Studies on the Development of the Air Pores and Air Chambers of Marchantia paleacea

IV. Cell Plate Arrangement in Initial Aperture Cells

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Received October 15, 1984
Accepted April 18, 1985

Summary

In Marchantia paleacea some of the superficial thallus cells are dividing at the same time as intercellular spaces (ISs) of the initial apertures (IAs) are being formed. The cell plate of these divisions exhibit a highly variable, but predictable to a significant extent, final arrangement. In many anticlinal and periclinal divisions, one or more cell plate edges following a curved path or continuously changing direction of growth, join(s) the parent wall regions delimiting the lower part of the IS(s) or that lining the surface cavity(ies) (SCs). The rest of the cell plate margins usually meet the parent wall region below the cortical cytoplasmic zone of the incomplete preprophase microtubule band (PMB) as well as at unpredictable wall positions which vary considerably along the older wall.

The preferential final alignment of the cell plate probably mirrors an intimate interaction between its expanding margins and the cortical cytoplasmic site abutting on the wall facing the lower part of the growing IS(s) or that underlying the SC(s). These regions, as well as that of the incomplete PMB, appear able to control the direction of growth of the cell plate. In the former sites, prominent microtubule (MT) organizing centres (MTOCs) seem to operate during interphase and probably during preprophase-prophase.

The mechanism of cell plate arrangement described above, successfully explains the formation of cell plates of highly abnormal shape laid down in IA cells of Marchantia paleacea. The phragmoplast-cell plate system responds to orientation mechanism(s) operating in different cytoplasmic sites, and seriously affecting cell plate morphogenesis. The MTOC cortical cytoplasmic sites, adjacent to the wall lining the lower part of the developing IS(s), behave like the PMB cortical zone.

Keywords: Air pore-air chamber development; Bryophyta; Cell plate arrangement; Marchantia paleacea.

1. Introduction

The IA cells of Marchantia paleacea, dividing during IS formation, are characterized by an extraordinary and highly variable preprophase-prophase MT organization, quite different from that described in vegetative cells of vascular plants. An incomplete PMB, which traverses a limited portion of a median plane of the cell cortex, is organized in these cells. Simultaneously, other MTs clustered in bundles, independent of each other, terminate in the cortical cytoplasm adjacent to the wall(s) lining the lower part of the IS(s) or that underlying the SC(s) (Apostolakos and Galatis 1985b). Completed PMBs are formed under proper conditions. The variability of MT organization described above expresses the establishment of different patterns of polarization of the cortical cytoplasm. They are mirrored in the site(s) and the number of cortical MTOCs which function in preprophase-prophase IA cells.

The acquisition of the aforementioned information directed our work to the mechanism(s) determining the shaping and final arrangement of the cell plate in the IA cells of Marchantia paleacea. Particular attention has been paid to the following questions: a) whether the cell plate intersects the parent wall below the cortical cytoplasmic zone of the incomplete PMB(s), and b) whether another positional relationship exists between the rest of the cell plate edges and any other cortical cytoplasmic region. The discovery of cortical cytoplasmic sites having a function similar to that of the

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PMB cortical zone in cells, in which a typical PMB is not organized or is absent, is theoretically expected.

2. Materials and Methods

The methods used in the present study were the same as those described in the preceding paper (Apostolakis and Galatis 1985b).

3. Results

In cytokinetic IA protodermal cells dividing anticlinally, as well as initial protodermal ones dividing periclinally during the stage of SC and IS formation, the cell plate exhibits a highly variable but predictable arrangement. In the course of some of the former divisions, the nearer edge(s) or the cell plate growing straight terminates in the parent wall region surrounding the lower part of the IS(s) or that outlining the SC(s) (see wall no. 1 in Figs. 1A–D). It always lodges on the wall thickening underlying the SC(s) or that adjacent to the lower part of the IS(s) (Figs. 1B and 14; for more information about the position and the mode of the formation of these thickenings see Apostolakis and Galatis 1985a). It is also noticeable that a number of IA cells divide obliquely. Their cell plates behave as described above (see wall no. 2 in Figs. 1A–C).

In a significant number of anticlinal divisions the cell plate locally expands in a curved mode and reaches the cortical cytoplasm adjacent to the wall facing the lower part of a IS or a SC (cell plate no. 3 in Figs. 1A and B, and 5; see also wall no. 3 in Figs. 17A–H). Study of serial sections of IA cells adjacent to a SC or a young IS showed that the above described divergence of the cell plate can be observed in external paradermal planes, becoming clearly evident on the level of the bottom of the IS (cell plate no. 3 in Figs. 1A and B). In inner planes the cell plate becomes straight (cell plate no. 3 in Figs. 1C and D). The final arrangement of some more abnormally-shaped daughter walls is described below.

Abbreviations Used in Figures: AC air chamber, Ch chromosome, Cp cell plate, EPW external periclinal wall, IA initial aperture, IPW internal periclinal wall, IS intercellular space, Mt microtubule, N nucleus, P plastid, S apical cell segment, SC surface cavity, TIS thickening of the wall area facing the lower part of the IS and portion of the wall underlying it, V vesicle.

Fig. 1. Drawings made from serial paradermal sections through the protodermal area where the ISs of the IAs develop. In these drawings, different cases of cell plate or young daughter wall arrangement can be observed. All the cells illustrated have undergone anticlinal divisions. For details about the final arrangement of the cell plates and young daughter walls no. 1, 2, 3, 4, and 5 see text. The arrows indicate the ISs.