

## FINE STRUCTURE OF THE THALLOCONIDIA OF THE LICHEN GENUS *UMBILICARIA*

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**ABSTRACT** - The ultrastructure of the thalloconidia (asexual propagules of the mycobiont) in eight species of the lichen genus *Umbilicaria* have been investigated. The selected species possessed thalloconidia corresponding to the three morphological types already described for the European flora. The study revealed for the first time the integrity of the cytoplasm in these propagules. Groups of well-differentiated concentric bodies, mitochondria with short and parallel cristae and vesicles coming from the endoplasmic reticulum were observed in the thalloconidia of *U. decussata* and *U. havaasii*. In some specimens of *U. polyphylla*, lipidic bodies filled most of the cytoplasm in the thalloconidia. In broad outline the ultrastructure observed in the thalloconidia was similar to that of the other mycobiont cells.

### INTRODUCTION

Thalloconidia - mycobiont propagules produced from the lower cortex (Frey 1929) - were known until the last decade only from the genus *Umbilicaria*, where they are present in nearly half of the species. Recently, analogous structures have been found in crustaceous lichens belonging to other families (Poelt & Obermayer 1990). Hasenhüttl & Poelt (1978) were the first to study thoroughly the thalloconidia in *Umbilicaria*. They called them "Brutkörner" and proposed a morphological classification based mainly on the origin and genesis of the thalloconidia and on the number of cells that constitute them in the mature state. Furthermore, they demonstrated the germinative capability of these propagules in *U. nylanderiana* and *U. vellea*. Hestmark (1990) proposed the replacement of the term "thallospore", in use at that time (Hawksworth *et al.* 1983, Topham *et al.* 1982), by the more precise "thalloconidium".

Poelt & Obermayer (1990) pointed out the richness of plasma in the thalloconidia which were hardly stained with lactophenol cotton-blue. Hestmark (1990, 1991a and 1991b) has used transmission electron microscopy as a complementary method in the morphological description of the thalloconidia to observe the type of septum and wall structure. Nevertheless, no information concerning the cellular fine structure of these propagules is available. The present work provides the first comparative data concerning the cytoplasmic ultrastructure of the thalloconidia in the genus *Umbilicaria*.

## MATERIALS AND METHODS

For the present study eight species belonging to the genus *Umbilicaria* were selected. The three morphological types of thalloconidia described by Hasenhüttl & Poelt (1978) for the European Umbilicariaceae were represented in these species. The selected species and the corresponding morphological type of thalloconidium were: *Umbilicaria decussata* (Vill.) Zahlbr., *U. leiocarpa* DC. in Lam. & DC., *U. nylanderiana* (Zahlbr.) H. Magn., *U. polyrrhiza* (L.) Fr. and *U. subglabra* (Nyl.) Harm. with the *Anthracina* type; *U. polyphylla* (L.) Baumg. Fl. with the *Polyphylla* type and *U. havaasii* Llano and *U. vellea* (L.) Ach. with the *Vellea* type of thalloconidia. Voucher specimens are in MAF.

The samples were collected between 1987 and 1989, and in all cases they were processed within three days of collection. From three specimens of each species, portions of 2 mm<sup>2</sup> from the zone halfway between the umbilicus and the margin were obtained. These portions were embedded in Spurr's resin (Spurr 1969) after conventional fixation and dehydration (Ascaso et al. 1986). Ultra-thin sections were stained with lead citrate (Reynolds 1963) for observation with the transmission electron microscope.

## RESULTS AND DISCUSSION

Transmission electron microscopy revealed the remarkable cellular integrity of the thalloconidia of *Umbilicaria decussata* and *U. polyrrhiza* (*Anthracina* type). These had well-differentiated nuclei (Fig. 1), often with a lobed outline and with a folded nuclear membrane delimiting some narrow compartments. The mitochondria had an ovoid shape with internal cristae of variable length and generally with a parallel arrangement (Figs. 1 and 2). This parallel distribution of the cristae within the mitochondria seems to be constant in all the cells of the mycobiont (Valladares & Ascaso 1992, and unpublished results). In Fig. 2 the vacuolar apparatus can also be seen, well-developed in these thalloconidia, with vacuoles with a lobed tonoplast. The vacuoles, very similar to the most common type found by Boissière (1979, 1982) in *Peltigera canina*, are less prominent as a cellular component than in the hyphae of the algal layer of other lichens belonging to the family Umbilicariaceae (Valladares & Ascaso 1992). In addition to the vacuoles, several vesiculated structures located at the end of the endoplasmic reticulum were also found (Fig. 3).

In the thalloconidia of *Umbilicaria polyphylla* two different ultrastructural appearances have been observed. One group of specimens possessed a large number of lipidic bodies in the cytoplasm to the detriment of the other organelles and structures (Figs. 4 and 5). The lipidic bodies, also called "sphaerosomes", have a homogeneous aspect with a low electron density and occupy between 70% and 80% of the cytoplasmic volume. As they have no external membrane and float freely within the cytoplasm, they very often lose their individuality, forming big irregular masses with rounded outlines. The second group of specimens did not possess this unusually large number of lipidic bodies. The differences between these two groups could be due to the different date of collection (the first group was collected in autumn and the second in spring), but more data are needed in order to determine the sources of ultrastructural variability.

The thalloconidia of *Umbilicaria havaasii* showed an aggregation of many cells (*Vellea* type, Figs. 6 and 7). The lipidic bodies are present, although in smaller numbers than in some thalloconidia of *U. polyphylla* and generally in a peripheral position.

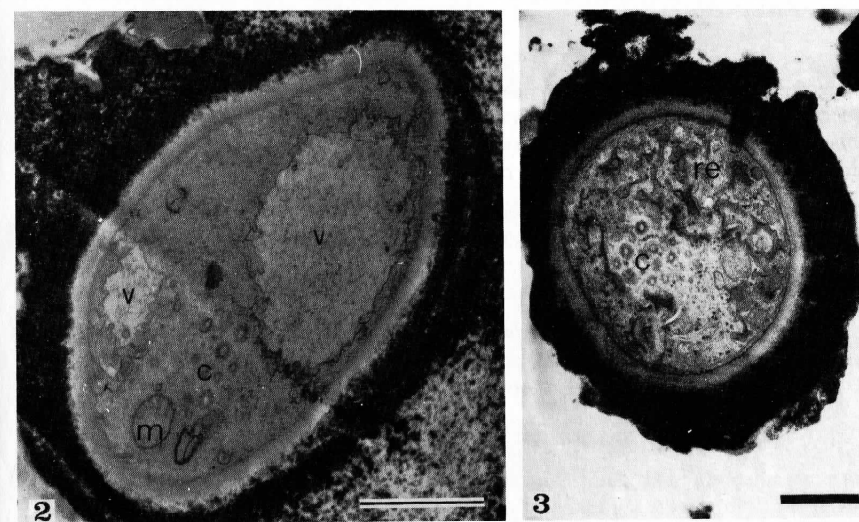
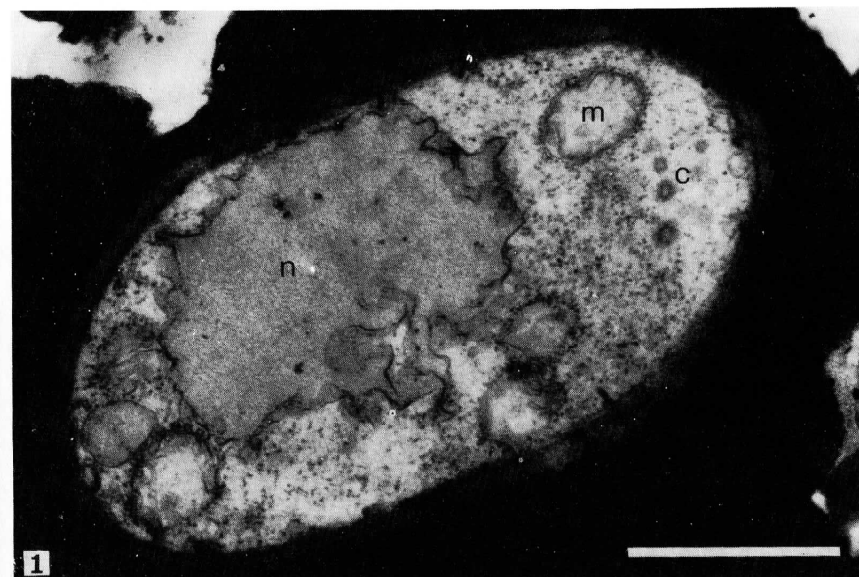


Fig. 1-3 - Transmission electron micrographs of *Anthracina* type thalloconidia in *Umbilicaria*. Fig. 1 and 2: *Umbilicaria polyrrhiza*. Fig. 3: *Umbilicaria decussata*. Symbols: c= concentric bodies, m= mitochondria, n= nucleus, re= endoplasmic reticulum, v= vacuole. Bar= 1µm.

Complexes of well-differentiated concentric bodies have been observed within the thalloconidia of all the species studied. These structures, which are very common within all the vegetative hyphae of lichenized fungi (Griffiths & Greenwood 1972), have also been found in ascospores (Ascaso & Galván 1975). The presence of concentric bodies in the thalloconidia points to a widespread distribution of these structures

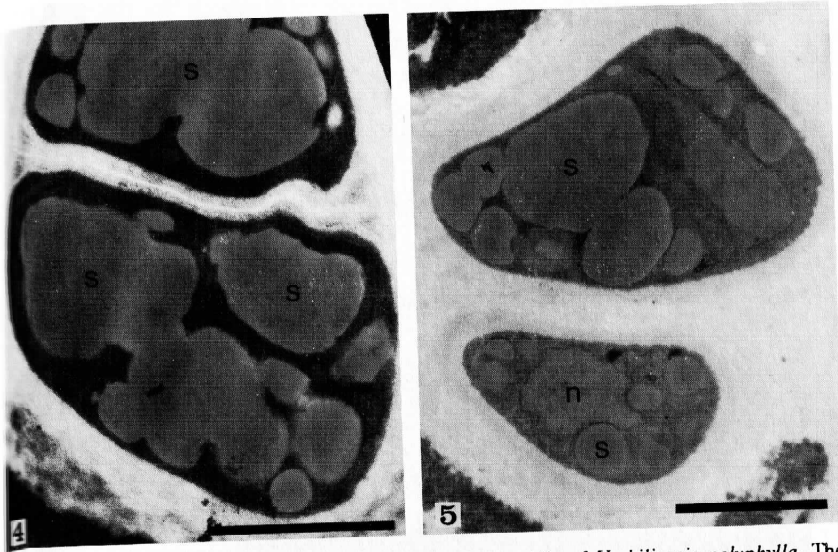


Fig. 4-5 - Transmission electron micrographs of the thalloconidia of *Umbilicaria polyphylla*. The symbols used are n= nucleus and s= sphaerosomes. Bar= 1 $\mu$ m.

among the mycobiont cells. They may be related to relatively high metabolic activity of these cells since they have been associated with growing regions of the thallus (Boissière 1979). In broad outline however, the ultrastructure observed in the thalloconidia was similar to that of the other mycobiont cells.

In all the species studied the cell wall of the thalloconidia consisted of several well-differentiated layers. The innermost layer next to the plasmalemma was stained poorly with lead citrate and was generally less than 0.5 $\mu$ m thick; the external layer was thicker but irregular and was stained more intensely.

In our opinion, the optimum ultrastructural state of many thalloconidia, in comparison with some rather necrotic or disorganized cells of the lower cortex, may indirectly support their potential role in the dispersal of the eight species studied.

We consider highly desirable further research on the evolution and seasonal variation in the germinative capability of the thalloconidia, combining germination-rate data with ultrastructural studies in continuation of the research begun by Fiechter & Honegger (1988) on the soredia of *Hypogymnia physodes*.

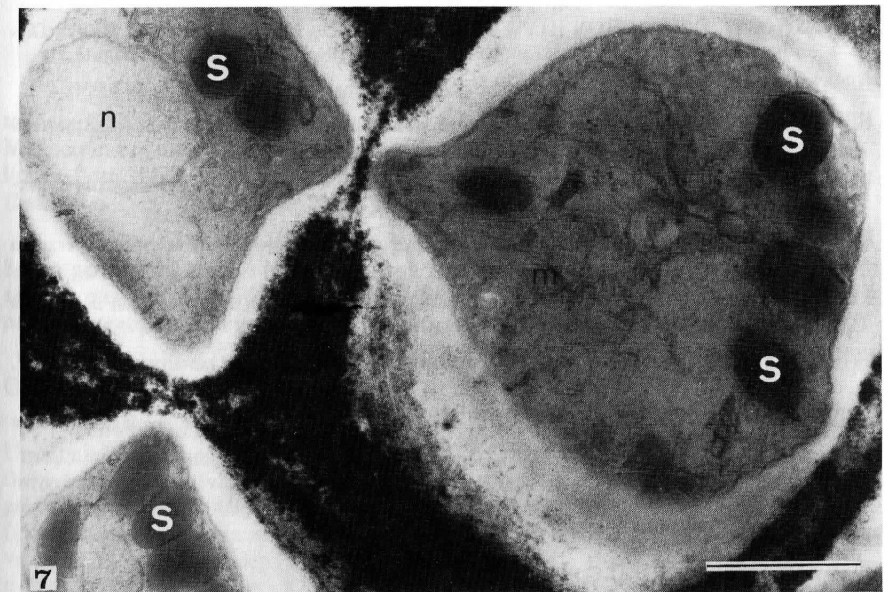
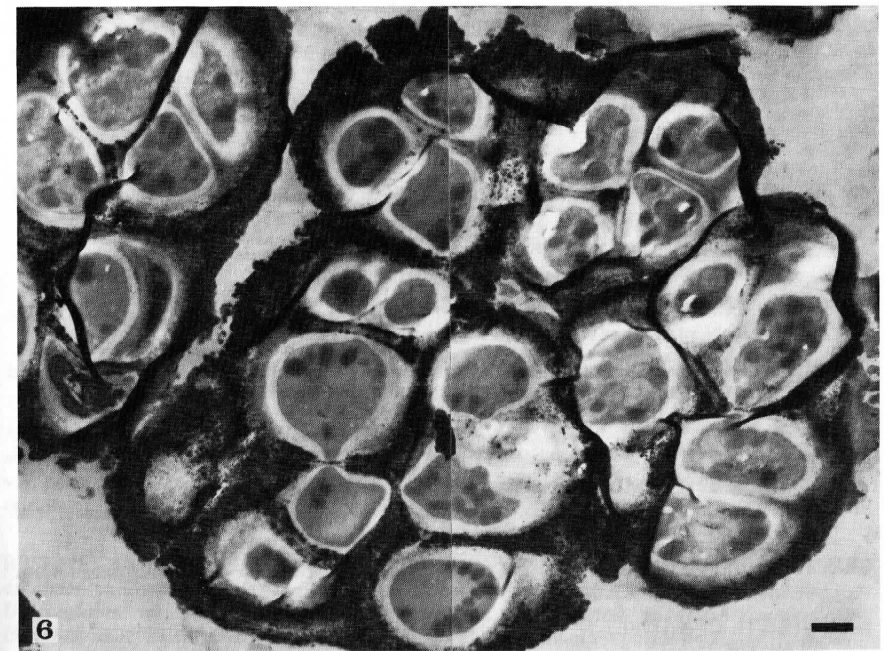


Fig. 6-7 - Transmission electron micrographs of the thalloconidia of *Umbilicaria havaasii*. Symbols: m= mitochondria, n= nucleus, s= sphaerosomes. Bar= 1 $\mu$ m.



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NOTES ON THE LICHEN GENUS *UMBILICARIA* IN CORSICA

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ABSTRACT - The paper lists 17 taxa of the genus *Umbilicaria* collected on a recent trip to Corsica. *Umbilicaria cinerascens*, *U. cinereorufescens*, *U. leiocarpa*, *U. ruebeliana* and *U. subglabra* var. *pallens* are reported from Corsica for the first time. The *Umbilicaria* flora of the Corsican mountains is shown to be closely related to that of the South French Alps and the Pyrénées.

RÉSUMÉ - Ce travail présente une liste de 17 taxons d'*Umbilicaria* récoltés lors d'une récente excursion en Corse. *Umbilicaria cinerascens*, *U. cinereorufescens*, *U. leiocarpa*, *U. ruebeliana* et *U. subglabra* var. *pallens* sont mentionnés pour la première fois en Corse. La flore des *Umbilicaria* de Corse est très proche de celle des Alpes françaises méridionales et des Pyrénées.

## INTRODUCTION

The island of Corsica is a lichenologist's dream. Clean air, large variations in topography, climate and substrate, and vegetation zones ranging from the Mediterranean *maquis* to the Alpine (cf. Deleuil 1975) make for an exceptionally rich lichen flora (Maheu & Gillet 1914, 1926; Crozals 1923; Zschacke 1927; Werner & Deschâtres 1969, 1971, 1975; Kalb 1976).

On a recent trip to Corsica I had the opportunity to sample members of the lichen genus *Umbilicaria* in a number of localities. Besides adding to the number of species previously reported from Corsica, my observations seem to throw some light on the biogeographical provenance of the Corsican mountain lichen flora.

In the present paper I list 17 taxa which are known also from localities outside Corsica and discuss their biogeographical affinity.

The generic concept adopted here is one tentatively accepting a family Umbilicariaceae consisting of two genera: *Umbilicaria* Hoffm. and *Lasallia* Mérat. In the contributions of Maheu & Gillet (1914, 1926) and Zschacke (1927) the latter genus is named *Umbilicaria* and the former *Gyrophora*, while Werner & Deschâtres (1969, 1971, 1975) accept only a single genus: *Umbilicaria*. The reasons for this vacillating generic concept are explained by Frey (1933, 1949) and Poelt (1977). The genus *Lasallia* is in Corsica represented by *L. brigantium* (Zschacke) Llano and *L. pustulata* (L.) Mérat. *L. brigantium*, originally described from Corsica (Monte Angelo) by Zschacke (1927), appears to be a Corso-Sardean endemic (Sancho & Crespo 1989).