Desmotubule—a Plasmodesmatal Substructure

THE precise nature of intercellular connexions in plants has been the subject of speculation for a considerable time. López-Sáez et al.[1] have recently reiterated the suggestion, frequently made, that the endoplasmic reticulum is continuous from cell to cell through the plasmodesmata. These authors consider that the endoplasmic reticulum traverses the plasmodesmata in the form of tubules about 200 Å in diameter, the inner opaque layer being represented by a single central rod. Robertson[2] has given convincing reasons for believing that a unit membrane in the form of a bimolecular leaflet could not assume such a tight configuration.

Thin sections of plasmodesmata between differentiating ray cells of willow which had been fixed in 3 per cent glutaraldehyde followed by 1 per cent osmium tetroxide were cut and then examined using an AEI EM6B electron microscope. The typical appearance of a plasmodesma sectioned in the middle lamellar region of the wall is shown in Fig. 1. The outer dark layers represent the plasmalemma. This membrane is continuous through the plasmodesmatal canal, and more granular than in its normal situation around the cytoplasm. A central rod runs through each plasmodesma. This rod is surrounded by a tubule of approximately 200 Å in diameter with a wall about 50 Å thick to which the rod is attached by fine filaments. The wall of the tubule commonly shows evidence of substructure, and preliminary experiments indicate the probable presence of eleven sub-units. A diagrammatic interpretation of Fig. 1 is provided by Fig. 2. At the ends of each plasmodesma the tubule is closely bound by the plasmalemma (Fig. 3). There is therefore no continuity between the cytoplasm of adjacent cells, nor is there continuity through the cavity of the endoplasmic reticulum (Fig. 4).

In structure and appearance the tubule described here is similar to the cytoplasmic microtubules described by Ledbetter and Porter[3]. The size is more compatible, however, with that of nuclear spindle fibres. It may be that sub-unit size in such tubules is fairly constant, and that different diameters are accommodated by different numbers of sub-units—thus explaining the discrepancy between the number of sub-units found here and the thirteen found in cytoplasmic microtubules by Ledbetter and Porter. Suggestions have been made in the past that the plasmodesmata may be traversed by nuclear spindle fibres[4,5], but this report is the first definite confirmation of this. For this reason, as well as to avoid confusion with other types of cytotubule, it is suggested that the name desmotubule (Greek desmos—bond) is appropriate for these structures. This would be compatible with
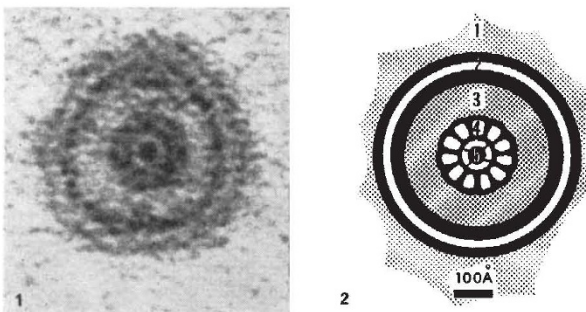

Fig. 1. Transverse section through the central region of a simple plasmodesma between differentiating xylem ray cells. Fixed in glutaraldehyde followed by osmium tetroxide; stained in uranyl acetate and lead citrate (× 500,000).

Fig. 2. Diagrammatic interpretation of Fig. 1: (1) cell wall; (2) plasmalemma; (3) plasmodesmatal cavity; (4) desmotubule; (5) central rod. The central rod is attached to the inside of the desmotubule by fine filaments.
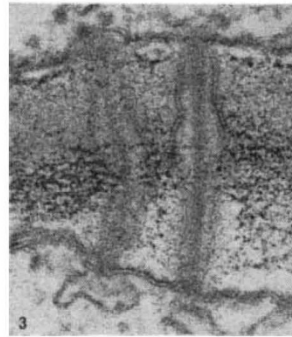

Fig. 3. Longitudinal section of plasmodesmata between adjacent ray cells. Prepared as Fig. 1. (× 100,000.)

Fig. 4. Diagrammatic interpretation of longitudinal sections similar to Fig. 3. Numbering as in Fig. 2; (6) endoplasmic reticulum; (7) cell cytoplasm.

nomenclature already existing for other intercellular connexions such as plasmodesmata and desmosomes.

The suggestion that the endoplasmic reticulum is continuous from cell to cell has been lent support by the fact that it can often be seen to be trapped during cell plate formation. The presence through the cell wall of a tubule apparently identical with nuclear spindle fibres suggests that they also may become trapped in such a manner. This matter will require further substantiation, but will also necessitate a complete reappraisal of the nature of intercellular connexions in plants.

A. W. ROBARDS

Department of Biology,
University of York.

[1] López-Sáez, J. F., Giménez-Martín, G., and Risueño, M. C., Protoplasma (Wien), 61, 81 (1966).

[2] Robertson, J. D., in Cellular Membranes in Development (edit. by Locke, M.) (Academic Press, London and New York, 1964).

[3] Ledbetter, M. C., and Porter, K. R., Science, 144, 872 (1964).

[4] Jungers, V., La Cellule, 42, 1 (1933).

[5] O'Brien, T. P., and Thimann, K. V., Protoplasma, 63, 417 (1967).

Petrifaction of Plant Tissue in the Laboratory

PLANT tissue can be petrified by impregnation with natural waters with a high concentration of dissolved silicate[1]. This occurs commonly in springs issuing from volcanic deposits in New Zealand, Ireland and Yellowstone Park in America. The process is easily duplicated in the laboratory in the following way. Small pieces of plant material (1 cm³ or less) are placed in 250 ml. polyethylene beakers, 50–100 ml. of deionized H_2O (pH 6·0, which is adjusted by dilute HCl) is added; after 5–10 min, 2–5 g sodium metasilicate ($Na_2SiO_3 : 9 H_2O$) is stirred into the beakers, which are then allowed to stand undisturbed for 12–24 h. The pH rises to 14. The material is then washed several times with deionized H_2O, allowed to soak for 30 min in 2 N HCl; organic material is removed by wet ashing, using boiling concentrated nitric acid (1 part) and concentrated chromic acid (1 part)[2].

The pieces of plant material are not preserved intact, but they fragment into single cell replicas of silica and macroscopic cellular aggregates 1 mm³ or larger. Opaline silica is deposited on all exposed cell wall surfaces, but it is deposited first and most completely on the inner cell wall surfaces, to produce siliceous replicas of cellular spaces (Fig. 1). The high pH of the silicate solution may facilitate dissolution of pectic material in the middle lamellar regions which also become filled with silica to form a grid-like network around the siliceous replicas of cellular spaces (Fig. 2). The amount of time