韓國林學會誌 84(4) : 432 - 436. 1995
Jour. Korean For. Soc. 84(4) : 432 - 436. 1995

Perforated Ray Cells in Korean Rosaceae[1]

Young Geun Eom[2] and Youn Jib Chung[3]

韓國産 장미科 闊葉樹材의 穿孔을 지니는 放射組織 細胞[1]

嚴永根[2] · 鄭然楫[3]

ABSTRACT

Perforated ray cells are recorded for the first time in the Korean hardwoods of *Rosa multiflora*, *Rosa multiflora* var. *platyphylla*, *Rosa rugosa*, *Spiraea cantoniensis*, and *Stephanandra incisa* belonging to the family Rosaceae. The perforated ray cells have simple perforations, which are identical with the types of perforation plates in the vessel elements of same wood.

Key words: perforated ray cells, Rosa, Spiraea, Stephanandra, Korean Rosaceae.

要 約

本 硏究는 國産 장미科의 찔레꽃, 덩굴장미, 해당화, 공조팝나무 및 국수나무에 있어서 木部 放射組織내에 穿孔을 지니는 放射組織 構成細胞가 存在함을 처음으로 報告하는 것으로 이들 放射組織 細胞의 穿孔은 導管要素에 發達하는 穿孔과 同一하게 單一穿孔을 지니는 것으로 밝혀졌다.

INTRODUCTION

Perforated ray cells are ray cells of the same dimensions or larger than the adjacent cells but with perforations, which generally are on the side of walls connecting two vessels on either side of the ray, and bordered pits on lateral walls similar to the intervessel pits (Bottoso & Gomes, 1982; Carlquist, 1988; IAWA Committee, 1989; Otegui, 1994). However, their pit size may be reduced compared to that in typical vessel elements, and their perforation type may not be necessarily coincident with the type of perforation plate occurring in the vessel elements of the same woods (Rao *et al.*, 1984; IAWA Committee, 1989).

These unusual ray cells with perforations, which were referred to as perforated ray cells (Chalk & Chattaway, 1933) and as vascular ray cells (McLean & Richardson, 1973), may occur either individually or in radial or tangential rows. Especially, radial rows of perforated ray cells with perforations in tangential walls have been described as radial vessels (van Vliet, 1976; IAWA Committee, 1989).

Chalk and Chattaway (1933) recorded for the first time the occurrence of perforated ray cells in a number of families. Subsequently, many workers (Carlquist, 1960, 1982, 1983, 1989; Stern, 1967; Koek-Noorman, 1970, 1972; McLean & Richardson, 1973; Koek-Noorman & Hogeweg, 1974; Miller, 1975; Nazma *et al.*, 1981; Bottoso

[1] 接受 1995年 7月 5日 Received on July 5, 1995.
[2] 國民大學校 森林科學大學 林産工學科 Department of Forest Products, College of Forest Science, Kookmin University, Seoul 136-702, Korea.
[3] 國民大學校 山林科學硏究所 Institute of Forest Science, Kookmin University, Seoul 136-702, Korea.

& Gomes, 1982; Carlquist *et al.*, 1983; Teixeira, 1983; Dayal *et al.*, 1984; Rao *et al.*, 1984; Rudall, 1985; Baas *et al.*, 1988; Zhang & Baas, 1992; Norverto, 1993; Eom and Chung, 1993; Eom, 1994; Otegui, 1994; Nagai *et al.*, 1994) have reported this feature occurring in the rays of hardwoods. However, there have been apparently little or no previous records of perforated ray cells in the woods of Rosaceae.

This paper reports the occurrence of perforated ray cells and their perforation types in the xylem of Korean hardwood species belonging to Rosaceae.

MATERIALS AND METHODS

The 43 Korean hardwood species from genus *Amelanchier*, *Chaenomeles*, *Crataegus*, *Eriobotrya*, *Malus*, *Photinia*, *Physocarpus*, *Pourthiaea*, *Prinsepia*, *Prunus*, *Pyracantha*, *Pyrus*, *Raphiolepsis*, *Rhodotypos*, *Rosa*, *Sorbaria*, *Sorbus*, *Spiraea*, and *Stephanandra* under Rosaceae were investigated in the present study.

Wood samples were obtained from the collections in Wood Anatomy and Physics Laboratory, Department of Forest Products, Kookmin University, Seoul and were also collected in Mt. Chiri located in the southern part of the Korean Peninsula. Their subdivided blocks of *ca.* 1 cm^3 size were softened in water in an autoclave and immediately stored in a mixture of equal volumes of glycerine, ethyl alcohol, and water till sectioning (Berlyn & Miksche, 1976). From these blocks, transverse, radial, and tangential sections of 20 to 30 μm thickness were cut with a sliding microtome and permanent slides were prepared following general laboratory techniques (Japan Wood Research Society, 1985). The observation and photomicrography of perforated ray cells were made in the radial and tangential sections by the aid of an Axioskop routine microscope with the attachment camera, Carl Zeiss, Germany.

RESULTS

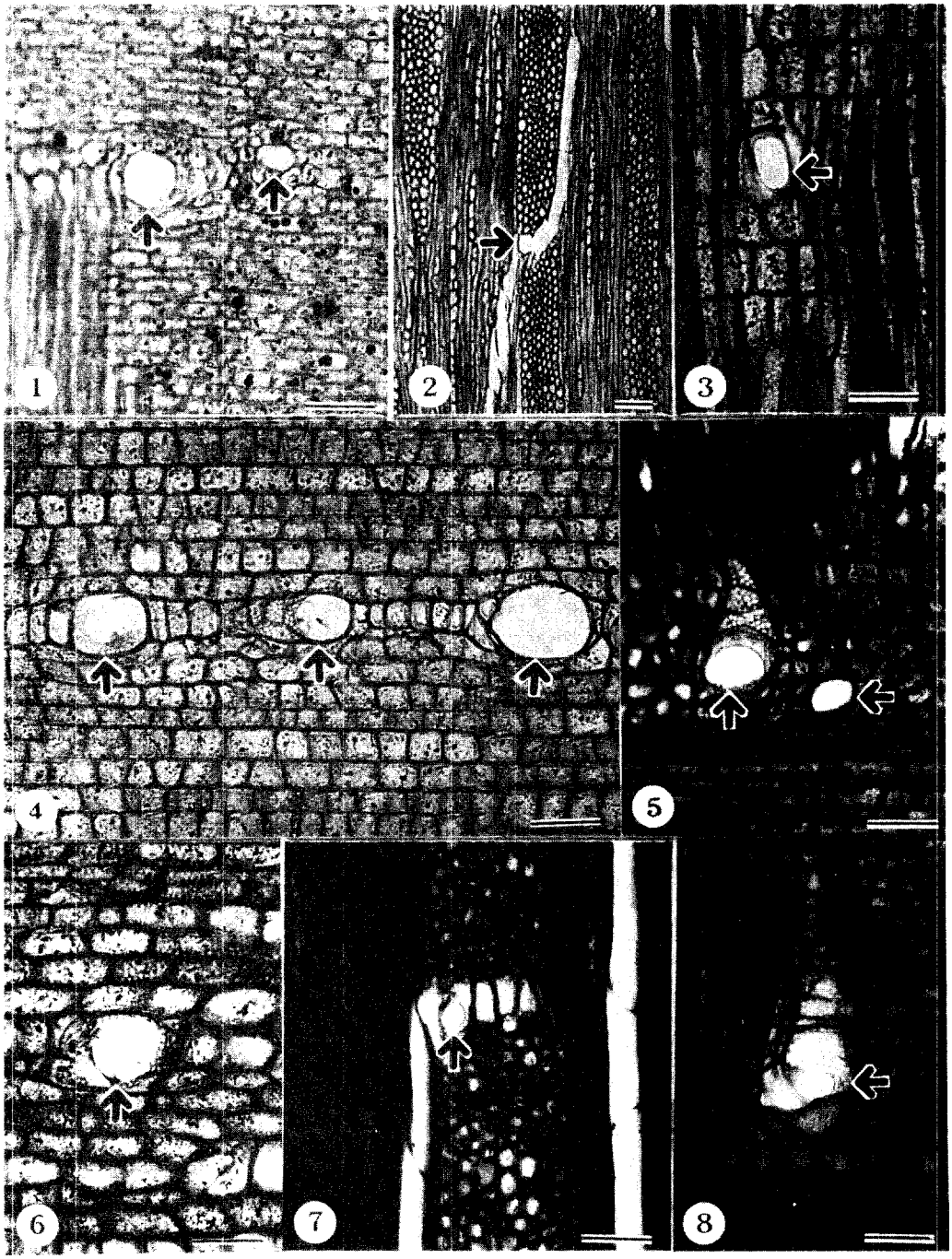
In present study, the unusual ray cells with perforation, which are the secondary xylem cells derived from ray initials but with perforation plates and lateral wall pitting like those of vessel elements, are identified in 5 species out of 43 species in the Korean Rosaceae (Table 1). Only simple perforation plates are observed in perforated ray cells of *Rosa multiflora*, *Rosa multiflora* var. *platyphylla*, *Rosa rugosa*, *Spiraea cantoniensis*, and *Stephanandra incisa* (Figs. 1-8), which coincide with the types of perforation plates in the vessel elements of same species. And the perforated ray cells are observed only in the multiseriate parts of rays (Figs. 2 & 7) and are generally much larger than the surrounding ray cells (Figs. 1-8). These ray cells with perforation usually have perforation plates in their radial walls (Figs. 1, 3-6 & 8), but their perforations are also found in the tangential walls. And ray splitting of larger rays into smaller ones is correlated with the development of perforated ray cells (Figs. 2 & 7).

Table 1. Types of perforations in vessel elements and perforated ray cells in the xylem of Korean Rosaceae.

Species	Vessel element	Perforated ray cell
Rosa multiflora Thunb.	simple	simple
Rosa multiflora var. *platyphylla* Thory	simple	simple
Rosa rugosa Thunb.	simple	simple
Spiraea cantoniensis Lour.	simple	simple
Stephanandra incisa Zabel	simple	simple

DISCUSSION

In the Korean Rosaceae, the perforated ray cells have simple perforations, which are identical with the types of perforation plates in the vessel elements of same wood. This is in agreement with the reports by Nazma *et al.* (1981), Dayal *et al.* (1984), Rudall (1985), Eom and Chung (1993), and Eom (1994). The fact, however, that the perforation type in a perforated ray cell does not necessarily coincide with the type of perforation occurring in the vessel element of the same wood was noted by Teixeira (1983), Rao *et al.* (1984), IAWA Committee (1989), and Otegui (1994). Recently, Nagai *et al.* (1994) reported that the perforation plates in the perforated ray



Figs. 1-8. Perforated ray cells with simple perforation (arrow). 1 & 2: *Spiraea cantoniensis* Lour.-3 & 4: *Stephanandra incisa* Zabel.-5: *Rosa multiflora* Thunb.-6: *Rosa multiflora* var. *platyphylla* Thory.-7 & 8: *Rosa rugosa* Thunb.-1, 3-6 & 8: radial surface.-2 & 7: tangential surface. Scale bars=50 um.

cells were mostly dimorphic with the total area of the openings smaller than the perforation plates in vessel element ends.

In present study, the ray cells having perfora-

tion are generally much larger than the surrounding ray cells and observed only in the multiseriate parts of rays. And they usually have perforation plates in their radial walls and ray splitting is correlated with the development of perforated ray cells. These ray cells with perforation were known to be of the same dimensions or larger than the adjacent cells (IAWA Committee, 1989; Eom and Chung, 1993; Eom, 1994; Nagai *et al.*, 1994) and those observed so far have been mostly confined to the uniseriate extensions of long rays and/or exclusively to uniseriate rays (Carlquist, 1960; Stern, 1967; Koek-Noorman, 1970, 1972; Koek-Noorman & Hogeweg, 1974; Nazma *et al.*, 1981; Norverto, 1993; Nagai *et al.*, 1994), but their occurrence only in the multiseriate parts of rays was also confirmed in a few genera (Chalk & Chattaway, 1933; Botosso & Gomes, 1982; Dayal *et al.*, 1984; Rao *et al.*, 1984; Eom, 1994). Thus, perforated ray cells may not be confined only to the uniseriate extensions of multiseriate rays and uniseriate rays. The ray cells with perforations in their radial and tangential walls were considered to be of two possibilities in connecting two longitudinal vessel elements in tangential and radial direction (Teixeira, 1983), and these perforated ray cells were believed to connect a vessel on one side of a ray with a vessel on the opposite side of that ray (Botosso & Gomes, 1982; IAWA Committee, 1989). Perforated ray cells seemed sometimes to be found in woods in which breakup of large rays into smaller segments is occurring actively, but there was no reason to believe this to be always or even usually true (Carlquist, 1988; Otegui, 1994).

The diagnostic value of these perforated ray cells has been discussed by several researchers. Dayal *et al.* (1984), Rudall (1985), and IAWA Committee (1989) stated that the presence or absence of perforated ray cells alone could not be of diagnostic value in wood identification due to their spasmodic occurrence. Otegui (1994), however, described that the ray cells with perforation in *Rapanea laetevirens* Mez and *Rapanea lorentziana* Mez of Myrsinaceae had diagnostic value because of their regular development.

LITERATURE CITED

1. Baas, P., P.M. Esser, M.E.T. van der Westen & M. Zandee. 1988. Wood anatomy of the Oleaceae. IAWA Bull. n.s 9: 103-182.
2. Berlyn, G.P. & J.P. Miksche. 1976. Botanical microtechnique and cytochemistry. 1st ed., Iowa State Univ. Press, Iowa.
3. Botosso, P.C. & A.V. Gomes. 1982. Radial vessels and series of perforated ray cells in Annonaceae. IAWA Bull. n.s. 3: 39-44.
4. Carlquist, S. 1960. Wood anatomy of Asteraceae (Compositae). Trop. Woods 133: 54-84.
5. Carlquist, S. 1982. Wood anatomy of Dipsacaceae. Taxon 3: 443-450.
6. Carlquist, S. 1983. Wood anatomy of Calycanthaceae: Ecological and systematic implications. Aliso 10: 427-441.
7. Carlquist, S. 1988. Comparative wood anatomy: Systematic, ecological, and evolutionary aspects of dicotyledon wood. Springer-Verlag, Berlin.
8. Carlquist, S. 1989. Wood and bark anatomy of *Degeneria*. Aliso 12: 485-495.
9. Carlquist, S., V.M. Eckhart & D.C. Michener. 1983. Wood anatomy of Hydrophyllaceae. I. *Eriodictyon*. Aliso 10: 397-412.
10. Chalk, L. & M.M. Chattaway. 1933. Perforated ray cells. Proc. Roy. Soc. London, B 113: 82-92.
11. Dayal, R., R.V. Rao & B. Sharma. 1984. Perforated ray cells in woods of Indian Myrsinaceae and Loganiaceae. IAWA Bull. n.s. 5: 225-228.
12. Eom, Y.G. and Y. J. Chung. 1993. Perforated ray cells in some Korean hardwoods. J. Kor. For. Eng. 13(2): 95-100.
13. Eom, Y.G. 1994. A new record of perforated ray cells in *Platanus orientalis* L. Kor. Wood Sci. and Tech. 22: 40-43.
14. IAWA Committee. 1989. IAWA list of microscopic features for hardwood identification. IAWA Bull. n.s. 10: 219-332.
15. Japan Wood Research Society. 1985. Wood science laboratory book. I. Physics and en-

gineering. Chugai Sangyo Chosakai, Japan.
16. Koek-Noorman, J. 1970. A contribution to the wood anatomy of the Cinchoneae, Coptosapelteae, and Naucleeae (Rubiaceae). Acta Bot. Neerl. 19: 154-164.
17. Koek-Noorman, J. 1972. The wood anatomy of Gardenieae, Ixoreae, and Mussaendeae (Rubiaceae). Acta Bot. Neerl. 21: 301-320.
18. Koek-Noorman, J. & P. Hogeweg. 1974. The wood anatomy of Vanguerieae, Cinchoneae, Condamineae, and Rondeletieae (Rubiaceae). Acta Bot. Neerl. 23: 627-653.
19. McLean, J.D. & P.E. Richardson. 1973. Vascular ray cells in woody stems. Phytomorphology 23: 59-64.
20. Miller, R.B. 1975. Systematic anatomy of the xylem and comments on the relationship of Flacourtiaceae. J. Arn. Arbor. 56: 20-102.
21. Nagai, S., J. Ohtani, K. Fukazawa & J. Wu. 1994. SEM observations on perforated ray cells. IAWA J. 15: 293-300.
22. Nazma, P., B.S. Rao & R.V. Rao. 1981. Occurrence of perforated ray cells in the wood of *Drypetes roxburghii* (Wall.) Hurusawa. IAWA Bull. n.s. 2: 201-203.
23. Norverto, C.A. 1993. Perforated ray cells and primary wall remnants in vessel element perforations of *Symplocos uniflora*. IAWA J. 14: 187-190.
24. Otegui, M. 1994. Occurrence of perforated ray cells and ray splitting in *Rapanea laetevirens* and *R. lorentziana* (Myrsinaceae). IAWA J. 15: 257-263.
25. Rao, R.V., B. Sharma & R. Dayal. 1984. Occurrence of perforated ray cells in Santalaceae. IAWA Bull. n.s. 5: 313-315.
26. Rudall, P.J. 1985. Perforated ray cells in *Hyptis hagei*: A new record for Labiatae. IAWA Bull. n.s. 6: 161-162.
27. Stern, W.L. 1967. *Kleinodendron* and xylem anatomy of Cluytieae (Euphorbiaceae). Amer. J. Bot. 54: 663-676.
28. Teixeira, L.L. 1983. Some unusual features in the wood of *Sloanea lasiocoma* K. Schum. (Elaeocarpaceae) and *Casearia obliqua* Spreng. (Flacourtiaceae). IAWA Bull. n.s. 4: 213-217.
29. Vliet, G.J.C.M. van. 1976. Radial vessels in rays. IAWA Bull. 3: 35-37.
30. Zhang, S.-Y. & P. Baas. 1992. Wood anatomy of trees and shrubs from China. III. Rosaceae. IAWA Bull. n.s. 13: 21-91.