
AN OBSERVATION ON THE PROTOPLASMIC CONNECTIONS
THROUGH SIEVE PLATES^{1, 2}

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ABSTRACT

Two electron micrographs of paradermal sections of veins of the leaves of *Beta vulgaris* are presented. The micrographs show the endoplasmic reticulum from one sieve cell passing through the sieve plate and into the adjacent sieve cell. This is evidently an unusual condition in this material.

As an adjunct to a study of the vein endings in leaves of *Beta vulgaris* var. Klein Wanzleben, we made a survey of the anatomy of the larger veins. This study is a part of a larger project dealing with the translocation of organic materials; therefore our attention was focused on phloem tissue. Investigations of a similar nature have been reported by Duloy, Mercer, and Rathberger (1961); Kollman (1960); Kollman and Schumacher (1961, 1963); Esau, Cheadle, and Risley (1962); and Esau and Cheadle (1961).

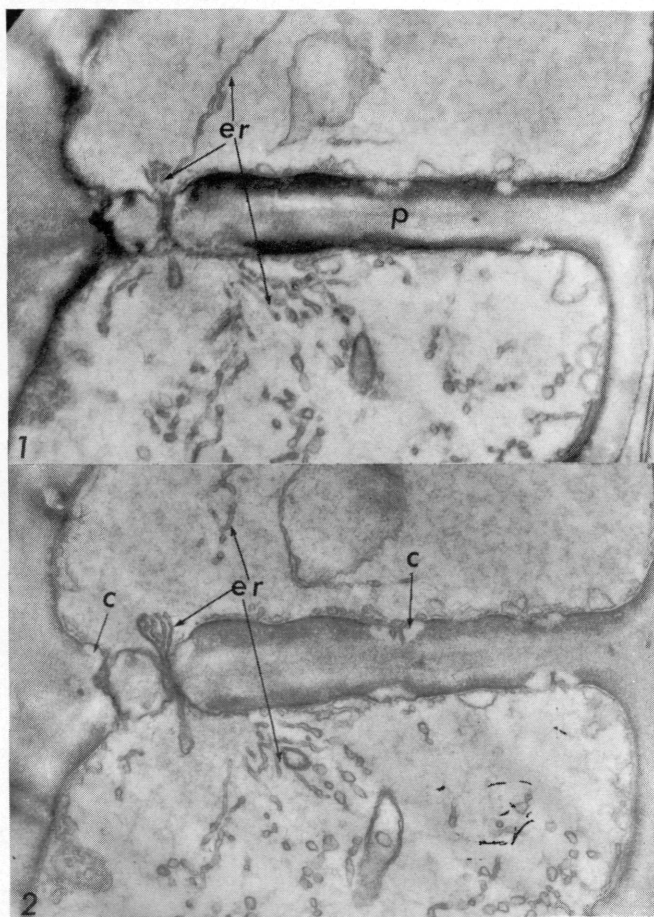
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Evidence presented by the above authors demonstrates that there is a characteristic change in the fine structure of sieve tubes during ontogeny involving degeneration of the nuclei, disappearance of the tonoplast, and a dissociation of the dictyosomes and endoplasmic reticulum into vesicles. Esau and Cheadle (1961) have studied the development of sieve plates in *Cucurbita* and related these changes to the changes in fine structure of the protoplast. In all of these studies, the question of protoplasmic continuity between adjoining sieve elements has been of great interest because of its bearing on rapid transport in the phloem. This paper presents a rare observation which may have a bearing on our understanding of the nature of the protoplasmic connections between protoplasts of adjoining sieve elements.

MATERIALS AND METHODS

Bits of leaves of *Beta vulgaris* var. Klein Wanzleben growing under controlled conditions were fixed and embedded for electron microscopy. Samples were



FIGURES 1-2. Figure 1 is the result of a paradermal section of one of the small veins in the leaf of *Beta vulgaris* var. Klein Wanzleben. Shown is a sieve element in cross section.
er, endoplasmic reticulum; p, sieve plate; c, callose. $\times 30,000$.
Figure 2 is a section adjacent to that in figure 1.

removed from the upper fourth of the leaf midway between the main vein and the leaf margin. All leaves were two-thirds fully expanded. The samples were fixed for 90 min in 2 per cent KMnO_4 at room temperature, dehydrated in an alcohol series, and embedded in epoxy resin in the usual manner. Paradermal sections of the veins were made at thicknesses of 250 to 500 Å on a Porter-Blum ultramicrotome using a duPont diamond knife. Sections were mounted on collodion-coated grids stabilized with carbon and viewed with an R. C. A. 3G electron microscope.

RESULTS AND DISCUSSION

We have been able to demonstrate in veins of the leaf of *Beta vulgaris* var. Klein Wanzleben all of the stages of sieve plate development described by Esau for *Cucurbita*. There are, however, certain variations which should be noted. Plasmodesmata are often seen in sections of sieve plates, but do not always occur singly. We have observed frequent double plasmodesmata and occasional branching of single ones. Callose platelets develop, but are not as well defined as in *Cucurbita*. Lateral sieve areas are quite common in our material.

The stages in development of sieve plates appear to be consistent in all plates developing at a given level, but we have noted that, in the majority of cases, the degree of disintegration of the protoplasts of adjoining sieve elements is not the same.

The figures demonstrate the stage of sieve-tube development at the point where the endoplasmic reticulum has become tubular or vesicular. The sieve plate pores extend completely through the sieve plates and the layers of callose from adjoining cells have become continuous through the pore. The most notable feature of figures 1 and 2 is the appearance of endoplasmic reticulum extending through the pore of the sieve plates. Kollman & Schumacher (1963) report endoplasmic reticulum extending through the sieve plates of *Metasequoia*. However, we have seen this feature only one time, in spite of a prolonged search.

It may be that this stage of pore formation occurs quite rapidly and that the endoplasmic reticulum from one cell is being swept through the sieve plate pore. Subsequent vesicularization of the endoplasmic reticulum may obliterate all traces of continuity of the reticulum through the pores. We are inclined toward the above interpretation rather than to the view that these pictures represent a condition of prolonged duration. This interpretation is of course tentative and is based upon the fact that a prolonged search of our material has failed to reveal similar situations. Further investigations are being conducted using leaves of various ages.

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