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BOTANY

Estimating Annual Height Growth by the Internode Method.—The best way to estimate an annual height increment in a tree is to measure the appropriate internode. In practice an internode is defined by the distance between two subsequent branch whorls (Romberger, U.S. Dep. Agric., For. Serv. Tech. Bull. 1293, 1963; Stiell, Can. Dep. For. Tech. Note 122, 1962); but when the positions of terminal and lateral buds are examined, it becomes apparent that annual shoot growth does not end at the center of a branch whorl (Fig. 1 and Table 1). When the true annual height increment of young trees or seedlings is desired, the accuracy of the measurable variables is critical. To make an accurate measurement one must have complete knowledge of the morphology of the nodal region and the technique of the measurement.

This study was undertaken to determine if the method of estimating annual height growth or volume growth by measuring internodes to branch whorls is acceptable for young trees and seedlings. The distinguishable zonation in the pith (Fig. 1), delineating the growth from year to year, is due to the collenchyma

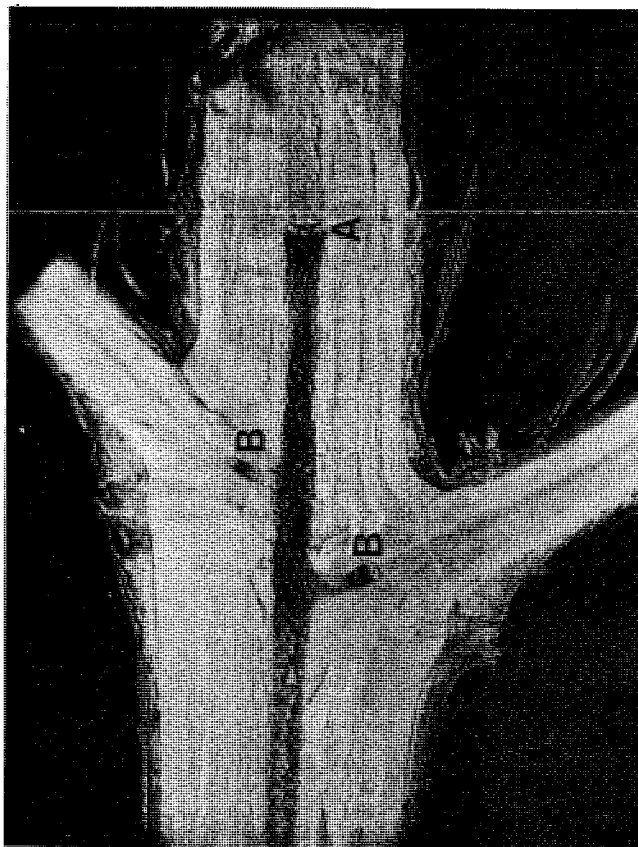


Figure 1. A longitudinal-radial section of a 23-year-old Douglas-fir 14 ft (4.3 m) in height showing the true ends of the segments in stem (A) and branches (B).

TABLE 1

Distance between the end positions of annual-growth segments and the centers of the corresponding branch whorls

Species	Number of observations	Average distance		Coefficient of variation %	Crown class
		mm	inches		
Lodgepole pine	88	11.72	0.46	59.2	Codominant
White spruce	26	10.31	0.41	74.8	Intermediate and dominant
Douglas-fir	39	11.87	0.47	68.8	Intermediate

plate that develops at the base of the buds. This plate extends across the pith of the stem and into the cortex (Romberger, U.S. Dep. Agric., For. Serv. Tech. Bull. 1293, 1963). Wagg (Can. Dep. For. Rural Dev., For. Branch, Dep. Publ. 1192, 1967) also noted a distinct year-by-year demarcation of pith growth in white spruce stems and branches. Early and late pith could be separated on the basis of color and cell structure, with special reference to lumen diameter and wall thickness, in much the same manner as springwood and summerwood. The ratio of early pith to late pith varied from 3:1 to 6:1, depending on species and growing conditions. Pith laid down early in the growing season was up to three times greater in diameter than that laid down at or near the end of the season. The pith diameter generally increased with increasing length of annual growth segments and increasing tree heights. This phenomenon clearly indicates the presence of compressive stresses exerted by the growing cambial force on the previously formed cell structure.

Two trees from each of three coniferous species, namely, lodgepole pine, white spruce and Douglas-fir, were investigated. After careful splitting of boles, the piths were examined along their entire lengths. The piths in all trees were readily separated into annual-growth segments (Fig. 1). Since the collenchyma plates are not always visible to the naked eye, the separation of internodes by the collenchyma-plate concept did not seem practical. However, when the continuous pith body in the split stems was exposed to drying, the adjacent annual pith segments retracted through shrinkage. The separation gaps that resulted had clearly defined the correct end positions of the annual-growth segments, i.e. the true length of the internodes. Further, it was observed that the separation gaps never occurred in the center of branch whorls but always at some distance above it. This clearly supports the view that the branch whorls are not the true end-boundary indicators of any true internode. The distances between the centers of branch whorls and the true ends of the annual-growth segments with their variations are shown in Table 1. The variation could perhaps be attributed to the degree of the annual effect of the environment. Besides, the variation suggests that the distance between the centers of branch whorls and their true ends cannot be compensated by a simple constant term in a stem-analysis model or volume model.

From the well-known concept of height-diameter relations for volume estimate, it might be assumed that a similar relation may be found between the true lengths of internodes and the corresponding thickness of annual radial-growth increments for annual volume-growth estimate. From the latter relation the estimation of annual volume increment of young trees and stands could be accomplished indirectly with a high degree of accuracy.—E.F. Wass, Forest Research Laboratory, Victoria, B.C., and T. Szabo, Eastern Forest Products Laboratory, Ottawa, Ont.

Temporary Stimulation of Photosynthetic Rate by a Short Photoperiod.—During the course of an experiment on the effect of temperature and photoperiod on induction of dormancy in two provenances of jack pine [*Pinus divaricata* = *banksiana* Lamb.], the photosynthetic rate of seedlings was observed to