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ULTRASTRUCTURAL STUDY OF THE PIT CONNECTIONS OF *GELIDIOCOLAX* GARDNER (PARASITIC *RHODOPHYTA*)

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ABSTRACT

A report on the ultrastructural observations of the pit connections in three species of *Gelidiocolax* (*G. margaritoides* (Martin & Pocock) Fan & Papenfus, *G. christianae* Feldmann and *G. deformans* Seoane-Camba) has been carried out. As has been described in other species, electrondense elements and myelinic figures, possibly formed by the endoplasmic reticulum, were condensed in a mass. This mass became a diabolos-shaped structure before the cytoplasm had finished its division and the septum had reached its complete development. Myelinic figures were usually found in the core of well formed pit plugs, but such figures were apparently substituted by granular material during the ontogeny.

Key words: *Gelidiocolax* ultrastructure, Pit connection, Pit connection ultrastructure, Pit connection Ontogeny.

RESUM

Estudi ultraestructural de les sinapsis de *Gelidiocolax* Gardner (*Rhodophyta* paràsit)

S'ha portat a terme l'estudi ultraestructural de les sinapsis de *Gelidiocolax* (*G. margaritoides* (Martin & Pocock) Fan & Papenfus, *G. Christianae* Feldmann i *G. deformans* Seoane-Camba). Tal com ja s'ha descrit en d'altres espècies, es produeix una massa compactada d'elements electrodensos i figures mielíniques possiblement produïdes pel reticle endoplasmàtic. Aquesta massa es transforma en una figura en forma de diàbolo abans que la divisió s'hagi acabat i el septe estigui completament desenvolupat. Les figures mielíniques es troben localitzades habitualment en el centre de les sinapsis madures; aquestes figures, però, sembla que es substitueixen per material granular durant l'ontogènia.

1. Introduction

Pit connections are characteristic structures of *Rhodophytes*, constituted principally of plugging bodies, enveloped by more o less apparent lamellae, and situated

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in the septum established between two adjacent cells of the thallus. The question as to whether the pit connections are, in fact, a connection which somehow allows intercellular cytoplasmic continuity, or one solid plugs, which completely sever the cytoplasmic connections through the septal pores, has been debated by phycologists for over a century.

Even its role in the metabolism of the thallus is still not completely understood, a relatively abundant list of publications on its ultrastructure, morphology and even biochemical composition have appeared in literature (MYERS & al., 1959; DAWES & al., 1961; RAMUS, 1969a, 1969b, 1971; BOURNE & al. 1970; FELDMANN & FELDMANN, 1970; SOMMERFELD & LEEPER, 1970; LEE, 1971; HAWKINS, 1972; DUCKETT & al., 1974; PUESCHEL, 1975, 1977, 1978, 1980, 1987, 1989; FELDMANN & al. 1977; PEYRIERE, 1977a, 1977b; PUESCHEL & COLE, 1982; WETHERBEE & QUIRK, 1982a, 1982b; WETHERBEE & 1984; SEOANE-CAMBA, 1985, 1989; PUESCHEL & MAGNE, 1987; TRICK & PUESCHEL, 1990, 1991; PUESCHEL & TRICK, 1991; PUESCHEL & al. 1992); and its formation has been described by different authors (RAMUS, 1964; PEYRIERE, 1977a; ADHAJANIAN & HOMMERSAND, 1978).

In the present paper are reported observations carried out in the pit connections of three species of *Gelidiocolax*: *G. margaritodes* (Martin & Pocock) Fan & Papenfus, *G. christianae* Feldmann and *G. deformans* Seoane-Camba.

Material and methods

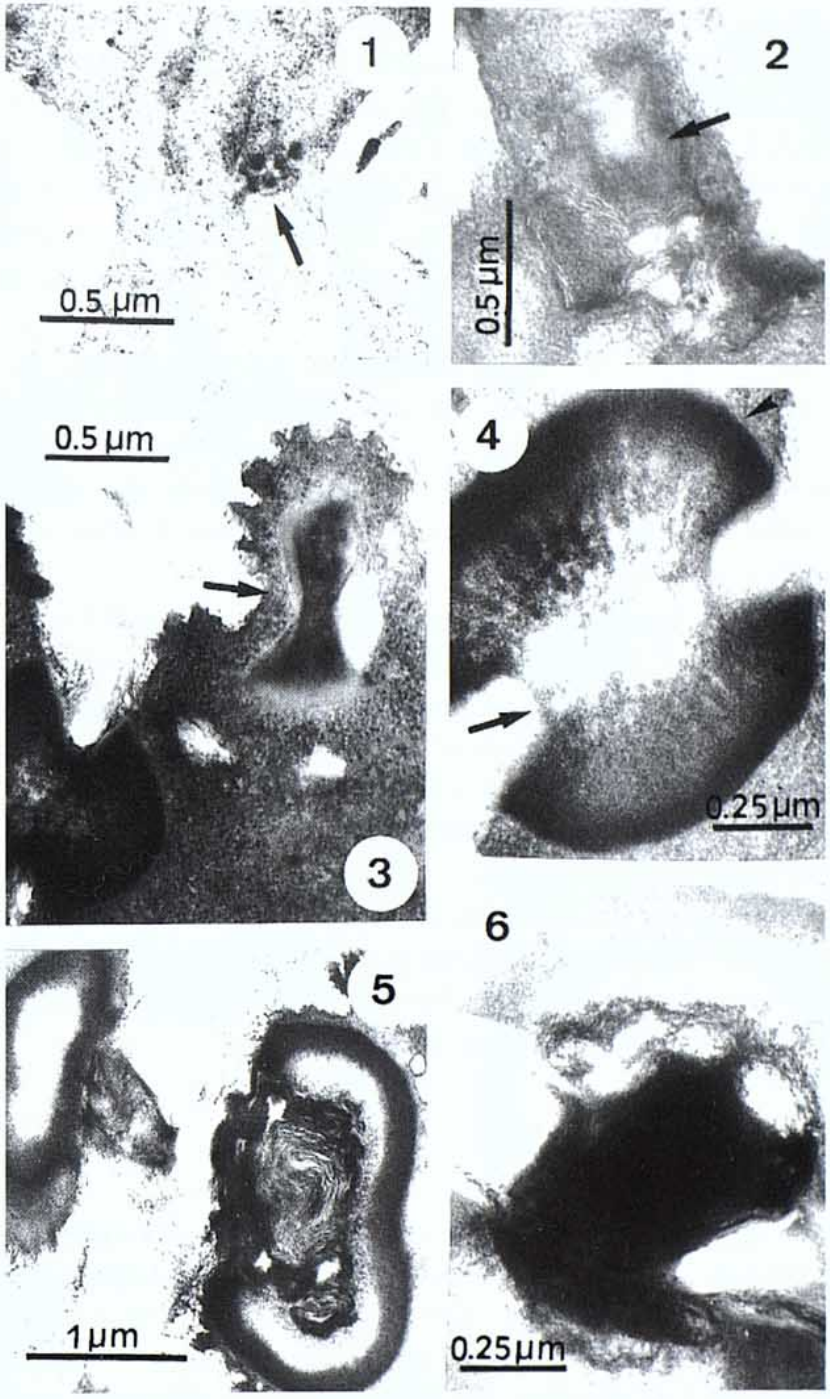
The specimens of *Gelidiocolax christianae* (on *Gelidium spathulatum* (Kützing) Bornet) were collected in February and December 1992, at Blanes and Tossa de Mar, on the Mediterranean coast of Spain; while *Gelidiocolax margaritoides* (on *Gelidium pulchellum* (Turner) Kützing) and *Gelidiocolax deformans* (on *Gelidium sesquipedale* (Clemente) Thuret) were collected in August 1991 and 1992, at Canido-Ría de Vigo, on the Atlantic coast of Spain. Some specimens of *Gelidiocolax deformans* (on *Gelidium sesquipedale*) were also collected in August 1991 and 1992, at San Vicente de La Barquera, on the Atlantic coast of Spain.

All the material used was fixed with 2.5% glutaraldehyde and 2% paraformaldehyde buffer (sodium cacodilate 0.1 M) at 4°C and postfixed with 1% osmium tetroxide in the same buffer. This was followed by dehydration in acetone and embedding in Spurr (Durcupan ACM de Fluka). Sections were contrasted with lead citrate and uranyl acetate, prepared according to REYNOLDS (1963).

Results

The first steps in the ontogeny of pit connections in *Gelidiocolax* have been observed on a limited number of opportunities during the formation of the conjunctor cells in *Gelidiocolax deformans* and *Gelidiocolax margaritoides*.

While the septum, which grew centripetally, was formed between the two



Figures 1-6. **1**. *Gelidiocolax margaritoides*. Two dividing cells, when the first steps of the myelinic figures formation (arrow) are detected; **2**. *Gelidiocolax deformans*. Myelinic figures and electrondense elements (arrow) are well evident in the subsistent cytoplasmic space of septum formation; **3**. *Gelidiocolax deformans*. Diabolos-shaped structure formed apparently as condensation of the myelinic figures and electrondense elements. This structure is formed before the cytoplasm has finished its division and the septum has completely developed (arrow); **4**. *Gelidiocolax deformans*. Well formed pit connection, where the plasmalemma can be seen (arrow), as well as the cap membranes seem to make themselves in some points (arrow cap); **5**. *Gelidiocolax margaritoides*. Pit connections well formed, showing myelinic figures in their central core together with granular material; **6**. *Gelidiocolax deformans*. Pit connections well formed, showing myelinic figures in their central core together with granular material.

dividing cells, electrondense elements and myelinic figures appear in the subsistent cytoplasmic space (Figures 1, 2). These structures were apparently formed by the endoplasmic reticulum. Gradually, these elements and figures were condensed into a mass, and subsequent observations showed the mass more and more condensed, becoming a diabolos-shaped structure with two caps situated in contact with each of the cytoplasm of both cells formed, and thus the pit plug was set up (Figure 3).

What is interesting to emphasize here is that the pit plug was differentiated before the cytoplasm had finished its division and the septum had completely developed (Figure 3, arrow).

When the pit plug was formed, its structure was granular and the granules became more electrondense toward the caps (Figure 4). Membranes (the plasmalemma) were apparent isolating the structure from the cell wall (Figure 4, arrow). Membranes between the structure and the cytoplasm (the cap membranes) seemed to make themselves in some observations (Figure 4, arrow cap) but they are not usually apparent.

It was relatively frequent that pit plugs of *Gelidiocolax*, well formed, showed myelinic figures in their central core, together with granular material (Figures 5, 6).

Sometimes pit plugs could be found in which myelinic figures had been apparently lost, with only remnants of these elements remaining at the periphery of the central core (Figure 7). It seems such figures have been substituted by very scattered granular material (Figures 7, 8, 9). Finally this material become more compact (Figure 10).

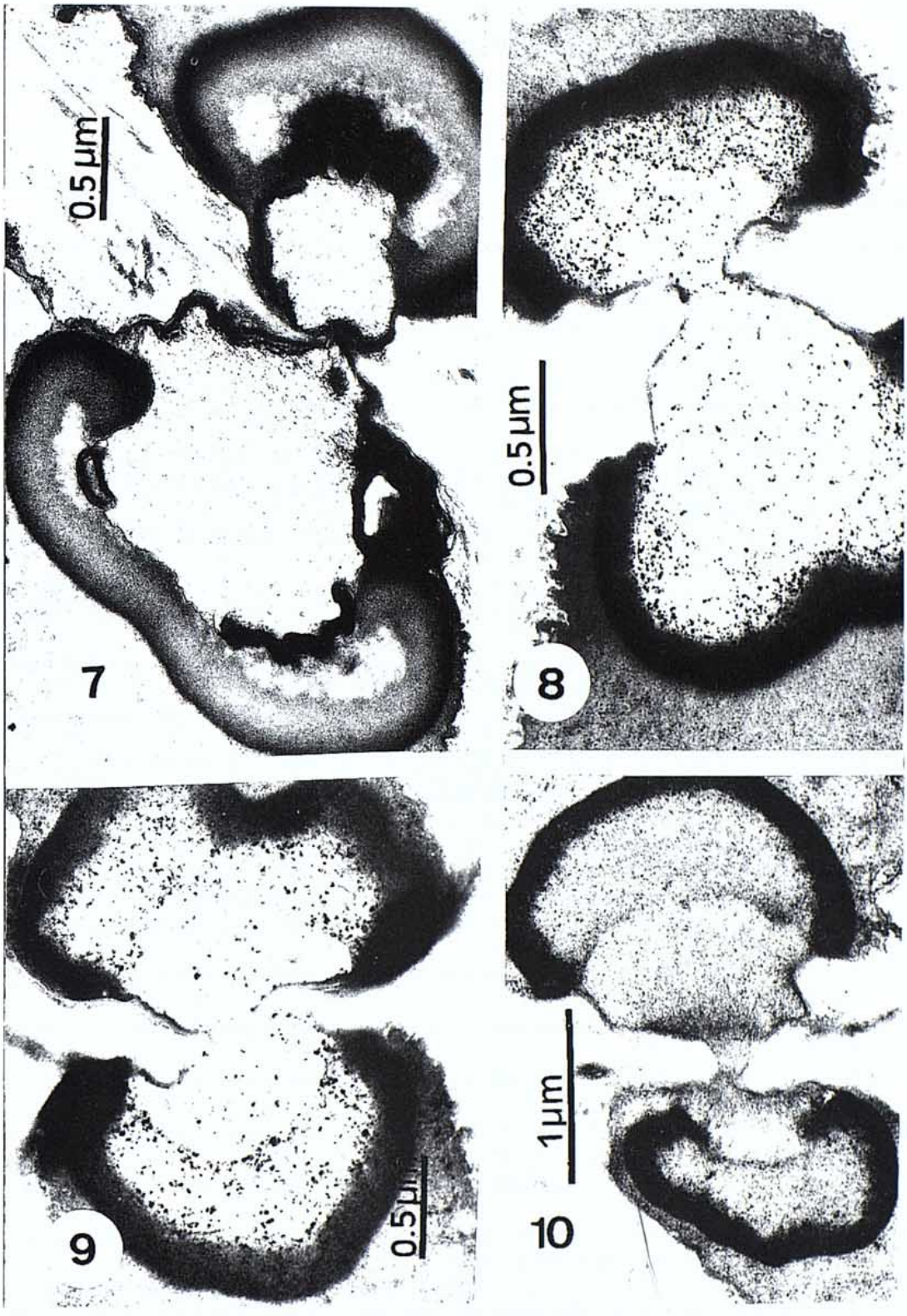
The pit connections situated in the adult part of the thallus are generally more ample. Its structure is granulose, with the granules relatively compact. Usually the cap plugs are more electrondense than the plug cores. No membranes are apparent in contact with the cytoplasm (the cap membranes).

Discussion

Observations of pit connections formation in *Gelidiocolax* do not seem especially different from descriptions carry out by other authors in different species. In this case, however, the existence of "flattened vesicles which lie parallel to one another", described by RAMUS (1969) in *Pseudiogloiophloea*, seems no to have been exactly reproduced here. Perhaps our figures are more in keeping with the electrondense elements and myelinic figures seen in *Griffithsia* by PEYRIERE (1977a).

The very common existence of abundant myelinic elements in the core of the pit plug suggested, that these figures could be homologous to the flattened vesicles of *Pseudogloiophloea* remaining unbroken in the structure, and included by the activity of the electrondense elements.

The apparent replacement of the myelinic figures by granular material showed, perhaps, that this material proceeded from such myelinic figures, or the pit plug material was subjected to an unknown metabolic activity. Such questions require further investigations.



Figures 7-10. 7. *Gelidiocolax margaritoides*. Pit connection with remnants of myelinic figures at the periphery of the central core, dispersed granular material replace apparently the more internal ones; **8** and **9.** *Gelidiocolax margaritoides*. Pit connections where the myelinic figures are lost and substituted by more or less dispersed granular material; **10**. *Gelidiocolax margaritoides*. Pit connection where the granular material of the central core is especially dense.

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