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THE STINGING HAIR OF *URTICA MEMBRANACEA* POIRET (URTICACEAE). I. MORPHOLOGY AND ONTOGENY

Riassunto — I peli urticanti di *Urtica membranacea* Poiret (Urticaceae). I: Morfologia e ontogenesi. Sono state studiate, al microscopio ottico e a quello elettronico a scansione, l'ontogenesi e la struttura dei peli urticanti di *Urtica membranacea* (= *U. dubia*), la base dei quali è caratterizzata dalla presenza di piccoli peli ghiandolari, mai prima d'ora identificati nel genere *Urtica*. È probabile che la loro attività sia correlata a quella dei peli urticanti nella formazione del liquido irritante, ma altre ipotesi — supporto al movimento o all'elasticità del pelo urticante; secrezione di particolari sostanze repellenti per i fitofagi, ecc. — possono tuttavia essere prese in considerazione. Sono in corso ulteriori osservazioni.

Abstract — Ontogeny and morphology of the stinging hairs in *Urtica membranacea* (= *U. dubia*) have ben investigated both by light and electron scanning microscopy. The presence of small glandular hairs — up to ten in number — on the pedestal of the stinging hairs has been shown for the first time in the genus *Urtica*. The functional significance of this type of hair is under discussion but, for the time being, some hypotheses — contribution to the formation of urticating liquid; implication on movement or on elasticity of the stinging hair through secretion and/or liquid reabsorbtion mechanisms; repelling substances production, etc. — have been made.

Key words — *Urtica* - stinging hairs - ontogeny - morphology.

Introduction

As well as having a complex structure, the stinging hairs are interesting for other reasons: they cause toxic reactions, the revulsive effect of which can be exploited in medicine.

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Hitherto any attempt to identify the toxic principle(s) causing urtication has not yielded satisfactory results. Some authors have identified hystamine, acetylcoline and 5-hydroxy-triptamine in the hairs of several *Urticaceae*; some degree of doubt remains however, as to whether these are truly responsible for the irritation caused by contact with the hairs (cf. THURSTON and LERSTEN, 1969).

The most recent study of the morphology and ontogenesis of these hairs was carried out by THURSTON (1974) on *Urtica dioica*. More recently a paper on the nuclear DNA amount of the stinging hairs in the same species was published by MATHWIESER & GUTTERNBERGER (1987).

Urtica membranacea Poiret (= *U. dubia* Forskal) is used in folk medicine in much the same way as *U. dioica*, to which it is often likened and with which it is even confused, being given the same general name of «nettle». In spite of this, and in contrast with *U. dioica*, the stinging hairs of *U. membranacea* have never been studied, either in a pharmacobotanic perspective or from the pharmacological or even phytochemical angle, unless we are to consider a paper by REGULA and DEVIDÉ (1980) reporting the presence of serotonine.

This short report refers to a study by light and scanning electron microscopy concerning the ontogenesis and — principally — the morphology of the hairs which turned out to be very peculiar.

MATERIAL AND METHODS

The specimens used in the present research come from the population of *Urtica membranacea* growing spontaneously in the Botanic Garden, Pisa University (*Exsiccata* in PI).

Light microscopy

Strips of leaf, petiole and stem epidermis were used, as well as isolated stinging hairs, leaf and petiole sections 20 μm thick, obtained with a digital Cryostat-Leitz 1720 used at —8 C°.

The samples were stained by toluidine blue O (TBO) (FEDER and O'BRIEN, 1968) and Delafield's haematoxylin (FAURE, 1914) as general stains.

Scanning electron microscopy

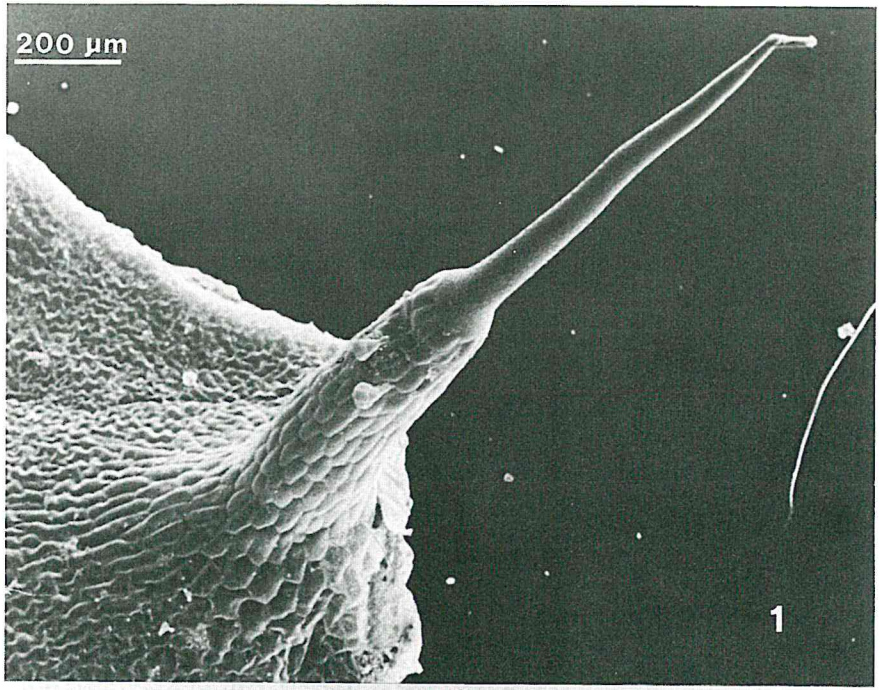
Material for analysis with S.E.M. was fixed in gluteraldehyde (2% with pH 7.4 buffer solution), dehydrated in increasing concentrations of alcohol and of acetone, dried to the «critical point», metallized and examined at 15 KV under a Cambridge Stereoscan 90.

Results

Stinging hairs (Fig. 1) are present in all the aerial parts of the plant. They are particularly numerous on the stem and on the upper surface of the leaf lamina, especially in the spaces between the ribs. As in all the entities of the genus *Urtica*, the stinging hair in *Urtica membranacea* is formed by a single ampoule-shaped cell with a calcarized base and a silicized apex. The silicization of the apex makes it extremely fragile so that as soon as it is touched it breaks, releasing the irritant liquid. The base of the hair is completely surrounded by epidermal and sub-epidermal cells which form a sort of pedestal and the walls facing the hair are strongly pitted (Fig. 2). Glandular hairs, formed by 1-celled stalk and 2-4-celled secreting head are present on this pedestal (Figs. 3 and 4). These are already present on the pedestal of the stinging hairs when the leaf is still very small; they reach their highest number at 50-75 mm leaf length (Tab. 1). The number of glandular hairs on each stinging hair may vary but can be as many as 10.

Ontogenesis

This closely resembles that reported by Thurston (1974) for *Urtica dioica*. Formation of the stinging hairs begins in the seedling stage in the gemmule when they are seen as simple extroflections of protodermal cells. The bulbous symmetrical tip differentiates immediately and the first leaves show a lenghthening of hair cells. Immediately following this, the pedestal supporting the hair develops from the epidermal and subepidermal cells, forming a kind of envelope around its base. Glandular hairs only begin to make their appearance on this pedestal later, when the leaf is larger (about 1.5 mm in length). The whole ontogenetic process is summarized in Fig. 5.



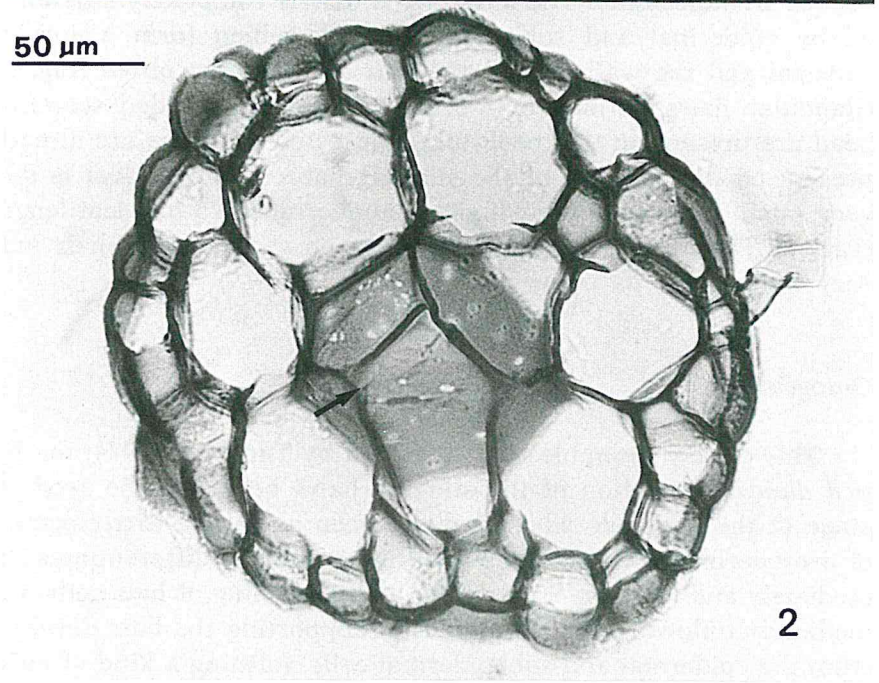


Fig. 1 - *Urtica membranacea*: S.E.M. micrography of the stinging hair.
Fig. 2 - *Urtica membranacea*: cross section showing large pits (arrow) at the base of stinging-cell wall (Delafield's haematoxylin).

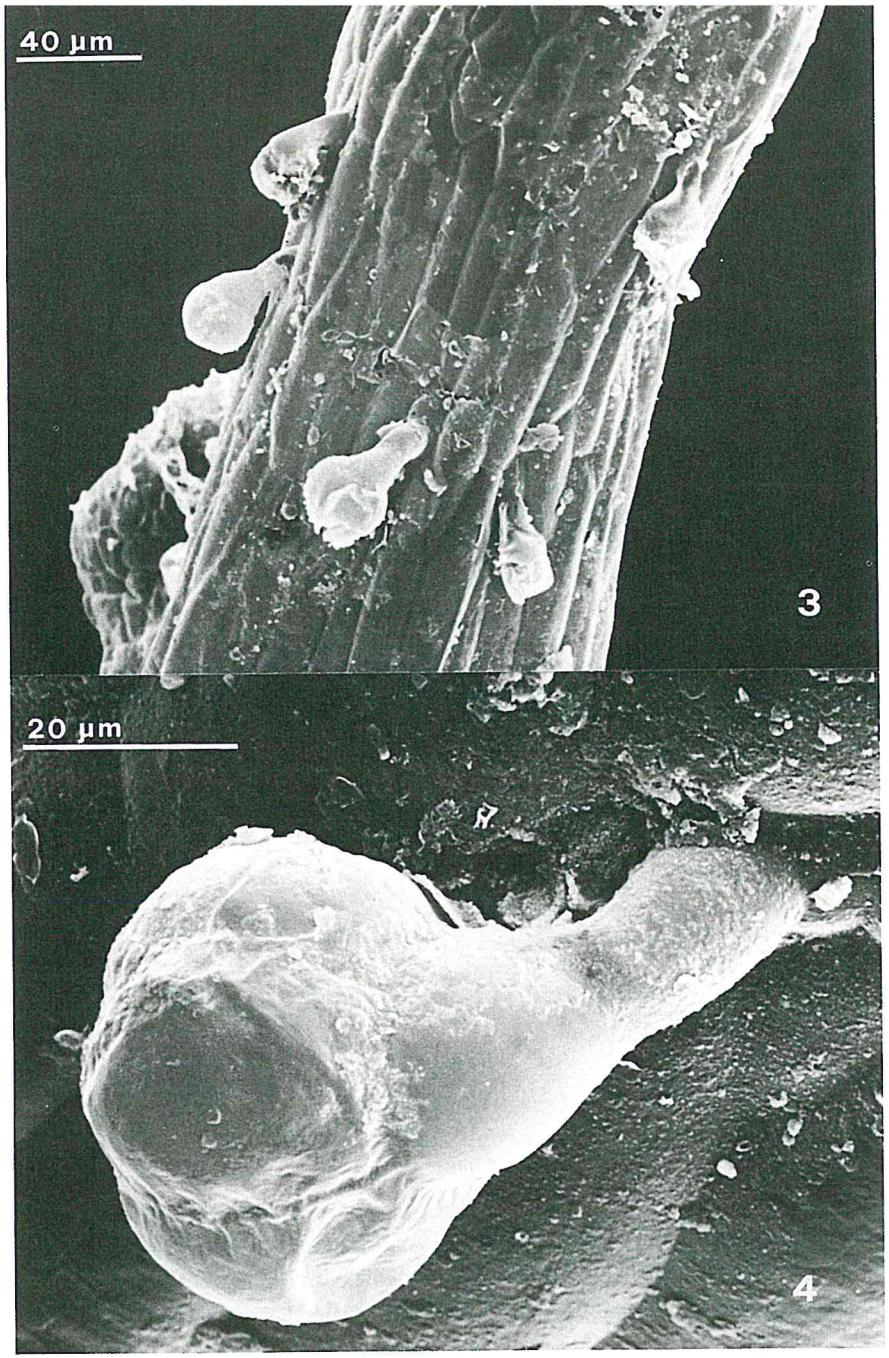


Fig. 3 - *Urtica membranacea*: glandular hairs on the stinging hair pedestal (S.E.M. micrography).

Fig. 4 - *Urtica membranacea*: glandular hair on the stinging hair pedestal formed by a 1-celled stalk and 4-celled head (S.E.M. micrography).

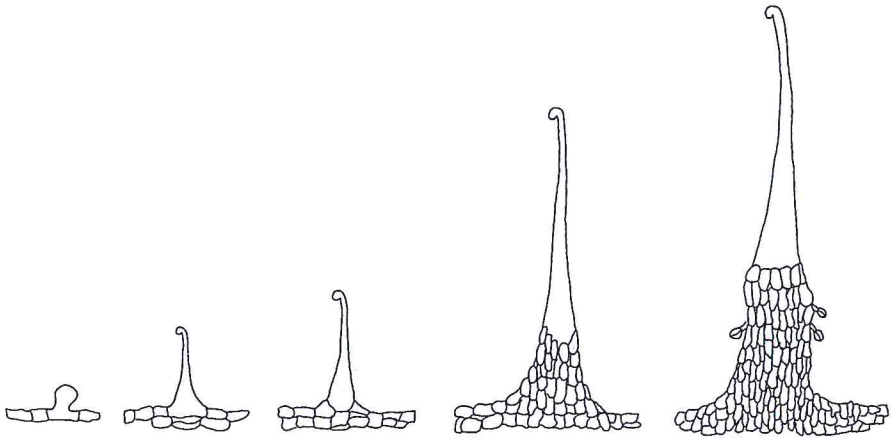


Fig. 5 - Ontogeny of *Urtica membranacea* stinging hair.

TABLE I

Leaf length	Number of glandular hairs on one stinging hair*
0 - 25 mm	2.1
25 - 50 mm	2.8
50 - 75 mm	3.9
75 - 100 mm	2.9

* Mean values calculated over 50 leaves.

DISCUSSION AND CONCLUSIONS

Morphologically and ontogenetically the stinging structure present in *Urtica membranacea*, closely recalls that of the better-known and more widely studied *U. dioica* (THURSTON, 1974). However it does show one character that has never yet been reported either for *U. dioica* or for any of the other entities of the genus *Urtica* studied hitherto, i.e. the presence of glandular hairs on the pedestal of the stinging hair. UPHOF and HUMMEL (1962) published some diagrams of the stinging structure in *Girardinia cuspidata* which do actually shows what might be glandular hairs on the pedestal without commenting to their significance.

Studies aimed at clarifying the functional significance of *Urtica*

membranacea glandular hairs on the pedestal are in progress. For the time being we can only surmise that either they are implicated in the movement or at least in the elasticity of the stinging hair through some secretory and/or liquid reabsorbtion mechanism which creates an osmotic gradient (as for example in the tentacle pedicel of certain carnivorous plants, cf. HESLOP-HARRISON, 1976). They may perhaps secrete some specific substance to repel particular animals (insects, mites, hymenopters etc.). Another possibility is that they contribute in some manner to the formation of the urticating liquid. In this context, we must not overlook the exsistence of large pits between the stinging cell and those of the pedestal — something overlooked by THURSTON (1974) in his detailed light and electron (scanning and transmission) microscopical study on *Urtica dioica*. The presence of these pits may indicate the way by which substances formed externally can move into the stinging hair.

Apart from any particular hypothesis concerning the function of these glandular hairs found on the pedestal, it is obvious that their presence may confer special features on urtication in *U. membranacea* because the substances secreted by the glandular hairs on the pedestal are most probably added to the substances secreted by the stinging structures.

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