

## IDIOLASTIC MUCILAGE CELLS IN *TEUCRIUM POLIUM* LEAF. ANATOMY AND HISTOCHEMISTRY

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**Abstract.** In the mesophyll of *Teucrium polium* L. leaves, isolated or grouped idioblastic secretory cells occur in contact with the distal (adaxial) vessel elements of the vascular bundles. They appear to originate from one or more bundle sheath cells and their intracellular space is entirely occupied by the secretory material. The latter has a glycoproteinaceous constitution (mucilage), as histochemical tests showed. Idioblastic cells, therefore, correspond to typical mucilage cells. Mucilage seems to play a crucial role in the adaptation of the plant to unfavourable environmental conditions.

**Key words:** *Teucrium polium*, mucilage cells, anatomy, histochemistry

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### Introduction

Idioblastic cells are individual cells which prominently differ from their neighbouring cells in size, content, ontogeny and metabolism. They are considered as secretory structures composed of one cell only. This fact stresses their functional complexity compared to the multicellular glands. Idioblastic cells secrete and deposit various substances, like mucilage (PAKRAVAN *et al.* 2007), proteins (UEDA *et al.* 2006), tannins (ZOBEL 1985), oils, etc. In certain idioblasts, oils are triglycerides (PLATT-ALOIA *et al.* 1983), while in others – essential oils (POSTER & TUCKER 1983). Idioblastic mucilage cells produce a slime composed either of a mixture of polysaccharides and protein (glycoprotein) (KRISTEN & LOCKHAUSEN 1985) or exclusively of polysaccharides (SAWIDIS 1998). Mucilage idioblasts typically occur within members of Cactaceae, Malvaceae, Orchidaceae, Liliaceae (HICKEY & KING 1988).

In the present work, the idioblastic secretory cells in the mesophyll of *Teucrium polium* L. (Lamiaceae) were studied in an attempt to elucidate their anatomical location, shape, and origin. Furthermore, histochemical tests were conducted to identify the chemical constitution of the secreted material.

### Material and methods

#### *Plant material and sampling*

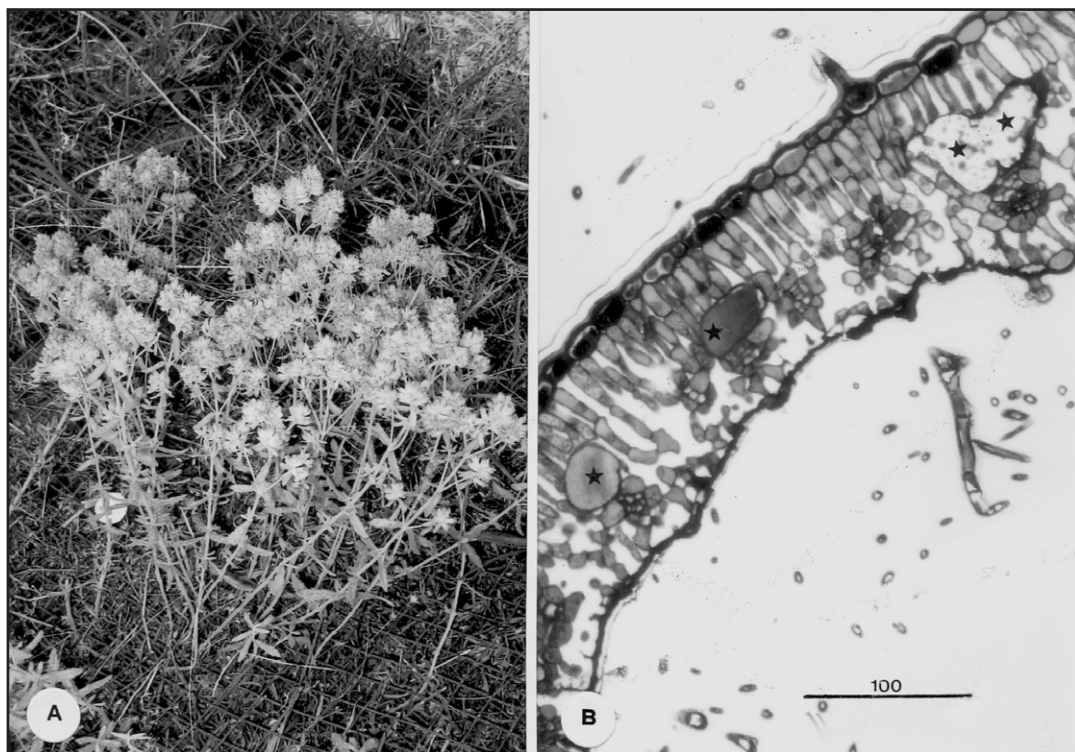
*T. polium* was studied at the region of Ormylia Chalkidiki, N. Greece (N 40°16'53", E 23°31'44", altitude 48 m a.s.l.). Sampling was performed in early July. Fully-developed leaves from the 3<sup>rd</sup> node (from the basis) of annual shoots were used.

#### *Microscopy*

A sample of 10 leaves, randomly selected from 5 plants, was used for light microscopy (anatomy and histochemistry). Small pieces of leaves were prefixed for 3 h with 5% glutaraldehyde in 0.05 M phosphate buffer (pH 7.2) and postfixed for 4 h with 2% osmium tetroxide, similarly buffered. Fixed samples were dehydrated in ethanol series (50-100%) and finally embedded in Spurr's resin. Semithin sections (1 µm thick) were obtained with a Reichert Om U<sub>2</sub> microtome (Reichert Optische Werke AG, Vienna, Austria) and examined on a Nikon Eclipse 180 light microscope (Nikon Instruments, Amstelvee, The Netherlands).

#### *Histochemistry*

For anatomical and histochemical observations, semithin sections of resin embedded tissue were used. Anatomical staining was performed with 1% Toluidine Blue



**Fig. 1.** **A** – surface view of *Teucrium polium* plant in the field in early July, coin 1 Euro = 2.4 cm diam. **B** – cross-section of the leaf illustrating the presence of idioblastic mucilage cells (asterisks) in contact with vessel elements of the vascular bundles, scale bar in  $\mu\text{m}$ .

O in 1% aqueous borax solution (70°C, 1 min) (PICKETT-HEAPS 1969). Histochemical staining comprised staining of lipids, polysaccharides, and proteins. Lipids were stained with 1% Sudan Black B in 70% ethanol (BRONNER 1975), polysaccharides with Periodic Acid-Schiff (PAS) (NEVALAINEN *et al.* 1972), and proteins with 1% Coomassie Brilliant Blue in 7% acetic acid (FISHER 1968).

### Results and discussion

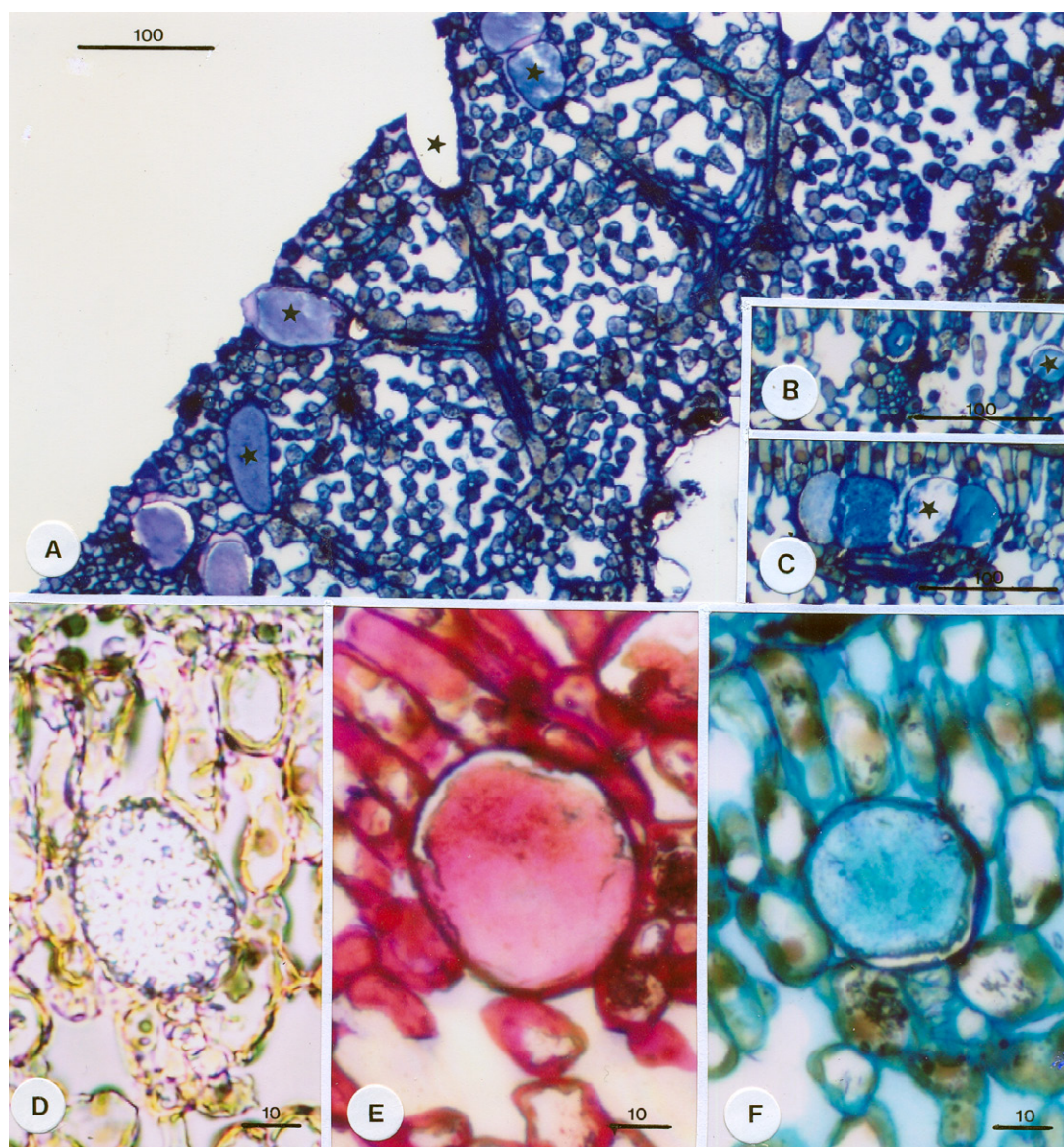
*T. polium* plants in early July form at the apices of their annual shoots inflorescences which are dichasia with terminal racemes (Fig. 1 A). Leaves are arranged in decussate phyllotaxy and have an average surface area per leaf side of 89.8 mm<sup>2</sup>. In leaf cross-section, the palisade tissue appears composed of 1-2 cell layers, and the vascular bundles are surrounded by a bundle sheath (Fig. 1 B). At the adaxial pole of each vascular bundle and in contact with the

vessel elements (Figs. 1 B; 2 A-C), one or more sheath cells differentiate into secretory idioblasts by largely increasing their size and by modifying the structure and function of their protoplasts. Secretory idioblasts have a globular/ovoid shape as deduced from the combination of leaf paradermal and cross-sections (Figs. 1 B; 2 A).

The mechanism of secretion in idioblastic cells has been ultrastructurally studied (BOUCHET & DEYSON 1976; FINERAN & LEE 1980) and comprises exocytosis of the secreted material into the extraplasmic space between the plasmalemma and the cell wall. With the progress of secretion, this space gradually increases in volume (at the expense of the protoplasm) until finally the whole intracellular space inside the cell wall becomes occupied by the secretory material. Due to this process, a parietal cytoplasmic layer internally lining the cell wall is missing.

In an attempt to identify the chemical constitution of the secreted material within the





**Fig. 2.** **A** – Paradermal section of the leaf at the level of location of the mucilage idioblasts (asterisks). Note the association of the idioblasts with the vascular bundles (longitudinally cut). **B** and **C** – Isolated and grouped idioblastic mucilage cells in touch with vascular bundles. **D–F** – Idioblastic cells treated with Sudan Black B for lipids (**D**), with PAS for polysaccharides (**E**), and with Coomassie Brilliant Blue for proteins (**F**). With Sudan Black B, the content of the idioblasts remained unstained (no presence of lipids), with PAS it stained pink (presence of polysaccharides), and with Coomassie Brilliant Blue it stained light blue (presence of proteins). The content, therefore, corresponds to glycoprotein (mucilage). Scale bars in  $\mu\text{m}$ .

idioblastic cells of *T. polium*, three histochemical tests were conducted. The first comprised the treatment of semithin sections (1  $\mu\text{m}$  thick) with Sudan Black B for lipids, the second with PAS for polysaccharides, and the third with

Coomassie Brilliant Blue for proteins. The tests showed that Sudan Black B does not stain the idioblastic cell content (Fig. 2 D), whereas PAS stains it pink (Fig. 2 E) and Coomassie Brilliant Blue, light blue (Fig. 2 F). The results

reveal that the secreted material is not a lipidic substance (essential oil), but a mucilaginous one composed of a mixture of polysaccharides and protein. Idioblastic cells, therefore, do not correspond to oil cells, but to mucilage cells secreting a glycoproteinaceous slime (not a pure polysaccharidic slime).

The mucilaginous content of the idioblastic cells and their location in contact with vessels of the conductive tissue are presumably associated with uptake from the vessels of amounts of water which are used for the impregnation and dilation of the mucilage mass. An analogous view that mucilage cells serve as deposits of water has been early expressed by CHRISTODOULAKIS *et al.* (2010). The water trapped in the leaf mucilage is difficult to transpire, and thus under heat/drought stress, the water relations are not remarkably disturbed allowing the plant to survive. Under cold stress, the water in the form of swollen mucilage undergoes reduction of its freezing point and so leaves become resistant to low temperatures. The accumulation, therefore, of mucilage in the leaves constitutes an excellent strategy of the plants to adapt to unfavourable environmental conditions.

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