Commun. Fac. Sci. Univ. Ank. Series C
V. 14. pp. 23-31 (1996)

A COMPARATIVE STUDY OF ULTRASTRUCTURE OF RESTING AND ACTIVE CAMBIUM IN *ARMENIACA VULGARIS* Lam.

GÖNÜL ALGAN

Ankara University, Science Faculty, Department of Biology, 06100 Tandoğan, Ankara, TURKEY.

(Received May 7, 1996; Accepted Oct. 7, 1996)

ABSTRACT

Dormant and active cambial cells of *Armeniaca vulgaris* have been studied after glutaraldehyde and osmium tetroxide fixation.

Active cambial zone consists of 5 to 8 rows of newly divided or expanded cells. They have one big central vacuole, less cytoplasmic materials. Rough ER is rich with free and membrane bounded ribozomes. Mitochondria and Golgi apparatus are abundant and very active state. Plastids are seen rarely. Some microflaments were seen in cytoplasm. There are some microtubules near the cell wall.

Dormant cambial zone comprises 1 to 4 layers of cells. Ray initials are bigger than fusiform initials. Fusiform initials generally have one big vacuole, like summer cambium. There are very dense cytoplasm having some stored materials. Protein bodies are abundant in these cells.

INTRODUCTION

It is known that the activity of the vascular cambium is periodic in temperate regions. It is initiated by cell division when the temperature rise in spring. Then, it produces new vascular tissues during the growing season. In autumn, cell division occurs rarely and activity is ceased by the changing of the cells, then it is completely inactive state in winter. These results have been obtained light microscope observations by the several workers. In recent years, some ultrastructural studies have been made on cambial zone.

Comparisons of inactive and active cambial cells have been made in some plants. Murmanis (1971) investigated the structural changes in the vascular cambium of *Pinus strobus* L. during an annual cycle. Barnett

(1973) observed seasonal variations in the ultrastructure of the cambium in New Zeland grown *Pinus radiata* D. Don. The ultrastructure of dormant and active cambium of *Salix fragilis* L. was compared by Robards and Kidwai (1968). Rao and Dave (1983) investigated cytological changes in the ultrastructure of cambial cells of *Tectona grandis* L. f. during active and dormant periods. Itoh (1971) and Tsuda (1975) worked on the ultrastructure of cambium of some conifer species. These works are concerned mostly with the ultrastructural differences between active and inactive cells in forest trees. But, the ultrastructure of cambial cells in fruit trees is meagre. The aim of this study was to observe the structural changes of cambial cells in *Armeniaca vulgaris* so as to determine whether the cytological differences are similar to those in forest trees.

MATERIAL AND METHODS

Samples were taken from one year-old branches of the trees growing in Ankara University's Botanical Garden. Sampling dates for dormant and active cambium were based on light microscope observations. The samples were fixed in 5% glutaraldehyde in 0.1 M phosphate buffer at pH = 7.2 for two hours. Then, they were postfixed in 1% osmium tetraoxide for two hours. The material was washed in buffer, dehydrated in a graded ethanol series and embedded in epon 812. Tranverse and longitudinal sections were cut with glass knives on a Reichert Om U4 - Ultracut. Sections were double stained in a saturated solution of Uranyl acetate in Sato's lead citrate (1967) for ten minutes. Sections studied and photographed using a Jeol 100 CX II electron microscope.

OBSERVATIONS

The general ultrastructure of cambial initials - There are great differences in size between cambial cells. Ray initials are generally bigger than fusiform initials (Fig. 1). The nucleus takes place in central position. It occupies on all the central area between inner and outer tangential walls (Fig. 2).

Cells sometimes have one big vacuole or more than one around the nucleus which is surrounded by cytoplasmic material. Parietal layer of cytoplasm present under the cell walls. The vacuole occupies a high proportion of the volume of fusiform cells. In transverse section, the cambial cells appear mostly to be empty for this reason. This appearance

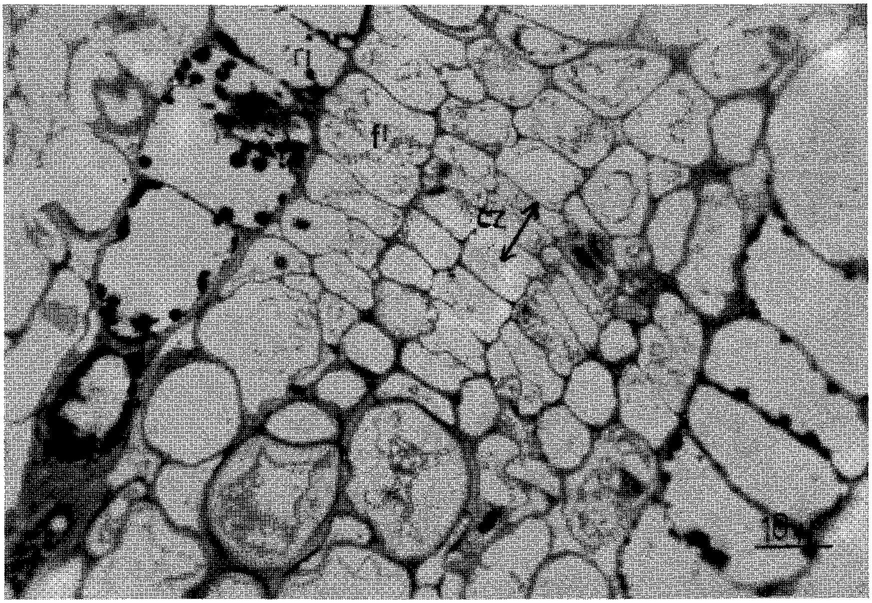

Fig. 1. Ray and fusiform initials in cambial zone. X 1000, ri, ray initials; fi, fusiform initials; cz, cambial zone.

changes when the plane of sections trans in nuclear region or near the cell tip. This time, the cell will be shown to filled out by the cytoplasm and have small vacuoles. Most nuclei contain either a single large nucleolus or two relatively small ones. Fusiform cells generally have less cytoplasm than the ray initials. Xylem and phloem mother cells in cambial zone have more cytoplasmic material than the cambial initials.

Dormant cambium - Dormant cambial zone of *Armeniaca vulgaris* consists of 1 to 4 cambial cell rows (Fig. 3). Thick walled xylem elements are present next to the cambial cells. The radial walls of these cells are generally thicker than their tangential walls, if the cells undergo radial division recently their radial walls seem to be thinner. Ray initials are distinguishable from fusiform initials on the basis of their size and also owing to abudance of stored materials. Some of dormant cells have one big vacuole, but some of them have more than one especially exist near the xylem and phloem zone (Fig. 4). The cytoplsm has a dense and dark appearance. Numerous free ribosomes are present in the cytoplasm. Single membrane bound bodies are characteristic of dark appearance in dormant cambium. Most of these are similar to the protein bodies reported

Fig. 2. Longitudinal view of the nucleus has two nucleolus in central position of the cambial initial. X 7200.

by Robards and Kidwai (1969). Lipid droplets and starch grain are rare in this study. Mitochondria are present throughout the cell. Plastids and golgi bodies appear rarely.

Active cambium - When the activity begins in late March the rows of cells increase in cambial zone. Cambial activitiy of the *Armeniaca vulgaris* reached at a maximum level in May (Algan 1988). The active cambia examined during the present investigation consists of 5 to 8 rows of undifferentiated cells (Fig. 5). The tangential walls are always very thin. Sometimes some radial walls are also very thin according to the others. Thin radial walls show that anticlinal divisions were present recently. Active cambial cells are rich with most types of cell organels. They have abundant ribosomes, mitochondria, endoplasmic reticulum and

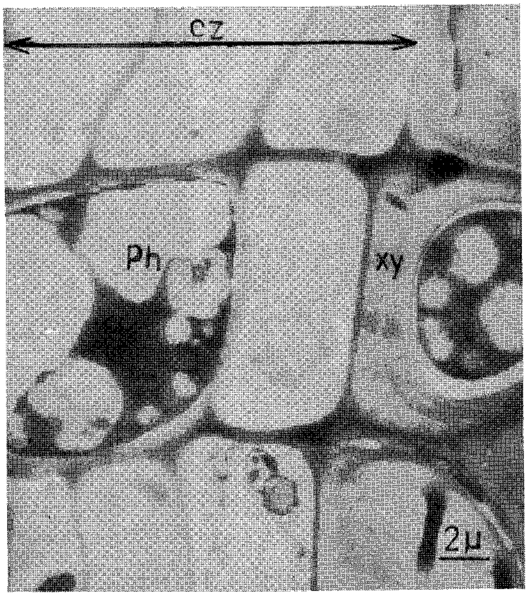

Fig. 3. Transverse views of dormant cambial cells in dormant cambium. X 3600. cz, cambial zone; xy, xylem cell; ph, phloem cell.

golgi bodies. But they have very rare plastids. The nuclear envelope has well defined pores (Fig. 6a).

Although their distribution is determined by the vacuolation of the cell, mitochondria are grouped generally around the nucleus. Sometimes they are grouped in the parietal cytoplasm. They are mostly globular or dumbell shaped and have tubular cristae (Fig. 6b).

Golgi apparatus are abundant in the ground cytoplasm especially in parietal zone. They appear to be producing vesicles. There is large number of vesicles in the cytoplasm (Fig. 6c, d).

Rough cisternal ER is present in active cambial initials. ER in the form of short segments occur frequently in tonoplast. Contact of the ER with the nuclear envelope is often to be seen.

The cytoplasm is rich in free ribosomes and aggregates. Microtubules frequently occur near the cell wall in the parietal cytoplasm (Fig. 6e). Microflament bundles are present in fusiform cells (Fig. 6f).

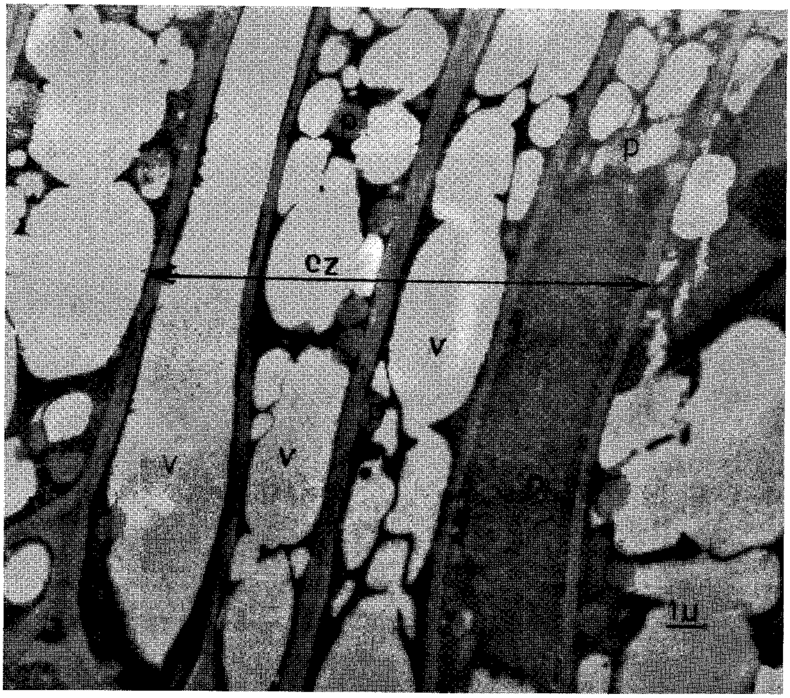

Fig. 4. Longitudinal view of winter cambium. X 5000. cz, cambial zone; n, nucleus; v, vacuoles; p, protein bodies.

DISCUSSION

Srivastava and O'Brien (1966), Itoh (1971) and Rao and Dave (1983) reported that the cambial cells have numerous small vacuoles in dormant state. During studing cytology of apricot cambium by electron microscope, most of the cambial initials have one big vacuole and seem to be empty like summer cambial cells. These results indicated that cambial divisions continue actively until winter frosts. Therefore, the initials couldn't have more stored materials. On the other hand, some of the cells of cambial zone have many small vacuoles and great amount of stored materials. These cells generally contact to the phloem or xylem cells, and probably xylem or phloem mother cells.

The radial diameter of the cambial cells in summer cambium are seen in various lengths. This is a result of division which occurs at

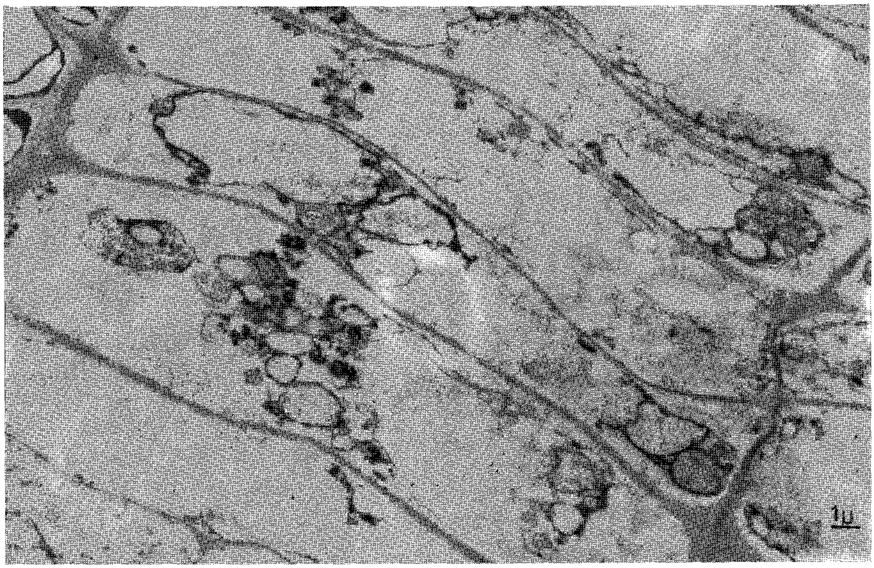

Fig. 5. Transverse view of active cambial zone. X 4800.

different time. But, in winter, cambium cells have almost the same radial diameter. This result has indicated that dormant cambium is stable.

Even though the nucleus has a similar appearance in active and dormant cells, a well defined porus have seen in nuclear envelope of the active cambial cells. It means metabolic activity increases in these cells.

In active cells, golgi bodies are abundant. They have many cisternea and vesicles. This result supports the findings of Rao and Dave (1983). The presence of rich cristae in active cell mitochondria more than that of tha dormant cell may be associated with a higher production of ATP in active cells. This result is similar to Tsuda (1975) and Rao and Dave (1983)'s reports. They found mitochondria in a chain like arrangement in dormant cells, also we saw them in a same arrangement in active cells of the apricot cambium. Murmanis (1971) and Rao and Dave (1983) reported that they have seen many plastids in cambial cells. In contrast to these results plastids are rare in cambial initials of the apricot and they present the agragranal state as a proplastid. This structure of cambial plastids in apricot are perhaps linked with the very small amount of light reaching the cambium across the bark. The absence of starch grains as a stored materials in cambial initials during our observations supports this view.

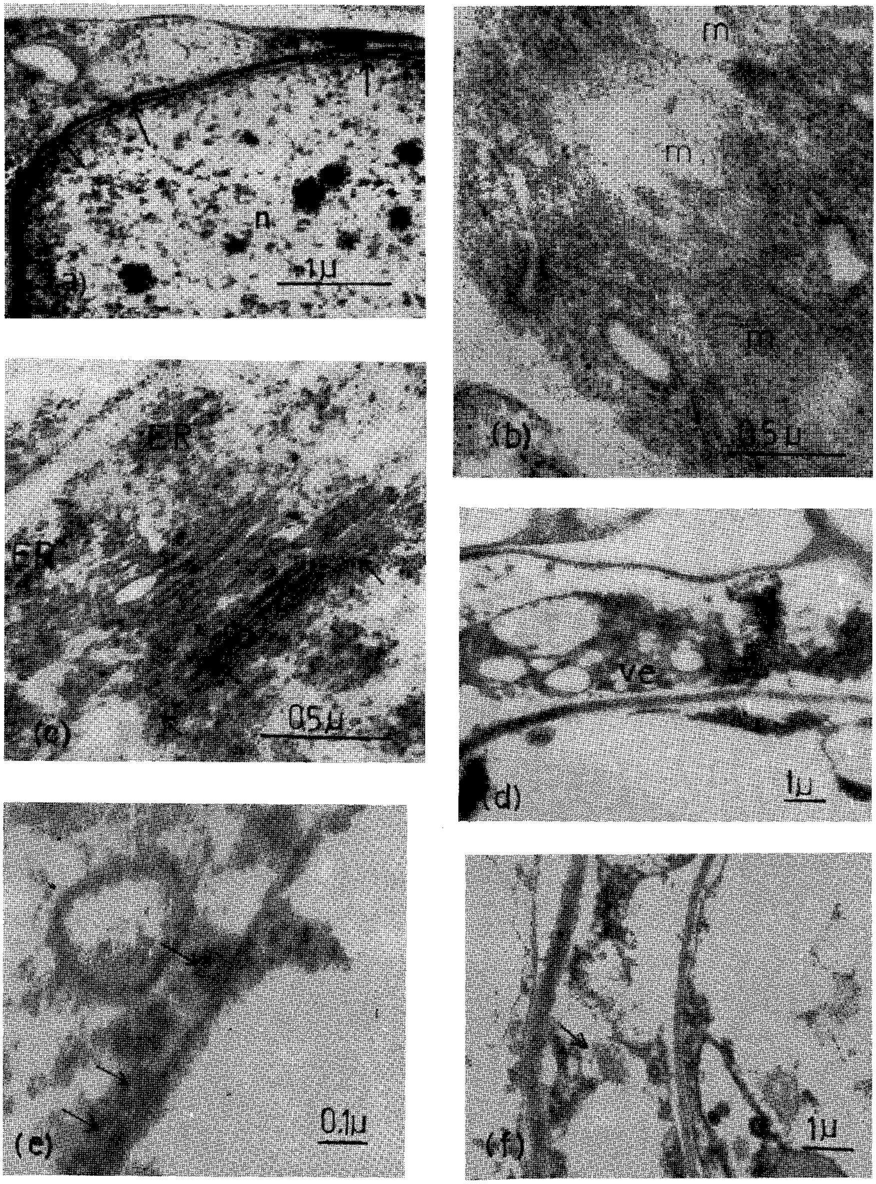

Fig. 6. (a) A well defined porus on the nuclear envelope of the active cambial cell (at arrows). X 14000. (b) Chain-like arrangement of mitochondria in a fusiform cell. X 29000. (c) Golgi vesicles in active cell. X 4200. (e) Transsection of the microtubules under the cell wall (arrows). X 72000. (f) Fusiform cell showing bundles of microflaments (at arrows). X 7200. n, nucleus; m, mitochondria; gb, golgi bodies; ER, endoplazmik reticulum; ve, vesicles.

REFERENCES

ALGAN, G. (1988) - Relations between flowering and leaf development and cambial reactivation and differentiation times of *Armeniaca vulgaris*. Communications. Fac. Sci. Univ. Ankara, 6, 91-99.

BARNETT, J.R. (1973) - Seasonal variation in the ultrastructure of the cambium in New Zealand grown *Pinus radiata* D. Don. Analls of Botany, 37, 1005-1011.

ITOH, T. (1971) - On the ultrastructure of dormant and active cambium of conifers. Wood Res., 51, 33-42.

KIDWAI, P., ROBARDS, A.W. (1969) - On the ultrastructure of the resting cambium of *Fagus silvatica* L. Planta, 89, 361-368.

MURMANIS, L. (1971) - Structural changes in the vascular cambium of *Pinus strobus* L. during an annual cycle. Ann. Bot., 35, 133-141.

RAO, K.S., DAVE, Y.S. (1983) - Ultrastructure of active and dormant cambial cells in teak (Tectona grandis L.f.). New. Phytol, 93, 447-56.

ROBARTS, A.W., KIDWAI, P. (1969) - Comparative study of the ultrastructure of resting and active cambium of *Salix fragilis* L. Planta, 84, 239-49.

SATO, T. (1967) - A modified metod for lead stainning of thin sections. J. Electron Microscopy, 16, 133.

SRIVASTAVA, L.M., O'BRIEN, T.P. (1966) - On the ultrastructure of cambium and its vascular derivatives: I. Cambium in *Pinus strobus* L. Protoplasma, 61, 257.

TSUDA, M. (1975) - The ultrastructure of the vascular cambium and its derivatives in coniferous species. I. Cambial cells. Bulletin of the Tokyo University Forests, 67, 158-226.