

S.E.M. STUDIES OF TRICHOMES TYPES IN REPRESENTATIVE SPECIES OF THE SECT. *POLYACTIUM* AND SECT. *LIGULARIA* IN THE GENUS *PELARGONIUM* L'HERIT., (GERANIACEAE)

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Abstract

Trichomes from the leaves of 11 species of *Pelargonium* L'Herit., were examined with the S.E.M. Trichomes observed were of either non-glandular unicellular and uniseriate-type or were glandular, uniseriate stalk of different length, with a unicellular head consisting of spherical or oblong spherical terminal cell. The surface of the trichomes were smooth to granulate-tuberculate. The study revealed that trichomes of the leaf indumentum can be used as an additional aid in the identification and determination of relationship between the species.

Introduction

Pelargonium L'Herit., belongs to family *Geraniaceae* and are mostly distributed in South Africa (Van Der Walt, 1977). Knuth (1912) recognized 15 sections of *Pelargonium*. Some species are cultivated as popular indoor plants and are widely known as rose geraniums containing both aromatic and non-aromatic species. The species of *Pelargonium* are conspicuously hairy and aromatic. The oil secreted by the glandular trichomes is highly scented and sometimes distilled for use in perfumery (Metcalf & Chalk, 1950). Geranium oil is distilled chiefly from the leaves of selected varieties of *Pelargonium* (Metcalf & Chalk, 1950).

The taxonomic significance of trichomes has been emphasized by Solereder (1908), Metcalf & Chalk (1950), Uphof & Hummel (1962), Inamadar (1967), Aleykuty & Inamadar (1980) and Carolin (1970). Rajput *et al.*, (1985) provided a large number of trichome illustrations alongwith scanning electron micrographs of *Dampiera* R.Br., and suggested that the structure of trichomes can be used as an important taxonomic tool in systematic comparisons. Fahn (1979), Werker & Fahn (1982) pointed out that trichomes are responsible for the secretion of aromatic oils. The systematic applicability of trichomes and other epidermal characters have been discussed in detail with respect to evolutionary aspects (Barthlott, 1981). Husain *et al.*, (1990) also suggested that micromorphological characters of leaf indumentum can be helpful as an additional taxonomic character.

Metcalf & Chalk (1950), Marais (1980) and Oosthuizen (1983) studied trichomes in *Pelargonium* with the light microscope. The trichomes of *Pelargonium* have not previously been examined with the S.E.M. In the present study, the structural type of trichomes *Pelargonium* which are usually cultivated as an ornamental plant were exam-

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ined with Scanning Electron Microscope, to determine whether aromatic and non-aromatic species of the section *Polyactium* (Eckl. Zeyh) DC., and Section (Sweet) Harv., could be identified on the basis of the trichome diversity.

Materials and Methods

Three adaxial surface leaf samples, approximately 1 cm in-size, from each species were taken from fresh material grown in the Plant Sciences glasshouse complex, South Bank University, London and Reading University, Reading U.K. Voucher specimens are deposited in the South Bank University. These were fixed in a 2.5% glutaraldehyde and Ringers solution and passed through a series of increasing concentrated solutions of acetone. The material was completely dehydrated in graded acetone solutions and critical point dried with CO₂. Dried leaf samples were mounted onto the stubs with double sided Cellotape, and were sputter coated with C. 30-50 nm gold, examined and photographed with a JEOL JSM T20 Scanning Electron Microscope, at an accelerating potential of 20 Kev. All the photographs were taken at the Electron Microscopic Unit, Department of Botany, University of Reading, Berkshire, U.K.

The terms short medium and long are used in the text. The range of measurement of trichome is as follows: Short 0.1 - 1.5 mm, medium 1.6 - 3.0 mm and long 3.1 - 6.0 mm.

Results and Discussion

Eleven species of the genus *Pelargonium* belonging to Sect. *Polyactium* and Sect. *Ligularia*, containing aromatic and non- aromatic species were examined with the S.E.M.

Trichomes: In the species of Section *Polyactium* (Eckl. & Zeyh) DC., and Section *Ligularia* (Sweet) Harv., basically two types of trichomes are found: (a) Non-glandular

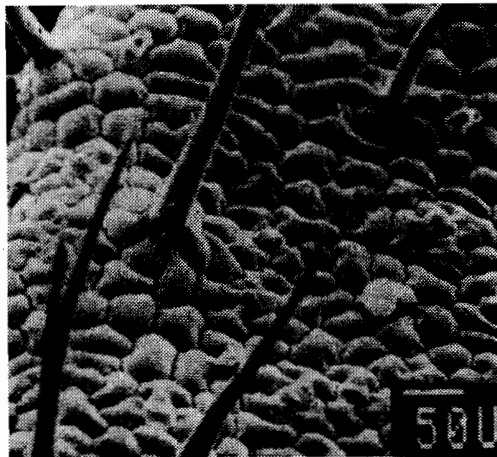


Fig.1. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium bowkeri*.

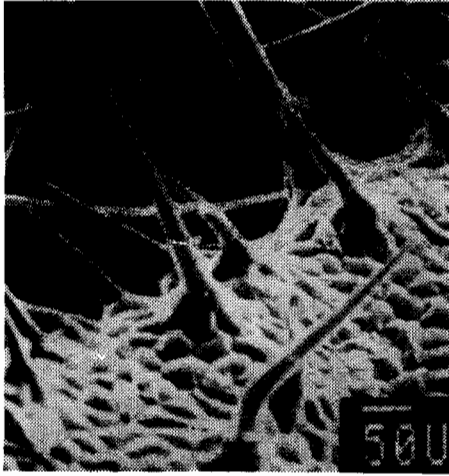


Fig.2. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium pulvenulentum*.

and (b) Glandular (present on both abaxial and adaxial leaf surface). Both types occur on the leaf surfaces, but usually are densely distributed on the veins on the abaxial surfaces. In some species the trichomes are borne on a podium made up of raised epidermal cells (Fig.10 & 11).

Non-glandular trichomes: Simple unicellular, stiff, pointed at the apex, broad at the base and tapering towards the apex. Generally long, usually raised on a podium, varying in size and with thick cuticles. Trichomes surface smooth to granulate, sometimes striate (Figs. 1,2 & 3) mostly spreading, straight rarely appressed against the leaf surfaces, rarely curved near the base (Figs. 5,6 & 7), sparsely to densely distributed on both adaxial and abaxial leaf surfaces.

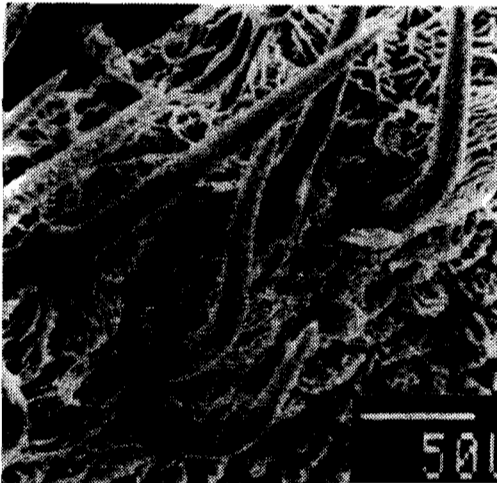


Fig.3. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium caffrum*.



Fig.4. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium barklyii*.

Glandular trichomes: Multicellular 3-7 cell high, uniseriate, can be differentiated into a simple or compound foot (base) uni or multicellular body (stalk) and a spherical to orbicular or globular or rarely pyriform terminal cell (Figs.4,9 & 10). The terminal cells (head) are mostly larger in size than body cell (stalk). The number of cells in the body varies from 1-5. Foot cell usually darker and broader than body cells (stalk). Body cells usually tapering towards the apex or sometimes equally broad at the base and apex. Lumen of body cell broad in comparison to that of non-glandular trichomes. Glandular trichomes vary in size mostly straight; cuticle very thin and completely smooth, except in *P. trifidum* Jacq., which has a striate pattern on foot and body cells (Fig.10). Terminal (head) cells translucent. Secretory material accumulates in the ter-

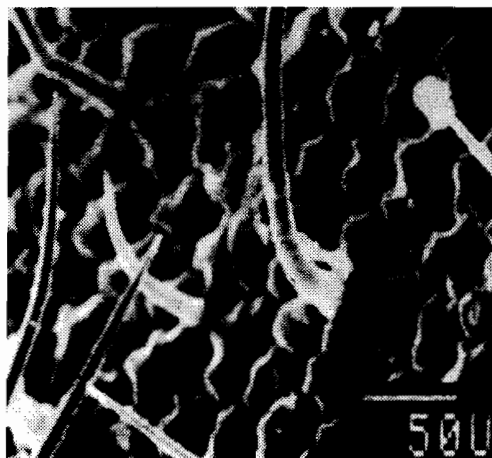


Fig.5. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium barklyii*.

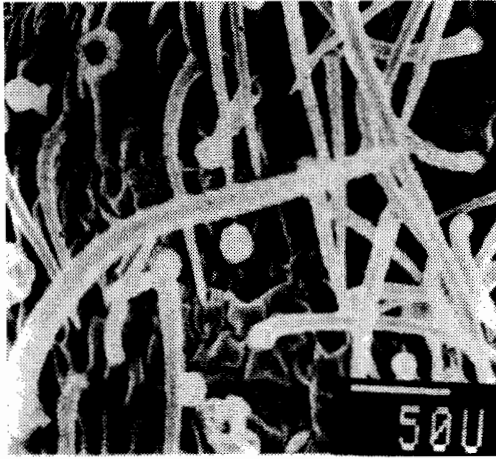


Fig. 6. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium abrotanifolium*.

minal cells, but after rupturing the terminal cell collapses and becomes cup-like in shape (Fig.8).

Section *Ligularia* (Sweet) Harv. Trichomes of *P. abrotanifolium* (L.f.) Jacq., *P. dolòmitieum* Knuth., *P. extipulatum* (Cav.) L'Herit., *P. griseum* Kunth., *P. ionidiflorum* (Eckl. & Zeyh). Steud. *P. barklyi* Scott Elliot and *P. trifidum* Jacq., were examined, and it was observed that a relationship between species within the section seems to emerge. Trichomes are short to medium sized, stiff and mostly not borne on a podium made up of raised epidermal cells (except *P. trifidum*, Fig.11). All the species under investigation in Sect. *Ligularia* and Sect. *Polyactium*, have both glandular and non-glandular type of trichomes except *P. griseum*, in which non-glandular trichomes are absent.

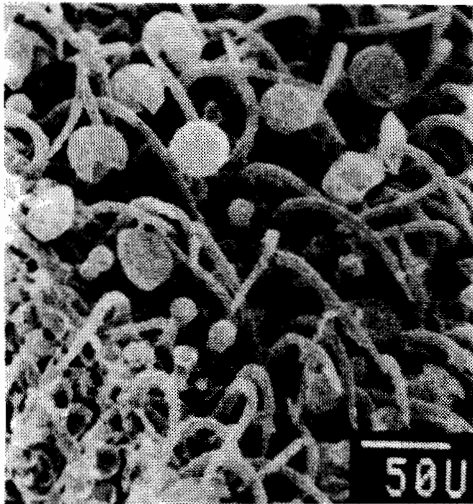


Fig. 7. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium stipulatum*.



Fig.8. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium exstipulatum*.

Section Polyactium (Eckl. & Zeyh) DC.: *P. bowkeri* Harv., *P. caffrum* (Eckl. & Zeyh) Harv., *P. gibbosum* (L.) L'Herit and *P. pulverulentum* Colv. ex Sweet were examined. All these species show the presence of aromatic and non-aromatic trichomes and show a relationship in having usually long non-glandular trichomes which are mostly borne on a podium composed of raised epidermal cells (except *P. gibbosum* Fig. 12). The details of the trichomes regarding size, presence or absence of podium, surface pattern, number of cells in the glandular trichomes, and the shape of the terminal cell or head are given in Table 1.

The trichomes of *P. trifidum* (Figs. 10 & 11) of Sect. *Ligularia* are quite different as compared to the other species of this section. In this species the non-glandular

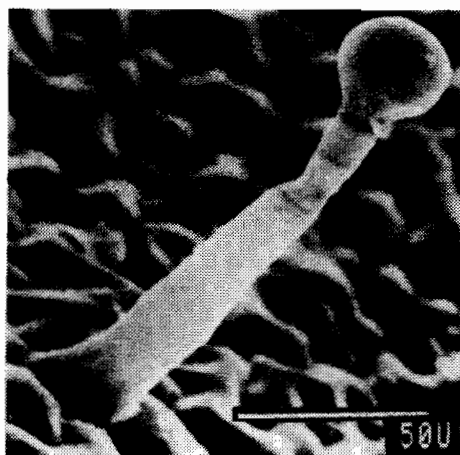


Fig.9. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium griseum*.

Table 1. Details of leaf indumentum in representative species of genus *Pelargonium* (Geraniaceae).

Name of species	Non-glandular trichomes					Glandular trichomes				
	Nature	Size	Podium	Surface	No. of cells per trichome	Size	Podium	Shape of terminal cell	Surface	
Sect. <i>Ligularia</i> (Sweet) Harv.										
<i>P. abrotanifolium</i> (L.f.) Jacq.	curved	medium	absent	smooth finely granulate	4	medium	present	global	smooth	
<i>P. dolomiticum</i> Knuth.	mostly straight, rarely curved	medium	absent	papillate	4	medium	present	globular	smooth	
<i>P. exstipulatum</i> (Cav.) L'Herit	curved	medium	absent	smooth	3	short	present	orbicular	smooth	
<i>P. griseum</i> Knuth.	—	—	—	—	4	long	present	± globular	smooth	
<i>P. ionidiflorum</i> (Eckl. & Zeyh) Steud	straight	short- medium	absent	smooth, lightly granulate	3	short	present	orbicular	smooth	
<i>P. barklyi</i> Scott Elliot	slightly curved	medium long	absent	densely granulate	4-6	short- medium	absent	globular- orbicular	smooth	
<i>P. trifidum</i> Jacq.	straight	medium	present	smooth	3-6	short- medium	present	globular, orbicular	smooth- striate	
						long		pyriform		

Table 1 (Cont'd)

Name of species	Non-glandular trichomes			Glandular trichomes		
Sect. <i>Poljactium</i> (Eckl. Zeyh) DC., <i>P. bowkeri</i> Harv.	straight	short + present medium	granulate	4-7	medium absent long	globular smooth
<i>P. cafrum</i> (Eckl. & Zeyh) Harv.	straight rarely curved	short + present medium	granulate	2-3	short, present medium, long	globular smooth
<i>P. gibbosum</i> (L.) L'Herit.	straight	long	smooth, rough	4-6	medium absent long	globular smooth
<i>P. pulverulentum</i> Colv. ex Sweet	straight	short + present long	smooth + granulate	4-6	short + absent long	globular + orbicular smooth



Fig.10. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium trifidum*.

trichomes are borne on a podium composed of 5-6 raised epidermal cells. Three types of glandular trichomes were observed on a single leaf surface, differing in size and structure. The short trichomes are made up of 4 cells in which the terminal cell is globular, a medium sized glandular trichome with a circular to orbicular terminal cell, and a large glandular trichome, in which the terminal cell is pyriform and is fairly large in size. Moreover this type of trichome has a prominent striate pattern (Fig.10) on the foot and stalk cell, fine granules were seen on the terminal cell. A waxy substance is also present on these trichomes. In *P. pulverulentum* (Fig.2) of Sect. *Polyactium*, non-glandular trichomes are of two different types; (a) short with prominent granulate pattern and (b) large with completely smooth surface, both these types are borne on a

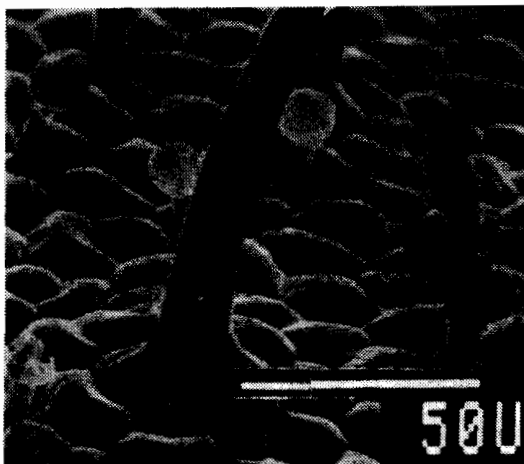


Fig.11. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium trifidum*.



Fig.12. Scanning Electron Micrograph of trichomes on adaxial leaf surface of *Pelargonium gibbosum*.

podium consisting of 5-6 raised epidermal cells. In this species, the glandular trichomes are also of two types, i.e. (i) trichomes in which the stalk is short but the terminal cell is orbicular and large, and (ii) trichomes with a very long stalk and body with a very small globular terminal cell.

This study of trichomes indicate that the placement of *P. pulverulentum* in Sect. *Polyactium* and *P. trifidum* in Sect. *Ligularia* is questionable since the trichomes show structural differences. Marais (1980) reported these types of trichomes in all the species in the Sect. *Jenkinsonia* and Sect. *Myrrhidium*. The relationship between aromatic and non-aromatic species using trichome characters in identification and separation seems inconclusive from the results of this study.

Acknowledgement

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