

# Structure of Longitudinal Tracheids in Different Tree Heights for *Pinus koraiensis*

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# Structure of Longitudinal Tracheids in Different Tree Heights for *Pinus koraiensis*<sup>\*1</sup>

Sheikh Ali Ahmed<sup>\*2</sup> · Song-Ho Chong<sup>\*3†</sup> · Byung-Su Park<sup>\*4</sup>  
and Kyeong-Soo Kim<sup>\*5</sup>

## ABSTRACT

An investigation was carried out for the annual ring width, longitudinal tracheid diameter and wall thickness in different tree heights for *Pinus koraiensis* Sieb. et. Zucc. The annual ring width increased along with the tree height, however the tracheid diameter and wall thickness decreased with the tree height. Tracheid wall thickness was found the thickest at 2.0m from the above ground samples and it increased gradually from pith to bark. Radial tracheid diameter was found to be larger than that of tangential tracheid diameter in earlywood. But, it was found to be the opposite in latewood. In earlywood, the average values of tracheid wall thickness was found the range of 2.1-3.0 $\mu$ m, whereas, in latewood, it was 2.4-4.2 $\mu$ m.

**Keywords:** *Annual ring width, earlywood and latewood, lignification, longitudinal tracheid diameter, wall thickness.*

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\*1 Received : 2006. 9. 10, This study was supported by the Technology Development Program for Agriculture and Forestry, Ministry of Agriculture and Forestry, Republic of Korea

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## 1. Introduction

Evolution in conifers has produced two distinct and somewhat antagonistic modes of selective pressure on tracheid morphology. Mechanical strength of conifer, which is important in tall trees, is highly correlated with the length of tracheids; longer tracheids provide greater strength. Under the conditions of water stress, however, it has been hypothesized that shorter tracheids, due to their relatively narrower diameter, may be advantageous to conifers because of their greater conductive efficiency due to their resistance to negative xylem pressure potentials (Carlquist 1975). There is a clear evidence for a relationship between the increased mechanical strength and the length of tracheids (Wardrop 1951; Wellwood 1962). Bannan (1965) found such variations were caused by a variety of ecological factors including elevation, relative habitat aridity and wind conditions. Even in the same individual, the tracheid length varies with the age and nature of woody tissue. Woody tissue in young branches is not subject to great requirements of strength, and tracheid length is relatively short in comparison to that of trunk. In this report, the variation of annual ring width, longitudinal tracheid diameter and wall thickness were measured in different heights of *Pinus koraiensis*.

## 2. Materials and Method

### 2-1 Wood species used

An 18-year-old *Pinus koraiensis* Sieb. et Zucc. was used for this experiment. The tree height was 9.5m. Wood samples were collected at breast height from the Kangwon National University Reserve Forest. The collected sample was first marked to identify the butt end from the top end. From the ground to 2.0m, 4.0m and 6.0m above, discs with 2-3cm thickness were made. The samples from bark to pith were made for microscopic observation.

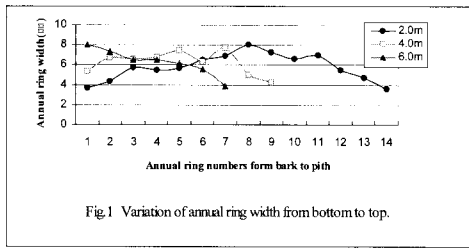
### 2-2 Slide preparation and measurement

Samples in 1cm (length) x 1cm (width) x 1cm (thickness) were made from pith to bark at 2m, 4m and 6m heights. After softening, 15-30 $\mu$ m of cross-sectional samples were made by sliding microtome. Microscopic slides and macerations were made according to standard techniques (Baas and Zhang 1986). The longitudinal tracheid diameter in tangential and radial directions were measured for both early and latewood.

## 3. Results and Discussion

### 3-1 Annual ring width

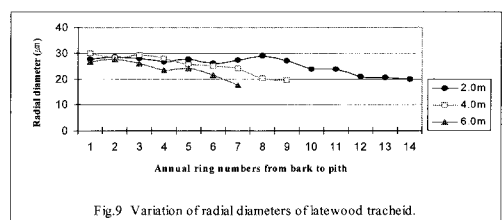
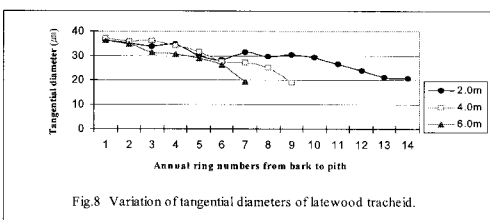
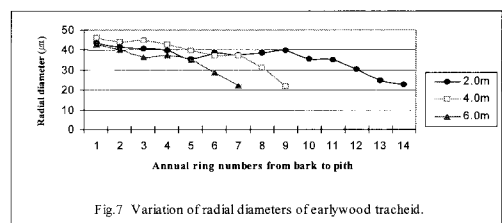
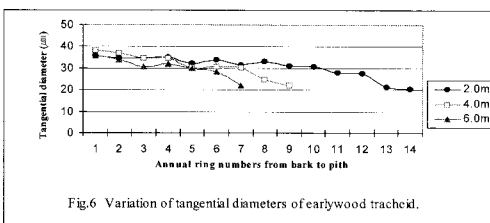
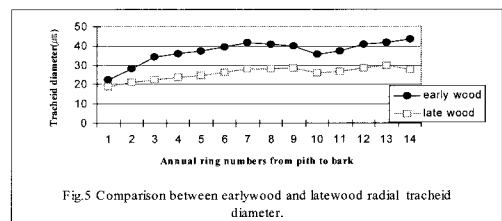
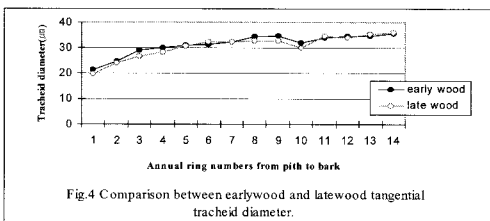
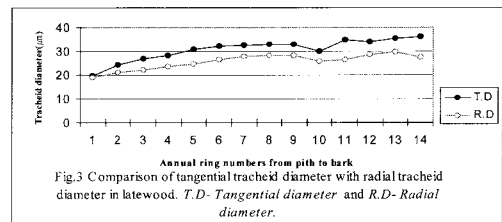
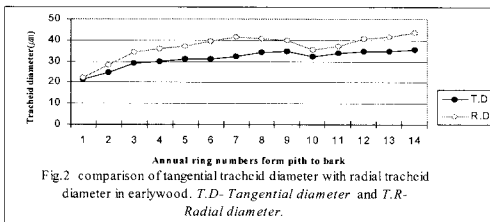
Annual ring width was measured to observe the variation in different plant height from pith to bark showed in Figure 1. From bark to third growth ring, it had tendency to produce clear and wider rings. The frequency of annual rings was found lower with increasing plant height and this result as also supported according to the nutrition theory by Lim (1985).



From pith to 6th or 7th annual rings, the width was reached at maximum and then gradually decreased. Distinct regions between juvenile wood and matured wood were not clearly found in Korean pine.

### 3-2 Tracheid diameter

Radial tracheid diameter was found to be larger than tangential tracheid diameter in earlywood. But, it was found to be the opposite in latewood (Figs. 2 and 3). With an increase of annual ring numbers, the tracheid diameter also increased. Radial tracheid diameter varied considerably from earlywood to latewood due to lignification (Figs. 4 and 5). Tangential and radial diameters of earlywood and latewood tracheids followed the same pattern. With an increase of tree heights, tangential and radial diameters increased from pith to bark (Figs. 6, 7, 8 and 9).



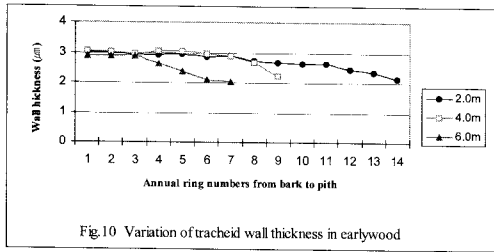


Fig.10 Variation of tracheid wall thickness in earlywood

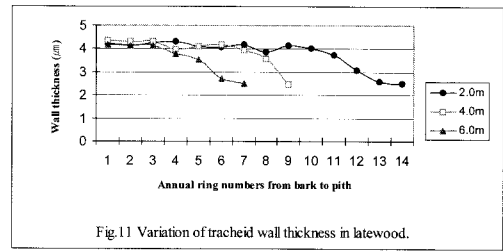


Fig.11 Variation of tracheid wall thickness in latewood.

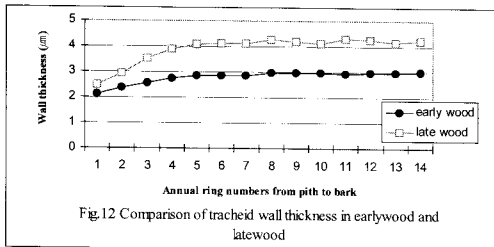


Fig.12 Comparison of tracheid wall thickness in earlywood and latewood

At 2.0m above the ground, the diameter of tracheid was found the largest and it gradually decreased with the increase of the plant heights.

### 3-3 Tracheid wall thickness

Tracheid wall thickness was found the thickest in 2.0m height and it increased gradually from pith to bark (Figs. 10 and 11). Latewood wall thickness was found to be thicker than earlywood tracheid thickness (Fig. 12). This is supposed because of lignification during the latewood growth. From pith to bark, tracheid wall thickness increased gradually. In earlywood, the average range of tracheid wall thickness was 2.1-3.0µm, whereas, in latewood, it was 2.4-4.2µm.

## 4. Conclusion

The anatomical investigation was carried out based on the annual ring width, longitudinal tracheid diameter and wall

thickness in different heights of *Pinus koraiensis*. The taller the height of the tree, the wider the tree annual ring width, tracheid diameter and tracheid wall thickness. Radial tracheid diameter was found to be larger than that of tangential tracheid diameter in earlywood. But, it was the opposite in latewood. With an increase of annual ring numbers, tracheid diameter also increased. Earlywood tracheid diameter was found to be larger than latewood tracheid diameter. Radial tracheid diameter considerably varied from earlywood to latewood due to lignification.

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