately both the nucleus and the cytoplasm degenerate. The outer walls are either straight, somewhat convex or concave and cutinised. In *Nyctanthes* these trichomes are conical and are surrounded by eight epidermal cells at the base.

(ii) **Simple Uniseriate Filiform Trichomes** (Figs. 1: 1, Fig. 2: 1-5, Fig 3: 1-4, Fig. 4: 19, Fig. 5: 1)

The simple uniseriate filiform trichome initiates from a papillate protodermal cell which becomes distinct from the adjoining cells by its larger size, prominent nucleus and dense staining properties (Fig. 2: 1, Fig. 3: 1). This hair initial becomes vacuolated and divides by a periclinal wall to form a basal cell (*bc*) and an outer cell (*ac*) (Fig. 2: 3, Fig. 3: 2). Successive periclinals in an outer cell result in an uniseriate 3-12-celled trichome (Fig. 1: 1, Fig. 2: 4-5, Fig. 3: 4, Fig. 4: 19, Fig. 5: 1). Normally the basal cell remains
undivided and forms a simple foot but sometimes as in *J. flexile* Vahl the basal cell divides anticlinally (Fig. 4), hence the foot becomes compound. The outer walls of the trichomes are cutinised. The trichomes are constricted at the cross walls. The cross walls are thin. The lateral walls are either straight, slightly convex or concave. The contents are translucent in some cases only.

(iii) **Conical Trichomes** (Fig. 1: 9-10, Fig. 4: 21-22)

Their ontogeny is similar to that of simple uniseriate filiform trichomes. The body is uniseriate, entire, 2-many-celled, conical with an acute or obtuse apex. The foot is either simple or compound. The trichomes are constricted at the cross walls, often nodulose at the joints. The cross walls are thin or thick. The outer walls are either straight, slightly convex or concave and cutinised. In *J. auriculatum* L. sometimes the conical trichomes have wavy outer walls (Fig. 1: 9). These are termed as wavy conical trichomes.

(iv) **Cylindrical Trichomes** (Fig. 1: 11, Fig. 4: 20)

These trichomes have a simple foot and an uniseriate cylindrical filiform 2-many-celled body with rounded apex. The trichomes constricted at the cross walls, rarely nodulose. The cross walls are thin or thick. The outer walls are mostly straight and cutinised. In *J. auriculatum* L. the cylindrical trichomes are sometimes hooked at the apex (Fig. 1: 11).

(v) **Truncate Trichomes** (Fig. 1: 8)

These trichomes are differentiated into a compound foot and an entire 2-celled body. They have a truncate rounded apex. They are constricted at the cross walls which are thin or thick. The outer walls are either straight, slightly convex or concave and cutinised.

(vi) **Fusiform Eglandular Trichomes** (Fig. 5: 7)

These trichomes have been observed in *Nyctanthes* only. They are differentiated into a simple or compound foot, a unicellular stalk and a fusiform head. The nucleus and the cytoplasm both degenerate and the whole trichome becomes highly vacuolated. Their outer walls are straight, slightly convex or concave and cutinised. Their ontogeny is similar to that of fusiform glandular trichomes which is discussed later.

(vii) **Cylindrical Glandular Trichomes** (Fig. 1: 4, Fig. 2: 14)

In the present study they have been observed only in *J. auriculatum* L. and *J. flexile* Vahl. They are not very common. They have a simple foot and a uniseriate cylindrical body. The distal cell is sometimes knobbed. The trichomes are cutinised at the outer walls and constricted at the cross walls. The cross walls are thin and the lateral walls are either straight, slightly convex or concave. The contents are glandular and translucent.

(βc, basal cell; oc, outer cell; sc, stalk cell and hc, head cell.)
(viii) **Peltate Glandular Trichomes** (Fig. 2: 6-11, Fig. 3: 5-10, Fig. 4: 4-11, Fig. 5: 13)

The hair initial (Fig. 4: 4) divides periclinally into a basal cell (bc) and an outer cell (ac) (Fig. 4: 5). The outer cell divides again periclinally into a stalk cell (sc) and a head cell (bc) (Fig. 2: 6, Fig. 3: 5, Fig. 4: 6). The basal cell forms a simple foot and the stalk cell the unicellular stalk. Successive anticlines in the head cell result in a peltate head or shield (Fig. 2: 10-11, Fig. 3: 8-10, Fig. 4: 10, Fig. 5: 13). According to Solereder (1908, p. 524) the shield consists of four cells only in *J. officinale* L. and *Nyctanthes arbortristis* L. While in *J. sambac* Ait. and other species of * Jasminum* the shield consists of 16 cells. During the present study it has been invariably observed in *J. officinale* L. that the shield consists of 4-8 cells rarely more (Fig. 3: 8-10). In *Nyctanthes* the shield consists of 4-8 cells. In *J. flexile* Vahl and *J. sambac* Ait, the shield consists of 6-8 cells. The trichomes are situated in the shallow depressions of the epidermis. The outer walls are cutinised. The shield is densely cytoplasmic. The contents are granular and translucent.

(ix) **Capitate Glandular Trichomes** (Fig. 1: 5-6, Fig. 2: 12-13, Fig. 3: 15-17, Fig. 4: 12-16, Fig. 5: 9-10)

These trichomes follow the same course of development as the peltate trichomes but here the divisions in the head cell are not strictly anticlinal. They may be anticlinal, periclinal, oblique or irregular. The trichomes have a simple foot and an unicellular stalk which may be either short or long (Fig. 4: 12-15). The head is multicellular consisting of several cells. There are several variants of these trichomes (see Figs.). They mainly vary in their shapes. The outer walls of the trichomes are cutinised. They are also situated in the shallow pits of the epidermis. The contents are granular and translucent.

In *Nyctanthes* rarely the basal cell undergoes anticlinal division, the stalk cell also divides anticlinally to form a biseriate stalk. The head consists of 4 cells only which lie parallel to each other (Fig. 5: 11-12).

(x) **Fusiform Glandular Trichomes** (Fig. 1: 7, Fig. 2: 15-19, Fig. 3: 11-12, Fig. 4: 17, Fig. 5: 14)

The hair initial divides periclinally to give rise to a basal cell and an outer cell (Fig. 2: 15). The outer cell divides again periclinally into a stalk cell and a head cell (Fig. 2: 16). The initial divisions in the head cell are periclinal (Fig. 2: 17). The divisions in the lower cells are anticlinal or

oblique. Ultimately a fusiform trichome is formed with a simple foot, unicellular stalk and a multicellular head. The outer walls of the trichomes are
cutinised. The head is densely cytoplasmic. The contents are granular and translucent.


(hec, basal cell; ace, outer cell; sce, stalk cell and hce, head cell.)
(xi) **Clavate Glandular Trichomes** (Fig. 1: 3, Fig. 2: 20, Fig. 3: 13–14, Fig. 4: 18, 5: 15)

The development of this trichome is similar to that of fusiform glandular trichome but the plane of divisions in the head cell is not constant. It may be anticlinal, periclinal, oblique or irregular. Finally a club-shaped trichome is formed. It has a simple foot, unicellular stalk and a multicellular head.

Trichomes of Some Oleaceae, Structure and Ontogeny

The outer walls of the trichome are cutinised. The head is densely cytoplasmic with granular and translucent contents. They are also slightly sunken in the pits of the epidermis.

(xi) Captitate Filiform Glandular Trichomes (Fig. 5: 2–6)

The hair initial (Fig. 5: 2) divides periclinaly to give rise to a basal cell and an outer cell (Fig. 5: 3) which divides again to give rise to a stalk cell and a head cell (Fig. 5: 4). The basal cell forms a simple foot, while the stalk cell undergoes one or two periclinal divisions (Fig. 5: 5) to form a stalk of 2–4 cells, the head cell remaining undivided. The trichomes are cutinised at the outer walls and constricted at their cross walls. The lateral walls are straight, slightly convex or concave. The head is unicellular, broader than the stalk swollen to an oblong-ovoid or ovate form (Fig. 5: 6). The contents in the head cell are dense, granular and translucent. These trichomes have been observed in Nyctanthes only.

Discussion

Solercder (1908) and Metcalf and Chalk (1950) have described only three types of trichomes, viz., unicellular, simple uniseriate and peltate trichomes in the family Oleaceae. Further according to Solercder in the family Oleaceae the peltate trichomes have a unicellular stalk and the shield is segmented by vertical walls only into variable number of cells showing different orientation. The present ontogenetical studies confirm the observations of Solercder regarding the peltate trichomes, but there are several other glandular trichomes in which the shield or the head is not segmented solely by vertical walls but by anticlinal, periclinal, oblique or irregular walls, they have been termed as capitate, fusiform, clavate glandular trichomes as the case may be. The twelve types of trichomes observed during the present studies can be classified as follows:

Trichomes of Jasminum (4 spp.) and Nyctanthes

Eglandular

<table>
<thead>
<tr>
<th>I. Simple unicellular</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. Simple uniseriate filiform</td>
</tr>
<tr>
<td>III. Conical</td>
</tr>
<tr>
<td>IV. Cylindrical</td>
</tr>
<tr>
<td>V. Truncate</td>
</tr>
<tr>
<td>VI. Fusiform eglandular</td>
</tr>
</tbody>
</table>

Glandular

<table>
<thead>
<tr>
<th>I. Cylindrical glandular</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. Peltate glandular</td>
</tr>
<tr>
<td>III. Capitate glandular</td>
</tr>
<tr>
<td>IV. Fusiform glandular</td>
</tr>
<tr>
<td>V. Clavate glandular</td>
</tr>
<tr>
<td>VI. Captitate filiform glandular</td>
</tr>
</tbody>
</table>
**Table I**

*Distribution of trichomes in Jasminum (4 spp.) and Nyctanthes and their comparison*

<table>
<thead>
<tr>
<th>Type of trichomes</th>
<th>J. auriculatum L.</th>
<th>J. flexile Vahl</th>
<th>J. officinale L.</th>
<th>J. sambac Ait.</th>
<th>Nyctanthes arbor-tristis L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Simple unicellular</td>
<td>Stem and leaf (C)*</td>
<td>.</td>
<td>.</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
</tr>
<tr>
<td>2. Simple uniseriate filiform</td>
<td>Stem (NC)†, leaf (C)</td>
<td>Stem (NC)</td>
<td>Stem (NC)</td>
<td>Stem (NC), leaf (C)</td>
<td>Stem (NC), leaf (C)</td>
</tr>
<tr>
<td>3. Conical</td>
<td>Stem and leaf (C)</td>
<td>.</td>
<td>.</td>
<td>Stem and leaf (C)</td>
<td>.</td>
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<tr>
<td>4. Cylindrical</td>
<td>Stem and leaf (C)</td>
<td>.</td>
<td>.</td>
<td>Stem and leaf (C)</td>
<td>.</td>
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<tr>
<td>5. Truncate</td>
<td>Leaf (NC)</td>
<td>.</td>
<td>.</td>
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<tr>
<td>6. Fusiform eglandular</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>Stem and leaf (C)</td>
</tr>
<tr>
<td>7. Cylindrical eglandular</td>
<td>Leaf (NC)</td>
<td>Leaf (NC)</td>
<td>.</td>
<td>.</td>
<td>.</td>
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<tr>
<td>8. Peltate eglandular</td>
<td>.</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
</tr>
<tr>
<td>9. Capitate eglandular</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
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<tr>
<td>10. Fusiform eglandular</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
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<tr>
<td>11. Clavate eglandular</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
<td>Stem and leaf (C)</td>
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<tr>
<td>12. Capitate filiform eglandular</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>Leaf (NC)</td>
</tr>
</tbody>
</table>

* (C)—Common, † (NC)—Not common.
**Systematic position of *Nyctanthes* L.**

The genus *Nyctanthes* is placed in the family Oleaceae, Airy Shaw (1952) considered it to be a member of Verbenaceae and placed it in the new subfamily Nyctanthoideae of Verbenaceae. Stant (1952) and Johnson (1957) have supported Airy Shaw. It may be mentioned here that Hutchinson (1959) makes no reference to *Nyctanthes* either under the Verbenaceae or the Oleaceae.

From the available morphological data and the present studies the author believes that *Nyctanthes* stands nearer to Oleaceae rather than Verbenaceae on account of the following reasons:

(i) Generally *Nyctanthes* shows presence of regular corolla and two stamens as in other Oleaceae.

(ii) Pleiomerism in the corolla and carpelloid stamens are frequent in *Nyctanthes* and Oleaceae. They are not reported in Verbenaceae.

(iii) The contorted rotate corolla of *Nyctanthes* is not typically Verbenaceous. Airy Shaw (1952, p. 271) also expressed that the corolla of *Nyctanthes* is somewhat like that of a *Jasminum*.

(iv) The ovary of *Nyctanthes* is bilocular with one ovule in each locule, a feature comparable with *Jasminum* of Oleaceae. The ovary of Verbenaceae is tetra-locular and possesses one ovule in each locule.

(v) Foliar nectaries are absent in *Nyctanthes* and other Oleaceae while they are present in Verbenaceae.

(vi) Stomata are anomocytic in *Nyctanthes* and Oleaceae. In Verbenaceae the stomata are mostly diacytic.

Stant (1952) refers only two types of hairs in *Nyctanthes*, viz., unicellular trichomes and glandular hairs, but during the present studies some eight types of trichomes have been observed on the stem and leaf of *Nyctanthes* (see Table I). It seems Stant has failed to observe them. Out of these eight types observed in *Nyctanthes*, simple uniseriate filiform, capitate glandular, fusiform glandular and clavate glandular trichomes are common with all the four species of *Jasminum* while peltate glandular trichomes are common with *J. flexile* Vahl, *J. officinale* L. and *J. sambac* Ait. The simple unicellular trichomes are common with *J. auriculatum* L. and *J. sambac* Ait. All the six types are common with *J. sambac* Ait. Moreover, their ontogeny is also similar.
CONCLUSION

Thus from the morphological data and the present studies there is a strong evidence that *Nyctanthes* should be retained in the family Oleaceae and should not be transferred to the Verbenaceae. This view is substantiated by the embryological studies of *Nyctanthes* and other Oleaceae made by Patel (1963) wherein he has concluded that the embryological features of *Nyctanthes* are similar to other Oleaceae rather than the Verbenaceae. Kapil (1967) while reviewing the literature on the embryology of the family Oleaceae has also remarked that 'Nyctanthes' has many features common with the Oleaceae and should not be included in Verbenaceae. From the present studies and the available literature it seems that the position of *Nyctanthes* is more natural in the tribe Jasmineae of Oleaceae.

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