# DIFFERENTIATED CALLUS NODULES IN RESIN POCKETS OF *PINUS PONDEROSA* LAWS

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## INTRODUCTION

Resin pockets are found as occasional defects in many softwoods and may, in some areas, reach epidemic frequency (Cown, 1973). They are initiated under mechanical and/or physiological stress by rupture of cells in the cambial zone (Frey-Wyssling, 1942; Cown, 1973). Resin under considerable pressure then enters the cavity from ruptured ends of resin canals, and this may be a factor in enlarging the original split into the eliptical shape (tangential longitudinal plane) and lens shape (transverse plane) that are characteristic of resin pockets.

Not only do these pockets contain resin, but around them may develop nodules of callus which sometimes coalesce into an irregular coating. They are formed by proliferation of ray cells into the resin pocket cavity in species where ray parenchyma cell walls lack secondary thickening (Amos, 1954; Bamber, 1972). Frey-Wyssling (1938) suggested that oleoresin acts as a hormone to stimulate division in cells that retain this capacity. Under certain circumstances the callus nodules can show some degree of differentiation to include recognisable tracheids, rays, and crushed cells resembling inner bark (de Carvalho, 1957).

This note describes extensive differentiation of callus observed in resin pockets of *Pinus ponderosa* Laws.

## MATERIAL AND METHODS

During felling of 20 *P. ponderosa* trees at Crookston in the Tapanui district, two trees were observed to contain very frequent resin pockets, while the remaining trees showed no sign of the defect. Samples were sent to the Forest Research Institute for assessment, but there was little that could be added to the observations made in the forest. However, it was noticed that some very large callus nodules in several resin pockets showed signs of advanced differentiation where they had been cut open in cross-cutting the stem (Fig. 1). These nodules were examined under the microscope by hand cutting sections and by macerating the woody part of the nodule in acetic acid/hydrogen peroxide. Unfortunately bark differentiation was so far advanced that phellem cells resisted impregnation with an embedding medium, and hand cutting therefore provided the best method of obtaining sections.

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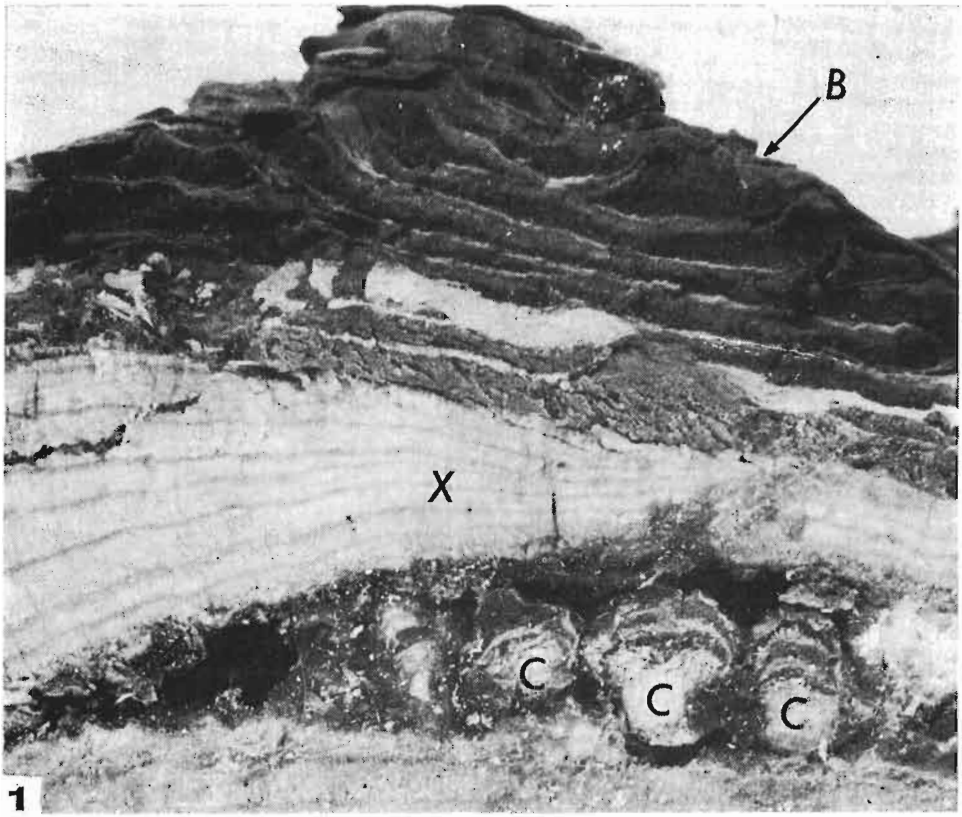


FIG. 1—Cross-section through a resin pocket containing differentiated callus nodules (C) with several annual growth layers of xylem (X) exterior to the pocket, and the bark of the main stem (B). × 2.5.

## OBSERVATIONS

Sections showed that bark on the abaxial side of the nodules was well differentiated into regular layers of phellem and phelloderm cells (up to three layers of each), and that the woody tissues contained tracheids (Fig. 2). Orientation of the tracheids was in "random groups" so that in the section illustrated, for example, some well-developed radial files are seen in transverse section, whereas an adjacent group of tracheids appears in radial longitudinal section. Some parenchyma cells appear to be filling the role of "wood rays" though they are not fully organised into complete rays of the normal type. Many of the "ray" cells have dark contents.

Macerated tissue contained cells in all stages of differentiation from parenchyma to mature tracheids up to 1.3 mm long. Fig. 3 shows several tracheids with bordered pits and also half-bordered pits of the type communicating with ray parenchyma in normal wood.

## DISCUSSION

Brown and San (1962) described the effect of pressure on differentiation of callus in partially detached bark strips of *Populus trichocarpa* and *Pinus strobus*. The nodules


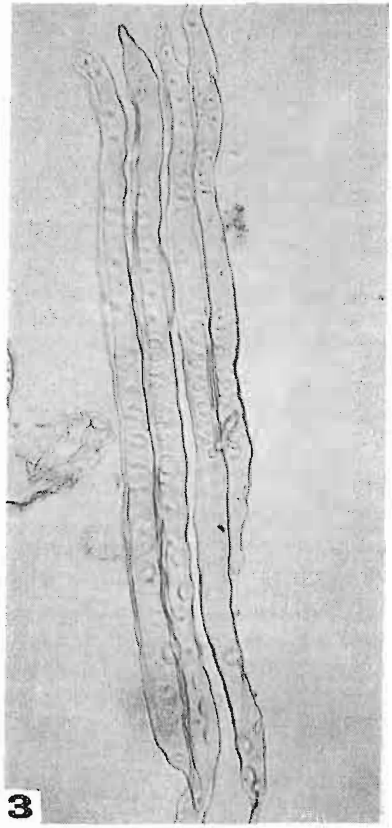

FIG. 2—Hand-cut section through a callus nodule showing alternate layers of phellem (ph), and phelloderm (pd). Radial files of tracheids are seen in both transverse section (T) and radial longitudinal section (R). Ray parenchyma cells (with dark contents) can be seen among similar lighter coloured cells throughout the xylem. × 48.

FIG. 3—Macerated tracheids showing normal bordered pits and ray-crossing pits. × 180.

described in this note also appear to have differentiated under lateral pressure, as they pressed against the outer margin of the resin pockets. They differed from the bark strips prepared by Brown and San, however, in the source and orientation of nutrient flow into them. Whereas nutrients and growth substances could continue to flow basipetally through the strips of bark from the point of attachment at the top to intact bark at the lower end, the nodules could only have been supplied from a "point" source or sources—the wood rays that initiated their development in the first place.

Random group orientation of tracheids probably reflects polarity in relation to the supply lines that had developed spontaneously from this source (cf. reorientation of fusiform initials with change in direction of nutrient flow (Harris, 1969; 1973). Radial files of tracheids indicate that a vascular cambium had been established and had functioned for some time, though orientation within it was inconsistent.

On the other hand successive phellogen layers (cork cambia) had formed within tissues outside the vascular cambium. As nodules increased in size they pressed against the outer margin of the resin pocket and produced very regular periderm with distinct layers of phelloderm and phellem. However, as neither phellem or phelloderm cells are elongate structures in the way that tracheids are, it should be noted that only their lateral organisation is involved in this statement.

## CONCLUSION

Structural differentiation of nodules in resin pockets of *Pinus ponderosa* indicates that lateral organisation has been induced by lateral pressures, but polarity (in the normal longitudinal direction of the stem) is lacking in the absence of a longitudinal flow pattern for nutrients and growth substances.

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