PERFORATION PLATES: OBSERVATIONS USING SCANNING ELECTRON MICROSCOPY

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INTRODUCTION

The value of the scanning electron microscope in wood science has now been established. In the field of wood anatomy it has been used successfully by Ishida and Ohtani (1969) in a study of the development of tyloses in *Robinia,* by Findlay and Levy (1969) in an investigation on wood decay, and by Schlink (1969) in research into the structure of the bordered pits in white fir. Scanning electron microscopy has also been used to investigate the surface architecture of reaction wood (Scurfield and Silva, 1969a, b) and vestured pits (Scurfield and Silva, 1970) before and after various chemical treatments. A full review of the use of the scanning electron microscope in wood science has been published by Collett (1970). This work also includes some useful notes on techniques for specimen preparation. Careful yet simple preparation of material for the scanning electron microscope can reveal excellent detail of the structure of wood in three dimensions. Scanning electron microscopy can be an aid in descriptive wood studies and has an obvious value for the teaching of wood science. The photographs of perforation plates included here were obtained during part of a larger survey of various aspects of the structure of wood (Meylan and Butterfield, in press).

MATERIALS AND METHODS

Cubes of wood about 3mm to 4mm per side were cut from air dried blocks of various trees along transverse, radial longitudinal, and tangential longitudinal planes where possible. No special drying techniques were used. These cubes were first softened by boiling in water before the final surface cuts were made by hand using a new razor blade for each surface. The cubes were mounted on specimen stubs and transferred to a high vacuum evaporating unit and lightly coated first with carbon and then with 40nm of gold palladium while being rotated at 150 r.p.m. The wood specimens were then examined in a vacuum dry state in the column of a Cambridge Series II scanning electron microscope.

RESULTS

Vessel perforation plates are shown in Figs. 1-7. Simple perforation plates are illustrated in Figs. 1-3, a reticulate form in Figs. 4 and 5, and two scalariform ones in Figs. 6 and 7.

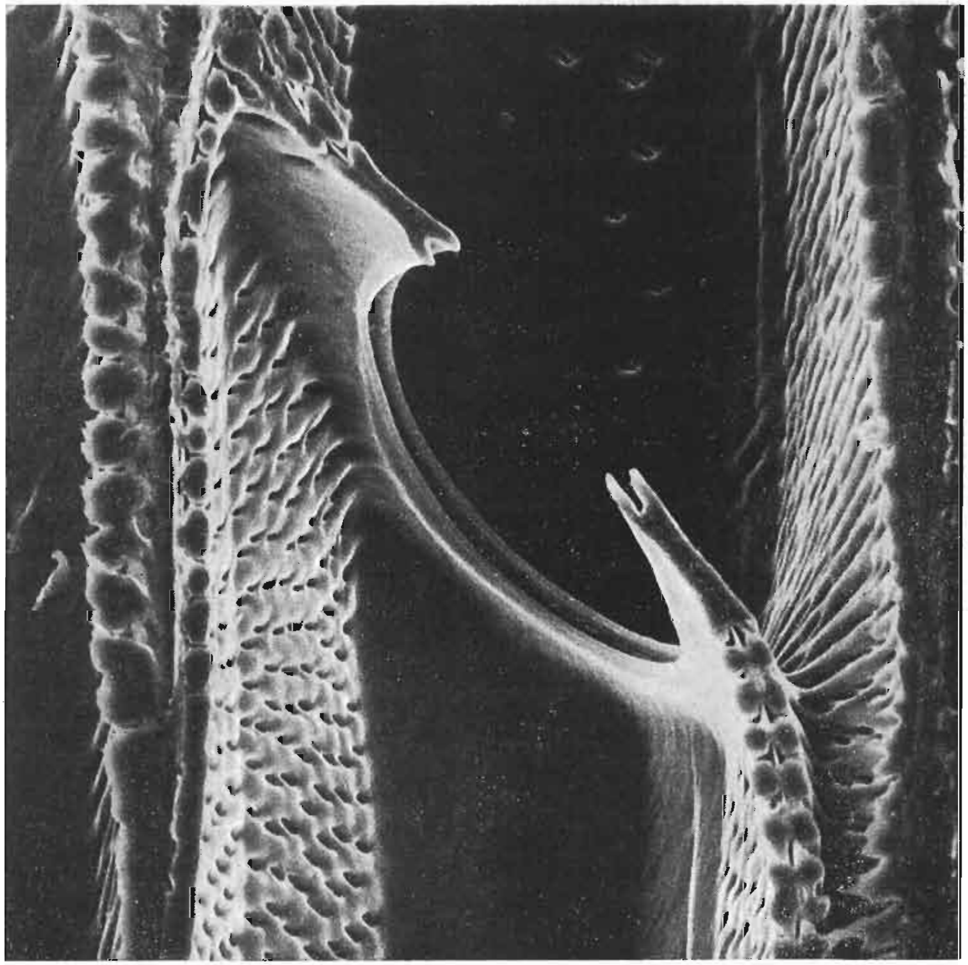

FIG. 1—A simple perforation plate between vessel members in rewarewa (**Knightia excelsa** R. Br.). In this example the perforation plate is at an oblique angle. Pit membranes can be seen traversing the pit-pairs in the side walls of the lower vessel member and a trace of the former primary walls and middle lamella can be seen between the over-arching borders of the perforation (× 1,100).

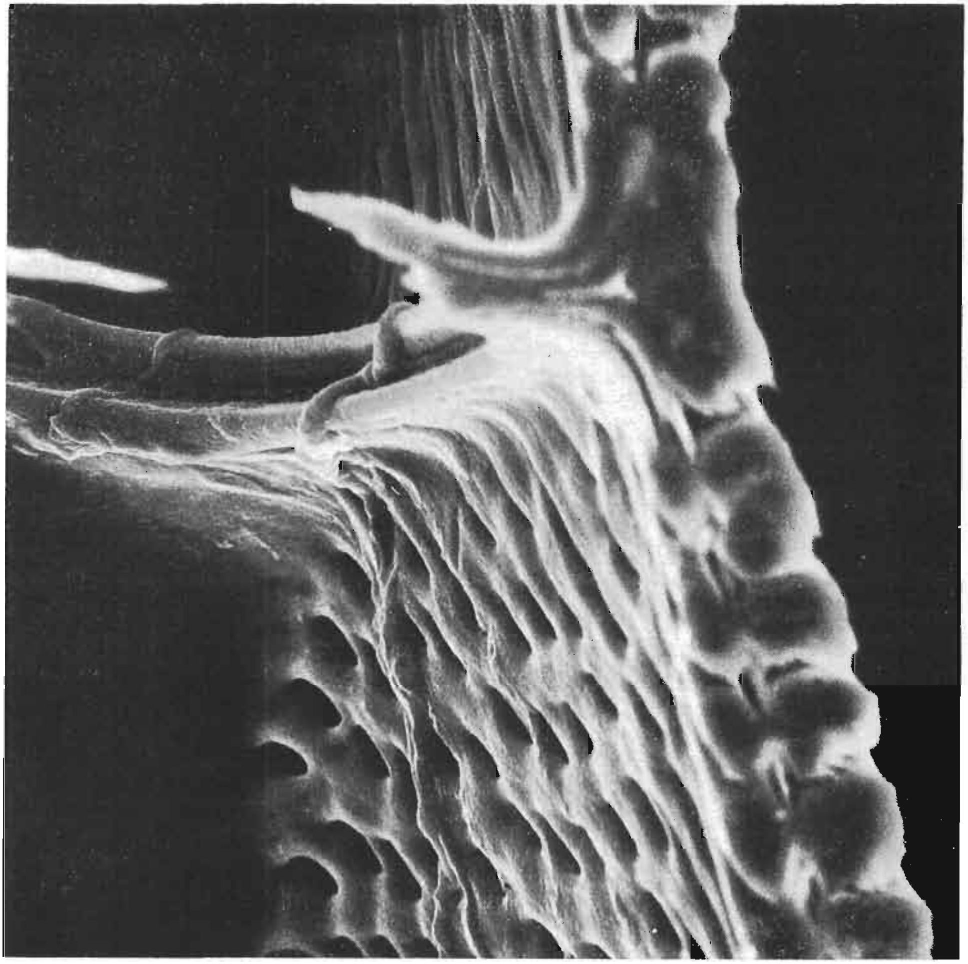

FIG. 2—The remains of the former perforation membrane is visible between the prominent borders in this transverse simple perforation plate in rewarewa. The material passing through the perforation and dried against the vessel wall is most probably fungal hyphae that have contaminated the specimen (× 2,500).

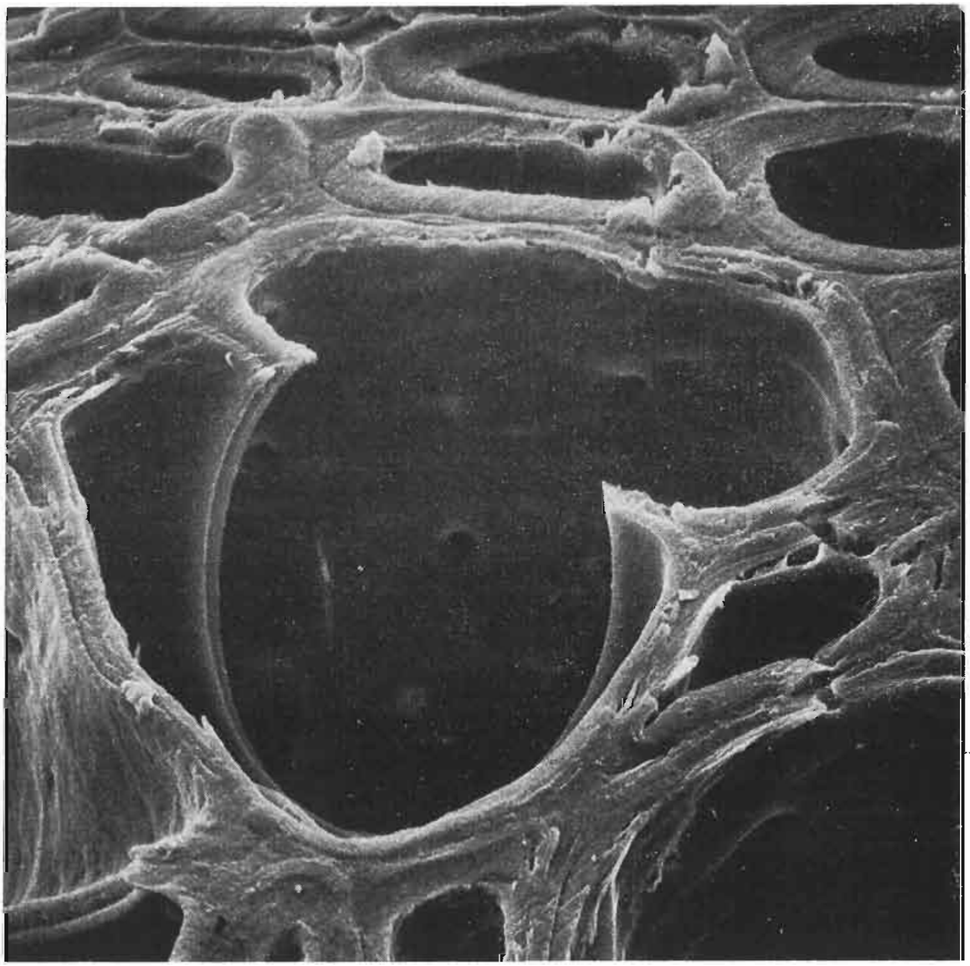

FIG. 3—An oblique simple perforation plate between vessel members in black maire (**Nestegis cunninghamii** Raf.) (× 1,800).

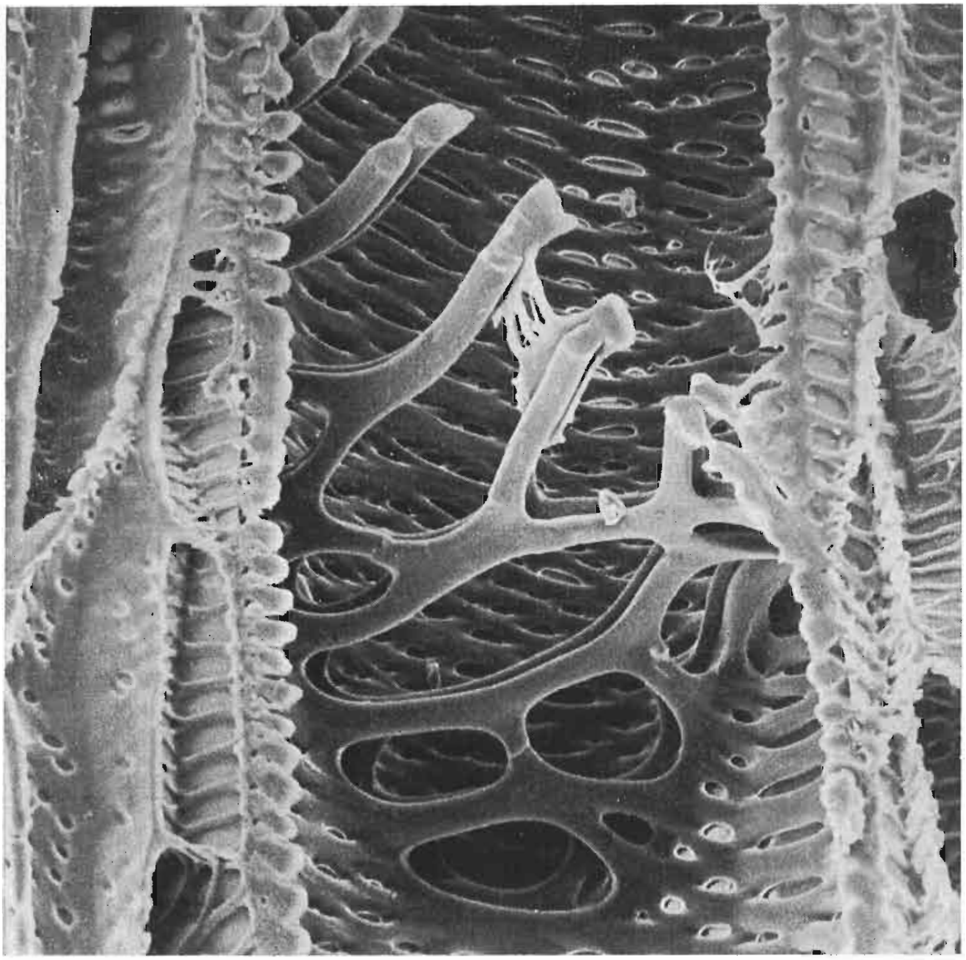

FIG. 4—A reticulate perforation plate in nikau (**Rhopalostylis sapida** Wendl and Drude). The individual bars separating the perforations appear to be shaped like a number 8, being thinnest in the region of the primary walls and the middle lamella (× 840).

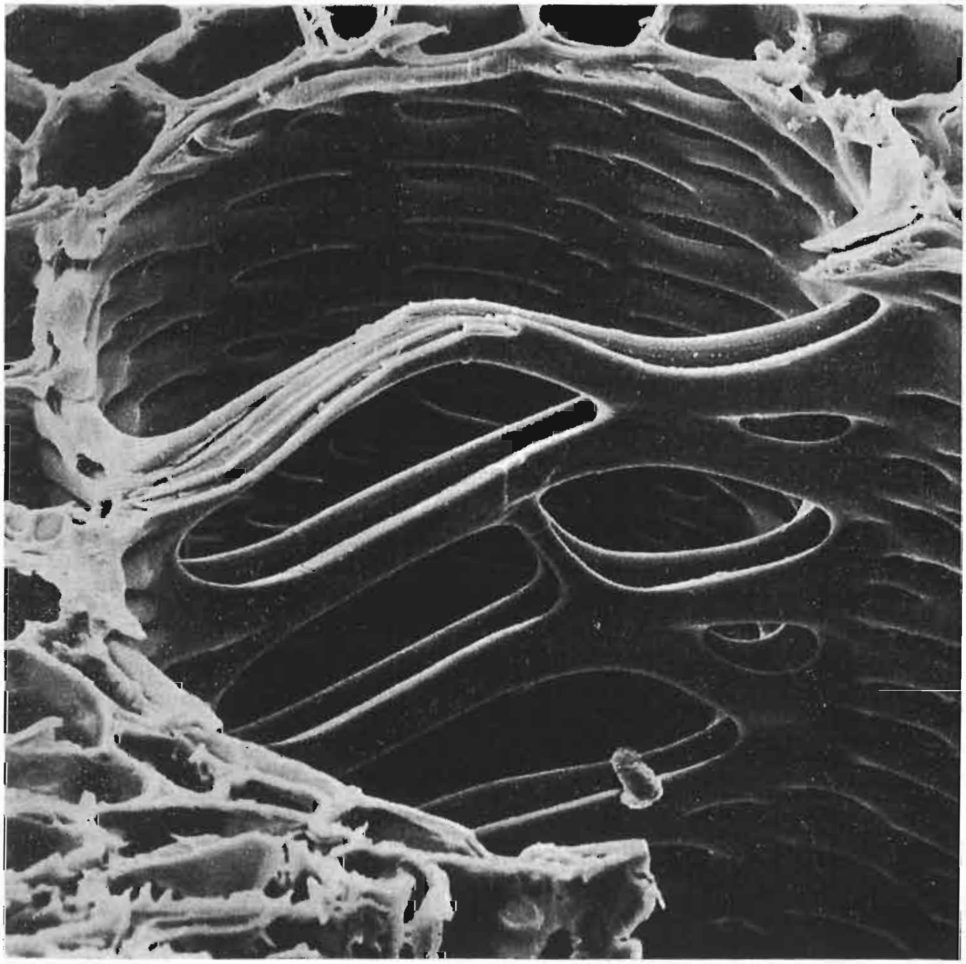

FIG. 5—A view of another perforation plate in nikau. Again the secondary walls of the separate vessel members overarch the perforations (× 950).

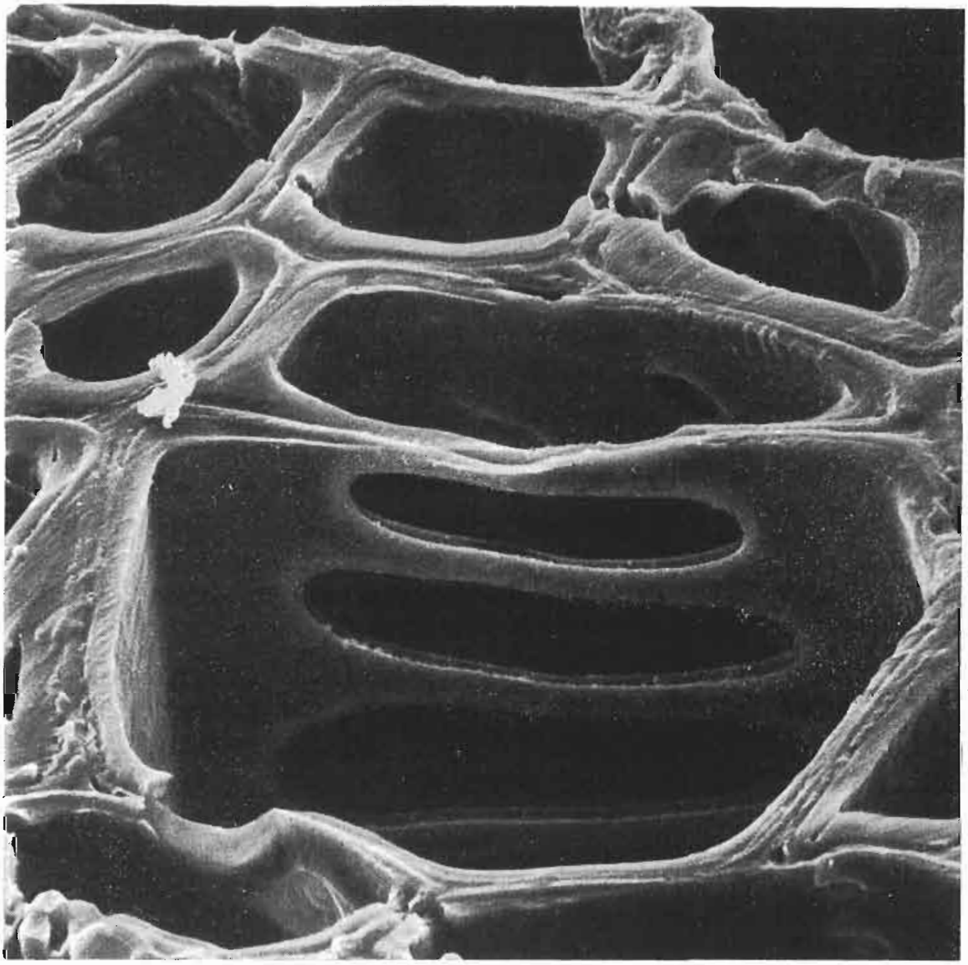

FIG. 6—A scalariform perforation plate in broadleaf (**Griselinia littoralis** Raoul) exposed by a transverse cut through the secondary xylem (× 1,450).

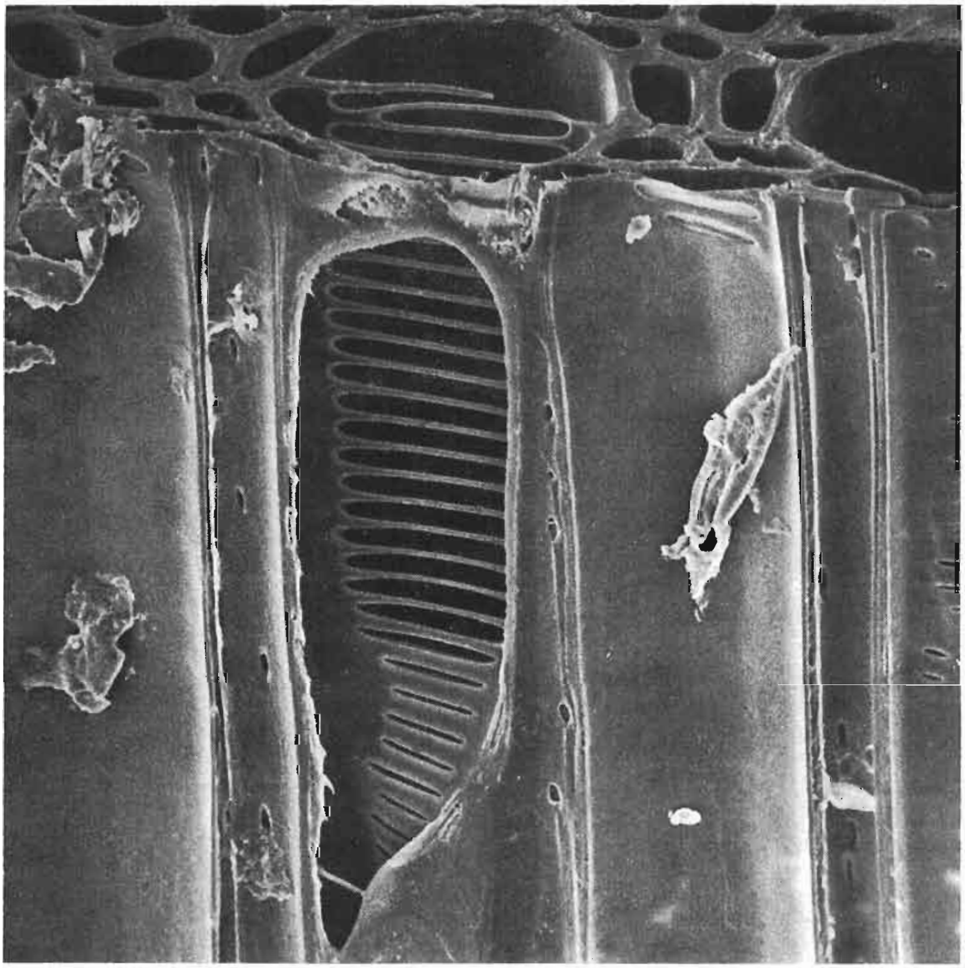

FIG. 7—Part of an extensive scalariform perforation plate in pukatea (**Laurelia novae-zealandiae** A. Cunn.). As the perforations become narrower they grade into scalariform pitting down the side walls of the vessel members (× 440).

DISCUSSION

Perforation plates are formed during the differentiation of the individual vessel members. According to an early theory (Priestley, *et al.,* 1935) the end walls in vessel members are lost during the expansion of the differentiating cell. This theory was subsequently discredited by Esau and Hewitt (1940). They concluded that the primary walls in the area of the perforation plate remain intact until the differentiating cell has reached its final diameter and the secondary wall has been laid down on other parts of the vessel member wall. The removal of the primary walls and middle lamella in the region of the perforation is not fully understood (Esau, 1965).

In most of the perforation plates examined during this survey under the scanning electron microscope, prominent borders similar to those overarching the pit membranes of bordered pits were observed. These can be most clearly seen in Figs. 1, 2, 4, and 5. Between these borders it is sometimes possible to see a small ridge (Figs. 1 and 2) marking the postiion of the former middle lamella and primary wall. A feature of these photographs is the similarity in architecture between the perforations and the pits. The basic difference, of course, is the greater size of the perforation apertures and their lack of a membrane. This similarity is particularly obvious in vessels that have both scalariform pitting and scalariform perforation plates. In some instances such perforation plates grade gradually into pit fields with smaller but similar-shaped apertures.

It is clear, therefore, that the mechanism which removes the membrane from perforations but not from pits invites some interesting investigation.

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