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Presence and structure of the wart layer in tracheids of some junipers as visualised in the scanning electron micscope

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Abstract

The presence and structure of the wart layer was investigated in the tracheids of the following juniper species: *J. communis* L., *J. communis* var. *saxatilis* Pall., *J. sabina* L., *J. virginiana* L., *J. chinensis* L. and *J. squamata* Lamb. The wart layer was found to be present in the tracheids of the stem, roots and branches of spring and summer growths, thus, it is an integral element of their structure. It would seem that this layer is a trait of these juniper species and may be one of the taxonomic features of their wood.

Key words: Juniperus, wart layer, scanning electron microscopy

INTRODUCTION

The wart-like convexities on the closing lamella in the S_3 layer in tracheids of coniferous plants were detected by Liese (1951) in *Pinus silvestris* and Kobayashi and Utusumi (1951) in *Pinus densiflora*. The definition of wart-like structures was introduced by Harada (1953) and adopted in the literature in connection with the wood structure (wood anatomy). In the period 1956-1965 Liese examined 160 plant species for this layer. He established that the presence of warts is not connected with the systematic position of the given species, genus or family. This problem in various coniferous plants was also tackled by Wardrop et al. (1959), Cronshaw et al. (1961) and Jayme and Azzola (1966). All these studies were performed with the use of a transmission electron microscope. At a later time the scanning electron microscope made possible direct observation of tracheid walls, and thus of the wart layer (Knigge 1971, Ohtani and Fujikava 1971, Verhoff and Knigge 1976).

In some conifers such as the spruce (*Picea excelsa* Link.) the Douglas fir (*Pseudotsuga douglasii* Carr.) and the larch the wart layer is very rare; it may be found more frequently in the pine (*Pinus silvestris* L.), but not in every tracheid. Preliminary investigations indicated the general occurrence of the wart layer in tracheids of *Juniperus communis*. It was therefore, decided to study the presence and structure of this layer in the tracheids of the stem, from the pith to the periphery, and from the butt to the top as well as in the tracheids of the roots and branches of the above enumerated junipers.

MATERIAL AND METHODS

Samples of *J. communis* wood were investigated in detail and so were those of *J. communis* var. *saxatilis*. The junipers were about 30 years old. Samples were taken from the butt, the middle of the stem and the apical part. Similarly samples were collected from the roots and branches. Samples of the other juniper species were taken only from the butt. The occurrence of the wart layer was also studied in the root and branch tracheids of the latter junipers. The presence and structure of the wart layer was examined on longitudinal-radial sections. This layer could be observed both in the spring and summer growths. Samples in the shape of cubes 5×5×5 mm were placed on the microscope table covered with silver paste, then they were dusted with carbon and silver in a vacuum duster at a pressure of $1.33 \cdot 10^{-6}$ Pa. The prepared samples were transferred to the scanning electron microscope JSM-35 and photographed at 25 kV. Sample current intensity was about 2.10^{-12} A.

RESULTS AND DISCUSSION

A radial section of *J. communis* is shown in Fig. 1. It is a fragment of a tracheid from summer growth, the layer S_3 of the secondary wall is covered with a wart layer. The sample was taken from the butt in the pith region. The wart layer appears also on the edges of pits (Fig. 2). A very similar layer is seen in tracheids from spring growth, as is visible at various magnifications in Figs. 3 and 4. These pictures show tracheids of the heartwood part of the cross section from *J. communis*. The wart layer is present in every tracheid from the pith to the stem periphery in this juniper. It is also present in the tracheids of both growths in the middle and apical parts of the stem as well as in the root and branch tracheids. It is noteworthy that on the S_3 layer of the secondary wall in some tracheids of the spring and summer growths there occur characteristic spiral thickenings also covered with a wart

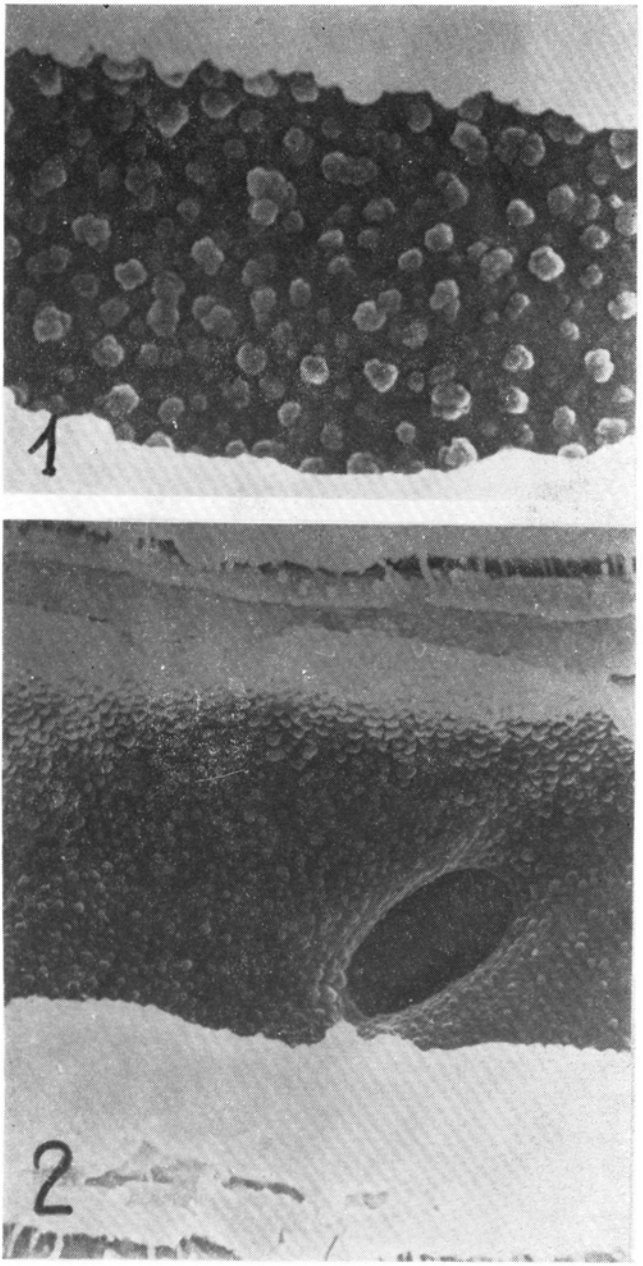

Fig. 1. Wart layer in tracheid of summer growth of *J. communis* (radial, longitudinal section). × 20 000

Fig. 2. Wart layer on edges of pits in summer *J. communis* tracheids (radial, longitudinal section). × 10 000

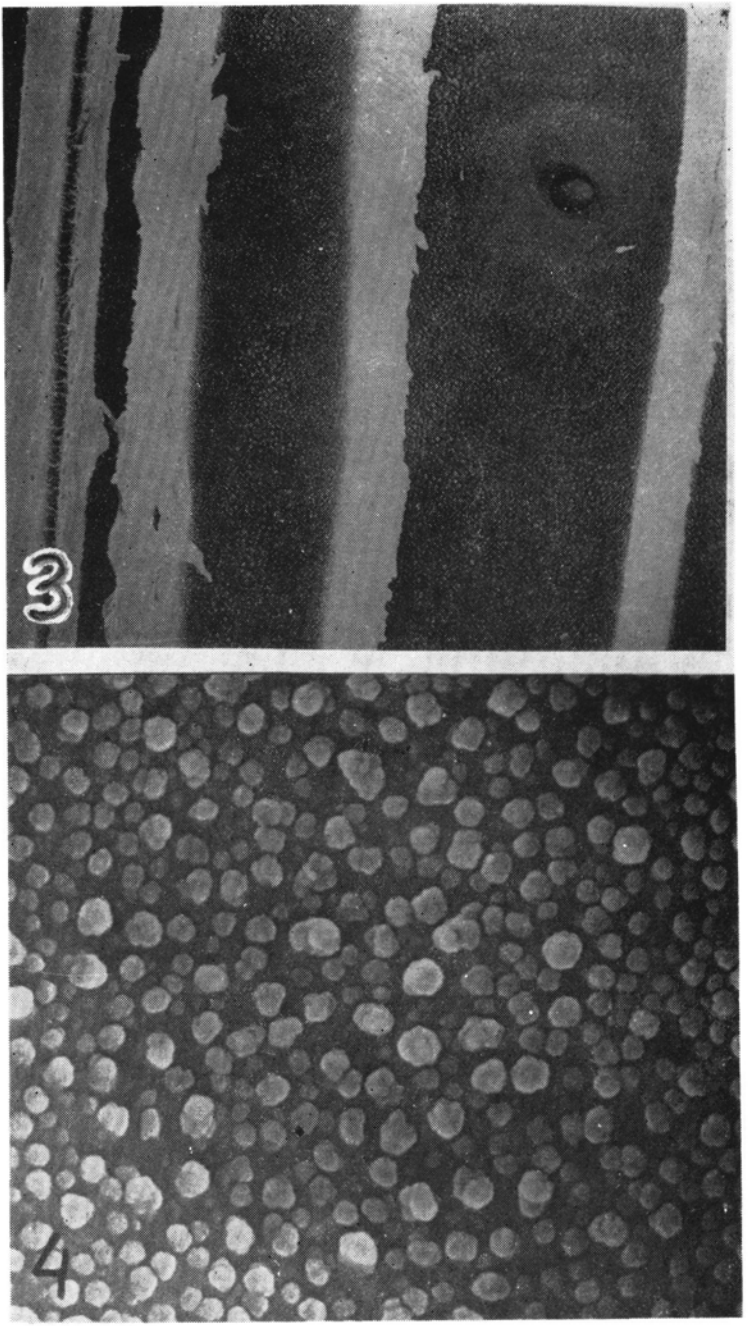

Fig. 3. Wart layer in spring growth *J. communis* tracheids (radial, longitudinal section). × 2000

Fig. 4. Wart layer in spring growth tracheids of *J. communis* (radial, longitudinal section). × 20 000

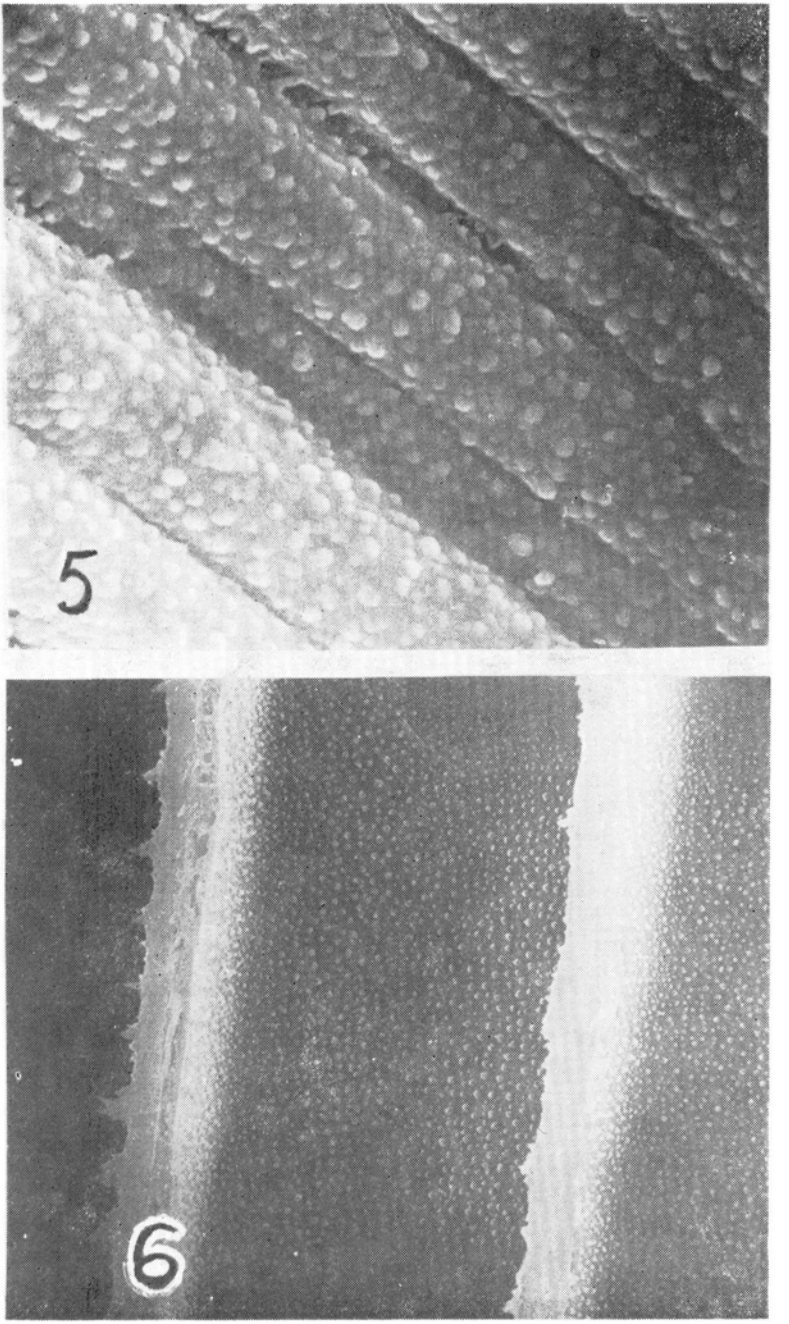

Fig. 5. Spiral thickening and wart layer in spring *J. communis* tracheids (radial, longitudinal section). × 20 000

Fig. 6. Wart layer in *J. virginiana* (radial, longitudinal section). × 2000

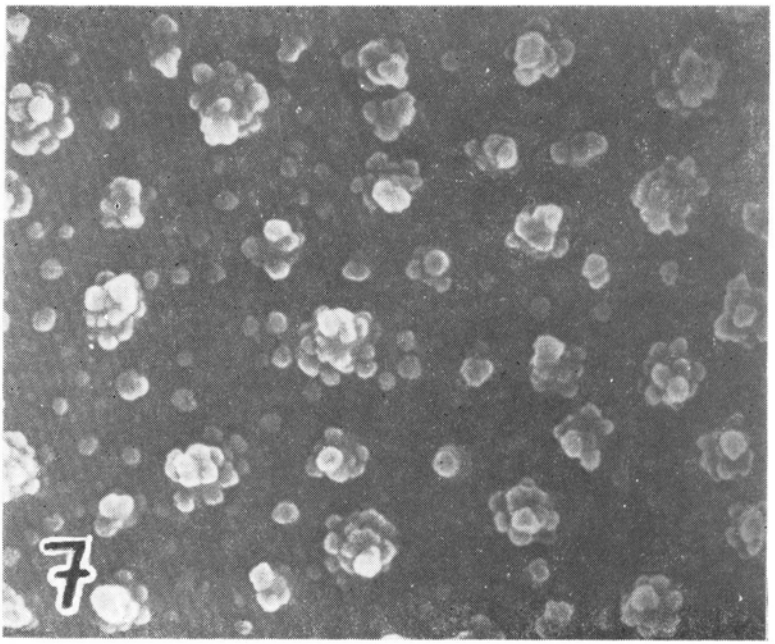

Fig. 7. Wart layer in *J. virginiana* (radial, longitudinal section). × 20 000

layer (Fig. 5), but here it is distinctly finer. The wart layer is a constant element of the wood structure of *J. communis* in both the annual growths. It would be difficult to find a tracheid in which the S_3 layer of the secondary wall would not be covered with a wart layer. The wart layer appears also in the tracheids of the stem, roots and branches of *J. communis* var. *saxatilis*. As regards *J. squamata, virginiana, chinensis* and *sabina*, only tracheids of the butt were investigated. In each tracheid of these junipers from the pith to the periphery the wart layer was present. This layer in the spring tracheids of the *J. virginiana* stem is shown in Figs. 6 and 7. At a higher order magnification (×20 000, Fig. 7) it can be seen that the large warts consist of small ones. The presence of the wart layer was found in every examined tracheid from the roots and branches of *J. squamata, chinensis, virginiana* and *sabina*. It seems on this basis that the wart layer appears in every tracheid of the studied junipers and should be considered as one of the taxonomic features of their wood. This, however, requires further confirmation. The wart diametre is 50-500 nm. The wart layer, is a remnant of the autolysed protoplast of the tracheal element and also the result of caving in of the S_3 layer of the secondary wall inside the tracheid. Thus, it arises much earlier than the time when the process of heartwood formation begins. It appears both in sapwood and heartwood.

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Występowanie oraz struktura warstwy brodawkowej w cewkach niektórych jałowców przedstawiona za pomocą skoningowego mikroskopu elektronowego

Streszczenie

Zbadano występowanie i strukturę warstwy brodawkowej w cewkach jałowców: pospolitego (*Juniperus communis* L.), pospolitego odmiany halnej (*J. communis* var. *saxatilis* Pall), sawińskiego (*J. sabina* L.), wirginijskiego (*J. virginiana* L.), chińskiego (*J. chinensis* L.) i łuskowatego (*J. squamata* Lamb.). Stwierdzono, że warstwa brodawkowa występuje we wszystkich cewkach pnia, korzeni i gałęzi przyrostów wiosennych i letnich badanych jałowców, jest więc ich integralną strukturą. Można wnioskować, że warstwa brodawkowa jest cechą gatunkową tych jałowców i może być jedną z cech taksonomicznych ich drewna.