목재공학 12(4):47~52. 1984(原著)
Wood Sci. & Tech. 12(4):47~52.(1984)

Scanning Electron Microscopical Study on the Compression Wood and Opposite Wood formed in Branch of *Juniperus virginiana* L.[1]

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연필향나무 枝材에 形成된 壓縮異常材 및 對應材에 관한 走査電子顯微鏡的 研究[1]

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要 約

本 研究는 연필향나무(*Juniperus virginiana* L.) 枝材내에 形成된 壓縮異常材(compression wood) 및 對應材(opposite wood)에 관한 走査電子顯微鏡的인 特性을 比較하기 위하여 遂行되었는데 그 結果는 다음과 같다.

1. 壓縮異常材의 假導管 移行은 年輪의 境界部를 제외하고는 漸進的이나 對應材의 假導管 移行은 急進的이다. 그리고 對應材에 있어서 秋材率은 變異가 심하며 秋材 假導管의 排列은 不均一하다.

2. 壓縮異常材 및 對應材의 假導管은 그 橫斷面의 模樣이 각각 둥근형 및 모난형이다. 그리고 壓縮異常材와 對應材 모두에서는 큰 假導管과 작은 假導管이 混在되어 있으나 螺線狀의 째짐이 假導管의 膜에 存在하지 않으며 細胞間隙은 境界部를 지니는 경우가 있는데 壓縮異常材에만 存在한다.

3. 分野膜孔에 있어서 壓縮異常材의 膜孔口는 對應材의 것보다 假導管측의 膜孔緣이 더 넓기 때문에 더 좁으며 傾斜가 급한 楕圓形을 나타낸다.

Introduction

The inclined stem and branch of gymnosperms generally form compression wood and opposite wood through growth eccentricity. As a rule, compression wood in under part and opposite wood in upper part when viewed on cross surface are related to the increased and decreased xylem production caused by the respective surplus and deficit of auxin which is one kind of hormonal growth regulators redistributed by the action of gravity (Yamaguchi, Shimaji, and Itoh. 1983).[17]

Compression wood is present in members of Ginkgoales, Coniferales, and Taxales but not present in Cycadales and Gnetales among gymnosperms (Timell. 1978)[12], and present even in primitive angiosperms such as many species of *Buxus* whose wood contain both tracheids and vessels (Timell. 1981, Onaka. 1949)[4,13]

Therefore, it is natural that these compression wood and opposite wood have attracted many wood anatomists' interestings but most studies have been concentrated on compression wood. Wardrop and Dadswell (1950)[10], Shelbourne and Ritchie (1968)[9], McGinnes and Phelps (1972)[3], Côté

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(1977)[1], Timell (1978, 1982, 1983),[11,14,15] and others provided informations on the features of compression wood and on the other hand, opposite wood was studied by Timell (1973)[10] and Park (1983, 1984).[6,7,8]

This paper purposes to compare the anatomical features between selected compression wood and opposite wood formed in branch of *Juniperus virginiana* L. with scanning electron microscope.

Material and method

Compression wood and opposite wood were obtained from the first branch above ground of *Juniperus virginiana* L. that grows on flat land in campus of Agricultural College, Seoul National University, Suwon, in other words compression wood and opposite wood were collected from the under part and upper part of the branch as ca. 5 x 5 x 5 cubic milimeters sized regular hexadrons respectively (Fig. 1).

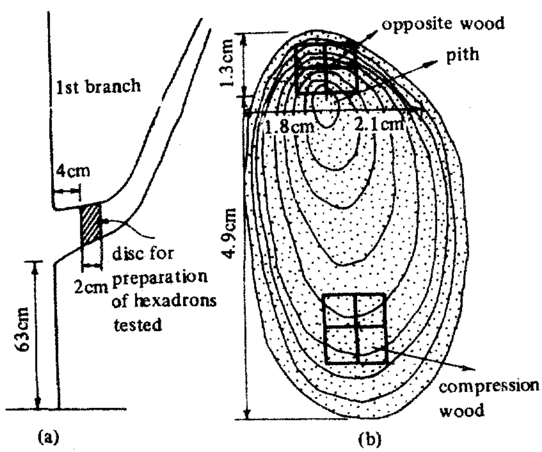


Fig. 1. Diagrammatic pictures on the branch cutted (a), and composite wood and opposite wood hexadrons tested (b).

After the hexadrons were removed from the branch, they were immediately microtomed to sections about 80 μm thick of radial and cross surface. The sections obtained were dehydrated in 30, 40, 50, and 60% ethyl alcohol for 30 minutes respectively and reserved in 70% ethyl alcohol until they were prepared for viewing with scanning electron microscope.

Prior to monting for observations, these sections were dehydrated further in 80, 90%, absolute ethyl alcohol, and absolute isoamyl acetate for 20 minute respectively and then dried in critical point drier. The dried sections were mounted on copper stubs, 1 centimeter in diameter and height, with two face vinyl tape and then coated with a layer of gold 200 Å thick to prevent primary reflected electrons containing high energy in FINE COAT ION SPUTTER JFC — 1100, and finally examined with JSM — T300 scanning electron microscope on tracheid transition through annual ring, intercellular space, spiral check, and cross-field pit of compression wood and opposite wood at 15 kv in Cancer Laboratory, Seoul National University, Seoul.

Result and discussion

On branch wood of pitch pine (*Pinus rigida* Miller) in gymnosperms, Lee (1972)[2] dealt with tracheid length, width, and thickness without distinction between compression wood and opposite wood through photomicroscopical method and concluded that the length and width of branch wood tracheid were smaller than those of stem wood (Fig. 2 and Fig. 3). Thereafter Park, Saiki,

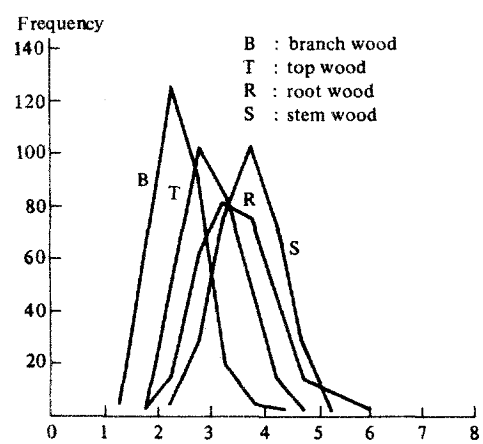


Fig. 2. Length distribution curves of tracheids in *Pinus rigida* Miller.[2]

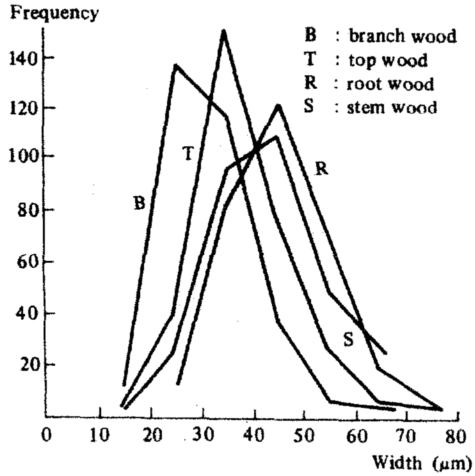
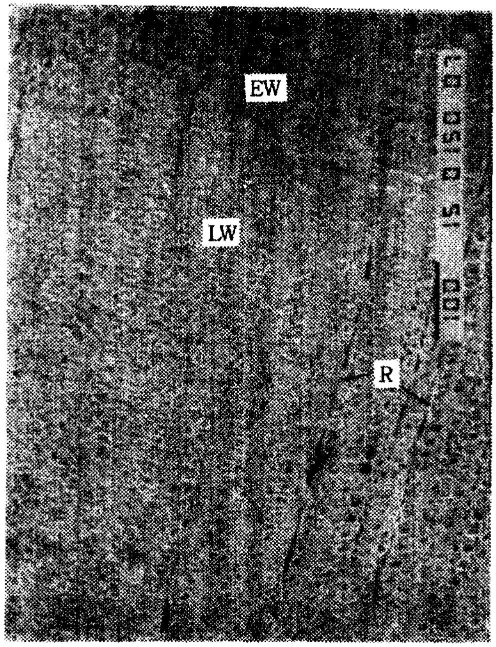


Fig. 3. Width distribution curves of tracheids in *Pinus rigida* Miller.[2]

and Harada (1979)[5] also reported the same result in red pine (*Pinus densiflora* S. et Z.) as Lee's in tracheid dimensions.

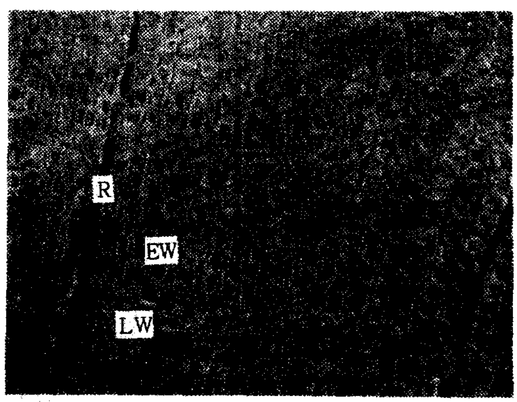
As a study on branch wood of gymnosperms in this experiment, compression wood and opposite wood were selected and treated artificially. By the observation, the tracheid transition in compression wood is gradual through annual ring but slightly abrupt in the vicinity of annual ring boundary, and transition in opposite wood is abrupt through annual ring on cross surface (Fig. 4 and Fig. 5). This transition in compression wood is similar somewhat to Timell's report (1978, 1981, 1983).[12,13,15] On the other hand, in opposite wood the percentage of latewood is variable as shown by Timell (1973)[10] and the arrangement of latewood tracheid is quite heterogeneous (Fig. 5).

The outline of tracheid in compression wood is somewhat round but in opposite wood is angular and both the compression wood and opposite wood are composed of large and small tracheids. Although intercellular spaces are present in compression wood only, spiral checks in cell wall are not present in both the compression wood and opposite wood (Fig. 6 and Fig. 7). The facts that intercellular spaces are present and spiral checks are not present in compression wood are identical with McGinnes and Phelps' report (1972)[3] but the fact that



LW : latewood EW : earlywood R : ray

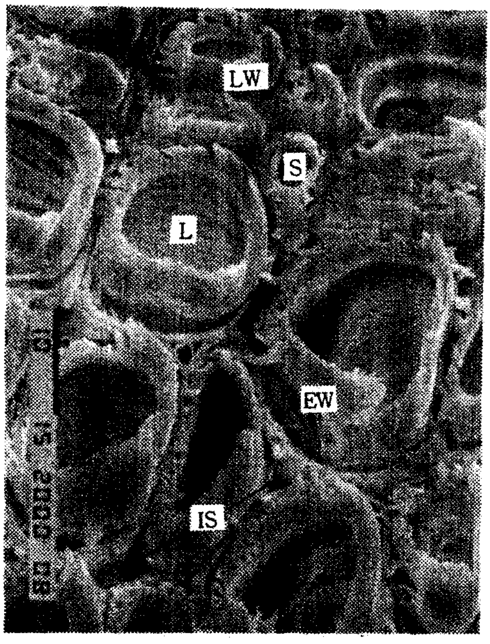
Fig. 4. Transverse surface of compression wood. Scanning electron micrograph (scale bar 100μm)



EW : earlywood LW : latewood R : ray

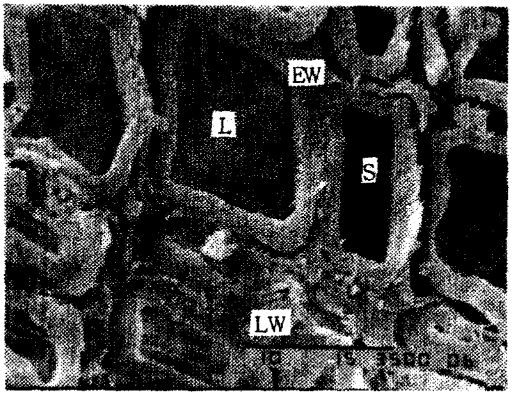
Fig. 5. Transverse surface of opposite wood. Scanning electron micrograph (scale bar 100μm)

tracheids of compression wood have round outline is not identical with their observation of having angular outline. But the spiral checks, as a rule, are present in compression wood of *Picea rubens*, *Taxus baccata*, *Ginkgo biloba*, *Larix laricina*, and *Psuedotsuga menziesii* according to Côté



L : large tracheid EW : earlywood
S : small tracheid LW : latewood
IS : intercellular space

Fig. 6. Transverse surface of compression wood, showing border on intercellular space (arrow). Scanning electron micrograph (scale bar 10μm)

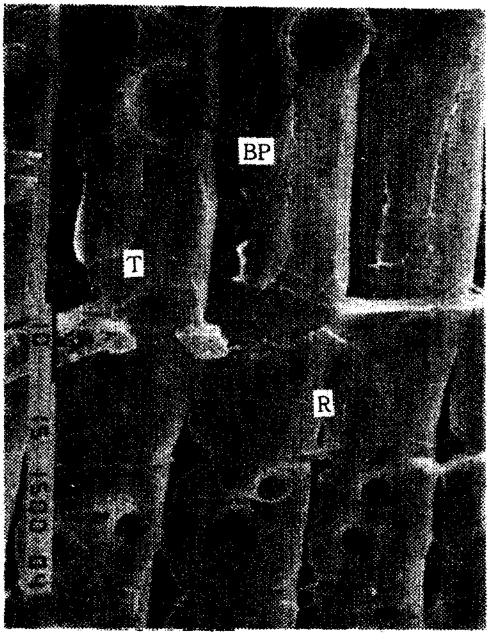


L : large tracheid
S : small tracheid
EW : earlywood
LW : latewood

Fig. 7. Transverse surface of compression wood. Scanning electron micrograph (scale bar 10μm)

T : tracheid R : ray

Fig. 8. Radial surface of compression wood, showing cross-field pit. Scanning electron micrograph (scale bar 10μm)



BP : bordered pit on radial wall of tracheid
T : tracheid R : ray

Fig. 9. Radial surface of opposite wood, showing cross-field pit. Scanning electron micrograph (scale bar 10μm)

(1977)[1] and Timell (1978, 1981, 1983)[11,12,13,15] As shown in *Juniperus virginiana* by McGinnes and Phelps(1972),[3] the intercellular spaces are present in compression wood and occasionally contain border (Fig. 6).

In radial surface, the common wall area between ray parenchyma cell and longitudinal tracheid is called cross-field and the pit in this area is most important in wood identification. By the observation, the cross-field pit aperture is included in both compression wood and opposite wood but the aperture in compression wood is narrower and steeper elliptical than that in opposite wood because the border on tracheid side in compression wood is wider than that in opposite wood (Fig. 8 and Fig. 9).

Conclusion

This study was executed to compare scanning electron microscopical features between compression wood and opposite wood formed in branch of *Juniperus virginiana* L. and the results obtained were as follows:

1. The tracheid transition in compression wood is gradual through annual ring but slightly abrupt in the vicinity of annual ring boundary and transition in opposite wood is abrupt through annual ring. The percentage of latewood is variable and the arrangement of latewood tracheid is heterogeneous in opposite wood.

2. The outline of tracheids is somewhat round and angular in compression wood and opposite wood respectively. The large and small tracheids are present but spiral checks in cell wall are not present in both compression wood and opposite wood, and only compression wood has intercellular spaces, which occasionally contain border.

3. In cross-field pit, the pit aperture in compression wood is narrower and steeper elliptical than that in opposite wood because the border on tracheid side in compression wood is wider than that in opposite wood.

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