# A NOTE ON THE FORMATION OF COMPRESSION WOOD INDUCED BY MORPHACTIN IT 3456 IN *THUJA* SHOOTS

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ABSTRACT

Light and scanning electron microscopes were used to examine the structure of normal wood, naturally formed compression wood, and wood formed after and influenced by morphactin IT 3456 treatment in *Thuja occidentalis* L. lateral shoots. Morphactin strongly induced typical compression wood formation around those shoots. On the basis of these and prior data, a relationship apparently exists between morphactin treatment and the formation of compression wood in Coniferales.

*Keywords*: *Thuja occidentalis*, compression wood, morphactins, microscopy.

## INTRODUCTION

Compression wood is formed on the lower side of branches as a geotropic phenomenon peculiar to species of Coniferales, Ginkgoales and Taxales (Westing 1965, 1968). In our previous work we have shown that morphactin IT 3456 induced the formation of compression wood in vertically growing shoots of two species of the family Pinaceae, *Picea excelsa* Link. and *Pinus sylvestris* L. (Smoliński et al. 1972; Phelps et al. 1974). Our present study was designed to determine if morphactin IT 3456 produced the same effect in *Thuja occidentalis* L., a species belonging to the Cupressaceae, and if so to characterize the response to morphactin in different families of Coniferales. The normal structure of secondary xylem of white cedar, *Thuja occidentalis* L. was previously described by Bannan (1941).

## MATERIALS AND METHODS

Three- to four-year-old lateral branches of field-grown *Thuja occidentalis* L. were treated on 1 June 1975, with 0.5% morphactin IT 3456 in lanolin paste applied as a ring around the shoot. Control shoots were treated with lanolin paste only. Six lateral branches, three from each of two trees, that were almost fully elongated were used for each treatment. The treated shoots were collected at the beginning of October 1975 and fixed in 75% ethyl alcohol for light and scanning electron microscopic analyses. The anatomical features of wood formed on the lower and upper sides of branches at the treatment area, 4 cm above the treatment area and 4 cm below the treatment area were analyzed. The anatomical features of the control branches were also examined. The method of light microscopic analysis was the same as previously described (Smoliński et al. 1972). The preparation of wood samples for scanning electron microscopic analysis was also as previously described (Phelps et al. 1974). Incremental widths prior to and including the treatment increment were measured at the treatment area and 3 cm below the

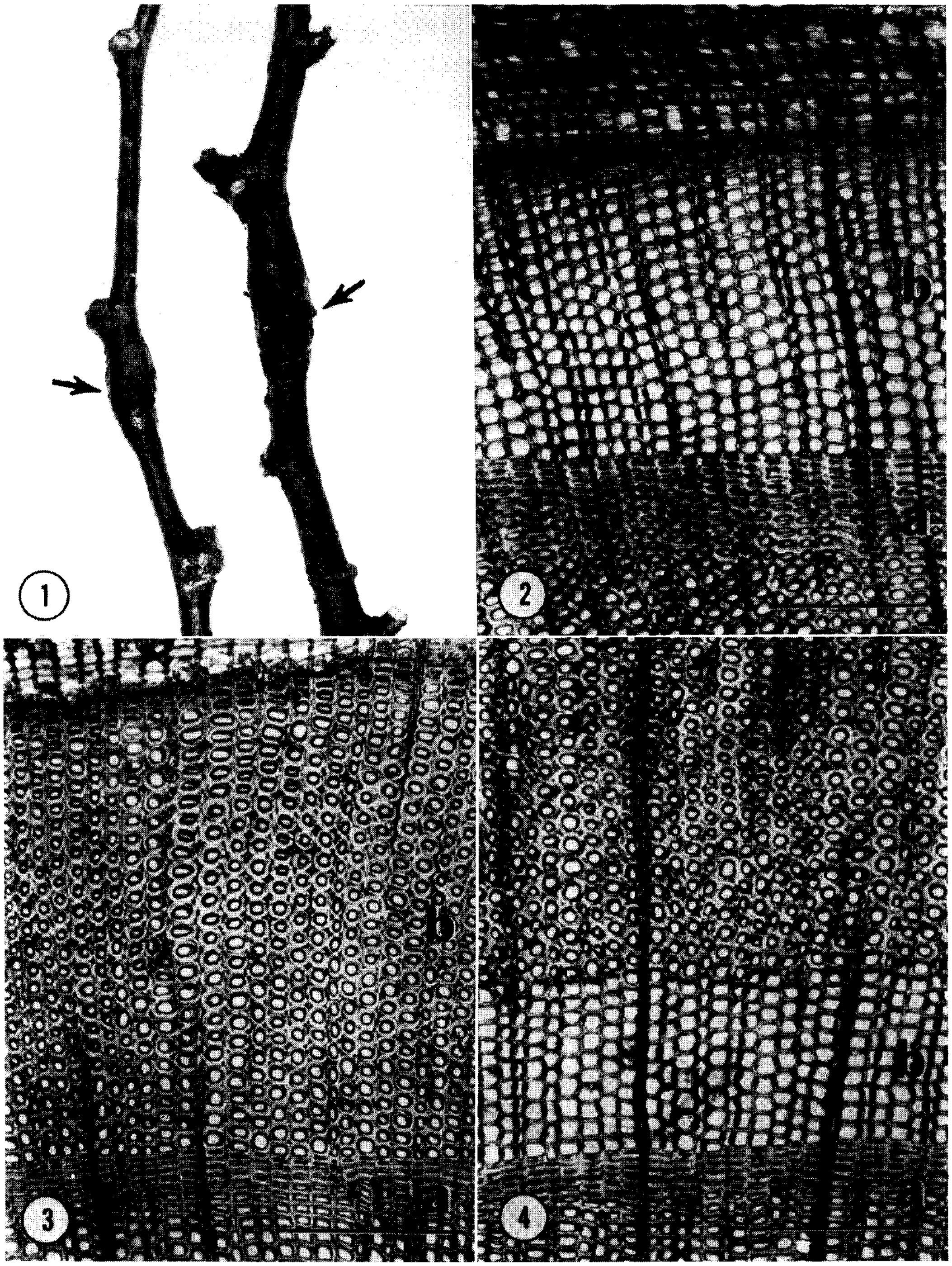

FIG. 1. The Thuja shoots at the time of sample collection. Strong thickening occurred at the place of morphactin application (arrows).

FIG. 2. Upper side of untreated branch formed a few cm below the area treated with morphactin (*all bars in Figures 2–4 equal 143 micrometers*). Morphactin had no effect in this area; *a* equals wood produced in 1974 and *b* is wood produced in 1975.

treatment area. The incremental data are averages of measurements taken from four shoots.

## RESULTS

Shoots treated with morphactin were markedly thickened at the place of application (Fig. 1). No effects were observed at the areas 4 cm above and 4 cm below the treatment area. Light and scanning electron microscopic analyses showed that the thickening was caused by formation of typical compression wood encircling the branch (Figs. 4c and 8). Under natural conditions, however, compression wood is formed only on the lower side of branches (Compare Figs. 3 and 6 with Figs. 2 and 5). Normal wood formation was observed on the upper side of the lateral shoot in the 1975 increment prior to morphactin treatment on June 1 (Figs. 4b and 7). The structure of morphactin-induced wood was very similar to compression wood produced during natural conditions (compare Figs. 6 and 8). Helical checks were observed in the $S_2$ layer of the wall, which was thick and highly lignified.

Data were obtained regarding the overall incremental changes that occurred at the place of morphactin application. The width of the two increments (1973 and 1974) immediately preceding the treatment time were 417 micrometers ($\mu$m) and 392 $\mu$m, respectively, while the width of the increment formed following morphactin treatment was 1,535 $\mu$m. The widths of the 1973, 1974, and 1975 increments at a point away from the influence of morphactin (3 cm below) were 392, 356, and 375 $\mu$m respectively. The only incremental width that occurred outside of normal variation was the width obtained following morphactin application.

## DISCUSSION

We have demonstrated that morphactin induces compression wood formation not only in *Picea excelsa* Link. and *Pinus sylvestris* L. (Smoliński et al. 1972; Phelps et al. 1974), members of the Pinaceae, but also in *Thuja occidentalis* L., a species belonging to the Cupressaceae. It seems that this phenomenon may be typical for Coniferales, an order showing a genetic potential for compression wood formation. In our previous study of *Picea* and *Pinus*, the treatment with morphactin was made before the development of new shoots in the spring. The disturbing effect on shoot development was then observed and a strong induction of compression wood formation in vertically growing shoots was produced (Smoliński et al. 1972; Phelps et al. 1974). In the present study of *Thuja* lateral branches, the new shoots were almost fully elongated before morphactin was applied. Normal wood was formed on the upper side of the shoot before treatment, but after morphactin was applied, all wood produced in the treated area had traits typical of compression wood.

Westing (1965) suggested five possible causes for compression wood formation: (a) an actual redistribution of auxin, (b) the lateral redistribution of some other substances (growth promoter, growth inhibitor, auxin oxidase, etc.), (c) an asymmetric local production of auxin, or of some other substances, (d) a differential mobility of auxin on upper and lower sides, or (e) an asymmetric local release of bound auxin. Compression wood can be induced by exogenous application of an auxin such as indoleacetic acid and $\alpha$-naphthaleneacetic acid (Westing 1965, 1968).

Although we have no detailed data concerning the physiological or biochemical nature of the action of morphactin on the

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FIG. 3. Compression wood formed on the lower side of untreated branches or in branches, lower side, a few cm below area treated with morphactin. Morphactin had no effect in this area; *a* equals normal wood produced in 1974 and *b* is compression wood produced in 1975.

FIG. 4. Wood produced at the thickened area in Figure 1. Tissue is on upper side of stem; *a* is normal wood in 1974, *b* is normal wood produced before 1 June 1975, and *c* is compression wood formed after morphactin treatment in 1975.

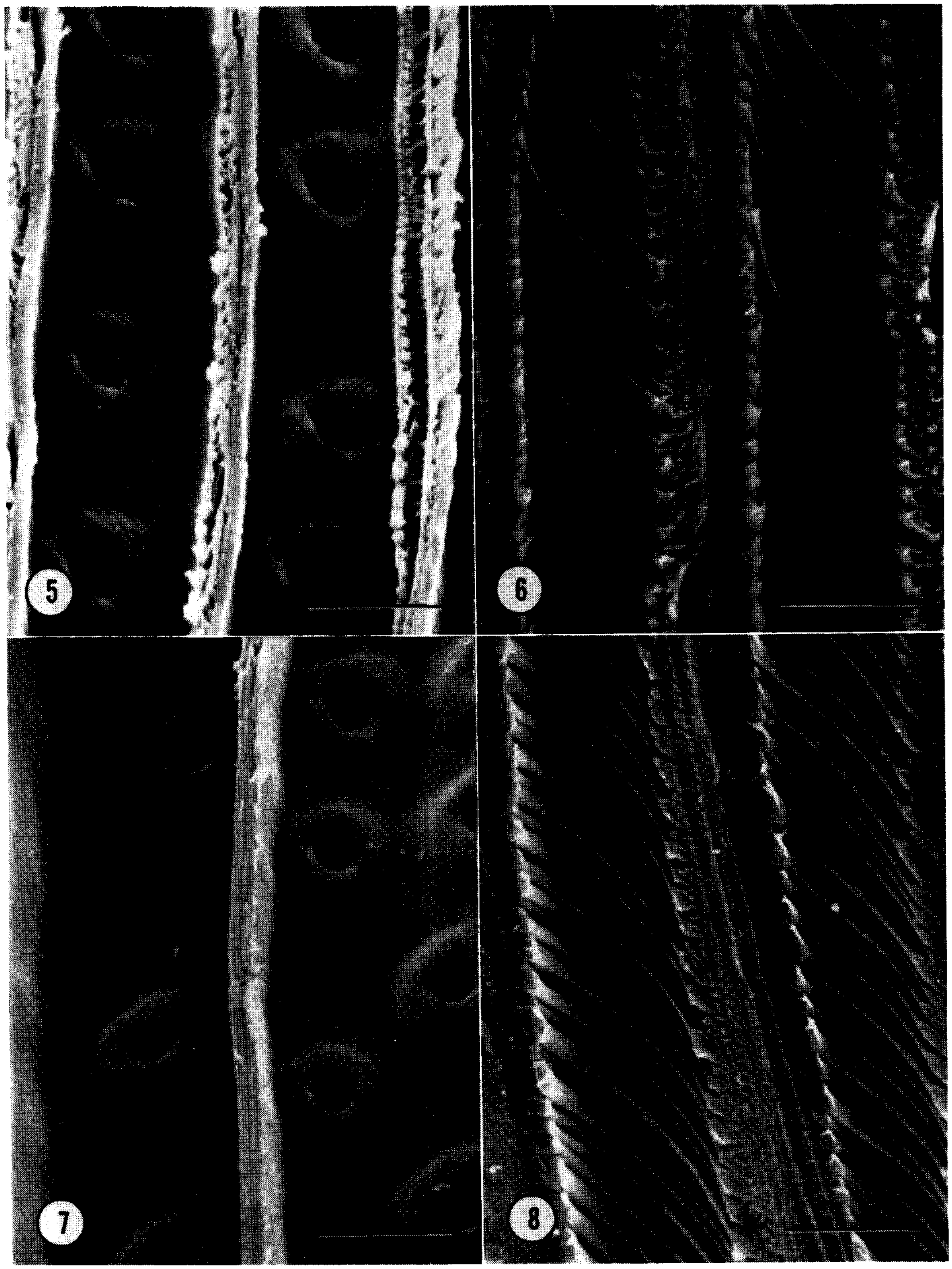


FIG. 5. Longitudinal section of normal tracheids formed on the upper side of an untreated branch (*bars in Figures 5–8 equal 10 micrometers*).

FIG. 6. Compression wood tracheids, longitudinal section, formed under natural conditions on the lower side of an untreated branch.

induction of compression wood formation, we believe that this compression wood induction is due not to the direct action of morphactin on new developing shoots but is due to an interaction of morphactin with endogenous hormones produced in shoots and possibly in roots. A synergistic effect of morphactin with exogenous auxin and cytokinin on cambial divisions has already been documented in *Malus* (Pieniążek et al. 1970). In further studies we will try to elucidate the formation of compression wood in natural conditions on the lower side branches since the physiology of its induction and the biochemistry of its formation are in large part obscure (Westing 1968).

Since morphactins are one of the best retardants of shoot elongation in many woody plants (Frank et al. 1975; Backhaus and Sachs 1975), and since morphactins have profound effects on wood differentiation at their place of application (i.e., compression wood formation and thickening of the shoot as described herein), studies on the action of morphactins on cellular differentiation in woody species are important for understanding some theoretical problems of wood formation and for understanding the consequences of their role in retarding shoot elongation.

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FIG. 7. Longitudinal section of earlywood tracheids formed on upper side of branch prior to morphactin treatment in 1975 increment. Compare with Fig. 4.

FIG. 8. Compression wood tracheids formed in the 1975 increment after morphactin treatment. Compare with Fig. 7.