서울 大學校 樹木園 硏究報告 19: 66-73(1999)
Bull. of Seoul Nat'l Univ. Arboretum 19: 66-73(1999)

Resin Canal and Ray Structure of Hard Pine Wood Grown in Korea

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韓國産 硬松材의 樹脂溝와 放射組織 構造

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요 약

本 硏究는 韓國産 硬松材의 樹脂溝와 放射組織의 構造 特徵을 糾明 檢討하기 위하여 着手하였다. 赤松과 黑松이 시험재로 選定 및 벌채되었고 이들 木材試料의 관찰을 위해 마이크로톰 切削과 영구 슬라이드가 作製되었다. 樹脂溝와 放射構造의 특징이 光學顯微鏡으로 관찰되었다. 赤松材에서 水平樹脂溝가 薄膜細胞를 통과하여 樹脂溝로 정확하게 가로질러 관통한 것으로 추정되는 垂直樹脂溝의 水平孔溝가 발견되었다. 그러나 黑松材에서는 이와 같은 특징을 觀察할 수 없었다. 한국산 硬松材는 鋸齒狀肥厚를 뚜렷하게 나타났으며 交分野壁孔은 1개의 大形 또는 1~2개의 窓狀型 壁孔을 나타내었다. 그러나 層階狀 放射組織은 적송재에서 挿入型과 上·下型이 함께 나타났으나 黑松材에서는 上·下型 層階狀 放射組織만을 나타났다. 1개의 水平樹脂溝를 갖는 放射組織은 赤松材에서 때때로 단열방사조직과 연결하여 連續放射組織型의 傾向을 나타내었다. 반면에 黑松材는 1~2개의 소형 水平樹脂溝와 薄膜柔細胞를 가지는 大形 放錘型 放射組織을 드물게 觀察할 수 있었다. 그러나 赤松材에서는 이와 같은 特徵을 觀察할 수 없었다.

Introduction

Resin canals appeared in pine wood among softwoods are in common as in the Korean larch, spruce and fir trees. There are two kinds of normal resin canal.

That is, The one is longitudinal (vertical) canal easily found in summer wood with naked eye on cross and the other is horizontal resin canal within fusiform ray on tangential surface. They are surrounded by the thin walled longitudinal or epithelial cells.

According to Lee (1997), in the resin canals of pine wood the size of normal longitudinal resin canals had been larger than that of horizontal canal found within fusiform ray on tangential surface. Although, normal resin canal does not have any special features for identification among the pine wood species except presence/absence and size difference in some genera of conifers, it has the unique wall thickness of epithelial cells around normal resin canal.

On the contrary, the rays composed by ray parenchyma cells and ray tracheids in pine wood are distinctive. The ray structures (ray tracheids dentation, storied ray tracheids, ray cross field pitting and other ray constructions) are useful for identification of the woods of conifers. Therefore, resin canals and ray structures should be examined to find new characters for wood identification.

This study was to observe and examine the new features of normal resin canal with epithelial cells and ray structure of Japanese red pine (*Pinus densiflora* Seib. et Zucc.) and Japanese black pine (*P. thunbergii* Parl.).

Materials and Methods

Each two individuals of Japanese red pine and Japanese black pine from the College Experiment Forests, College of Agriculture and Life Sciences, Seoul National University at Kwangyang, Chollanam-do, Korea, were cut and prepared for the materials as Table 1.

Table 1. Sample trees of planted Japanese red pine and Japanese black pine.

Common name	Scientifical name	Tree age (sample tree)	Annual ring density	Air specific gravity
Japanese red pine	*P. densiflora* Sieb. et Zucc.	47(2)	10.08/2.54cm	0.53
Japanese black pine	*P. thunbergii Parl.*	46(2)	6.06/2.54cm	0.57

Small pieces of one cubic centimeter size for microtome sectioning were prepared and five blocks per individual of trees were used for exact cross, radial and tangential surfaces.

Sectioning materials were given boiling treatment in equal solution of glycerine and distilled water to soften their hard tissues. Hard materials were treated six to eight hours and four to six hours for soft materials. Sectioning of materials was performed by Spencer Sliding Microtome in relatively thick 20 to 30 ㎛ in cross, 15 to 20㎛ in radial and tangential sections. These sliced sections were stained by safrannin solution, dehydrated with treating 50 percent to absolute alcohol and finally cleared by chemically pure and anhydrous xylol. After clarification, the preparations were mounted in Canada balsam on the slide glass.

From the prepared sectioning slides, longitudinal and horizontal resin canals and their surrounding epithelial cells were observed and measured, and the ray structures (ray parenchyma cell, ray cross field pitting, ray tracheids dentation and storied ray tracheids) were observed using light microscope.

Results and Discussion

Longitudinal and horizontal resin canals of Japanese red pine were observed. They were encircled by thin walled epithelial cells. The longitudinal canal were found in summer wood zone within an annual ring. Their diameter size was 59~176㎛ in radial and 41~147㎛ in tangential section. A horizontal resin canal with cells, however, was in fusiform ray and much smaller than longitudinal canal.

At the same time, the longitudinal and horizontal resin canals were observable in Japanese black pine as were in Japanese red pine. The longitudinal canal were found in summerwood zone within an annual ring. Their diameter size was 53~153㎛ in radial and 76~171㎛ in tangential. A horizontal resin canal with epithelial cells, however, was within fusiform ray, and much smaller than that of longitudinal canal.

Based on the above observations and measured results, the longitudinal and horizontal resin canals between Japanese red pine and Japanese black pine were not different from each other. However, we found the horizontal opening canal within a longitudinal resin canal(Plate 1, C or D) on tangential surface from Japanese red pine. It is assumed that the horizontal canal was crossed correctly

through epithelial cells into longitudinal canal. But on tangential surface, it was not possible to observe them in Japanese black pine, though a little variation of canal in were found.

For this opening horizontal canal within longitudinal resin canal of Japanese red pine, we named the feature as "horizontal opening canal to longitudinal resin canal".

From the studies of Kukachka(1962), Chung, et. al.(1992), Panshin and Zeeuw(1980), ray tracheids dentation, ray cross field pitting and storied ray tracheids of ray structures were described as the important identification features of coniferous woods. Likewise, these features of Japanese red pine and Japanese black pine are described here.

It was reported that the ray tracheids dentation forming above and below or central parts of ray structure on radial surface had been clearly appeared in hard pines. In this study, Japanese red pine was shown the clear dentation of ray tracheids above and below or central parts of ray structure (Plate Ⅰ, A) while Japanese black pine was shown only above and below parts of ray structure (Plate Ⅱ, A). Accordingly, the ray tracheids dentation was shown the same result in Korean hard pine though the difference was shown in appearing position, as described in the hard pine of the above reported papers and a textbook.

The pitting types occurring in ray cross field are well known features in softwood identification (Phillips 1941, Panshin and Zeeuw 1980). At this study, the window-like pit(Plate Ⅰ, A or Plate Ⅱ, A) in the cross field of ray parenchyma in both Japanese red pine and Japanese black pine were shown in the same one large or 1~2, though the shapes of pitting of these species were shown slight difference. The difference between these two species was practically not distinctive because they were same type of window-like pit.

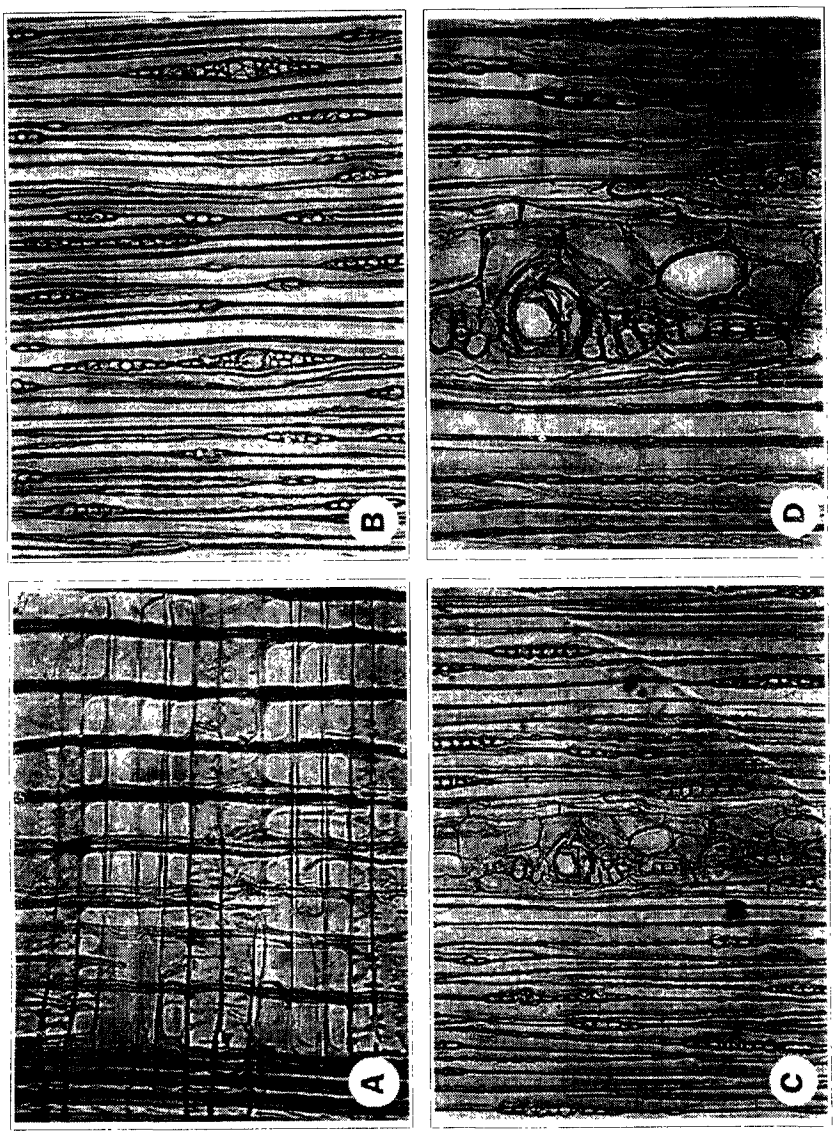

Plate I. Microscopical features of Japanese red pine (*Pinus densiflora* Sieb. et Zucc.) showing A: window-like pit of ray cross field(×400), B: connecting tendency with uniseriate and fusiform ray(×200), C(×200) or D(×400): horizontal opening canals to longitudinal resin canals.

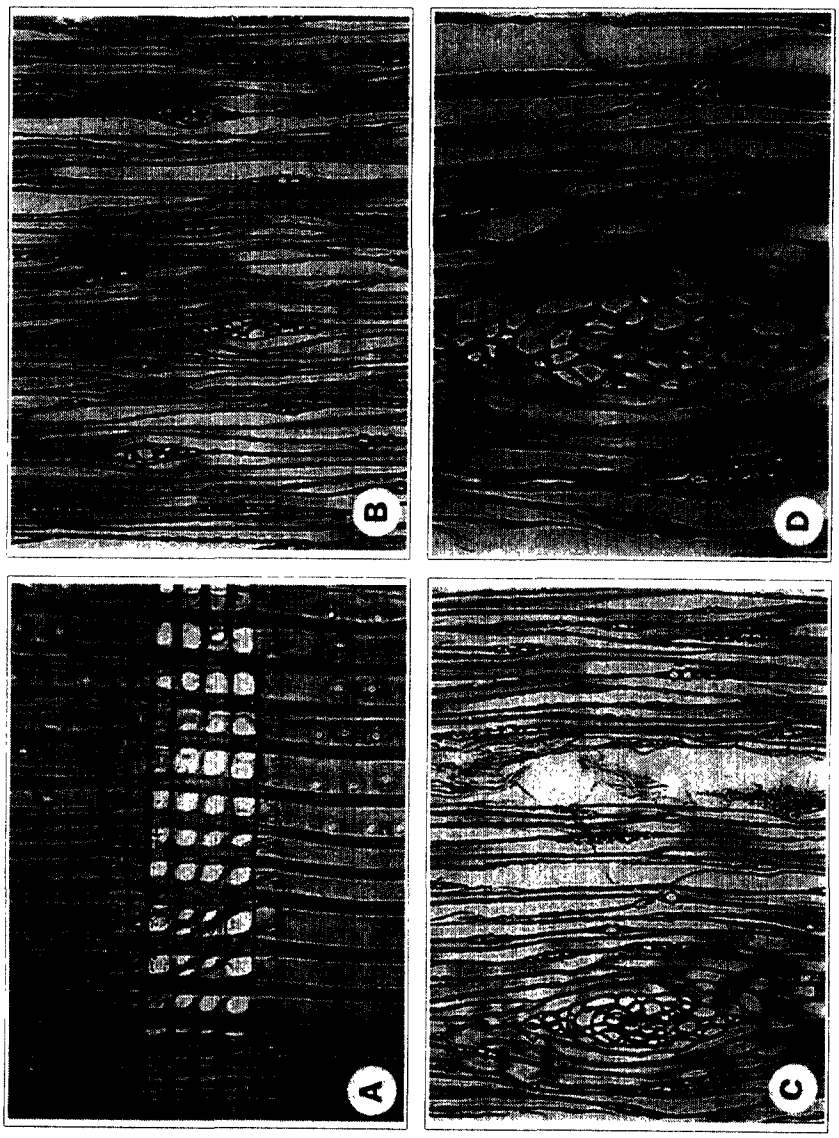

Plate Ⅱ. Microscopical features of Japanese black pine (*Pinus thunbergii* Parl.) showing A: window-like pit of ray cross field(×400), B: thickened fusiform ray(×200), C(×200) or D(×400): large fusiformed ray.

There are two types of storied ray tracheids. The one is the marginal type and the other is the interspersed with marginal storied ray tracheids. These arranged features of ray tracheids structure were shown the marginal (Plate Ⅱ, A) only in Japanese black pine but the interspersed together with marginal type (Plate Ⅰ, A) in Japanese red pine. These are the only different features between Japanese red pine and Japanese black pine.

Uniseriate and fusiform rays of Japanese red pine (Plate Ⅰ, B) and Japanese black pine (Plate Ⅱ, B) were evenly scattered in the tangential section. Comparing with the shapes of these two species, the difference in uniseriate rays was not appeared except slight difference in measured height and connected rays (uniseriate and fusiform ray). Also the others were not different in normal fusiform rays. Each of fusiform rays shared with one horizontal canal in center position. It was found from this study that the fusiform rays in Japanese red pine showed sometimes the tendency of connecting ray form (Plate Ⅰ, B) unlike the ray of Japanese black pine. However, large fusiform ray (Plate Ⅱ, C or D) in Japanese black pine, which had contained one or two small horizontal canals with epithelial cells, was appeared occasionally.

Summary

This study was executed to trace the features of resin canal and ray structure of hard pine wood grown in Korea. Japanese red pine and Japanese black pine were selected and observed. The structures of resin canal and ray were examined under light microscope level. In woods of Japanese red pine, it was found the horizontal opening canal to longitudinal resin canal, which are assumed the horizontal canal crossed correctly through passed epithelial cells into longitudinal canal on tangential surface, but it was not observed in Japanese black pine. Korean hard pines including Japanese red and Japanese black pine were shown clear ray tracheids dentation and 1 large or 1~2 window-like pit of ray cross field. But storied ray tracheids were shown marginal with interspersed type in Japanese red pine and marginal only in Japanese black pine. Fusiform rays contained a horizontal canal in Japanese red pine were shown sometimes the tendency of connected ray form connecting with uniseriate ray. On the contrary, large fusiformed ray which may be seen to contain one or two small horizontal canals with epithelial cells, was able to observe rarely in Japanese black pine.

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