UVic Centre for Forest Biology at the

by B.J. Hawkins, Centre for Forest Biology, University of Victoria

This is an exciting time for biological research, and tree biology is no exception. New molecular and genomic tools are allowing us to explore fundamental questions of how trees grow and interact with their environment. Using these new tools in concert with physiological and ecological approaches is giving us new understanding of the control and regulation of growth, reproduction, and stress resistance.

Ian Major and Peter Constabel photo

Patrick von Aderkas photo

Top photo: *Western tent caterpillar on trembling aspen.*
Bottom photo: *Taxus x media pollination drop.*

The Centre for Forest Biology, a Research and Graduate Training Centre at the University of Victoria (UVic), is at the forefront of this new era in forest research. We are a group of researchers and graduate students in the Departments of Biology and Biochemistry and Microbiology at UVic, who also work with adjunct professors from the BC Ministry of Forests and Range (MFR), Pacific Forestry Centre, and the private sector. We seek to understand the adaptations of trees and their interactions with the environment at levels ranging from the gene to the whole plant. We also train students and post-doctoral fellows in a collaborative atmosphere, often working closely with scientists in federal and provincial research laboratories and industry.

Since the genome of black cottonwood (*Populus trichocarpa*) was sequenced and published in 2006 by an international team of researchers including Centre faculty, poplar has become the "fruit fly" of tree biology research. Many of the researchers at the Centre for Forest Biology use poplar as a model organism to understand the basic biochemistry of tree growth and disease resistance. Research in the **Constabel** and **Ehlting** labs is discovering the molecular mechanisms and biochemistry of the synthesis of phenylpropanoids, a large group of compounds important in plant development and defense in poplar and other plants. Lignin is a phenylpropanoid that makes up to one-third of wood dry weight and is the second most abundant polymer on earth. Understanding the biosynthesis of lignin will help us develop wood with reduced lignin content for optimal pulping or biofuel production.

Tannins are another abundant group of phenylpropanoids that protect plants, particularly trees, from pests, pathogens, and other stresses. In addition, tannins are a carbon sink in forest ecosystems and have a direct impact on nutrient cycling in forest soils. In poplars and aspens, pest damage rapidly stimulates tannin synthesis, which may make the foliage less palatable, thereby reducing further attacks. Our researchers have identified a key regulatory gene of tannin synthesis that increases leaf tannin content and impacts insect feeding, and could potentially be used to increase sequestration of carbon in forest soils. The research team is working to apply their discovery to other useful plants, especially apples and blueberries, which also contain tannin and other compounds that promote health in humans, including a reduced risk of cardiovascular disease.

Although insect pests have dramatic, visible impacts on forests, diseases caused by fungi and other microbes also result in the loss of millions of cubic metres of wood annually in BC. Researchers in the **Hintz** and **Misra** labs at UVic are using molecular tools to control several important forest diseases. One focus of their research is the fungus-causing Dutch elm disease, *Ophiostoma ulmi*. Efforts are focused on understanding what makes the fungus such a lethal pathogen and how to decrease its pathogenicity. Interestingly, Dutch elm disease has some parallels to the mountain pine beetle in that tree death is caused by a related pathenogenic fungus transmitted by a bark beetle. Therefore, lessons learned from these studies may be applicable to the mountain pine beetle epidemic in BC. Taking a different approach to disease control, some Centre members are developing cationic peptides that have anti-microbial action, while others are trying to harness pathogenic fungi for our own purposes. By developing particular strains of the fungus *Chondrostereum purpureum* as a certified biological control agent, researchers are hoping to manage forest weeds.

In the **von Aderkas**, **Hawkins**, and **Roy** labs, studies of the reproductive biology, tree physiology, and soil microbial ecology of BC forest species and ecosystems are being applied to tree breeding, forest regeneration, and silviculture. The background for much of this work is the forest's response to climate change; we are striving to find ways to mitigate the expected effects of warming and drying climates on our long-lived tree species. For example, soil process studies are examining how

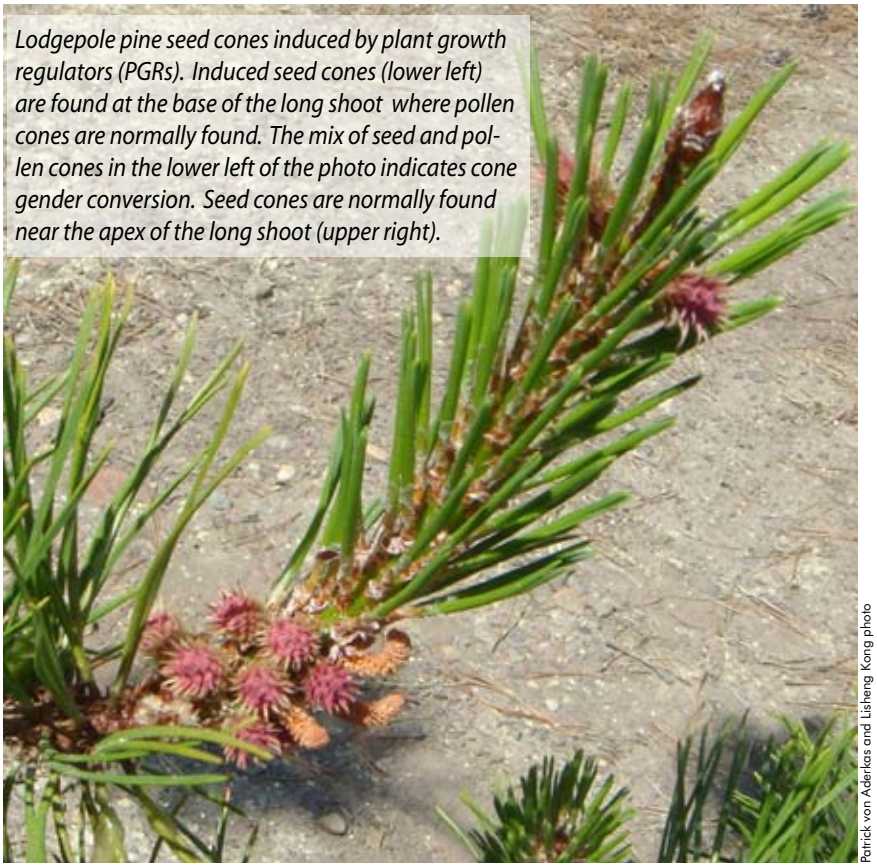
forefront of new era in forest research

thinning and fertilization can affect nitrogen cycling and the consumption of methane, a greenhouse gas 25 times more potent than CO_2, in forest soils.

Many climate change-related projects are in collaboration with the MFR. Seed production from BC seed orchards is one area of focus, particularly lodgepole pine orchards, where large volumes of seed are needed to produce seedlings to reforest areas devastated by the mountain pine beetle. Seed is in high demand, but supply from North Okanagan seed orchards is limited by poor cone production. Centre researchers have been experimenting with plant-growth regulators such as abscisic acid, auxin, cytokinin, and gibberellin that are applied during cone initiation, and have found new treatments that increase female seed production by altering the sex determination of pollen cone buds and turning males into females! Work in Douglas-fir seed orchards is exploring how a seed insect, *Megastigmus spermotrophus*, is able to parasitize seed and fool the mother tree into feeding the growing insect larva rather than the tree embryo. Other work in tree reproductive biology has found proteins in the secretions from conifer ovules that could kill fungal spores and bacteria, and protect the developing seed. These anti-microbial proteins may potentially find application in human medicine.

Collaborative studies between scientists in the Centre for Forest Biology and the MFR's Forest Genetics Section are measuring growth, cold, and drought hardiness of Douglas-fir and red alder families on progeny test sites to find families that are fast-growing, yet resistant to environmental stress. We are also working with the Sitka spruce breeding program to help develop lines resistant to the white pine weevil, which kills the leaders of young Sitka spruce. Resistant trees produce large amounts of protective resin and have tough sclerid cells that help resist weevil feeding. We are exploring how genotype and the environment affect these protective features.

Research at the Centre for Forest Biology spans all levels of biological organization from the gene to the ecosystem. In 2010. we will be celebrating our 20th anniversary as a UVic Research Centre, with sustained funding from a diverse range of agencies including the Natural Sciences and Engineering Research Council, Forest Investment Account–Forest Science Program, and previous provincial funding agencies, Canadian Foundation for Innovation, National Centres of Excellence, BC MFR, and Genome BC. In the past 5 years, the Centre has trained 25 PhD and MSc students as well as a large number of postdoctoral fellow and international students. We have strong provincial, national, and international collaborations and always welcome new collaborators. To find out more about our research, please visit our website (***http://web.uvic.ca/forbiol/***) or contact ***forbiol@uvic.ca***, ***bhawkins@uvic.ca*** or phone 250-721-7117.



Lodgepole pine seed cones induced by plant growth regulators (PGRs). Induced seed cones (lower left) are found at the base of the long shoot where pollen cones are normally found. The mix of seed and pollen cones in the lower left of the photo indicates cone gender conversion. Seed cones are normally found near the apex of the long shoot (upper right).

Patrick von Aderkas and Lisheng Kong photo

Research Groups

Molecular Biology, Biochemistry and Ecology of Tree Defense Against Insect Herbivores (Peter Constabel)

Functional Genomics of Plant Natural Products (Jürgen Ehlting)

Conifer Nutrition and Cold Hardiness (Barbara Hawkins)

Fungal Genetics and Molecular Biology (Will Hintz)

Structure and Regulation of Gene Expression and Developing Gene Transfer Technology in Plants (Santosh Misra)

Molecular Biology and Microbial Ecology of Soil (Réal Roy)

Tree Reproductive Biology (Patrick von Aderkas)

To learn more about the Research Groups, visit ***http://web.uvic.ca/forbiol/research-groups/index.htm***