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Morpho-functional features of leaves of *Centaurea tenorei* Guss. ex Lacaita (Asteraceae)

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Riassunto. *Caratteristiche morfo-funzionali delle foglie di* Centaurea tenorei *Guss. ex Lacaita (Asteraceae)*
Gli autori hanno condotto uno studio sulle foglie di *Centaurea tenorei* Guss. ex Lacaita (Asteraceae). Sono state riscontrate differenze morfologiche e anatomiche che hanno portato all'individuazione di tre tipi fogliari, con una transizione da caratteri sciafili a xeromorfi. Sono illustrate le differenze tra i tre tipi, interpretate come variazioni morfologiche in risposta a diversi parametri climatici.

Key words: **Asteraceae, *Centaurea tenorei*, Leaf morphology**

Relatively few morphological studies on genus *Centaurea* L. (Asteraceae) are available (*i.e.* RUNEMARK, 1967; CELA RENZONI, 1970; KARAWYA *et al.* 1974; 1974a; 1974b). Particularly, very few morphological informations are available about the *C. parlatoris* Heldr. group, which includes four species living in central and southern Italy: *C. parlatoris*, *C. tenorei* Guss. ex Lacaita, *C. scannensis* (Anzalone) Pign., and *C. ambigua* Guss. (PIGNATTI, 1982).

This present study represents the first step in a wider research on the entities of this group and was carried out at macroscopic and microscopic levels with the aim of verifying the morpho-histological variation in leaves of *C. tenorei*. This entity is endemic in the Sorrentine Peninsula (Campania, Italy), where it grows from 0 to 1400 m a.s.l., usually on calcareous rocks.

HISTORICAL BACKGROUND

TENORE (1842) first mentioned plants belonging to the entity currently known as *C. tenorei* (LACAITA, 1922). He ascribed the plants to *C. dissecta* Ten. var. *glabrata* Ten. and reported on the occurrence of this entity in the Sorrentine Peninsula.

Giovanni Gussone was the first author to name this entity *C. tenorei* but he did not publish the new name. LACAITA (1922) confirmed the use of this specific name and published it. For this species he distinguished three forms: the first one (typical form), growing on the top of the mountain S. Angelo (*locus classicus*) and on most of the reliefs of the Sorrentine Peninsula; the second one (var. *montaltensis* Lacaita), growing on the dolomitic reliefs near Maiori (Salerno); the third one (var. *maritima* Lacaita), commonly found in patches of coast in the Sorrentine Peninsula.

Later, FIORI (1923-1929) did not consider this entity as a distinct species and included it in *C. dissecta*. He identified the three forms of Lacaita with two varieties of the species: the first corresponding to var. *maritima*; the second, reported as var. *glabrata* Ten., including the other two forms.

More recently, DOSTÁL (1976) included this entity in the Sect. *Dissecteae* (Hayek) Dostál, as a subsp. of *C. parlatoris* (*C. parlatoris* subsp. *tenorei* (Guss. ex Lacaita) Dostál). Finally, PIGNATTI (1982) considered *C. tenorei* a true species with four forms (i.e. the three reported by Lacaita plus a form represented by the plants living near Scala, Salerno). However he considered them of insignificant taxonomic relevance.

MATERIALS AND METHODS

Leaf samples of *C. tenorei* plants from localities near Amalfi were studied. Middle portions of leaf blades were processed for light microscopy and scanning electron microscopy (SEM).

Light microscopy

Leaf samples were fixed in FAA (formaline-acetic-alcohol:10-5-50), dehydrated in a graded ethanol series and embedded in paraffin wax with a melting point of 51-53 °C. Sections 10 µm thick were obtained using an R. Jung rotary microtome and stained with 0.05% toluidine blue O in distilled water (BERLYN & MIKSCHE, 1976).

Scanning Electron Microscopy (SEM)

Leaf samples were fixed in 3% glutaraldehyde in phosphate buffer (0.065 M, pH 7), dehydrated in a graded ethanol series, critical point dried in liquid CO_2 and coated with c. 30 nm of gold. Observations were carried out by using a Philips 505T SEM.

RESULTS

The study of the primordial up to the subsequent leaves resulted in the observation of three morphological types described below as A, B and C.

Morphology of type A leaves

Leaves of type A morphology were slightly tomentose, oblanceolate, entire, sometimes with slight incisions usually in the apical portion (Fig. 1a).

Furthermore, they are isolateral (Fig. 2a) with epidermal surfaces presenting stomata, trichomes and hollows lodging glands (Fig. 2b, 3a). The surfaces of the epidermal cells and stomata are almost smooth (Fig. 3a, 3b). Epidermal cells have polygonal outlines and anticlinal walls of the straight/curved type. Stomata are 28,9 µm long and 21,8 µm wide and belong to the anomocytic type, i.e. the aperigenous type according FRYNS-CLAESSENS & VAN COTTHEM (1973) classification (Fig. 3b). The epidermis shows nonglandular trichomes of two types: multicellular uniseriate trichomes (with an average frequence of

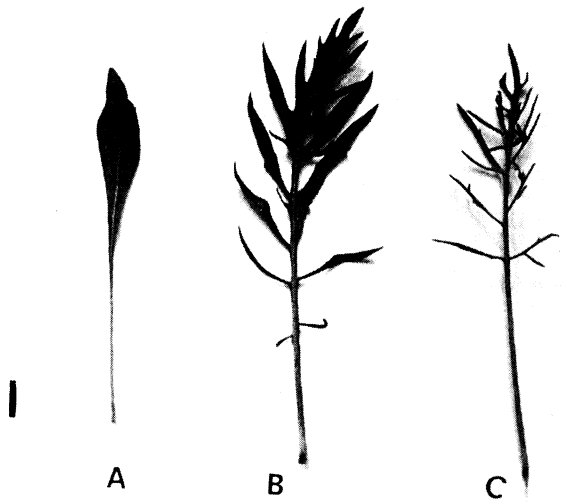

Fig. 1 - The three leaf types (A, B, and C) observed in *C. tenorei*. Bar = 1cm.

cellular trichomes (with an average frequence of 8/mm^2) elongated to form flattened and crooked threads (Fig. 2b). The epidermal surfaces show also hollows lodging capitate trichomes, with the head 48,8 μm wide (Fig. 3a), usually indicative of glands (THEOBALD *et al.*, 1979). Stomata are arranged in irregular rows (Fig. 2b) and in rings on the edges of the hollows lodging the glands (Fig. 3a). Transverse section (Fig. 2a) shows medium and small vascular bundles surrounded by conspicuous sheath cells. Inner ends of the palisade assimilatory cells wedge in the sheat cells. Outer ends of the most external layer of palisade cells are tightly in contact with the epidermis. Stomata are slightly prominent and show wide sub-stomatal chambers (Fig. 2a).

The leaves of A type are usually produced during rainy months (November - April).

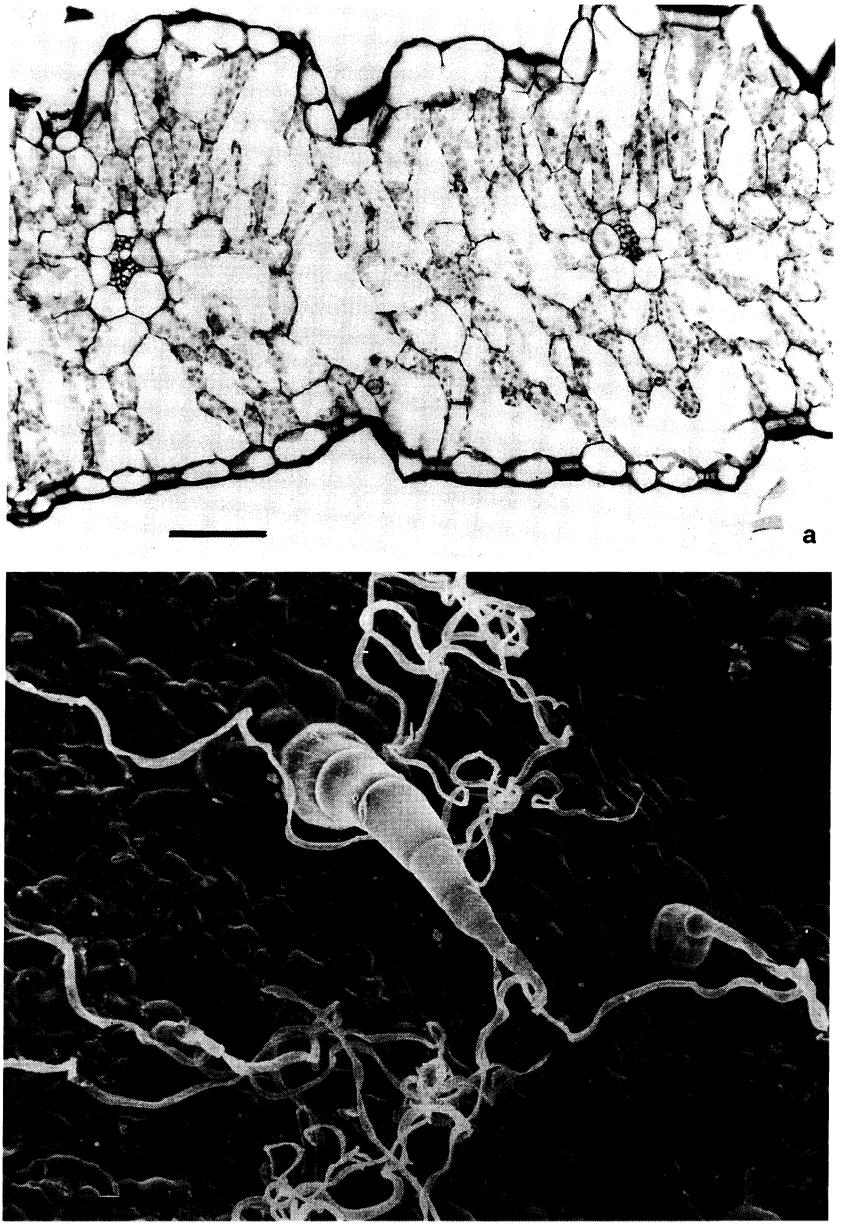

Fig. 2 - Morphology of type A leaves. Optical transverse section (a) and electronic photograph showing epidermal surface with stomata, trichomes and hollows lodging glands (b). In a and b, bar = 100μm.

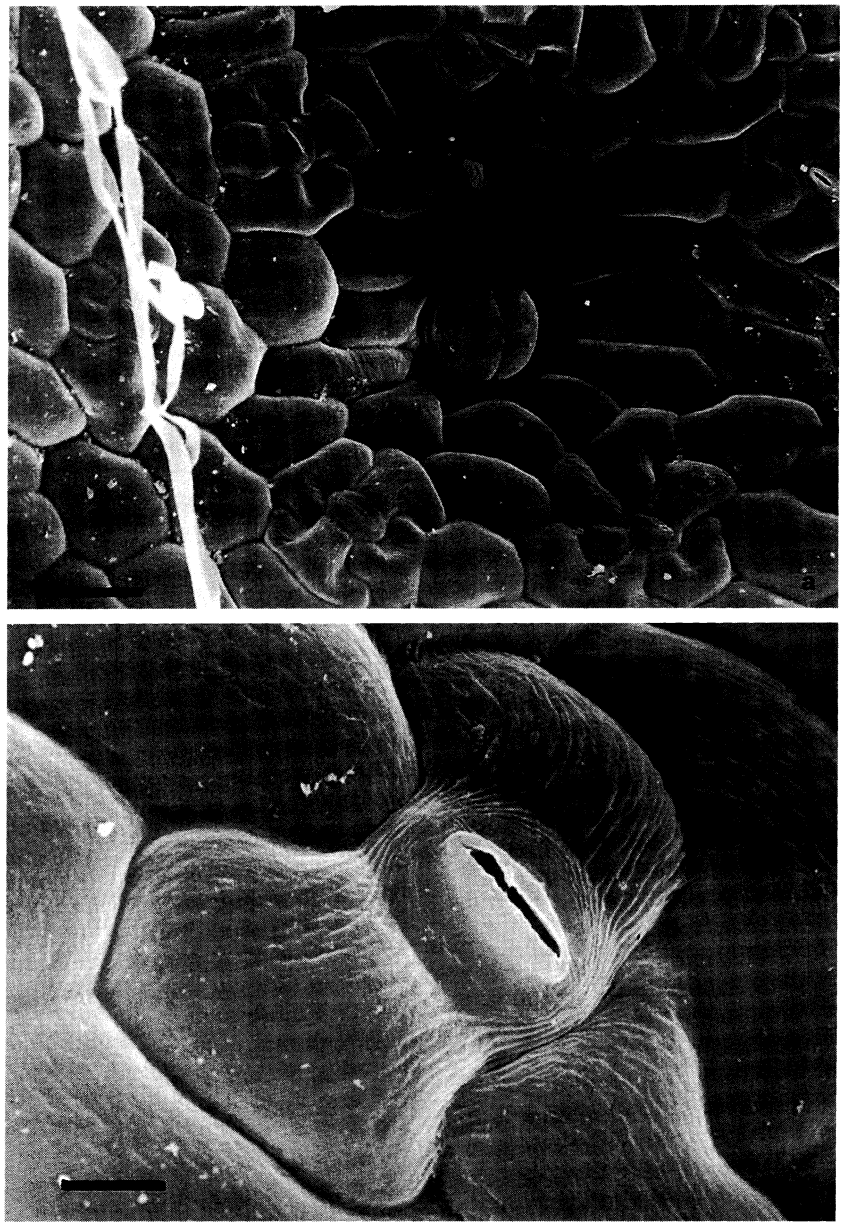

Fig. 3 - Morphology of type A leaves. Electronic photographs showing a hollow lodging a capitate trichome (a) and a stoma (b). In a, bar = 40μm, in b, bar = 10μm.

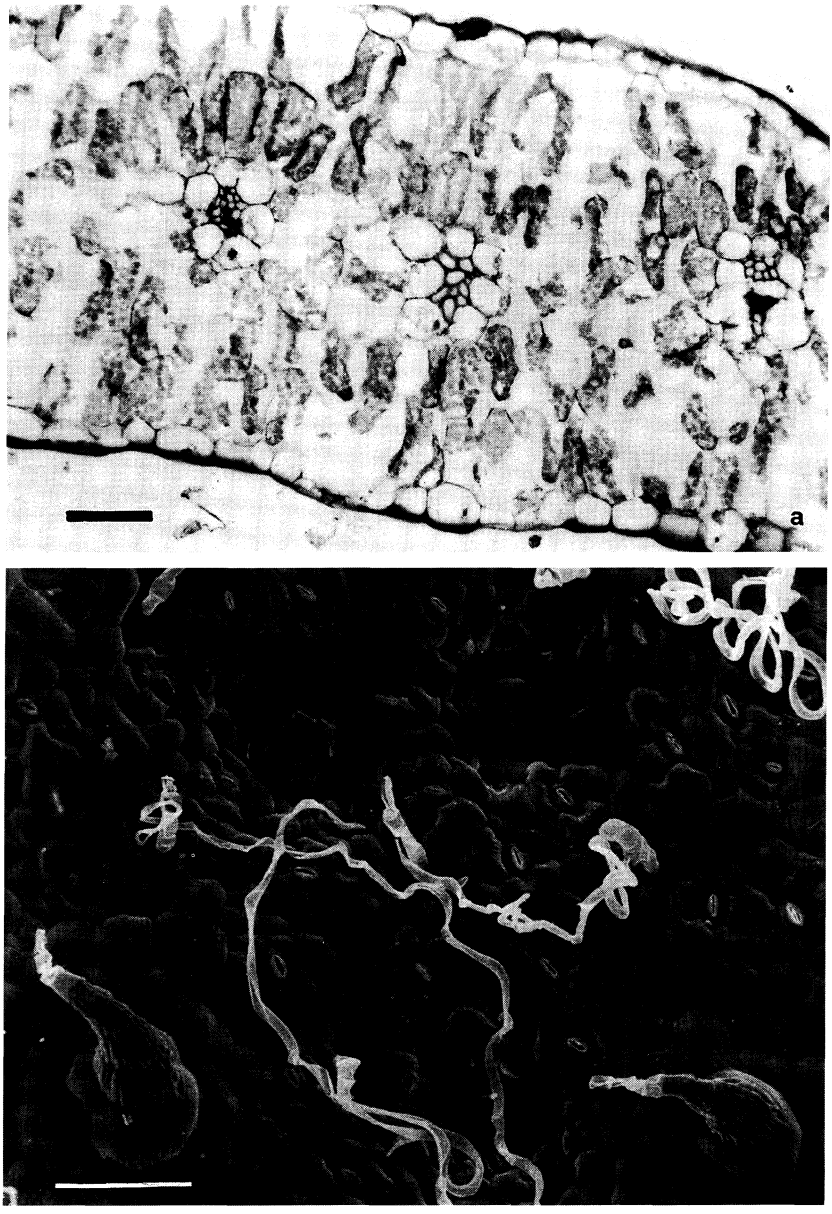

Fig. 4 - Morphology of B type leaves. Optical transverse section (a) and electronic photograph showing epidermal surface (b). In a and b, bar = 100μm.

Morphology of type B leaves

Type B leaves are slightly tomentose, lyrate-pinnatisect, with entire or incised segments (Fig. 1b).

Anatomy and morphology (Fig. 4a, 4b) of type B leaves are quite similar to that of the leaves of type A showing conspicuous sheath cells, palisade assimilatory cells inserted on the sheat cells and external layer of palisade cells tightly in contact with the epidermis.

The cuticle exhibits a slight striation radiating from the base of the trichomes and stomata (Fig. 5b), and the surface is slightly richer in glands (18/mm^2) and unicellular trichomes (20/mm^2) than in type A (Fig. 4b, 5a). The stomata are arranged in irregular rows and disposed in ring on the edges of the hollows lodging the glands as in type A leaves (Fig. 4b).

The leaves of B type are usually produced during rainy months (November - April).

Morphology of type C leaves

Leaves of this morphological type are very tomentose, lyrate-pinnatisect, with narrow segments which are either entire or with one or more incisions (Fig. 1c).

Epidermis is heavily covered by trichomes (Fig. 6b) and the cuticle is strongly striated (Fig. 7a, 7b). The leaf is typically xeromorphic, with multilayered, quite compact abaxial and adaxial palisade (Fig. 6a). The bundles shows a cambium-like region, usually characteristic of long-living leaves (MAUSETH, 1988) (Fig. 6a). Stomata are slightly prominent (Fig. 6a, 7b).

The leaves of C type are usually produced during hot and dry months (May - October).

The basal rosette successively produces leaves with the morphological sequence indicated as types A, B and C. In some cases it was observed in the field that the same sequence (A, B and C) of leaf types is also repeated when leaves develop in dry months.

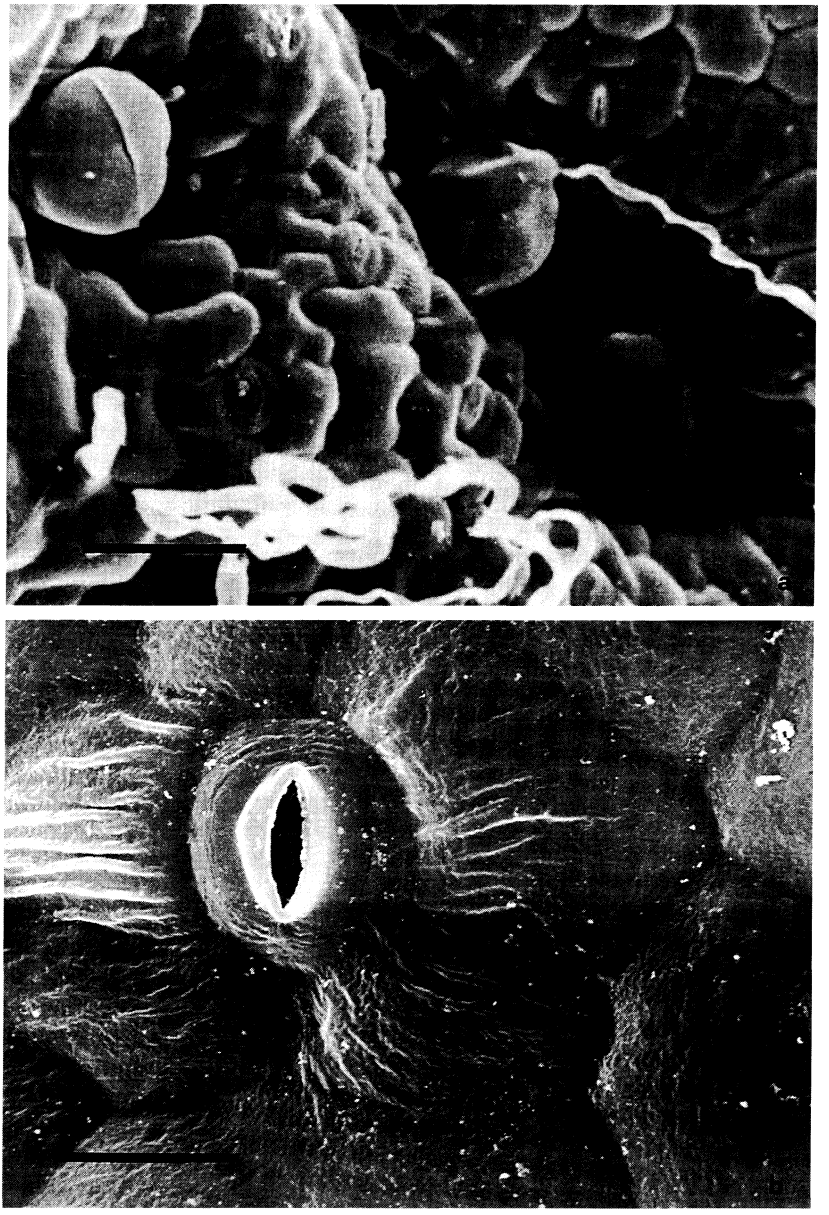

Fig. 5 - Morphology of B type leaves. Electronic photographs showing hollows with capitate glands (a) and a stoma (b). In a, bar = 50μm, in b, bar = 20μm.

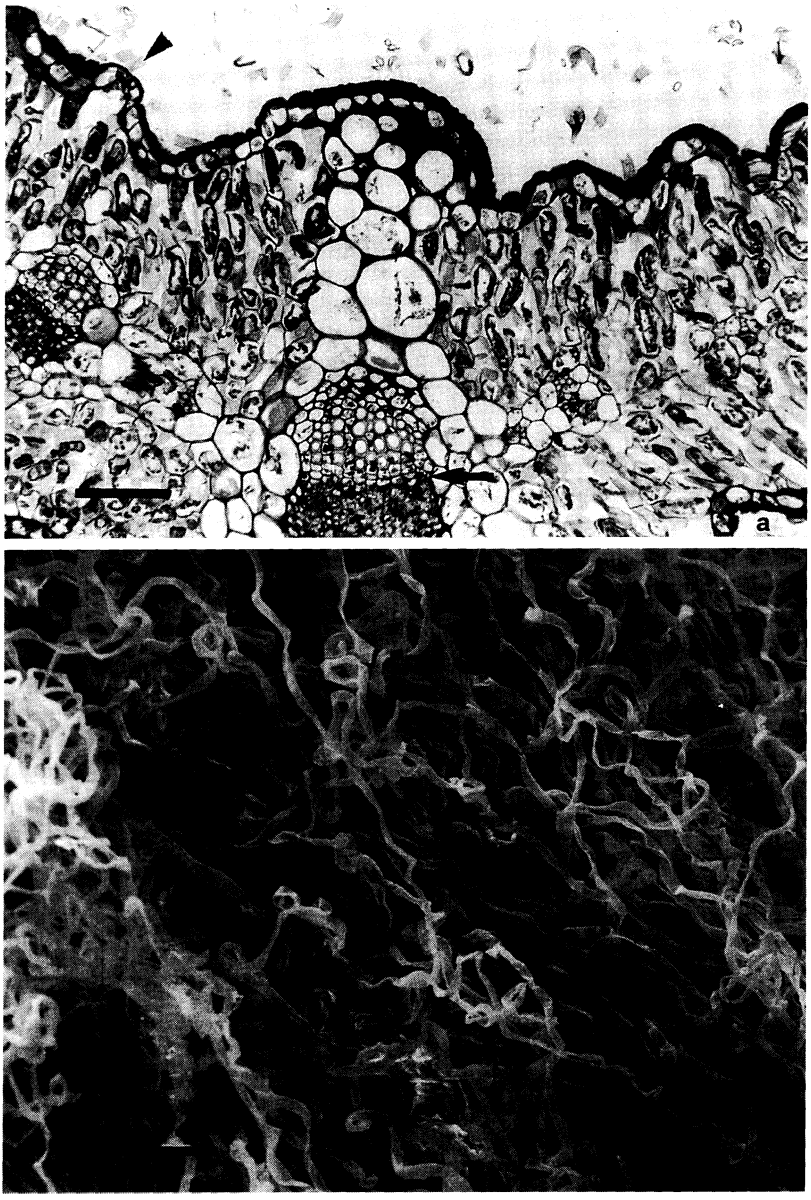

Fig. 6 - Morphology of C type leaves. Optical transverse section (a) showing a prominent stoma (arrowhead) and a cambium-like region (arrow) and electronic photograph showing the epidermal surface heavily covered by trichomes (b). In a and b, bar = 100μm.

DISCUSSION

The three types of leaves described in *C. tenorei* plants show a transition from sciaphilous to xeromorphic features both in morphology and anatomy. As a matter of fact, epidermal surfaces in the type A leaves have fewer trichomes (8/mm^2) than type B (20/mm^2). The C type leaves are very tomentose and the transverse section shows a very compact parenchyma (Fig. 6a).

However, the presence of lightly prominent stomata (Fig. 6a) in the latter type is in contrast with the xeromorphic features otherwise noted.

The presence of conspicuous sheath cells, palisade assimilatory cells (even incompletely surrounding the vascular bundles) inserted on the sheat cells and external layer of palisade cells tightly in contact with the epidermis are reported as "deviated" Kranz structure (METCALFE, 1979). HEINRICHER (1884) already reported the presence of Kranz structure in genus *Centaurea* in his work on the structure of isolateral leaves. The presence of Kranz structure in *C. tenorei*, typically found in plants maintaning a maximum rate of photosyntesis under high light intensity (LAETSCH, 1968), can be easily correlated with the presence of prominent stomata on leaves that are tomentose and xeromorphic.

The three leaf types could be interpreted as an adaptative morphological variation in response to climatic parameters. However field observations (i.e. the sequence of A, B and C leaf types also repeated when leaves develop in dry months) seem to suggest that other elements can play a role in controlling the leaf development.

Fig. 7 - Morphology of C type leaves. Electronic photographs showing detail of the epidermal surface with three glands (a) and stomata (b). In a and b, bar = 20μm.

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Abstract

In a study on the leaves of *Centaurea tenorei* Guss. ex Lacaita (Asteraceae) we observed morphological and anatomical differences, with the leaves showing a transition from sciaphilous to xeromorphic. Such a transition could be interpreted as an adaptative response to different climatic conditions.

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