CWPA Proceedings, 2009, 160-168

CURRENT RESEARCH IN WOOD DURABILITY AND PROTECTION AT FPINNOVATIONS

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Summary

FPInnovations was formed in 2007 by the merger of Forintek (wood products), Paprican (pulp and paper), and Feric (forest engineering) to form the world's largest private, not-for-profit forest products research institute. Research on wood protection, in the broad sense, is divided into two aspects: Durability covered under the Building Systems program and Protection covered under the Lumber Manufacturing program in the Forintek Division of FPInnovations. Durability research focuses on the performance of wood in service, while Protection research focuses on preventing biological deterioration of wood during harvesting, transport and storage.

FPinnovations' Durability research is broken down into three themes: Durability by Nature, Durability by Design and Durability by Treatment. Durability by Nature focuses on understanding the natural durability of Canadian species. Most of this work concerns improving our understanding of which extractives contribute to the natural durability of the Canadian cedars, western red cedar, eastern white cedar, and yellow cypress (Liu et al 2004; Stirling and Morris 2006; Chedgy et al 2007; Daniels and Russell 2007; Stirling et al 2007; Laks et al 2008), and finding ways of limiting extractive loss in service (Stirling et al 2006; Wan et al 2007). Durability by Design focuses on quantifying biodeterioration hazards (Wang et al 2007; Morris and Wang 2008; Wang and Morris 2008), understanding factors that contribute to decay and mould initiation (Morris and Uzunovic 2003; Fazio et al 2005; Clark et al 2006; Yang 2007, 2008a; Rao et al 2009), helping to improve design and construction practices (Hazleden and Morris 2001; Wang et al. 2009), and facilitating the introduction of new products, such as profiled decking (Morris et al 2008; Knudson et al 2009). Durability by Treatment focuses on improving our understanding of the factors limiting the performance of treated wood (Choi et al 2004; Morris et al 2004; Morris et al 2007; Stirling et al 2008; Stirling and Drummond 2009; Woo et al 2010), facilitating the introduction of new preservatives in Canada through treatability studies (Morris et al 2002; Cooper and Morris 2007) and contract field testing (confidential reports to clients), developing treatments to expand the use of wood (Morris and McFarling 2006; Wang et al. 2007; Morris and Morse 2008; Morris et al 2008; Stirling et al 2010), generating performance data on treated wood products (Morris et al 2009), and developing accelerated test methods. Three out of the last five methods to be standardized by AWPA were developed by FPinnovations (American Wood Protection Association 2009a,b,c) and new methods are constantly under development (Morris 2004; Morris et al 2009). A considerable amount of effort is also put into national, regional and international codes and standards (Morris

2004; International Standards Organisation 2007; Canadian Standards Association 2008; Stirling 2009; Wang et al 2009) and advice to specifiers.

Protection research aims to facilitate the delivery of clean wood products (void of discoloration but also free from pests such as moulds, insects, nematodes and fungi) by developing and evaluating biological, physical and chemical methods of protection. We also investigate the use of biotechnology for the advancement of wood products (Wan et al 2006; Yang et al 2006; Yang et al 2007a,b,c,d; Yang 2008b), address consumer perception of infested wood, and discuss these issues in the context of marketing and trade (Uzunovic et al 2003; Yang 2003). The program addresses both microbial (bluestain, mould, decay and bacteria) and non-microbial discolorations (mechanical, chemical, biochemical and photochemical) (Yang 2004, 2005; Uzunovic et al 2008a). A large focus has been on preventing bluestain through improving our understanding of the biology of bluestain fungi in order to develop successful control methods, or evaluating integrated pest management techniques, such as albino fungi and insect traps (Uzunovic et al 1999a; Yang et al 2004; Uzunovic 2006; Massoumi et al 2007; Yang 2009a,b). Physical protection research focuses on identifying best practices to limit chemical and biological stains through fast processing, water storage, reduction of bark damage, winter storage, storage under controlled atmosphere, crown drying and lumber wrapping (Uzunovic et al 1999b; Uzunovic et al 2004; Gignac 2007). Chemical protection research focuses on evaluating anti-sapstain chemicals and products for mould control (Minchin et al 2008). Protection research also generates technical data to mitigate phytosanitary restrictions that threaten trade of wood products (Uzunovic 2007). A considerable amount of effort is put into participation in international forums and development of relevant standards (International Standards for Phytosanitary Measures) through participation in the work of International Forestry Quarantine Research Group (IFQRG) and development of standard test protocols to evaluate new phytosanitary treatments (Uzunovic et al 2006; Ormsby et al 2008; Uzunovic et al 2008b; Hoover et al 2009; Uzunovic 2009a,b; Uzunovic et al 2009).

Forest pathology is outside our remit so we do not study pests on standing trees including the mountain pine beetle outbreak. We do, however, help people to understand the effects of the fungi carried by the beetle on wood properties, market issues associated with beetle-affected wood and look for ways to upgrade it and increase its usage (Byrne and Uzunovic 2005; Byrne et al 2006a; Byrne et al 2006b; McFarling et al 2006; Stirling and Morris 2009).

Acknowledgements

FPInnovations would like to thank its industry members, Natural Resources Canada, and the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba Ontario, Quebec, New Brunswick, Nova Scotia, and Newfoundland and Labrador, for their guidance and financial support for this research.

References
(A non-exhaustive list focussing on the last 4 years)

American Wood Protection Association, 2009a. E21-06. Standard test method for the evaluation of preservative treatments for lumber and timbers against subterranean termites in above ground protected applications (UC1 and UC2). AWPA Standards 2009. AWPA, Birmingham AL. p. 420 – 424.

American Wood Protection Association, 2009b. E24-06. Standard method for evaluating the resistance of wood products to mold growth. AWPA Standards 2009. AWPA, Birmingham AL. p. 436 – 441.

American Wood Protection Association, 2009c. E25-08. Standard field test for evaluation of wood preservatives to be used above ground. AWPA Standards 2009. AWPA, Birmingham AL. p. 41 – 447.

Byrne T., Stonestreet C., Peter, B., 2006b. Characteristics and utilization of post mountain pine beetle wood in solid wood products. Chapter 9: 233-253 In: The mountain pine beetle: a synthesis of biology, management, and impacts on lodgepole pine. Safranyik, L.; W. R. Wilson eds. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. 304p.

Byrne, T., Uzunovic, A., 2005. Addressing market place durability issues with post-mountain pine beetle lodgepole pine-A compilation of three reports. Mountain pine beetle initiative Working Paper 8.06. Natural Resources Canada, Canadian Forest Service. Victoria, BC.

Byrne, T., Uzunovic, A., Allen, E., 2006a. Mitigation of phytosanitary issues with mountain pine beetle. Mountain pine beetle initiative Working Paper 8.41. Natural Resources Canada, Canadian Forest Service. Victoria, BC.

Canadian Standards Association, 2008. CSA O80. Series 08 Wood Preservation. Canadian Standards Association, Etobicoke ON. 117p.

Chedgy, R.J., Morris, P.I, Lim, Y-W., Breuil, C., 2007. Black stain of western red cedar (*Thuja plicata* Donn) by *Aureobasidium pullulans*: The role of weathering. Wood and Fiber Science. 39 (3): 472-481.

Choi, S., Ruddick, J.N.R., Morris, P.I., 2004. Chemical redistribution in CCA-treated decking. Forest Products Journal. 54(3): 33-37.

Clark, J.E., Symons, P., Morris, P.I., 2006. Resistance of wood sheathing to decay. In Wood Protection 2006. Editor, H.M. Barnes Forest Products Society, Madison WI. pp.45-56.

Cooper, P., Morris, P.I., 2007. Challenges in treating Canadian species. Proceedings Canadian Wood Preservation Association. 28: 9-20.

Daniels, C. R., Russell, J.H., 2007. Analysis of western redcedar (*Thuja plicata* Donn) heartwood components by HPLC as a possible screening tool for trees with enhanced natural durability. Journal of Chromatographic Science. 45(5): 281-285.

Fazio, P., Bartlett, K., Yang, D.-Q., Rao, J., Miao, G., 2005. Development of experimental procedure to evaluate potential movement of mold spores from wall cavity to indoor environment. Proceedings of the 10th Canadian Building Science and Technology Conference. Ottawa, ON, Canada. 1: 215-224.

Gignac, M., 2007. Chemical stain in hardwoods and control. Proceedings Canadian Wood Preservation Association. 28: 31-37.

Hazleden, D.G., Morris, P.I., 2001. The influence of design on drying of wood-frame walls under controlled conditions. Proceedings: Performance of Exterior Envelopes of Whole Buildings VIII: Integration of Building Envelopes. ASTM West Conshohocken PA.

Hoover, K., Janowiak, J., Gething, B. Mulfinger, K., Uzunovic, A., Dale, A., 2009. 2009-25. Determination of lethal temperatures against pine wood nematode using microwaves. Report to the International Forestry Quarantine Research Group. Rome, September 2009. Document 2009-IFQRG-25.

International Standards Organization, 2007. ISO 21887. Durability of wood and wood-based products – Use classes. ISO, Geneva Switzerland. 11p.

Knudson, B., McFarling, S.M., Morris, P.I., 2009. Extracting greater value from subalpine fir: Profiled decking. Forest Products Journal 59(3): 24-28.

Laks, P., Morris, P.I., Larkin, G.M., Ingram, J.K., 2008. Field tests of naturally durable North American wood species. International Research Group on Wood Protection. Document No. IRG/WP/08-10675 11p.

Liu, Z., Daniels, B., Morris, P.I. 2004. The isolation of nezukone from western red cedar. Proceedings 7th Pacific Rim Bio-Based Composites Symposium, Vol. II: 186-195.

Massoumi Alamouti S., Kim, J-J., Humble, L.M., Uzunovic, A., Breuil, C., 2007. Ophiostomatoid fungi associated with the northern spruce engraver, *Ips perturbatus*, in western Canada. Antonie van Leeuwenhoek: 91(1):19-34.

McFarling, S.M., Byrne, A., Morris, P.I., 2006. Characterising the permeability of beetle-killed wood. Proceedings Canadian Wood Preservation Association. 27.

Minchin, D., Byrne, A., Morris, P.I., 2008. Protection of kiln dried lumber rewetted during transport and storage. Proceedings American Wood Preservers' Association 104: 203-226 AWPA, Birmingham AL.

Morris, P.I., 2004. The role of field testing in standardisation. Proceedings American Wood Preservers' Association 100: 135-117 AWPA, Birmingham AL.

Morris, P.I., 2006. Damp coastal weather field issues and improving performance. pages 165-172 In Wood Protection 2006. Editor, H.M. Barnes. Forest Products Society, Madison WI.

Morris, P.I., Ingram, J.K., Ruddick, J.N.R., Choi, S.M., 2004. Protection of untreated wood by adjacent CCA-treated wood. Forest Products Journal. 54(3): 29-32.

Morris, P.I., McFarling, S.M., 2006. Enhancing the performance of transparent coatings by UV protective pre-treatments. International Research Group on Wood Protection. Document No. IRG/WP/06-30399 12p.

Morris, P.I., McFarling, S.M., Dale, A., 2009. An accelerated field simulator for aboveground testing of wood preservatives. Forest Products Journal 59 (7/8): 1-6.

Morris, P.I., McFarling, S.M., Zahora, A.R., 2002. Treatability of refractory species with amine and amine/ammoniacal formulations of ACQ. Forest Products Journal 52(10): 37-42.

Morris, P.I., Minchin, D., Zylkowski, S., 2007. A mold resistance test on adhesives used in wood composite products. Forest Products Journal 57(12): 25-29.

Morris, P.I., Morse, B., 2008. Improving the performance of transparent coatings. Proceedings Canadian Wood Preservation Association. 29: 42-46.

Morris, P.I., Tsunoda, K., Grace, J.K., 2009. Field Testing of Wood Preservatives. Ten year performance of borate treated wood against termites in Hawaii, Japan and Canada. Proceedings Canadian Wood Preservation Association. In press.

Morris, P.I., Uzunovic, A., 2003. A review of Forintek research on mold. Proceedings American Wood Preservers' Association 100: 152-154 AWPA, Birmingham AL.

Morris. P.I., Wang, J., 2008. A New Decay Hazard Map for North America Using the Scheffer Index. International Research Group on Wood Protection. Document No. IRG/WP 08-10672.

Morris, P.I., Wang, J., Ingram, J.K., 2008. Ability of Transparent Coatings to Retard Leaching of Borates in a Weather-Ometer Test. J. Coatings Tech. 5(3): 44-47.

Ormsby, M., Evans, H., Burgess, R., Wilson, B., Uzunovic, A., Grgurinovic, C., 2008. Treatment Criteria for ISPM No. 15. Report to the International Forestry Quarantine Research Group. September 2008.

Rao, J., Fazio, P., Bartlett, K., Yang, D.-Q., 2009. Experimental evaluation of potential transport of mold spores from moldy studs in full size wall assemblies. Building and Environment 44:1568-1577.

Stirling, R., 2009. Natural durability classification systems used around the world. The International Research Group on Wood Protection. Document No. IRG/WP 09-10694 10p. IRG, Stockholm, Sweden.

Stirling, R., Bicho, P., Daniels, B., Morris, P.I., 2010. Kraft pulping of wood treated with carbon-based preservatives. Holzforschung. (In press).

Stirling, R., Daniels, C.R., Clark, J.E., Morris, P.I., 2007. Methods for determining the role of extractives in the natural durability of western redcedar heartwood. The International Research Group on Wood Protection. Document No. IRG/WP 07-20356 12p. IRG, Stockholm, Sweden.

Stirling, R., Drummond, J., 2009. Re-distribution of copper in the cell walls of wood treated with micronized copper quat. The International Research Group on Wood Protection. Document No. IRG/WP 09-30506 10p. IRG, Stockholm, Sweden.

Stirling, R., Drummond, J., Zhang, J., Ziobro, R.J., 2008. Micro-distribution of micronized copper in southern pine. The International Research Group on Wood Protection. Document No. IRG/WP 08-30479 16p. IRG, Stockholm, Sweden.

Stirling, R., Morris, P.I., 2006 the influence of extractives on western red cedar's equilibrium moisture content. The International Research Group on Wood Protection. Document No. IRG/WP 06-40331 12p. IRG, Stockholm, Sweden.

Stirling, R., Morris, P.I., 2009. Decolourization of blue stain in lodgepole pine sapwood by hypochlorite bleaching and light exposure. Forest Products Journal 59 (7/8): 47-52.

Stirling, R., Morse, B., Morris, P.I., 2006. The effect of various coatings on western redcedar extractive retention. Proceedings Canadian Wood Preservation Association. 27: 10p.

Uzunovic, A., 2006. Beetle-fungus associations. Proceedings Canadian Wood Preservation Association.

Uzunovic, A., 2007. Beetle-fungus associations in woody substrates in the context of international trade. The International Research Group on Wood Protection. Document No. IRG/WP 07-10610 17p. IRG, Stockholm, Sweden.

Uzunovic, A., 2009a. Fumigants alternative to Methyl Bromide. Report to the International Forestry Quarantine Research Group. Rome, September 2009. Document 2009-IFQRG-31.

Uzunovic A., 2009b. Efficacy testing statistics background. Report to the International Forestry Quarantine Research Group. Rome, September 2009. Document 2009-IFQRG-32.

Uzunovic, A., Byrne, T., Allen, E., Morrell, J.J., Britton, K., Ormsby, M., 2006. Time-temperature schedules to kill wood inhabiting fungi: proposed test method. Report to the International Forestry Quarantine Research Group. Rome, September 2006. Document : http:// /www.forestry-quarantine.org/Sept08/2006_Uzunovic-HT-protocol.pdf.

Uzunovic, A., Byrne, A., Gignac, M., Yang, D.-Q., 2008a. Wood discolourations and their prevention with an emphasis on bluestain. FPInnovations – Forintek Division. 48 p. (Special publication No. SP-50) [W-2531].

Uzunovic, A., Byrne, T., Yang, D-Q., Morris, P., 2003. Review of mold issues in North America and mold related research at Forintek. International Research Group on Wood Preservation. Document No. IRG/WP/03-10458.

Uzunovic, A. Khadempour, L., Leung, K., 2009. Heat disinfestation of fungi found in wood affected by mountain pine beetle (MPB), Dendroctonus ponderosae (Coleoptera: Scolytidae) in the context of international trade. Canadian Journal of Forest Research. (submitted).

Uzunovic, O'Callahan, D., Kreber, B., 2004 Mechanical tree harvesters spread fungal inoculum onto freshly felled Canadian and New Zealand pine logs. Forest Products Journal. 54(11): 34-40.

Uzunovic, A., Schroeder, T. Janowiak, J. and Hoover, K., 2008b. Sample preparation, inoculation and incubation of test wood with PWN. Report to the International Forestry Quarantine Research Group. Rome, September 2008. Document 2008-IFQRG-25.

Uzunovic, A., Webber, J.F., Peace, A.J. and Dickinson, D.J., 1999b. The role of mechanized harvesting in the development of bluestain in pine. Canadian Journal of Forest Research. 29(2):242-251.

Uzunovic, A., Yang, D.-Q., Gagne, P., Breuil, C., Bernier, L., Byrne, A., Gignac, M., Kim, S.H., 1999a. Fungi that cause sapstain in Canadian softwoods. Canadian Journal of Microbiology 45:914-922.

Wan, H., Wang, X.M., Yang, D.-Q., 2007. Utilizing eastern white cedar to improve the resistance of strand boards to mold and decay fungi. Forest Products Journal. 57 (3): 54-59.

Wan, H., Yang, D.-Q., Zhang, C., 2006. Impact of biological incising to improve phenolic resin retention and hardness of various wood species. Forest Products Journal. 56 (4): 61-67.

Wang, J., Morris, P.I., 2008. Effect of climate change on above ground decay hazard for wood products according to the Scheffer Index. Proceedings Canadian Wood Preservation Association. 29: 92-103.

Wang, J., Morris, P. I., McFarling, S., Byrne, T. 2007. Developments in Borate Treatment of Canadian Species for Decay and Termite Resistance. The International Research Group on Wood Protection. Document No. IRG/WP 07-30443. IRG, Stockholm, Sweden.

Wang, J., Ni, C., Zhang, J.H., 2009. Ensure Durable Wood-Frame Construction under the Climate and Biological Hazards in Shanghai. The International Research Group on Wood Protection. Document No. IRG/WP 09-20413. IRG, Stockholm, Sweden.

Wang, J., Wu, X., Jiang, M., Morris, P.I., 2007. Decay hazard classifications in China for exterior above-ground wood. The International Research Group on Wood Protection. Document No. IRG/WP 07-20357 10p. IRG, Stockholm, Sweden.

Woo, C., Daniels, C.R., Stirling, R., Morris, P.I., 2010. Tebuconazole and propiconazole tolerance and degradation by basidiomycetes: A wood-based bio-assay. International Biodegradation and Biodeterioration. (Submitted).

Yang, D.-Q., 2003. Biotechnology applied in wood protection: present and future trend. In: Resent Research Developments in Cell Biology. Transworld Research Network, Kerala, India. pp.131-144.

Yang, D.-Q., 2004. Isolation of wood staining fungi from standing trees of jack pine. Forest Products Journal 54(12): 245-249.

Yang, D.-Q., 2005. Isolation of wood-inhabiting fungi from Canadian hardwood. Canadian Journal of Microbiology 51:1-6.

Yang, D-Q., 2007. Control of moisture content in wood materials for mold growth The International Research Group on Wood Protection. Document No. IRG/WP 07-10630 11p. IRG, Stockholm, Sweden.

Yang, D-Q., 2008a. Water absorption of various building materials and mold growth. The International Research Group on Wood Protection. Document No. IRG/WP 08-10657 10p. IRG, Stockholm, Sweden.

Yang, D.-Q., 2008b. Reduction of wetwood content in lumber by biological treatment. In: Proceedings of Quality Drying for the 21st Century: Energy and Market Realities. Forest Products Society, Madison, WI, USA. pp 99-106.

Yang, D-Q., 2009a. Potential utilization of plant and fungal extracts for wood protection. Forest Products Journal. 59(4): 97- 103.

Yang, D-Q., 2009b. Biological treatment to improve wood product quality and durability – Fifteen years of effort and experience at FPInnovations-Forintek Division. The International Research Group on Wood Protection. Document No. IRG/WP 09-40444 10p. IRG, Stockholm, Sweden.

Yang, D.-Q., Gignac, M., Bisson, M.-C., 2004. Sawmill evaluation of a bioprotectant against moulds, stain and decay on green lumber. Forest Products Journal 54(9):63-68.

Yang, D.-Q., Wan, H., Wang. X.M., 2006. Increasing mould resistance of strand boards with spruce heartwood. Forest Products Journal 56 (11/12):111-115.

Yang, D-Q, Wan, H., Wang, X.M., 2007a. Potential of Biological treatment to improve durability of composites. Proceedings Canadian Wood Preservation Association. 28: 138-146.

Yang, D.-Q., Wan, H., Wang, X.M., 2007d. Use of fungal metabolites to protect wood-based panels against mould infection. BioControl. 52:427-436.

Yang, D.-Q., Wang, X.M., Wan, H., 2007b. Biological treatment of aspen strands to improve mold resistance and reduce resin consumption of strand boards. Forest Products Journal 57 (7/8):58-62.

Yang, D.-Q., Wang, X.M., Wan, H., 2007c. Biological protection of hardwood logs destined for panel manufacturing using *Gliocladium roseum* against biodegradation. BioControl. 52:559-571.