DEVELOPMENT OF LONGITUDINAL SPLIT FAILURE IN WHITE-ROTTED ASPEN (*POPULUS TREMULOIDES* MICHX.)

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ABSTRACT

Longitudinal splits and associated smooth fracture planes were often noted along the growth ring boundaries of aspen, *Populus tremuloides* Michx., which were impact-loaded on the tangential plane, after decay by *Trametes versicolor* (L.: Fr.) Pilat, and *Bjerkandera adusta* (Willd.: Fr.) Karst. To characterize this failure pattern, scanning (SEM) and transmission (TEM) electron microscopy were employed. Results showed that this failure is a result of longitudinal fracture lines that cut through the parenchyma cell-wall layers (*transwall* failure) and opened the lumens. These parenchyma cells were preferentially invaded by fungal hyphae early (weight loss = 10%) in the degradation process. Prominent on the fracture planes was evidence of parenchyma cross walls perpendicular to the fiber axis, fungal hyphae, and associated hyphal sheaths. Localized fracturing along the parenchyma cells suggests that fungal invasion and degradation patterns influence the development and morphology of longitudinal fracture in wood.

Keywords: Smooth, split, transwall, *Populus tremuloides, Trametes versicolor, Bjerkandera adusta,* parenchyma, SEM, TEM.

INTRODUCTION

It is important to understand fully how decay fungi affect failure morphology in wood. Early researchers on wood-decay interactions recognized an abrupt "transverse" brash failure type resulting from advanced (e.g., >60% weight loss) fungal decay (Panshin and De Zeeuw 1980). Another failure type occurring at lower levels of stress is the longitudinal split failure (Fig. 1a) associated with more incipient stages of decay. Observations on broken samples of *Populus tremuloides* Michx., decayed to 10% weight loss by *Trametes versicolor* (L.: Fr.) Pilat and *Bjerkandera adusta* (Willd.: Fr.) Karst. revealed evidence of longitudinally split failure having smooth and planar fracture surfaces. The term "split" essentially describes a lengthwise separation due to cleavage along the grain (Gove 1961). Visual evaluation of the longitudinal split failure planes suggested that the surface areas are smaller than those of their sound wood counterparts.

Failure is known to occur along the weakest area in wood (Debaise et al. 1966). The weak zone may be related to the anatomical arrangement of the tissues (Kucera and Bariska 1982) or may be caused by a degrading factor like fungal decay. The unique appearance of the split fracture plane encouraged an ultrastructural characterization of the nature of interaction between the test fungi and wood anatomical elements. The underlying objective was to identify the processes leading to longitudinal split failure in white-rotted aspen. Both scanning (SEM) and transmission (TEM) electron microscopy were employed for this research.

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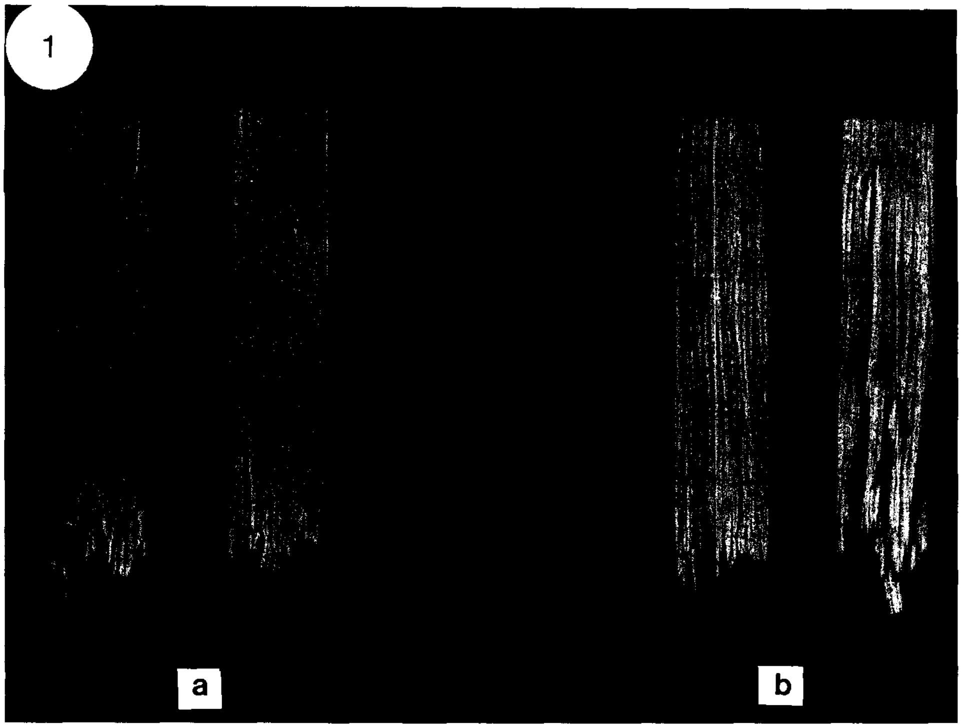

FIG. 1. Comparison of a smooth longitudinal split fracture plane (arrow on 1a) typical of the white-rot degradation with a rough shear fracture plane (arrow on 1b) in sound wood. Identical smooth split fracture planes were obtained after failing wood samples decayed by *Trametes versicolor* and *Bjerkandera adusta* to 10% weight loss.

MATERIALS AND METHODS

Wood specimens

Defect-free specimens (1.3 cm × 1.3 cm × 15.2 cm longitudinal) were machined from freshly kiln-dried sapwood of *Populus tremuloides*. One hundred and twenty specimens (thirty per fungus and sixty more for two sets of controls) were utilized. Control specimens were divided into two sets to run the different incubation periods anticipated for the two fungi. Test specimens were all straight-grained and designed to fit into the decay chambers. Their configuration was such that they could be impact-loaded to failure using the Forest Products Laboratory (FPL) toughness testing machine. Sapwood was utilized so that decay was achieved at a relatively fast rate; and the choice of wood was based on availability, decay susceptibility, and a noticeable lack of adequate research on hardwoods. *P. tremuloides* is widely distributed in the United States, and in view of current efforts to find structural uses for hardwoods, its choice for this study is justified. Ovendry weights of the test specimens were taken prior to decay experiments.

Decay procedure

An agar-block method was employed. Fresh cultures of *Trametes versicolor* (L.: Fr.) Pilat (SUNY ESF 42), which can cause a simultaneous white-rot, and *Bjerkan-*