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Short Note

Presence of a Distinct S_3 Layer in Mild Compression Wood Tracheids of *Pinus radiata*

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Introduction

Compression wood has attracted the attention of wood scientists for a long time because of its importance in relation to tree form, wood processing and the performance of wood products. The chemical composition and anatomical features of severe compression wood cells are well characterized (Timell 1986). However, mild compression wood cells have not been examined in the same detail as the cells of severe compression wood. The available information suggests that mild compression wood cells generally lack intercellular spaces, are slightly rounded to normal in appearance, have few to no cavities in their secondary walls and their outer S_2 wall is more highly lignified than the remaining S_2 wall (Donaldson *et al.* 1999; Singh and Donaldson 1999). With the exception of a few studies (Wardrop and Dadswell 1950; Harris 1977; Yumoto *et al.* 1983; Yoshizawa *et al.* 1985) which have provided some indication of the presence of an S_3 layer in severe compression wood cells, mild compression wood cells, and transitional cells with features similar to mild compression wood cells, it is generally accepted that compression wood cells lack an S_3 layer. Studies on the transition from normal to compression wood (Fujita *et al.* 1979; Yumoto *et al* 1981; Yoshizawa *et al.* 1985) have shown the disappearance of the S_3 layer to be an early sign of this transition. More recent studies employing transmission electron microscopy have provided evidence for the occasional presence of a rudimentary S_3 layer in the mild compression wood (Singh and Donaldson 1999).

There is growing recognition that the S_3 layer, being the innermost layer in the normal wood cell wall and with a microfibrillar orientation nearly perpendicular to that of the S_2 layer, may have an important role to play in strengthening the xylem tissues in standing trees and in minimizing collapse in wood tissues (Booker 1993; Booker and Sell 1998). The S_3 layer is also likely to be an important factor in wood processes involving physical and chemical treatments, as well as in the biodegradation of wood, where this layer forms the initial barrier to the penetration of enzymes (Blanchette *et al.* 1990; Singh and Butcher 1991). This may also be the case for those mild compression wood cells which have much of the physical and structural attributes of normal wood cells, including the presence of an S_3 layer.

It is becoming clear that fast growth and silvicultural practices such as excessive thinning and pruning, may lead to the formation of large amounts of mild compression wood, much of which may go undetected because the cells formed in this type of wood superficially resemble normal wood cells, particularly in their form. However, these cells do differ from normal wood cells in some important characteristics that define compression wood (Donaldson *et al.* 1999; Singh and Donaldson 1999), and therefore need to be examined more closely.

In this communication we provide electron microscopic evidence for the presence of a distinct S_3 layer in mild compression wood tracheids of *Pinus radiata*.

Materials and Methods

The wood panels from which the samples were obtained for electron microscopy came from radiata pine (*Pinus radiata*) trees grown in New Zealand. However, information on the site, tree form, tree height, growth ring *etc.* is not available. Small pieces of the wood were dehydrated in acetone and embedded in Spurr's low viscosity resin (Spurr 1969). Ultrathin sections were cut from a total of 5 blocks from 3 wood panels with an ultramicrotome using a diamond knife. The sections were stained with 1 % $KMnO_4$ (prepared in 0.1 % sodium citrate), to contrast lignin in wood cell walls because of the specificity of this reagent for lignin (Bland *et al.* 1971). Subsequently, sections were examined with JEOL JEM-1010 transmission electron microscope (TEM).

Results and Discussion

It must be noted from the outset that the extreme forms of mild compression wood examined here could not be