CANADIAN TREE IMPROVEMENT ASSOCIATION/
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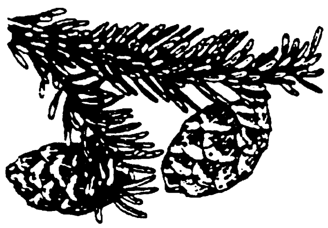

Tree Seed Working Group

NEWS BULLETIN

No. 41 June 2005

CONE AND SEED PESTS

THIS ISSUE AT A GLANCE

CHAIR'S 'ARMCHAIR' REPORT

The cycle of cone crop development is underway and I wish everyone all the best with their 2005 crops. The theme of this edition is the 'pests' that degrade our crops through seed and/or pollen consumption, cone-opening restriction, fungal contamination and/or infection, and seed death. Thank you to everyone who contributed to this News Bulletin – it simply could not happen without your input.

Although exceptions exist, insect pests generally consume developing cones and fungi generally cause seed deterioration and mortality of young seedlings. Both pests can have incredible financial consequences within the seed handling system. In 2004, *Dioryctria* spp. (coneworms) were estimated to have caused over $ 1,000,000 worth of seed loss to interior BC spruce crops alone!

The significance of these losses is huge and is only shadowed by the incredible devastation being caused in BC by the mountain pine beetle. The BC Ministry of Forests has responded to our seed losses and will be advertising a research position for a cone and seed entomologist. More information can be found in Robb Bennett's contribution (page 21). Our need for assistance with our pest problems will only increase with greater reliance on orchard-produced crops, a reduction in available pesticides, and the unknown consequences of climate change on the interactions with pests. I hope this edition enlightens you on some pest issues and helps advance your program in dealing with many of our common crop enemies.

Summer is generally a time when we have the opportunity to interact with colleagues at the various meetings occurring throughout Canada and beyond. I invite all of you to provide a brief synopsis of meetings you attend that have implications to tree seed science and technology. As a heads-up, the summer of **2006** will provide some great opportunities to increase your knowledge concerning tree seed science and technology. The CTIA meeting will be held August 21–24 in **Charlottetown, Prince Edward Island** and we will be hosting a Tree Seed Working Group workshop. If you have specific ideas concerning a theme or topic, please forward them to Dale or myself. We are also excited that the IUFRO Seed Physiology and Technology Research group (2.09.00) is planning their next meeting in Fredericton, NB to allow participants to attend both the CTIA and IUFRO meetings. This is an excellent opportunity to meet some of the world's most distinguished scientists working on the physiological and technical issues associated with forest tree seed. It may be worthwhile indicating the uniqueness of this opportunity to your managers. Further details of this IUFRO meeting will appear in the December issue of the News Bulletin.

For the next edition of the News Bulletin the theme will be "**Cone and Seed Processing**". I am interested in hearing from cone and seed processors regarding their operational results (and how they present them) as well as any processing steps that have been integrated to improve processing efficiency. Articles concerned with seed upgrading are also welcomed as these subjects fit well together. I wish everyone a wonderful summer and I greatly look forward to next year's meetings on the East Coast, catching up with friends and colleagues (and the associated lobster boils – nudge, nudge – wink, wink) ☺

Dave Kolotelo
Chairperson

EDITOR'S NOTES

Many thanks to Dave again for all his hard work and successful persuasion techniques in soliciting articles for this New Bulletin. The theme "Cone and Seed Pests" is aptly chosen because these organisms can have such an impact on seed production. Seed losses not only impact the seed orchard manager's bottom line but have further reaching consequences by delaying the deployment of genetically improved planting stock thus impacting Annual Allowable Cut and future stumpage values and harvesting costs.

Several articles deal directly with control of these pests. I am sure you will find something of interest in this issue. You will also find a number of general interest and newsy articles. It is this diversity that I think continues to make the News Bulletin interesting and successful.

Dale Simpson
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Comments, suggestions, and contributions for the News Bulletin are welcomed by the Chairperson and Editor.

Dioryctria RESEARCH IN BRITISH COLUMBIA

The Fir Coneworm, *Dioryctria abietivorella*, is a North American native in the moth family Pyralidae, or snout-nose moths (Fig. 1). Many members of this family are pests in the larval form, and *D. abietivorella* is no exception. As its common name implies, the larvae of this species feed on cones of Douglas-fir, tunneling through the cones and eating the seeds as they go. Despite its common name, it also attacks the cones of many other conifers, and will also feed on the cambium layer of stems and branches, particularly near wounded areas.

Feeding damage

Cambial feeding by *D. abietivorella* larvae is most problematic with newly grafted seed orchard trees. Up to 10% of grafts have been found attacked,

Figure 1. Adult male D. abietivorella.

Figure 2. Spruce cones attacked by larvae of *D. abietivorella*.

which weakens the graft union, introduces pathogens, and sometimes kills the tree. The adult female moth detects the graft wound, despite it being covered with grafting wax and tape, and lays eggs near the wound. The larvae are small enough to find their way to the graft union, where they tunnel the wounded area. Attacks sometimes continue in the second year after grafting, when the wound is apparently healed. Though sprays of systemic insecticides have been found to reduce the number of attacks, this is an intransigent problem with no solution ready at hand.

Cone feeding is the greater economic problem. *Dioryctria abietivorella* prefer soft cones such as Douglas-fir, spruce, hemlock, and white pine. Harder cones such as lodgepole and ponderosa pine are infrequently attacked and they have not been found feeding on western red cedar or yew. Multiple larvae are often found inside a single cone, which they riddle with tunnels leaving few seeds. They then move to nearby cones, continuing until they are large enough to pupate. As they feed, they tie cones together with silken webbing, and also leave globs of frass hanging from the cones (Fig. 2). Cones which have been attacked frequently dry out and open early, thus shedding any remaining viable seed before harvest.

Population cycles

In British Columbia (BC), *D. abietivorella* has flared up in Douglas-fir and hemlock seed orchards on the coast, become a problem for a year or two, and then faded away. The ecological forces behind the sporadic appearance of this insect are not known. Its on-again, off-again nature has provided neither opportunity nor incentive to look into its life cycle, population dynamics, or ecology, knowledge which is fundamental to developing a pest management plan.

In 2002 another cycle appeared to be starting in the interior seed orchards of BC. Rather than fading away after a couple years, though, it continued to increase, to the point that up to 80% of spruce and Douglas-fir cones were attacked. One estimate is that up to $1 million worth of seed were lost in 2004. Populations also appeared and have persisted on the coast, and there have been persistent populations developing in many seed orchards in the USA as well. Unfortunately, little basic biology of *D. abietivorella* is known, hindering our ability to manage this pest affectively.

Basic biology

It is thought that most *D. abietivorella* overwinter as late-instar larvae, pupating in early spring. By mid-May the first damage is seen in cones of Douglas-fir in interior orchards. Cone damage increases as the year progresses and larvae of all different sizes are seen at any given time, implying that there are multiple or overlapping generations within a year. At harvest, infested cones are stored in cone sacks along with clean cones and the larvae continue to feed within the bag, moving from cone to cone. Therefore damage can continue even after harvest. When they are full-size (5th instar), they leave the cones to find a site to spin their cocoon. This is often in the fabric of the cone sack, though they also move away from the sack and are seen marching in full rank away from the cone shed. Where they spin cocoons in nature is not known, though it is probably in bark crevices, old cones, and duff and needle litter on the ground. It is not known whether the earlier larvae, which mature in late June, pupate and emerge as moths in the current year or go into diapause immediately, to emerge the following spring. It is not known where eggs are laid in nature, though it is probably on the needles or shoots near cones. It's also not known whether other life stages are capable of overwintering: adults, young larvae, or eggs. We don't know how long adults live, though the presence of new larvae showing up throughout the summer implies that adults hang around and continue to lay eggs for a considerable period of time. We don't know how far adults move, though they are likely good fliers which can easily fly from orchard to orchard. All of these bits of information are important in the development of a rational pest management plan.

Pesticide research

Despite our lack of biological knowledge, the problem was severe enough that we embarked on a pesticide trial in 2004 to provide immediate relief from damage. Dimethoate 480E, being both registered in seed orchards and a systemic pesticide, was chosen. Two replicated experiments were conducted in interior Douglas-fir seed orchards. In the first, we applied dimethoate by airblast sprayer to large orchard blocks. Treatments were a 5% solution, 2% solution, and a double application of 5% followed after 6 weeks with a 2% application. In the second experiment, we applied dimethoate with a backpack sprayer to individual trees. Treatments were 2.5%, 1%, and a double application of 2.5% followed after 6 weeks with a 1% application. In both experiments, the first application was applied just after conelet receptivity, when the cones were half-pendant. We found that with no sprays, cone infestation increased over time. By late July, between 60 and 90% of all cones showed feeding damage. With a single spray at either concentration, damage was reduced to between 0 and 9% at the first damage assessment in mid-June. By late July though, damage had increased to between 38 and 57%. With the double application, damage in late July was held to between 4 and 7%. With the single sprays, most of the damage in late July was caused by young larvae, with only small amounts of damage on each cone. Therefore it appears that each application of dimethoate, regardless of rate, provided approximately 6 weeks of protection from *Dioryctria*.

When applied just after cone receptivity, 12 weeks of protection was not enough to carry through to harvest. Indeed, at harvest in early August, even the cones with double sprays were showing significant amounts of damage, though no quantitative assessment was conducted. Therefore in 2005 we have similar trials, but timed so that the first spray is applied when the first sign of larval feeding is detected. This should extend the period of coverage right up until harvest.

Unfortunately, dimethoate registration is currently under review by the Pest Management Regulatory Agency (PMRA) and there is a possibility that its registration will be lost. In anticipation of this, we have also started an individual-tree trial using two other promising chemicals, Admire (imidacloprid) and Tristar (acetamiprid), both in the neonicotinamide group of insecticides. These are highly systemic chemicals and are not undergoing PMRA review. If one provides adequate control it will be submitted to PMRA for a user requested minor use label expansion (URMULE).

Pheromone research

Pheromones are odours released by insects to communicate with each other. Many moths use female-released sex pheromones which males track to find mates. Sex pheromones can be used in pest management to determine flight phenology and the number of generations, to time sprays, and to control moths. The sex pheromone for *D. abietivorella* was not known for many years; a known blend of three chemicals attracted only a few moths. In 2004 we joined with workers at the Canadian Forest Service and the University of California to try to optimize the blend and find other missing components which would make the blend highly attractive to male moths. Different blends were used in wing traps to attract and catch male moths. The first try was not terribly successful, but we did get an early start on flight times and population trends. Males were first caught in early April, and catches increased to a peak in early July (Fig. 3).

Subsequently a new chemical was discovered which promised to be the "missing link". We first tried this chemical in early August, and immediately started catching large numbers of moths (Fig. 4). Catches peaked in mid-September and continued until late October. Apparently male moths are flying and sexually active throughout the season. Their presence suggests that females are around and mating; this in turn implies that they are laying eggs right up until winter. Do these eggs overwinter? Do they hatch and the larvae overwinter? Do they all die? If so, why are the females laying them? Is it possible that males fly around for weeks after receptive females have disappeared? These questions and more need answering in the future.

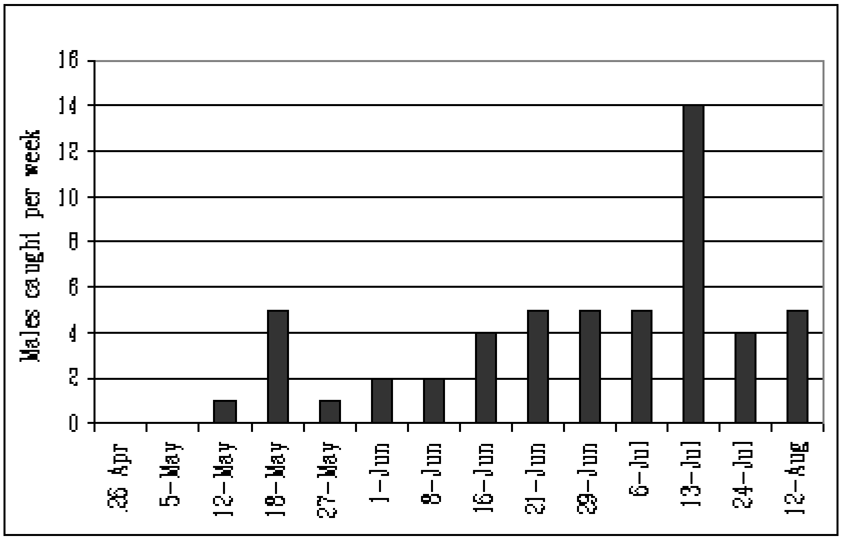

Figure 3. Total moths caught in 2004 with the 3-component blend. Trapping stopped in mid-July.

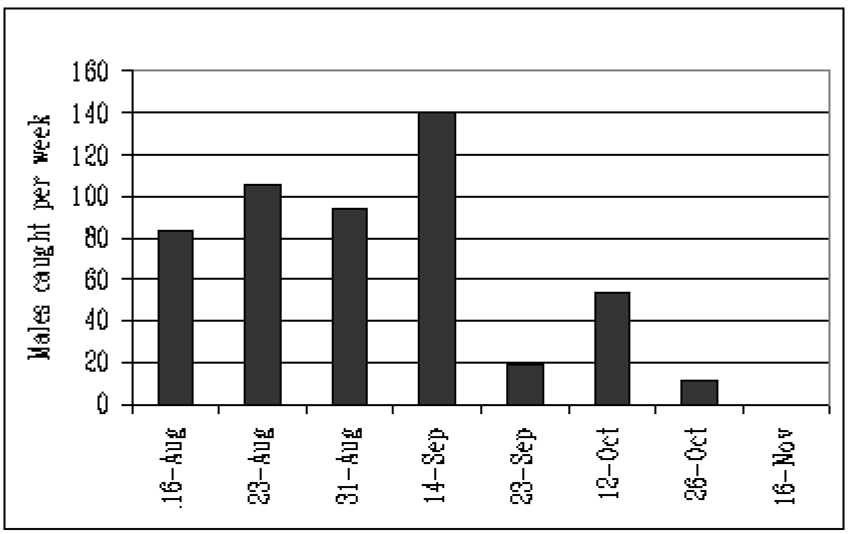

Figure 4. Total moths caught in 2004 with the improved 4-component blend. Trapping started in early August and continued through until no more moths were caught.

We have started trying to answer some of these questions in 2005 using the new pheromone blend. We have deployed a series of traps in both the interior and on the coast to determine when flight starts, how long it lasts, and whether there are detectible population peaks. So far the earliest catches have been in the Fraser Valley and south Vancouver Island, in mid April. Traps in north Vancouver Island and the Interior followed by one to two weeks. Traps at higher elevations have yet to catch anything at the time of writing (May 21). We also plan to determine where on the tree traps should be hung; towards the top or near the bottom. Another experiment is designed to determine the best type of trap to use, testing four common pheromone traps.

We are also working to optimize the blend of chemicals which make up the pheromone lure. Moths are highly sensitive to relative concentrations of the chemical, and our first guess from last year may not be the most attractive. We have a series of experiments to determine the most attractive ratio of each of the four components.

If we find a ratio which is attractive enough, it may be possible to use the pheromone in a mating-disruption program. This is a means of controlling the moths without using insecticides. *Dioryctria abietivorella* pheromone is placed in an orchard at a very high dose. Because the entire area is swamped with pheromone, the male moths are unable to track the pheromones of females. Therefore, females go unmated and do not produce the larvae which feed on cones. Mating disruption has been used successfully with many other moth species, notably moths attacking fruit trees such as codling moth and leaf rollers. With luck, this new pheromone may make our pesticide research redundant!

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TENTATIVE BIOLOGICAL CONTROL OF CONIFER SEED INSECTS USING PARASITOIDS – A CASE STUDY OF THE DOUGLAS-FIR SEED CHALCID, *Megastigmus spermotrophus* WACHTL

The Douglas-fir seed chalcid, *Megastigmus spermotrophus* Wachtl (Hymenoptera: Torymidae), was probably introduced to Europe during the last part of the 19th century from Western North America along with seeds of its host, Douglas-fir (*Pseudotsuga menziesii*). At present, the chalcid is widespread throughout Douglas-fir plantations and seed orchards in Europe, and severely impacts seed orchards. Because the use of pesticides is less and less accepted in Europe, two European teams from France (INRA Orléans, Dr. A. Roques) and Belgium (Université Libre de Bruxelles, Drs. A.C. Mailleux and J.C. Grégoire) in collaboration with the Canadian Forest Service (J.J. Turgeon, Sault Ste Marie) are considering the possibilities of classical biological control, by using parasitoids originating from the chalcid's native range.

In the native range of Western North America, little information exists about possible parasitoids due to both the minor impact of seed chalcids compared to that of other cone insects attacking Douglas-fir and the way of collecting seeds from ripe cones. In Europe, a pteromalid, *Mesopolobus spermotrophus* Hussey (Hymenoptera: Pteromalidae), has been recorded since the 1950s, but it seemed to have limited impact on chalcid populations. Because no parasitoids were previously observed over billions of chalcid-infested seeds collected when the cones are still closed we hypothesized that the parasitoids may attack the chalcid larvae only when the cones begin to open and the seeds become easily accessible. Cone collections were thus carried out during autumn and winter of 1998–2003 throughout the native American range of the Douglas-fir seed chalcid. A total of 132 natural stands of Douglas-fir were sampled in British Columbia, Washington, Oregon, Utah, California, Colorado, and New Mexico, and additional collections were obtained from seed orchards of British Columbia by way of Robb Bennett (BC Ministry of Forests, Victoria BC). In addition, seed traps were also designed to offer large numbers of chalcid-infested seeds to parasitoids in native stands in Oregon, California, and Utah. Finally, all seeds were submitted to X-ray analysis, and about 23 000 chalcid-infested seeds could be individually reared in France.

A total of 4 chalcid parasitoid species emerged from these seeds. Apart from *Mesopolobus spermotrophus*, they included another *Mesopolobus* species, new for science, which is currently in the process of description as *Mes. americus* Dzhakomnen and Roques, an eupelmid, *Brasema* nr. *brevicauda*, and an eurytomid, *Eurytoma* sp. Laboratory rearings proved that *Mes. americus* is a primary parasitoid of *M. spermotrophus* while the status of the two other species remained uncertain. A few specimens of the three species were observed in Belgian plantations but not in France suggesting possible accidental introductions in the former country. All these species are capable of prolonged diapause for over 2 years such as is the case with *Megastigmus*.

During summer 2002, 240 specimens of *Mes. americus* (120 males, 120 females), originating from British Columbia, were released in four plantations surrounding a Douglas-fir seed orchard in south-western France, which is heavily infested every year by *Megastigmus spermotrophus* arriving from nearby plantations. The parasitoids were not released within the orchard because all the cones are collected every year preventing the development of a resident parasitoid population. A mathematical model was previously designed to select plantations which contributed the most to the annual invasion of the orchard by *Megastigmus* (Jarry et al., Can. Entomol. 1997). The release was apparently successful because by winter 2003 we found that 8 to 15% of the chalcids were parasitized by *Mes. americus* in the four plantations used for release. However, parasitoid dispersal remained limited because *Mes. americus* was found in only two additional plantations, including the seed orchard (1% parasitism) over a total of 40 surveyed. It was not possible to carry out a new release in 2003 because parasitoid rearings were affected by the severe heat which occurred in central France during that summer. In the summer of 2004, 160 *Mes. americus* from the same Canadian origin as these of 2002 could be released in the same four plantations. The cone collections planned during autumn 2005 will indicate whether or not the released parasitoids could contribute or not to a decrease in the population density of *Megastigmus* in the seed orchard.

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OCCURRENCE OF WESTERN CONIFER SEED BUG, *Leptoglossus occidentalis* Heidemann, (Heteroptera: Coreidae) IN NEW BRUNSWICK AND NOVA SCOTIA

According to Hedlin et al. (1981), the distribution of the western conifer seed bug, *Leptoglossus occidentalis* Heidemann, in the United States extended from northern Texas to North Dakota and westward and across southern British Columbia, Alberta, and Saskatchewan. McPherson et al. (1990) documented its spread to eastern Michigan and provided a key to the North American species. Records in the University of Michigan Museum of Zoology and University of Guelph collection showed that *L. occidentalis* had been present in Michigan and Ontario since at least 1983 and 1985, respectively (Marshall 1991). In a comprehensive coverage of the seed bug's eastern expansion, Gall (1992) accounted for numerous specimens from several jurisdictions including western New York State and southern Ontario. It was first collected in Connecticut in 1985 (Ridge-O'Conner 2001). In 1994, it was first discovered at Mt. Vernon, Maine and by 1998 it could be found throughout the southwestern portion of the State (Dearborn and Granger 1999). In 1999, it was recovered as far east as Ottawa (M. Schwartz, pers. info.). Outside of North America, *L. occidentalis* was recently found in northern Italy where it was accidentally introduced (Taylor et al. 2001, Tescari 2001).

In New Brunswick (NB), the Provincial Department of Natural Resources has well-established forest management plans based on detailed wood supply analyses and future projections. An integral component of these long-term plans is a reforestation program based on planting seedlings from seed orchards established from traditional genetic breeding to produce faster-growing trees. To guard against unwanted seed losses due to pest attack, annual monitoring programs have been conducted in seed orchards since 1988.

The senior author has been involved with this pest monitoring program since its inception. In July 1999, during a routine visit to a jack pine seed orchard located at the Kingsclear Nursery at Island View, NB, a seed bug was found resting on a jack pine shoot. The insect was collected and later confirmed to be *L. occidentalis* Heidemann by M. Schwartz. This was its first occurrence in NB and to the best of our knowledge was the eastern most record in North America for *L. occidentalis* at that time. This stimulated interest for compiling the recent records of the western conifer seed bug in the Maritimes. Since 1999, specimens of this insect have been collected in several years and at several locations in NB and Nova Scotia (NS) (Table 1). The first record of the western conifer seed bug in NS was at Kentville in April 2001, when 12 adult specimens were collected inside a private residence by the homeowner, sent to J. Sweeney and R. Rogers, and subsequently confirmed as *L. occidentalis* by M. Schwartz (Anon. 2001, Georgeson 2001). The most recent report of the insect in either Province was in 2005 at Paradise, NS (J. Ogden, pers. comm.) (Table 1).

This insect has not yet been recorded from Prince Edward Island (M. Butler, pers. comm.), Newfoundland, or Labrador (H. Crummey, pers. comm.). Consequently, the New Glasgow, NS findings represent the easternmost known distribution of the western conifer seed bug in North America (Fig 1).

Table 1. Summary of *L. occidentalis* collections in New Brunswick and Nova Scotia from 1999 to 2005. The initial specimen from 1999, plus four other voucher specimens (2 per sex) are retained in the National Collection at the Eastern Cereal and Oilseed Research Centre, Ottawa, Canada. Other vouchers are at Canadian Forest Service, Fredericton, NB.

Date	No. specimens	Location	Coordinates
		New Brunswick	
1999 July	1	Island View	N 45 57 26.4 W 66 47 59.4
2001 September	1	Fredericton	N 45 55 39.9 W 66 38 16.6
2002 November	1	Fredericton	address not specified
2003 March	1	New Maryland	N 45 53 13.8 W 66 41 15.5
2004 October	1	Fredericton	N 45 55 39.9 W 66 38 16.6
2004 October	1	Fredericton	N 45 58 40.0 W 66 40 12.2
		Nova Scotia[1]	
2001 April	12	Kentville	N 45 04 18.48 W 64 29 6.0
2003 April	1	Kentville	N 45 04 18.48 W 64 29 6.0
2003 December	1	Mill Village	N 44 08 9.0 W 64 27 45.6
2004 March	9	Kentville	N 45 04 18.48 W 64 29 6.0
2004 March	1	New Glasgow	N 45 35 13.98 W 62 39 13.98
2004 October	3	New Glasgow	N 45 35 13.98 W 62 39 13.98
2005 February	1	Paradise	N 44 51 42.96 W 65 12 54.24

[1] Data provided by J. Ogden, NS Dep. Nat. Res.

Leptoglossus occidentalis has a broad host range. Hedlin et al. (1981) list Douglas-fir, grand fir, incense-cedar, Jeffrey pine, knobcone pine, lodgepole pine, Monterey pine, ponderosa pine and western white pine as hosts, and interior spruce is also known to be attacked (W. Strong, pers. comm.). In western North America, *L. occidentalis* can have a significant impact on seed production in lodgepole pine (*Pinus contorta* var. *latifolia*) (Strong et al. 2001, Bates et al. 2002), Douglas-fir (*Pseudostuga menziessi*) (Bates et al. 2000), and western white pine (Connelly and Schowalter 1991).

Blatt and Borden (1996) observed low seedbug damage in Douglas-fir seed orchards in coastal British Columbia but speculated that damage would be greater in warmer sites or years. To date, there have been no reports of seed damage by the seedbug in Maritime forests and seed orchards, but it may be simply a matter of time. Cones and seeds fed upon by the seedbug have no external signs of damage at harvest (Koerber 1963); damaged seeds appear partially filled or empty in radiographs, and the latter are indistinguishable from seeds that have aborted for environmental or genetic reasons (Schowalter and Sexton 1990). It is therefore possible that damage has already occurred in Maritime seed orchards but has gone undetected. However, seedbugs are large and fairly conspicuous (especially when they occur in large numbers and elicit complaints from members of the public who find them in and on their homes in late summer and fall), so it is unlikely that high seedbug populations or extensive seed damage has occurred in the Maritimes to date. Judging by the repeated records of the seedbug in NB from 1999–2004, and earlier records from Michigan, the seedbug successfully overwinters in colder climates, likely due in part to its habit of seeking overwintering sites in houses. We encourage seed orchard managers in eastern Canada to keep an eye out for the seedbug and for seed damage that may be associated with the seedbug, such as high levels of empty or partially-filled seeds.

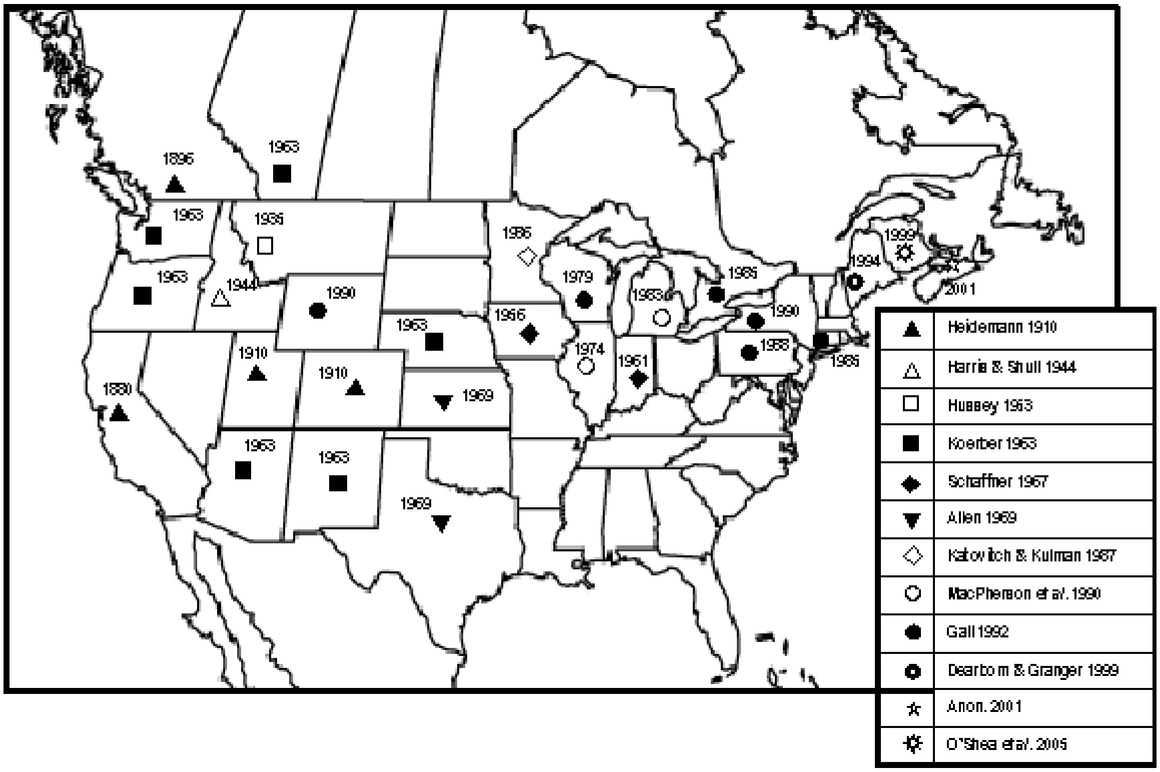

Figure 1. Distribution of *Leptoglossus occidentalis* across North America from 1880 to 2005. (Map is updated from Gall 1992. *Note: sources identified in map key are provided in the references*).

Acknowledgments

We thank Robert Meister for collecting and submitting seedbug specimens, Jeff Ogden for providing NS records of the seedbug, Hubert Crummey and Mike Butler for checking specimen collections in Newfoundland and Labrador and Prince Edward Island, respectively, Ross Farquhar for providing GPS coordinates, and Nelson Carter for helpful comments on an earlier version of the manuscript.

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BC MINISTRY OF FORESTS FUNGAL ASSAY PROGRAM

The BC Ministry of Forests has been co-ordinating a program for testing seedlots for pathogenic fungi since 1991. Results of this program were presented in Edition 27 (1997) of this News Bulletin, the Seed Handling Guidebook [SHG] (Kolotelo et al. 2001), and at various meetings. The intent of the program is to provide standardized seedlot test results on the incidence of the three significant seed-borne pathogens: *Caloscypha fulgens*, *Fusarium* spp., and *Sirococcus conigenus*. Michael Peterson's article on "Testing for Seed-borne Pathogens" in this News Bulletin provides an excellent support document to this article and the Seed Handling Guidebook provides the detailed test methodology for the fungal assays (Kolotelo et al. 2001).

The fungal assay results are an important tool for identifying high-risk seedlots and directing Integrated Pest Management (IPM) practices. The results of these tests are available on our seedlot information system (SPAR) and on the sowing request labels that are sent to nurseries with the seed.

The fungal assays are performed on dry seed as the results are far more repeatable and more easily standardized. The topic of this News Bulletin has encouraged me to review and share the data that we have gathered to date.

Fungal assay results are most useful when they are seedlot specific. It is also useful to have 'species' estimates for comparison and prioritization of IPM activities and this is the topic of this article. Initial species results, nursery feedback, and the experience of pathologists has aided in the construction of a priority matrix for fungal assay testing (Table 1). These priorities guide sampling of seedlots with additional consideration given to seedlot balance, germination capacity, and operational use.

Table 1. Priorities for fungal assay testing by pathogen and tree species

Species[1]	Fungi		
	Caloscypha	*Fusarium*	*Sirococcus*
Ba	High	Medium	Low
Bg	Medium	Medium	Low
Bl	High	High	Low
Cw	Low	Medium	Low
Fdc	Low	High	Low
Fdi	Low	Medium	Low
Hw	Low	Medium	Low
Lw	Low	High	Low
Plc	Low	Low	Low
Pli	Low	Low	Low
Pw	Medium	High	Low
Py	Low	High	Low
SS	High	Medium	High
Sx	High	High	High
SxS	Medium	Medium	High
Yc	Low	Low	Low

[1] Ba-Amabilis fir; Bg-grand fir; Bl-subalpine fir; Cw-western red-cedar; Fdc-coastal Douglas-fir; Fdi-interior Douglas-fir; Hw-western hemlock; Lw-western larch; Plc-coastal lodgepole pine; Pli-interior lodgepole pine; Pw - white pine; Py-Ponderosa pine; SS-Sitka spruce; Sx-interior spruce; SxS-Sitka X interrior spruce hybrid; Yc-yellow cedar.

Species estimates of contamination (*Fusarium* spp.) or infection (*Caloscypha* and *Sirococcus*) can be presented in a variety of ways:

1) **% Seedlots affected**[2] – indicates the proportion of tests for a pathogen that indicate a result > 0.0. This provides a 'reasonable' probability estimate for the occurrence of a specific fungi on the seed of a tree species.
2) **Affected average** – provides the average level of contamination or infection for seedlots with a positive test result. Provides an indication of severity on a species basis. This could be used for prediction if one knew that the pathogen was present on the species of interest.

3) **Overall average** – provides the average contamination or infection level calculated based on all tests performed. The previous variable (Affected average) only includes positive test results, but all test results are averaged in this statistic. Without any additional information this could be used as the estimate of the level of a pathogen on a tree species.
4) **Maximum affected** – indicates the maximum test result obtained for a species/fungi combination. Provides an estimate of the worst-case scenario for seedlots of a species assayed to date.
5) **Sample size** – don't underestimate the importance of the sample size. An estimate performed on a large number of seedlots will be more accurate and precise than one performed on only a few seedlots.

In the past the percentage of seedlots tested was also presented. This was a difficult statistic to maintain as seedlots are continuously being used (expired) and others added to the inventory. This led to the question of what should be reported – should it be all seedlots ever tested or should it be seedlots that currently reside in the inventory? In the past all test results were presented and this makes maximum use of the data and can be considered the best 'Biological' estimates of the parameters. Others would argue that the results should be indicative of what is currently in the inventory and 'expired' seedlot data should not be included. This may offer a better predictive estimate of our current inventory, but it does not use all available data and would have lower precision than the previous estimate. Currently, 80% of the seedlots tested still have a seed balance (are active), but this varies somewhat by pathogen: *Caloscypha* (87%), *Fusarium* (77%), and *Sirococcus* (86%). The following detailed tables will use all of the available data, but an indication of the percentage of seedlots tested and still being used (active) is also included for reference.

[2] Affected is used to cover incidences of both contamination and infection. Read either contamination or infection for the pathogen of interest.

Results

The fungal assay program has had 5 719 seed assays performed (*Caloscypha* – 1 277 [22%]; *Fusarium* – 3 553 [62%], and *Sirococcus* – 889 [16%]). The assay results, by pathogen, are presented in Table 2 to provide a high-level comparison of the three pathogens. Assaying for *Fusarium* is clearly a priority and this pathogen is especially problematic operationally with Douglas-fir and western larch seedlots.

Table 2. Summary of fungal assay results conducted by the BCMoF Tree Seed Centre between 1992 and 2005

	Caloscypha	*Fusarium*	*Sirococcus*
Sample size	1 277	3 553	889
% of Program	22	62	16
% Seedlots affected	13.5	37.7	15.5
Affected average	3.8	1.8	0.6
Overall average	0.5	0.7	0.1
Maximum value	37.6	75.4	7.8

In general, average pathogen levels are relatively low, but certain seedlots can have extremely high levels. Even a high pathogen level does not guarantee a disease problem. Keep in mind the disease triangle that indicates the <u>pathogen</u>, a <u>susceptible host</u>, and <u>the proper environmental conditions</u> must ALL be present for a disease to occur. The detailed results of each fungus will be discussed separately in the following sections.

Caloscypha fulgens (seed or cold fungus)

Caloscypha fulgens infects and kills the contents of the seeds. Seeds become hard and mummified and the fungus can spread through direct contact during stratification. This fungus has been shown to increase in the field with prolonged contact with the forest duff under cool and moist conditions, but proper cone storage can halt the spread of the fungus (Sutherland 1981). Looking at seeds in storage it was found that collections derived from squirrel caches had significantly higher levels of *Caloscypha* compared to collections from slash or from the ground (Sutherland 1979). In a comparison of cone collection methods, *Caloscypha* appeared more frequently on squirrel cache collections, but the authors indicate the differences were small and likely not practically important (Pigott and Peterson 1996). The debate on the quality of squirrel-cache collections continues. Is it possible to obtain good collections from squirrel caches? The answer is yes, but the risk of introducing *Caloscypha* is greater with this collection method. Older caches would have a higher probability of containing the fungus and wet, cool weather will increase the probability of a *Caloscypha* infection occurring in a cache. Serotinous lodgepole pine cones are probably the least at risk due to the sealed nature of the cones. There are obvious cost advantages to raiding squirrel caches, but these should be weighed carefully against the increased potential of the cold fungus infecting your seedlot.

The incidence of *Caloscypha* appears most prevalent on seedlots of subalpine fir (Bl) and populations consisting of white and Sitka spruce hybrids (SxS) (Table 3). I don't believe that it is coincidental that these species inhabit the cool, moist environments in which this fungi thrives. Although infection levels may not be as high in Amabilis fir (Ba), Noble fir (BN) or western white pine (Pw) – the long stratification periods required for these species to break seed dormancy will provide a larger window for the fungi to bulk-up. These species are of concern as well as any seedlot in which extended stratification is employed to increase the germination rate or robustness of the seed to sub-optimal germination conditions. This fungus is able to out-compete other fungi at cooler temperatures.

Table 3. Results of testing for *Caloscypha fulgens* by the BC Ministry of Forests Tree Seed Centre, 1991–2005

Species	Sample size	% Seedlots affected	Affected average %	Overall average %	Maximum value	% Tested seedlots active
Ba	189	14.3	4.0	0.6	22.0	86.2
Bg	42	14.3	**5.1**	0.7	12.4	23.8
Bl	187	**31.0**	**5.0**	1.6	**32.8**	78.1
BN	21	4.8	2.0	0.1	2.0	81.0
Cw	1	0.0		0.0		100.0
Fdc	55	1.8	0.4	<0.1	0.4	76.4
Fdi	108	9.3	1.6	0.1	4.4	90.7
Hm	8	0.0		0.0		100.0
Hw	47	8.5	0.4	<0.1	0.4	89.4
Lw	14	0.0		0.0		92.9
Plc	5	0.0		0.0		100.0
Pli	41	0.0		0.0		73.1
Pw	74	6.8	1.8	0.1	4.8	83.8
Py	15	13.3	**5.2**	0.7	10.0	93.3
SS	74	10.8	**7.8**	0.8	**37.6**	97.3
Sx	356	11.5	2.2	0.3	16.0	89.6
SxS	34	**26.5**	3.4	0.9	16.0	97.1
Yc	6	0.0		0.0		100.0
TOTAL	**1277**			**0.5**		

For Sitka spruce, approximately one in ten seedlots will be infected, but the average infection is quite high at 7.8% and this species also showed the highest observed level of *Caloscypha* (37.8%). Ponderosa pine also had a relatively high affected average of 5.2% indicating disease potential is present. Pathologists indicate that a seedlot with a *Caloscypha* infection of 5% or greater is significant and strategies should be employed to minimize the spread (Kolotelo *et al.* 2001; page 31).

Fusarium spp.

This pathogen group is reported only at the genus level due to the taxonomic complexity of the genus, high cost of species identification, and uncertainty of the impact of the various species on conifer tree seeds. The fungi is not only complex to identify, but also complex because it can be involved in a variety of disease problems including pre- and post-emergence damping–off, late season root rots, and shoot blights. As opposed to the other two pathogens, Fusarium 'primarily' contaminates the seed surface allowing for a wider range of sanitation methods to be effective. Compared to *Caloscypha*, there is a large amount of published information regarding *Fusarium* and sanitation methods – see the Seed Handling Guidebook (Kolotelo et al. 2001) for references.

Several species have greater than 50% of their seedlots contaminated with Fusarium: western larch (Lw), Douglas-fir (Fdc, Fdi); white (Pw) and Ponderosa pine (Py) (Table 4). This means half of the seedlots will be contaminated and have the potential to cause disease. The overall average contamination levels are not high but the maximum values obtained for some seedlots is quite alarming. The importance of this pathogen cannot be overstated. Pathologists indicate that a seedlot with a Fusarium contamination of 5% or greater is significant and strategies should be employed to minimize the spread.

Table 4. Results of testing for *Fusarium* spp. by the BC Ministry of Forests Tree Seed Centre, 1991–2005

Species	Sample size	% Seedlots affected	Affected average %	Overall average %	Maximum value	% Tested seedlots active
Ba	260	31.9	1.2	0.4	14.0	66.5
Bg	59	40.7	**1.6**	0.7	7.0	74.6
Bl	222	31.5	**0.7**	0.2	2.8	67.1
BN	21	47.6	1.0	0.5	2.0	81.0
Cw	246	45.5	1.6	0.8	20.4	72.0
Fdc	374	59.6	2.7	1.6	75.4	55.9
Fdi	441	59.6	2.0	1.2	42.0	89.8
Hm	21	14.3	0.2	<0.1	0.2	100.0
Hw	139	32.4	0.8	0.3	4.8	90.6
Lw	199	64.3	2.4	1.5	43.2	75.4
Plc	12	8.3	0.1	<0.1	0.1	100.0
Pli	529	6.4	0.3	<0.1	1.2	62.8
Pw	99	57.6	2.7	1.6	29.0	82.8
Py	191	50.3	**1.7**	0.9	17.0	90.6
Sb	5	0.0		0.0		100.0
SS	82	22.0	**1.3**	0.3	6.4	95.1
Sx	592	26.7	1.7	0.4	39.8	88.3
SxS	34	23.5	1.6	0.4	4.6	100.0
Yc	22	27.3	0.4	0.1	0.8	81.8
TOTAL	**3553**					

It is also important to understand that although *Fusarium* can be seed-borne, it can also enter seed handling facilities through the air, organic debris, and improperly cleaned equipment. Control of Fusarium-caused problems requires a thorough look at the entire seed handling system at your facility.

Sirococcus conigenus (Sirococcus shoot blight)

The third pathogen is *Sirococcus* which does not kill the seed, but causes a shoot blight that can spread rapidly through a crop or infect adjacent crops. Due to the potential build-up of this pathogen it is considered significant at a 1% level. To enable this greater precision, a total of 1 500 seeds are used in *Sirococcus* fungal assays (versus 500 for *Fusarium* and 250 for *Caloscypha*).

Sirococcus is primarily seed-borne on spruce species but it has also been found on western larch Lw), western hemlock (Hw), and western white pine (Pw) seeds (Table 5). Sirococcus has not been found on lodgepole pine (Plc, Pli) seed but it has been reported that spores could travel from infected spruce seedlots and infect lodgepole pine within the same nursery (Peterson 1996). Emphasis will continue to focus on spruce species followed by western larch and additional samples of western white pine will be assayed.

I would appreciate feedback on our program. We will continue to perform fungal assays using our priority matrix, but feedback on seedlots with disease problems is always appreciated. This article provides detailed baseline information on a species level, but the specific seedlot test result, if available, should be the criteria to use in determining whether seed (or environmental) treatments are warranted.

Table 5. Results of testing for *Sirococcus conigenus* by the BC Ministry of Forests Tree Seed Centre, 1991–2005

Species	Sample size	% Seedlots affected	Affected average %	Overall average %	Maximum value	% tested seedlots active
Bg	1	0.0				100.0
Fdc	4	0.0				75.0
Fdi	6	0.0				66.7
Hw	81	7.4	0.3	<0.1	0.5	90.6
Lw	44	19.5	0.5	0.1	1.4	75.4
Plc	7	0.0				100.0
Pli	22	0.0				62.8
Pw	3	33.3	0.9	0.3	0.9	82.8
Sb	1	0.0				100.0
SS	85	20.0	**0.3**	0.1	1.5	95.1
Sx	600	15.7	0.7	0.1	7.8	88.3
SxS	33	36.4	0.8	0.3	2.4	100.0
TOTAL	**887**					

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TESTING FOR SEED-BORNE PATHOGENS

The potential for conifer seed to become contaminated or infected with several fungal species makes testing for their presence a viable first step for managing seed-borne disease. In British Columbia (BC) three seed-borne fungi, found on conifer seeds, are of special importance to seed and seedling health. Species of fungi in the genus *Fusarium* contaminate seeds and are responsible for damping-off of seedlings and may potentially lead to *Fusarium* root rot and possibly even *Fusarium* shoot blight. Both *Caloscypha fulgens* and *Sirococcus conigenus* infect seeds. *Caloscypha* is responsible for killing seeds while *Sirococcus* infected seeds can kill the resulting germinants and spread by spores to further infect and kill adjacent seedlings.

Fusarium spp.

1) Some species in the genus *Fusarium* contaminate seeds and are responsible for:
   a) pre- and post-emergence damping-off,
   b) implicated with root rot and,
   c) shoot blight of conifer seedlings.
2) *Fusarium* is primarily spread by spores i.e.,
   a) air-borne,
   b) water-borne,
   c) soil-borne or,
   d) seed-borne.
3) Soil-borne *Fusarium* – primarily a concern in bare root nurseries
   a) can arise from overwintering of spores in soil or,

    b) introduction of spores by air or water
4) Similar mechanisms in natural soils can occur in container nurseries:
    a) contaminated growing media
        i) can infect seedling roots leading to post-emergence damping-off,
        ii) *Fusarium* root rot or shoot blight
    b) water- or air-borne *Fusarium* spores
        i) can lead to *Fusarium*-contaminated growing media,
    c) seed-borne *Fusarium* can lead to above but,
        i) most often responsible for pre-emergence damping-off.

Caloscypha fulgens

1) *Caloscypha fulgens* lives in forest duff or litter:
    a) becomes seed-borne when cones contact forest soils
2) Common names, 'seed' or 'cold' fungus refer to:
3) seed-borne nature as well as
    a) ability to spread to healthy seeds during cold conditions, i.e., stratification
4) First reported in Ontario as damping-off of fall-sown pine seed then,
    a) identified in Britain on Sitka spruce seeds imported from North America.
5) The fungus has been isolated from stored seeds in BC, Oregon, and Washington.

Sirococcus conigenus

1) *Sirococcus conigenus* causes a shoot blight on:
    a) > 19 coniferous species in North America, Europe, and Asia.
2) Particularly severe in BC forest nurseries mainly affecting,
    a) spruces, lodgepole pine, western hemlock seedlings and to a lesser extent, Ponderosa pine.
3) In BC the disease is seed-borne on spruces but *S. conigenus*,
    a) has recently been observed on western larch seed.

Assay result

1) Knowing the percentage of infected or contaminated seeds within any seed lot:
    a) provides growers options to minimize their impact on germination and growth.
2) As levels of contamination or infection within a seed lot rise,
    a) potential to negatively affect germination and growth becomes significant.
3) Potential risk increases as infection or contamination threshold approaches.
4) Contamination or infection threshold levels of 5% or greater within any seed lot,
    a) significant for either *Fusarium* or *Caloscypha*.
5) Seed-borne *Siroccocus conigenus* can become systemic and spread spores to infect adjacent seedlings therefore,
    a) infection levels as low as 1% within seedlots become significant.

Minimizing the impact of seed-borne fungi

Fusarium spp.

1) Strategies for *Fusarium* and *Caloscypha* are:
    a) aimed at putting each at a disadvantage in ability to spread within a seedlot.
2) Methods to control the impact of *Sirococcus* infection in a seedlot are,
    a) designed to eliminate the organism.
3) *Fusarium* contamination can intensify during stratification following imbibition,
    a) Spread of fungus results from imbibition moisture combined with prolonged damp, stratification.
    b) In BC, running water during imbibition of all seeds,
    c) effectively washes *Fusarium* inoculum from seed & prevents intensification.
4) Other strategies to reduce *Fusarium* levels on conifer seeds include:
    a) Sanitation of stratified Douglas-fir, western larch, and spruce seed using a four-hour, 3% H_2O_2 soak followed by a five-minute running water rinse.
    b) Reducing potential for *Fusarium* contamination between seed lots during imbibition,
        i) cleaning seed soaking tanks with Ivory™ dishwashing soap and hot water with particular attention given to the tank bottoms.
    c) Seed soaking screens cleaned regularly with a bleach and buffer soak solution.
    d) For seedlots contaminated with *Fusarium* approaching 5% threshold,
        i) strict adherence to optimal temperature and moisture conditions to encourage rapid germination can minimize damping-off losses.
    e) Succulent shoots of emerging germinants can be injured as they traverse the layer of coarse grit covering the cavity surface.
        i) Stem lesions here become infection courts and *Fusarium* inoculum originating from the seed coat can enter stem tissues and cause rotting.
    f) *Fusarium* root rot is aggravated in heat or drought stressed seedlings,
        i) these conditions should be avoided for *Fusarium* infected seedlots.

Caloscypha fulgens

1) *Caloscypha fulgens* grows and spreads in colder conditions than those favouring many other diseases thus,
    a) *Caloscypha* can rapidly intensify during cool, moist stratification.
    b) drying seed can help overcome this however,
    c) moisture must only be removed from the seed surface
    d) removal of internal moisture may delay germination.
2) The fungus kills seeds and its major effect is seen through low germination rates
    a) with the exception of the true firs (*Abies*) and white pine,
        i) consider sowing seed from 'significantly' infected lots without stratifying.
3) Uneven germination may be an acceptable alternative to risking disease spread.
    a) if stratification is necessary,
        i) sow seed immediately afterwards, to minimize additional cool storage.
4) Infected seed lots can be double or triple sown to help ensure filled cavities.

Sirococcus conigenus

1) Seed-borne *Sirococcus* usually manifests as *Sirococcus* blight,
    a) killing of primary needles from the base upwards is a common symptom.
2) This seed-borne disease kills seedlings via secondary spread of spores from infected germinants.
3) Control is based upon:
    a) culling seedlings infected with *Sirococcus* and burning them to destroy any fruiting bodies on the dead foliage, which can continue to release spores thus,
    b) dead seedlings should not be left to overwinter as fruiting bodies can form and release spores again in the spring.
4) Spores can spread some distance via rain splash and mist therefore,
    a) lodgepole pine seedlings should not be grown downwind of spruce crops known to have high *Sirococcus* infection levels.

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SUDDEN OAK DEATH

Sudden oak death is caused by the fungus *Phytophthora ramorum*, which was first recognized as a pathogen in 1995. *Phytophthora ramorum* can be spread over long distances through movement of infected plants or infested plant parts; however the fungus has not been demonstrated to be seed-borne. The fungus can also be moved with contaminated soil (e.g., on vehicle tires, tools, or shoes), or in contaminated water. Once established on plants in a given location, the fungus produces reproductive structures (sporangia) that can be moved from plant to plant by rain splash, or wind. *Phytophthora ramorum* has currently been documented as occurring in California, Oregon, Washington and Europe. In 2004, several infected plants imported from Washington State to British Columbia were also identified.

Symptoms of sudden oak death vary depending upon the plant species infected. On some hosts, infections occur primarily on leaves leading to light brown leaf spots and blotches. These leaf symptoms may be indistinguishable from other, more common, leaf spots and blights, or may mimic sunburn or leaf scorch symptoms. Twigs and branches that become infected often wilt, forming a "shepherd's-crook", and subsequently die back. Infection of tree trunks leads to cankers that produce copious amounts of an amber to black colored ooze. This ooze can dry to form a stained area on the bark. Removing the bark over the affected area will reveal discolored wood beneath that sometimes has a black border. Cankers can eventually expand to girdle trunks, thus resulting in death. Trunk infections appear not to extend into the root system of the plant. Once sudden oak death cankers develop, other pathogens may invade the infected areas, accelerating tree or shrub death and complicating the diagnosis of the disease.

The Canadian Food Inspection Agency (CFIA) and the United States Department of Agriculture (USDA) have agreed to develop a bilateral management plan for *Phytophthora ramorum*. This includes the intent to harmonize Field Level Procedures for management of *P. ramorum*. The CFIA and USDA will mirror standards where it is immediately practical, with further harmonization being based on advice from Canada-US Pest Risk Assessment and Science panels. Ultimately there may be small differences in the language of the protocols, particularly if there is external terminology or legislation affecting the wording or the regulatory actions of the protocol.

The goal of this protocol is to ensure that any infestations of this serious pathogen are consistently and effectively addressed, mitigated, and eradicated. Cooperation by nursery management personnel is essential. Early detection and reporting of potential *P. ramorum* infections are critical to ensure that spread is contained. The strategies to be employed in the protocol are intended to ensure rapid suppression of infection, and to prevent the spread of the pathogen.

The BC Landscape and Nursery Association (BCLNA) has worked closely with the CFIA to address many of the concerns associated with the movement of plants to and from BC and the USA as well as within Canada. On October 11, 2004 the CFIA was notified that the USDA intended to impose, within 7 to 14 days, an emergency federal order on British Columbia, Washington, Oregon, and California which specified requirements for movement of host and non-host nursery, floriculture, and forest seedling products. The order required 40 samples of host materials and visual inspection of non-host with sampling of any suspicious materials.

Following meetings between the BC and US industry along with the CFIA to persuade the USDA to not impose the federal order so quickly, the USDA agreed to meet with the CFIA in mid-November to resolve Canadian – US issues. The USDA also agreed to not impose the order in the US until internal US issues were resolved.

The majority of an implemented BC sampling and inspection program of about 260 nurseries was completed by mid-November 2004. Following this, the CFIA and USDA met and the USDA agreed to not impose their federal order on Canada. The CFIA was able to show BC's industry had voluntarily set up a certification program that resulted in standards equivalent to the emergency order. Without the industry program, BC would have been regulated. Additionally, BC has had fewer *P. ramorum* finds than many of the US states that are not regulated. However, if BC has even a few more finds, it was agreed that BC will be regulated for plant movement within Canada and to the US, including nursery, floriculture, forest nursery, and live Christmas trees.

The CFIA has now agreed to harmonize the Canadian protocol with the USDA's. The USDA and CFIA agreed in early February that they will introduce four new harmonized protocols in early spring 2005 – one each for:
1) a wholesale nursery,
2) a retail nursery,
3) a landscape setting, and
4) a forest setting.

The details of the new protocols will not be available to industry until CFIA and the USDA complete their work, anticipated to be very soon. It is expected the CFIA will conduct a spring national survey once some of the new protocols are in place.

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INSECTS OF SEED CONES IN EASTERN CANADA: FIELD GUIDE

The publication of this field guide is timely with the topic of this News Bulletin. The guide is a revised version of "Management of insect pests of cones in seed orchards in eastern Canada" published in 1992. The authors are Jean Turgeon and Peter de Groot of Natural Resources Canada in Sault Ste. Marie and Jon Sweeney of Natural Resources Canada in Fredericton. The guide consists of five sections. The first section contains general information on the diversity and ecology of cone and seed insects. The second section comprises a key supplemented with color photographs to provide a quick, reliable means of identification. Biological information on these insects is provided in the third section. The fourth section describes some simple methods that can be used to assess cone crops for insect damage. The fifth section describes a formal method to assess quantity and quality of cone crops in seed orchards. The guide is jointly published by Ontario Ministry of Natural Resources and Natural Resources Canada in Sault Ste. Marie. A copy can be obtained by calling (705) 946-2981 or (705) 541-9461.

Dale Simpson

ALBERTA TREE SEED REGULATIONS

Alberta public land tree seed activities are regulated by the *Standards for Tree Improvement in Alberta* (STIA) that are enabled through the *Timber Management Regulations* which fall under the *Province of Alberta Forests Act*.

The underlying principles of STIA are that forest genetic resources are crucial to the well being of the people of Alberta, to sustainable forest management, and to the long-term economic and ecological stability of the province. Both the Government of Alberta and forest industry will:

1) Endeavour to ensure the adaptability, diversity and health of wild and managed populations, and conserve the genetic integrity of wild populations of trees on the landscape, and
2) Recognize the value of tree improvement in enhancing the productivity of the forest land base and generating economic benefit.

The STIA were implemented May 1, 2003 and apply to all public land seed collections and Green Area (primarily forested public land) seed deployment and cover 16 native tree species with lodgepole pine, white spruce, and increasingly black spruce being the main species. Two reforestation seed categories are identified. Stream 1 seed is adapted seed collected from wild or artificially regenerated stands of native species within a seed zone and Stream 2 seed is adapted seed produced in a production facility in association with a controlled parentage program. STIA regulate the activities of those who:
1) Work with wild seed (Stream 1) collected for reforestation activities.
2) Produce seed or vegetative material through controlled parentage programs (Stream 2).

All seed to be deployed within the Green Area must be registered with the Department.
The Department's registration process designates seedlots as either restricted or unrestricted for deployment based on their origins and genetic composition. To obtain unrestricted registration, seedlots must meet the following minimum collection guidelines:
1) Be collected within a specific seed zone (Stream 1) or for a specific breeding region (Stream 2).
2) Have a minimum of 10 or 30 (species dependent) contributing parent trees for Stream 1 lots or a minimum effective population size of 18 for Stream 2 lots.
3) Be processed and tested at approved facilities.
4) Be stored at approved facilities.

Stream 1 seedlots that are collected within a 2 or 5 km radius (species dependent) and within a 100 m elevational range can be deployed up to 1 km outside the seed zone of origin and, with Department approval, are eligible for movement outside the seed zone of origin. Collections made from areas larger than the specified 2 or 5 km radius have a maximum deployment limit of 5 million seedlings per lot. The Department may retain up to 30 000 or 5% (which ever is less) of the initial total seedlot for conservation purposes.

Movement of Stream 1 seed is regulated through a seed zone system based on geographic subdivisions of the Natural Regions and Subregions of Alberta. There are 84 seed zones. Stream 1 seedlots are to be deployed in their seed zone of origin but can be moved outside with Department approval. Each disposition holder must maintain a minimum of one registered Stream 1 seed or vegetative lot for each species in each seed zone where artificial regeneration on public land is planned. Movement of Stream 2 seed is regulated through Controlled Parentage Program plans that identify deployment zones specific for each seed orchard.

Copies of *The Standards for Tree Improvement in Alberta* can be accessed by following the Alberta Sustainable Resource Development website located at:
http://www3.gov.ab.ca/srd/forests/fmd/manuals/index.html

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NEW SEED USE STANDARDS FOR BRITISH COLUMBIA

In November 2004, Jim Snetsinger, Chief Forester (CF), Ministry of Forests, introduced a new set of standards to govern the use of tree seed in the province of British Columbia. These *Chief Forester's Standards for Seed Use* took effect on **April 1, 2005** and apply to persons who use tree seed in establishing a free growing stand under the *Forest and Range Practices Act* (FRPA).

These standards are those the CF considers necessary and appropriate for registering, storing, selecting, and transferring seed used for Crown land reforestation. Their purpose is to maintain the identity, adaptability, diversity, and productivity of the province's tree gene resources. They are based on stewardship principles and over forty years of research in forest genetics and tree seed management.

The standards represent an updated consolidation of the seed use requirements that existed under the *Forest Practices Code*, which included regulations, a guidebook, and ministry policies. Bringing these requirements into one document provides "one-stop-shopping" for licensees and ministry staff.

Tree seed must continue to be registered and stored at the Ministry of Forests' Tree Seed Centre located in Surrey. Seed must meet minimum collection, genetic diversity, and physical quality requirements to be eligible for registration. Seed that has a genetic worth (i.e., level of improvement) of 5% or greater for a trait that best achieves the forest management objectives of the stand (e.g., growth or pest resistance) must be selected if available. Transfer limits are prescribed for species collected from natural stands, untested orchards, and several acceptable non-BC sources. Transfer limits for seed collected from tested orchards are based on the area (e.g., seed planning zone and elevation range) where its parent trees have been tested in accordance with generally accepted scientific methodology.

These standards were developed in conjunction with *FRPA* and its regulations by ministry staff in consultation with forest sector representatives over the past two years. Input was provided by licensees, members of the Forest Genetics Council of BC and it's technical advisory committees, BC Tree Seed Dealers Association, and the Forest Nursery Association of BC.

The *Chief Forester's Standards for Seed Use* can be viewed and downloaded from the Ministry of Forests' website at: http://www.for.gov.bc.ca/code/cfstandards/. For further information regarding these standards, please refer to the above website or contact Brian Barber.

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NATIONAL TREE SEED CENTRE

There was a good fruit and seed crop on most species in the Maritimes in 2004 and Seed Centre staff actively took part in making collections. About 550 collections were made from 15 species. Most all these collections were made from individual trees which continues to be the approach that is being used when collecting seed for the Centre. Processing has been completed and germination testing is all but finished except for a few species requiring lengthy moist chilling treatments.

Staff cooperated in a project focused on the collection of ash seed. This project was developed in response to the threat posed by the Emerald Ash Borer on the ash resource in Canada. Collections focused on black (*Fraxinus nigra*) and white ash (*F. americana*). Seed was collected from individual trees in 14 white ash populations in Nova Scotia, New Brunswick, Québec, and Ontario and two black ash populations in New Brunswick. Additional collections will be made elsewhere in the range of these two species when there is a seed crop. The seed will be used to evaluate genetic variation within these species and stored long-term to conserve this germplasm which could be used in the future for restoration after the insect has swept through. Seed will also be collected from the other ash species as resources permit and opportunities arise. White ash seed was de-winged which allowed empty seed to be removed by aspiration and had the added benefit of reducing storage volume. Seed quality was evaluated by viability tests. These involved excising embryos, placing them on Versa-pak™ in germination boxes, and incubating them for 14 days in a germinator. This test is a measure of the viability of the seed indicating the percentage of seed that has the capacity to germinate. In contrast, a regular germination test requires 9 months to complete. Results showed variation between trees within populations as well as among populations.

Seed from three willow species (*Salix bebbiana*, *S. discolor*, and *S. eriocephala*) which had been stored at four temperatures (4°C, -20°C, -80°C, and -145°C) for five years was germination tested. Results showed that seed stored at 4°C was dead after 24 months. There was no significant difference in germination of seed stored at the three sub zero temperatures. Initial germination of *S. bebbiana* seed was about 90% and averaged about 84% after five years at the three sub zero temperatures. *S. discolor* seed was initially 60% and averaged about 54% while *S. eriocephala* started at just over 70% and was about 50% after five years. There are a number of willow species in Canada listed as Special Concern or Endangered. Assuming seed from these species would store in a similar fashion as the three species tested, there is an opportunity for effective *ex situ* conservation of these listed species.

As a result of the number of seed lots collected and acquired as well as the number of seed lots already in storage, the Seed Centre formalized its gene conservation collection. A separate database was established in order to track this material separately from the active collection. At this point all the seed is stored at -20°C. Quantities vary depending on seed size and number of seed available but typically ranges between 1 000 to 5 000 per seed lot. Practically all the material is from individual-tree collections. Seed will only be withdrawn for specific, high priority research projects and for periodic germination testing.

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NEW NSERC CHAIR AT UBC

I am pleased to announce that effective June 1, Dr. Yousry El-Kassaby was appointed Full Professor in the Department of Forest Sciences at UBC and incumbent of an NSERC Industrial Research Chair entitled "Applied Forest Genetics and Biotechnology". The chair is supported by ten industrial partners and Yousry will undertake an ambitious research program involving all of these. Initially he will focus on modelling alternative seed orchard designs, genotypic and pulp attribute variability in natural and selected poplar populations, impact of genetics and silviculture on whole tree wood quality attributes, and DNA genotyping to determine coancestry in a phenotypically selected clonal population. At UBC, Yousry will be joining a large group of researchers focused on forest genetics, genomics, and biotechnology, and his extensive industrial experience as well as a long career in genetics and tree improvement will be a valuable addition to that group. We expect great things of this new Chair.

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RESTRUCTURING SEED PEST MANAGEMENT IN BRITISH COLUMBIA: NEW RESEARCH PROGRAM PLUGS A SERIOUS HOLE

The conifer seed and seedling industry is strongly developed in British Columbia. Around one quarter billion seedlings are planted each year in the province with about 50% of the required seed currently coming in the form of "improved seed" from public and private seed orchards. Within this decade this percentage is projected to increase to 75%.

Cone and seed insects and diseases pose a significant risk to an on-going successful forest regeneration effort. Recognizing this, the BC Ministry of Forests (MoF) has, for over two decades, supported a provincial conifer seed pest management program (PMP) providing operational expertise, training, and advice to seed orchard staff and other members of the provincial seed production community. In the early years this program received research support from a Canadian Forest Service program operating at the Pacific Forestry Centre. However, the federal program was terminated in the late 1980s and research has been pursued in the intervening years in an *ad hoc* manner by PMP staff when and where funds have been available. Additionally, in recent years the MoF pest management program has been reduced. Early on, when seed orchards were a much smaller component of the provincial forest regeneration effort, three full time PMP staff and a variable number of seasonal auxiliary staff provided operational and extension support and assisted with the federal research effort. By 2004, only two full time staff remained to handle operations and extension work as well as the research program for a much larger conifer seed production community.

Growing cone and seed insect problems, especially resulting from a burgeoning population of fir coneworm (*Dioryctria abietivorella*), in the first years of the new millennium illustrated the need for a restructured approach to seed pest management. Late in 2002, in response to PMP staff and orchardist's concerns, the Forest Genetics Council of BC (FGC) attempted to address this problem. A cone and seed pest management technical advisory committee (PM-TAC) was established to develop a research business plan and oversee development of a new research program based on an annual call for proposals. However, insect damage continued to rise. Disastrous losses were caused by fir coneworm in interior BC seed orchard crops in 2004 (estimated losses in BC interior spruce, white pine, and Douglas-fir seed orchards alone amounted to approximately $1,000,000). Faced with the substantial financial loss and obvious risk to its seed production goals caused by cone and seed pests, in late 2004 the FGC directed the PM-TAC to prepare a proposal for restructuring the delivery of the entire provincial cone and seed pest management program.

In March 2005 the PM-TAC presented the FGC with a proposed new model for delivery of cone and seed pest management consisting of separate but interdependent operations, extension, and research components.

1) Operations. Routine pest management activities to be the responsibility of seed orchard staff with guidance and training provided by MoF PMP as necessary. Funding to be provided through existing FGC Operational Tree Improvement Program (OTIP) channels and orchard base budgets.
2) Extension. Extension activities (e.g., development of new pest management tools, protocols, and guidelines) to remain the responsibility of MoF with funding provided through existing OTIP and BCFS base budgets.
3) Research. Creation of a new research program led by a research scientist working in collaboration with the FGC PM-TAC. Salary, base, and project funding to be awarded through the FGC.

The proposed new model required an estimated $250,000 in new funding to support the new research program. The FGC accepted the proposal and implementation of the new model commenced.

Restructuring of operations and extension activities is relatively straightforward. Staff from MoF PMP staff are continuing to lead the extension program and are delivering a series of training workshops to bring orchard staff up to speed with routine pest monitoring and damage prediction techniques. Implementation of the new research program requires substantially more effort. The FGC obtained agreement from the MoF to house the program at the Kalamalka Forestry Centre, Vernon, BC within its Research Branch. A research scientist job description has been written and has now been posted on the BC government website. By the end of summer 2005, the new scientist should be hired and planning a research program to begin in the 2006 field season.

It is hoped that restructuring of the pest management program, especially the creation of an exciting new, well-organized research component, will result in a significant reduction of the current unacceptable levels of pest damage to conifer seed crops in BC. The support of the MoF, the FGC and its PM-TAC, and other members of the Canadian conifer seed production community were crucial to the success of this initiative. In particular the support and efforts of Jack Woods, David Reid, Dale Draper, Alvin Yanchuk, Peter de Groot, and Jon Sweeney are warmly acknowledged.

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8th INTERNATIONAL WORKSHOP ON SEEDS: GERMINATION OF NEW IDEAS

The 8th International Workshop on Seeds was held this year in Brisbane Australia, May 8–13. This event was sponsored by the International Society for Seed Science (ISSS) and is held every three years. This meeting brought together seed scientists from over 30 countries. The conference was very diverse with workshop topics ranging from such areas as seed ecology, conservation, seed desiccation, and dormancy. In addition, there were special sections, which highlighted research in seed biotechnology and in the seed biology of Australian native species.

A surprising number of presentations dealt with tree seeds. Briefly, Dr. Jerry Baskin presented work on the classification and ecology of dormant seeds from tree species native to Central America. His work examined the relationship of the different types of seed dormancy (physiological dormancy, physical dormancy, etc.) to precipitation. Dr. Dolores Rodriguez presented work on the molecular basis of seed dormancy in *Fagus sylvatica*. Their results pointed to the interaction of ABA signaling and GA biosynthesis through a phosphatase.

Dr. Offord presented work on the conservation of Wollemi pine (*Wollemia nobilis*) a threatened Australian tree species. I found this particularly interesting since I remember the excitement around the discovery of this species in 1994 by a bushwalker in a national park close to Sydney. This species is one of the world's oldest plants; fossil records suggest that this species goes back to the Cretaceous period, 110 million years ago. There are only 100 adult trees known to exist in the wild. Conservation efforts are challenging since there is a limited amount of seed available. Their efforts are focusing on studying seed germination, viability and fatty acid characteristics of the fresh and stored seed.

More detail about the meeting can be found at the International Society for Seed Science website (http://www.SeedSciSoc.org) and hopefully the Abstracts will be made available on-line. The next ISSS meeting will be in three years in Poland.

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KEW GARDENS' UPDATED SEED INFORMATION DATABASE

After a considerable period of apparent inactivity, while we replaced John Tweddle with our new Seed Information Coordinator, Sarah Flynn, we have released a new version of Seed Information Database (SID). It has additions of content to existing modules, plus a couple of new modules. In connection with a compilation of known seed viability constants, one is an on-line viabilty calculation tool, based on the Ellis and Roberts Improved Viabilty Equation. The other is a pilot of seed morphological data, with associated images, from the Millennium Seed Bank Project's collections. Because species' coverage in both these new modules is limited at present, you will have to be careful with your searching procedure, to avoid 'no hits' - see below for more details. As always, we'd welcome feedback, positive or not-so, so long as it's constructive; especially on these two additions, but also on SID in general. We're in the process of reviewing SID's structure and function, and where we might go in future. So comments from users will be useful.

What's new in release 6.0? A new module containing Seed Morphology Data along with associated images has been added. This is a prototype initially containing data on ca 150 species. As the module contains so few entries it is possible to search the entire dataset simultaneously. This can be achieved by ticking the morphology box on the primary search page. This eliminates empty hits that could result in searching by species.

Seed Viability Constants have been added for ca 69 species. There is also an accompanying set of useful calculating tools, at an advanced stage, which will be available to use with the viability constants.

We would particularly welcome feedback on the usefulness and usability of these two new modules: sid@rbgkew.org.uk

In addition, the Seed Weight Dataset has been expanded to include ca 5 000 new entries The Storage Behaviour Dataset has been expanded to include 975 new entries, and a number of existing entries have been updated to take into account new research observations. The Germination Dataset has been expanded to include 851 new entries.

Please visit the web site at: http://www.rbgkew.org.uk/seedbank/msb.html

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UPCOMING MEETINGS

4th International Symposium/Workshop on Frugivores and Seed Dispersal
July 9–16, 2005 Brisbane, Australia
http://www.learnaboutwildlife.com/frugivory2005.htm
Contact: ronda.green@griffith.edu.au

BC Seed Orchard Association (BCSOA)
July 11–13, 2005 Sidney, BC
Contact: Annette van Niejenhuis
avanniejenhuis@westernforest.com

Forest Nursery Association of BC (FNABC)
September 19–21, 2005 Prince George, BC
Contact: Mike.Thelitz@prtgroup.com

IUFRO 2.09.00 Seed Physiology and Technology
August 17–19, 2006 Fredericton, NB
Contact: Tannis.Beardmore@nrcan.gc.ca

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