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# OCCURRENCE OF TRANSFER CELLS IN THE SPOROPHYTE OF *PTERIDIUM AQUILINUM* L.

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Abstract

Cells with wall ingrowths called transfer cells were observed in foot cells of sporophyte of *Pteridium aquilinum* L. Gametophytic cells contiguous with foot cells of sporophyte also possessed wall ingrowths. Cell walls of foot cells of sporophyte immediately adjacent to the gametophyte, had wall ingrowths on both sides. Wall ingrowths or projections, irrespective of their distribution were always delimited by plasmalemma. The distribution of cell organelles in transfer cells and their possible role in transport of nutrients is discussed.

## Introduction

Like animal cells plant cells also possess specialized wall ingrowths in the regions actively engaged in absorption and secretion. Such cells are named as 'Transfer Cells' (Gunning & Pate, 1969a) and are present in almost all groups of vascular plants. Amongst ferns (*Adiantum capillusveneris* and *Polypodium vulgare* (Gunning & Pate, 1969b) and liverworts (*Sphaerocarpos dennelli* (Kelly, 1969) wall ingrowths have been reported in the cells located at the junction of gametophyte and sporophyte where cytoplasmic discontinuity and nutritional relationship exists between the alternating generations. In angiosperms like *Capsella* (Schulz & Jensen, 1969), *Pisum* (Marinos, 1970) and *Lobelia* (Torosian, 1971) wall ingrowths are reported in the embryo-sac walls between gametophyte and sporophyte. Transfer cells are also reported to be present in the filiform apparatus of the synergids and young embryo of cotton (Jensen, 1965) and in antipodals and endosperm initials of *Linum* and *Zea* (Vazarat & Vazarat, 1966; Vazarat, 1968; Diboll & Larson, 1966; Diboll, 1968). The general interpretation is that the ingrowths facilitate the passage of nutrients from the ovular tissue into the embryo-sac.

Transfer cells are recognized by wall projections which are seen as short finger-like protuberances or as network-like proliferations of wall material, the cytoplasm penetrating between the individual outgrowths. The projections are always delimited by plasmalemma, the surface of which is greatly increased through the development of characteristic infoldings.

The present communication is the first report of the occurrence of transfer cells in the foot cells of *P. aquilinum* sporophyte which constitutes the absorptive organ of the plant.

## Material and Method

Spores collected from the fertile fronds of *P. aquilinum* were used for growing gametophytes. Spores were surface sterilized in 1% calcium hypochlorite for 30 min., and then centrifuged. The pellet washed three times with sterile distilled water was mixed to form thick spore suspension and spread on the surface of agar slants with a sterile wire loop. The culture medium was prepared following Moore (1903) with 1.5% Difco agar at pH 5.5 and autoclaved at 15 psi for 15 min. After inoculation the test tubes were kept under white fluorescent lamp (10 $W/m^2$) at 15°C with a light regime of 12 h day and 12 h night. Germination of spores occurred in a week. The young gametophytes 1–2 mm in diameter were transferred to the fresh medium. Each tube contained 4–6 gametophytes. Mature gametophytes 1 cm in diameter were used for fertilization. Fertilization was brought about by putting them in a suspension of spermatozoids, obtained by mixing and shaking dense culture in sterile water and left for 3–4 h. The gametophytes were always washed thoroughly before putting them in the suspension of spermatozoids or after fertilization when they were transferred to the fresh media. After 8 days of fertilization the embryos were excised from the fertilized gametophytes and fixed in 5% gluteraldehyde in sorensen buffer at pH 7.1, for 5 h at room temperature with occasional shaking. Fixed material was washed 3 times with the same buffer at 4°C. Washed material was post-fixed in 2% osmium tetroxide in water for 2 h at 4°C. The material after dehydration in acetone grades in water in an ice bucket was kept in propylene oxide for 2 h in a desiccator at room temperature before embedding in grades of Epon (1:2) in propylene oxide.

For electron microscopy sections were cut at 800Å on an LKB ultrotome III. After staining for 15–20 min., each in uranyl acetate and lead citrate (Reynolds, 1963), the sections were examined in a Hitachi HS-9 electron microscope.

## Results

The mature embryos of *P. aquilinum* shows young sporophyte distinguishable into four regions; shoot apex, root apex, first leaf and foot. In 8-day old embryo the part of the embryo destined to form leaf is provided with a large apical cell at its tip which is roughly triangular in outline. At the opposite pole well developed foot contains cells of bigger diameter with large vacuoles. At this stage differentiation of xylem is not apparent. Embryo is 1 mm in diameter and is almost fully dependent on the gametophyte for its nutrition. The cells of the foot which are adjacent to the surrounding gametophytic tissues develop certain wall ingrowths. On the sporophytic side wall ingrowths are more abundant and are directed towards the sporophytic side. The wall labyrinths were not visible in the younger embryos. These wall ingrowths appeared as short finger-like projections (Fig. 1a) or as branched anastomosing structures (Fig. 1b) of the wall material delimited by plasma membrane.

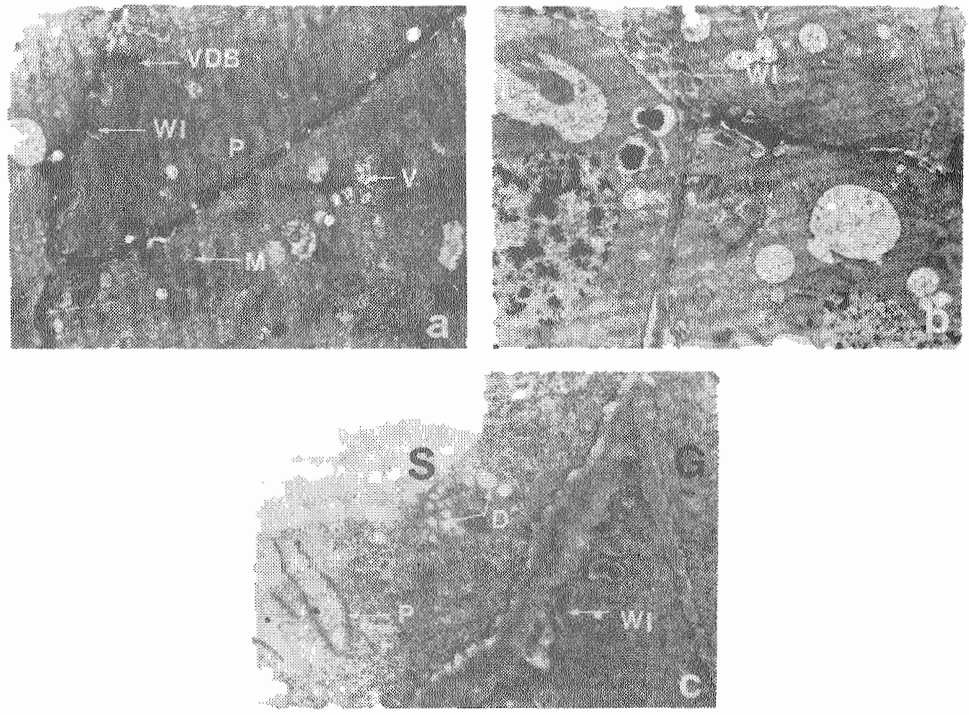


Fig. 1. A. An electron micrograph of the cells of sporophyte foot. The wall ingrowths occur along the walls of the cells as finger-like unbranched projections (WI). Note numerous mitochondria (M) and plastids (P). Vacuoles containing fibrillar material (VFM) and electron dense bodies (VDB) can be seen. B. An electron micrograph showing branched wall ingrowths (WI) in the cells of sporophyte foot and vacuoles (V). C. An electron micrograph of cells located at the boundary between gametophyte (G) and sporophyte (S). The wall ingrowths (WI) occur along the walls of adjacent foot cell and gametophytic cell. Vesicles of dictyosome (D) and plastid (P) are indicated in the foot cell. Note warty appearance of the cell wall of foot cell showing the initial stage of wall ingrowth development.

The walls of the gametophytic cells which were contiguous with the sporophyte foot also contained wall projections which were either rounded or short finger-like unbranched or sparsely branched structures. However, wall projections were present on both the sides of those walls of foot cells which were immediately adjacent to the gametophyte (Fig. 1c). Irrespective of their location such cells contain numerous mitochondria and ribosomes. Vesicles possibly of dictyosome origin containing some fibrillar material were also observed adjacent to the wall projections. Plastids containing starch and well developed grana were found in the cells of the gametophyte. Plastids present in the cells of the foot were devoid of starch.

## Discussion

The nutrition of the growing sporophytes in lower plants with well defined alternation of generation has always been a matter of much interest to the plant biologists. Wall ingrowths which increase the absorptive area of cells by their irregular projections provide a system which has been suggested to be involved with the passage of nutrition from gametophyte to sporophyte in *Adiantum*, *Polypodium* and *Sphaerocarpos*. The existence of transfer cells in the parallel anatomical situations in *P. aquilinum* are in agreement with the findings of other workers and substantiate the claim of Gunning & Pate (1969a). Similar wall projections have been shown to be present at the micropylar end of embryo-sac wall in *Helianthus annuus* (Newcomb & Steeves, 1971), at the boundary between gametophyte and sporophyte in *Capsella* (Schulz & Jensen, 1968b), in *Pisum* (Marinos, 1970) and in *Lobelia* (Torosian, 1971).

A functional relationship between transfer cells and cell organelles has also been suggested (Gunning & Steer, 1975). The close proximity and abundance of the mitochondria along with the ingrowths suggests high energy requirements by the cells in question for absorption and movement of nutrition across the cell membrane. The vesicles containing fibrillar material might have a role in the deposition of their contents on the developing ingrowths. The lack of starch from the plastids of sporophytic tissues reinforces the idea of the dependence of sporophyte on gametophyte for food particularly in young condition

The absence of transfer cells from younger developing embryos may be due to the presence of stored essential metabolites in the mature egg of *P. aquilinum* before fertilization, sufficient to sustain growth of young embryo up to mature stage like *Echinoderm* ova which possesses enough quantities of preformed deoxyribonucleotides, to maintain DNA synthesis for 6S periods (Young *et al.*, 1967).

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