

Warty Layer Structure of Bordered Pits in Main Wood Species of Pinaceae Grown in Korea

Sheikh Ali Ahmed · Su Kyoung Chun

Warty Layer Structure of Bordered Pits in Main Wood Species of Pinaceae Grown in Korea^{*1}

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ABSTRACT

An investigation was done to know the warty layer structural difference in bordered pit of longitudinal tracheid in *Pinus densiflora* Sieb. et Zucc., *Pinus koraiensis* Sieb. et Zucc., *Pinus rigida* Mill. and *Larix kaempferi* Carr. grown in Korea. Among the four wood species, warty layer was found in bordered pit of longitudinal tracheid of *Pinus densiflora* Sieb. et Zucc. and *Pinus rigida* Mill. The mean height and horizontal diameter of warty layer was found highest in *Pinus densiflora* Sieb. et Zucc. The height of warty layer was found the highest in juvenile wood of *Pinus densiflora* Sieb. et Zucc. and it gradually decreased towards the matured wood.

keywords: Warty layer, structure, bordered pit, longitudinal tracheid.

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*2 Graduate student, Department of Wood Science & Engineering, College of Forest Sciences, Kangwon National University, Kangwon-do, Chunchon 200-701, Republic of Korea

*3 Professor, Department of Wood Science & Engineering, College of Forest Sciences, Kangwon National University, Kangwon-do, Chunchon 200-701, Republic of Korea

† Corresponding author : Su Kyoung Chun (E-mail: chun@kangwon.ac.kr)

1. Introduction

The ultrastructure of bordered pits in coniferous tracheids, as a modified region of the cell wall organization or as a main route in the movement of liquids within the wood, has attracted considerable attention from many investigators (Imamura and Harada 1973). In terms of wood ultrastructure, the cell wall is built up by several layers, namely the middle lamella (M); the primary wall (P); and the secondary wall (S), which is composed of three layers, designated as the outer (S1), the middle (S2) and the inner (S3) secondary layers; and the warty layer. Warty layer is an isotropic layer of material deposited on the inner surface of the secondary wall of many wood species; this layer frequently contains encysted globules of a dissimilar material; these inclusions produce the warts which lend the name to the layer. The warty structure gradually developed at the external surface to the plasma membrane after secondary wall deposition and a greater part of lignification were completed and warts were synthesized first in the cell corners and pit cavities and then on the remainder of the cell walls (Baird et al. 1974). This study was conducted to observe the warty layer structure in bordered pit of *P. densiflora*, *P. rigida*, *P. koraiensis* and *L. kaempferi* longitudinal tracheids from pith to bark.

2. Materials and Methods

Considered wood species were ① *Pinus koraiensis* Sieb. et Zucc. ② *Pinus densiflora* Sieb. et Zucc. ③ *Pinus rigida* Mill. and ④ *Larix kaempferi* Carr. Wood samples were collected from a tree at breast height in Kangwon National University Reserve Forest. Discs were made immediately after collection, and then kept in air tight cellophane bag to protect moisture loss. Climatic condition of the area of sample collection is shown in Table 1.

(Table 1) Climatic condition in Chunchon
(average of 30 years)

Month	Temperature (°C)	Precipitation (mm)	Relative humidity (%)
April	11.3	78.5	61
May	16.9	93.3	65
June	21.4	139.6	72
July	24.2	331	79
Aug.	24.3	267.4	79
Sept.	18.8	153.6	78
Oct.	12.3	40.1	75
Average	18.46	157.64	72.71

Number of annual rings 27, 26, 35 and 18 ; range of juvenile wood 1-17, 1-14, 1-19 and 1-14; range of matured wood 18-17, 15-16, 20-35 and 15-18; range of heartwood 1-6, 1-6, 1-22 and 1-13; range of sapwood 7-27, 7-26, 23-35 and 14-18 were observed in *P. densiflora*, *P. rigida*, *P. koraiensis* and *L. kaempferi* respectively. For radial surface observation, small blocks were cut from each growth ring including earlywood and latewood of all wood species. In case of tangential surface observation, small blocks were prepared from each growth ring dividing early and late wood separately. Their radial and tangential surfaces were

finished with a microtome and the clean-cut surface was (3x2mm) cut of 1mm thick. They were mounted on FE-SEM specimen stubs using a electrically conducting paste. Samples were dried under vacuum condition and coated with platinum and palladium by using an ion sputter apparatus. At different resolutions and magnifications, samples were examined at 15kV in a Field Emission Scanning Electron Microscope (FE-SEM).

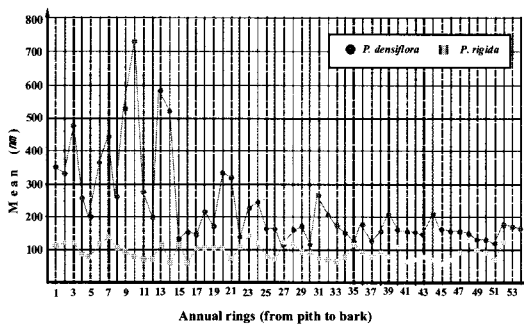
3. Result and Discussion

Table 2 represents the Field Emission Scanning Electron Microscope observation of the warty layer structure in bordered pit chamber of longitudinal tracheid. The height and diameter of warty layer varied from pith to bark,

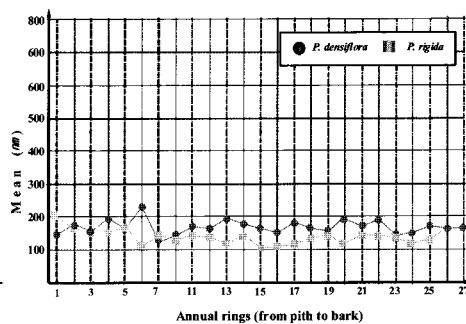
The warty layer is a thin amorphous membrane located in the inner surface of the cell wall in all conifers, containing warty deposits of a still unknown composition (Sjöström 1993). Warty layer structures of different wood species were observed in bordered pits from pith to bark. Among four species, only *P. densiflora* and *P. rigida* have the wart in their bordered pits. The height of warty layer was found higher in *P. densiflora*. In this species the warty layer height fluctuated from pith to bark especially in juvenile wood (Fig. 1). But in *P. rigida*, the height of warty layer was found in same trend from juvenile to matured wood. Mean horizontal diameter also found highest in *P. densiflora* (Fig. 2). From juvenile to matured wood, the mean horizontal diameter fluctuation of warty layers were found almost in same trend for *P. densiflora* and *P. rigida*.

〈Table 2〉 Warty layer height and diameter in bordered pit of four wood species

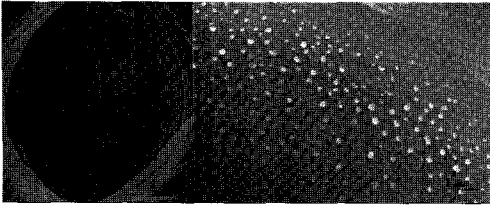
Features	Species			
	<i>P. densiflora</i>	<i>P. rigida</i>	<i>P. koraiensis</i>	<i>L. kaempferi</i>
Height of warty layer (nm)	237.67	95.46	-	-
Horizontal diameter of warty layer (nm)	172.79	139.84	-	-



〈Fig.1〉 Mean height of warty layer observed in tangential section.



〈Fig.2〉 Mean horizontal diameter of warty layer observed in radial section.



(Fig.3) Warty layer in bordered pit of *P. densiflora* (left) and *P. rigida* (right).

Warty layer in bordered pit was not observed in *P. koraiensis* and *L. kaempferi*. The height of warty layer was found highest in the early growth stage of *P. densiflora* and it decreased, gradually in matured wood.

4. Conclusion

In bordered pit of longitudinal tracheid, the mean height of warty layer and horizontal diameter was found the highest in *P. densiflora*. This type of structure was not observed in *P. koraiensis* and *L. kaempferi*. The size of warty layer was found higher in *P. densiflora* than *P. rigida*.

5. References

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