

## Minutes of the FGC Pest Management Technical Advisory Committee

Thursday, 30 October 2008: 10:00 AM – 12:30 PM PST

### Telephone conference

**Present:** Robb Bennett (Chair), BC MoFR  
 Ward Strong, BC MoFR  
 Jim Corrigan, BC MoFR  
 Staffan Lindgren, UNBC  
 Peter de Groot, CFS Sault Ste Marie  
 Dan Gaudet, Vernon Seed Orchard Company  
 Tim Crowder, Timberwest Forest Company  
 Chris Walsh, BC MoFR  
 Jack Woods, SelectSeed

**Coast pest management**  
 MoFR pest management research  
 Interior pest management  
 University pest management research  
 CFS pest management research  
 Interior industry orchards  
 Coast industry orchards  
 MoFR orchards  
 Forest Genetics Council

**Forest Genetics Council**  
 Research Branch

**Guests:** Keith Thomas, BC MoFR  
 Alvin Yanchuk, BC MoFR

**Regrets:** None

#### ACTIONS:

<b>Bennett, Thomas</b>	Set up publicly accessible PM TAC information distribution
<b>Strong, Bennett, et al.</b>	Resolve URMULE issues
<b>Bennett</b>	Continue with revisions to Business Plan
<b>Bennett</b>	Organize meeting re: <i>Contarinia</i> work for 2009/10 fiscal year.
<b>Bennett</b>	Post 2007/08 field guide report to PM TAC website
<b>Bennett</b>	Discuss reorganization of <i>Fusarium</i> manuscript with Mike Peterson
<b>Bennett</b>	Organize next "face-to-face" meeting for Winter 2009
<b>Corrigan</b>	Review needlecast issues (UNBC), monitor budworm populations (MoFR Regional staff) in Salmon Arm area
<b>Strong</b>	Lead development of research proposals
<b>Bennett</b>	Develop Interior pest management proposal and others as required
<b>Strong</b>	Develop limited call for proposals for pesticides trials

#### IMPORTANT DATES:

Next PM TAC meeting slated for **27 November 2008**, teleconference @ 10:00 AM (PST).  
 Proposals and FGC budget request should be completed by **mid-February 2009**.

1. **CALL TO ORDER** at about 10:00 AM (PST). Previous minutes (18/iii/08) were not formally reviewed; no issues with minutes noted. Agenda briefly outlined.
2. **BUSINESS ARISING FROM 18 MARCH 2008 MINUTES.**
  - a. **Organize individual member reporting for Fall 2008 meeting (Bennett).** Done. See Item 4 below.
  - b. **Public access to research results (Strong).** Concern has been expressed that the results of our work are not adequately being made available to stakeholders and other interested parties. **Bennett will work with Thomas to set up listserver and/or Sharepoint public access sites to address this issue.**
  - c. **Resolve URMULE issues (Strong, Bennett, et al.).** No progress to report. **Carry forward.**
  - d. **Continue with revisions to Business Plan (Bennett).** On-going, business plan currently in fairly good shape but requires inputting of some revisions discussed at last meeting. **Bennett will continue with further revisions for future PM TAC discussion.**
  - e. **Contarinia proposal for 2009/10 fiscal year (Bennett, Strong).** A new graduate student has started work on *Leptoglossus* and *Contarinia* projects in the Gries SFU insect communication

lab, primarily on expansion of infrared work and other related aspects of host-finding behaviour. Lindgren also has a student that may be interested in working with *Contarinia*. Previous groundbreaking work with *Contarinia* pheromones should not be overlooked. **Bennett will work to arrange a meeting between Strong, Lindgren, Gries, and Bennett.**

- f. **Ensure field guide progress report is prepared (Bennett).** Bennett outlined 2007/08 progress (photography field work, production & curation of image bank, spreadsheet of work accomplished/needed, drafting of 8 individual fact sheets (*Barbara colfaxiana*, *Cydia strobilella*, *Adelges lariciatus*, *Strobilomyia neanthracina*, *Megastigmus* spp., *Leptoglossus occidentalis*, *Contarinia oregonensis*, *Mayetiola thujae*). Annual report has not been filed on Sharepoint website **Bennett will prepare report and post on PM TAC website.**
- g. **Continue redrafting *Fusarium* manuscript (Lindgren).** Some progress achieved but, for various good reasons, was stalled during the summer. New outline was sent out for comments earlier this year; replies received from Corrigan and Dave Kolotelo. Reorganization of the document is the critical issue currently and should not proceed without Mike Peterson's blessing. **Bennett will discuss changes with Peterson and report back to Lindgren.**
- h. **Discuss ways to ameliorate start-up lags in annual projects funding (Strong).** Considerable discussion generated on this topic. Initial issue was a timeliness problem: a lack of funding in researchers' hands at start of annual field season. Discussion morphed into broader deliberations about overhead issues: new overhead percentage policies imposed by university administrations in current fiscal year with apparently little input from their collaborators (*e.g.* us) or even their own research labs. Discussion was interesting and informative but there is little that PM TAC and our research partners can do other than, during current round of proposal deliberations, be aware that the funding playing field is changing – we cannot expect 2006 *status quo* overhead percentages. Forest Science Program administrators are aware of this issue and we hope that an agreeable and workable course of action for the future will be presented to us in due course (we can always dream).
- i. **Ensure timely production and filing of annual progress reports (Bennett).** Bennett and Strong are working to ensure that annual progress reports are written and posted on PM TAC's Sharepoint website.
- j. **Organize next "face-to-face" meeting for Winter 2009 (Bennett).** Carry forward.

### 3. PROJECT PROGRESS REPORTS

- a. **Main research program (Strong).** Three annual reports for 2007/08 fiscal year (*Leptoglossus* infrared – SFU, *Dioryctria* – UAb, and adelgids – UBC) have been received and will be forwarded to Bennett for posting. [**Done – received and posted 31/x/08.**] Brief updates on current research progress with *Leptoglossus* mark/release/recapture, *Dioryctria*, and adelgids were circulated prior to this meeting (see attachments). *Leptoglossus* infrared host-detection work is expanding to include *Contarinia*; problems encountered with obtaining a wave-length adjustable light source but study of *Leptoglossus* light perception has proceeded with LEDs (*Leptoglossus* "sees" light spectrum in similar manner to humans (*i.e.* not UV-shifted)); trap colour/size bioassays are in progress; cones show IR differential during night as well as day. Adelgid work will be completed in current fiscal year.
- b. **Interior pest management program (Corrigan).** 2008/09 is the first fiscal year for this annual program with funding administered by PM TAC. Work has gone smoothly: there have been no pest disasters, "traditional" pests have been minor, mountain pine beetle management program is proceeding well. MPB has collapsed in PGTIS area, is rising around the north Okanagan, and is "hot" in the Skimikin area. Ground emergence traps used at Kalamalka and elsewhere have shown the existence of substantial populations of root-feeding crane flies, scarab beetles, and weevils – especially in Kalamalka larch and at PRT Grandview. Emergence of *Dioryctria auranticella* from Pw at Bailey Road is an apparent new host record and possibly a new pest problem. Pest reports/updates have been sent on a regular basis to stakeholders. In October Corrigan made 2 presentations to professional entomologists re: aspects of mountain pine beetle / seed orchard interactions. Stakeholders are very pleased with Corrigan's work.

- c. **Other (Bennett).** Bennett presented brief updates on progress with field guide (see also Item 2f above) and pesticides projects. Photography field work was carried out during the spring and early summer; further work on fact sheet drafts will proceed in the winter. New pesticide trials were installed in the spring; injection equipment has not measured up to expectations and no significant effects have been observed with any treatment. Mid-season cone samples were collected and analyzed for damage from Cwr, Fdi, and Sx trials (no cones on 2008 Cwr or 2007 and 2008 Fdc); harvest cone samples collected for seed extraction and germination tests. Bennett will continue to monitor trials in 2009 but, after about a decade of various trials, little of value has been or is expected to be accomplished. A new approach will be suggested for the next fiscal year (see Item 5 below).

#### 4. MEMBER REPORTS (All)

- a. **Coastal industry orchards (Crowder).** No new significant issues reported. Finding effective new pesticides remains a critical and dominant issue for orchardists.
- b. **Interior industry orchards (Gaudet).** No new significant issues reported. Stakeholders are very please with interactions this year with research collaborators.
- c. **Ministry orchards (Walsh).** Mountain pine beetle management program has had significant effect of apparently knocking back *Dioryctria* pitch moths and *Hylobius* root collar weevils at PGTIS. Skimikin site is being impacted by needlecast diseases in pine and by a build-up of *Choristoneura* western spruce budworm populations in the area. **Corrigan will discuss needlecast issues with Kathy Lewis (UNBC) and will monitor budworm populations with aid of MoFR Regional staff.**
- d. **Canadian Forest Service (de Groot).** CFS research entomologists are still largely focused on invasive alien species. *Eucosma*, *Leptoglossus*, and *Conophthorus* all appear to be causing increasing problems in Ontario seed orchards.

#### 5. NEW BUSINESS – 2009/10 business planning

- a. **Format & timelines (Bennett, Thomas).** As in previous years, business meetings will be held by teleconference monthly or as necessary (face-to-face meeting will be held sometime in winter) as development of proposals and budgets proceeds. Initial indications are for *status quo* budgets – *i.e.* hoping for no reductions but who knows for sure. **Final drafts of proposals and FGC budget request should be completed by mid-February 2009.**
- b. **Projects planning (all).** No issues are foreseen with development of 2009/10 PM TAC proposals except for continuation of pesticides trials. Much discussion ensued regarding pros and cons of past pesticides trials work, the need to continue trials in an effective manner, and how best to achieve this. **Strong will lead development of a limited call for pesticides trials proposals with input from Crowder, Gaudet, Walsh, Yvonne Herbison, and Mario Lanthier.**

#### 3. OTHER BUSINESS

- a. **Next meeting (Bennett).** Date for next meeting was set as a teleconference on Tuesday, 27 November 2008, commencing at 10:00 AM (PST).

#### 4. ADJOURN.

Business meeting was adjourned at about 12:30 PM PST.

Minutes compiled by R. Bennett, 4 November 2008.

***Leptoglossus occidentalis* mark release recapture project interim report for FGC Fall 2008  
 Tamara Richardson, Staffan Lindgren, Ward Strong and Sylvie Dejardins  
 UNBC Ecosystem Science and Management Program**

**Introduction**

The western conifer seed bug, *Leptoglossus occidentalis* Heidemann (Hemiptera:Heteroptera:Coreidae) is one of the most prolific seed orchard pests in south interior British Columbia. *L. occidentalis* is responsible for significant seed loss in lodgepole and Douglas-fir and lower seed loss in other conifer species. Pesticides are used multiple times per season to combat *L. occidentalis*, yet substantial seed loss still occurs. Fundamental questions about the life history of *L. leptoglossus* remain, and answering them will assist in the development of more effective pest management management strategies.

The research goals for the 2008 field season were to determine spring immigration patterns, to understand factors influencing within orchard dispersal and to estimate the accuracy of a visual monitoring system employed by seed orchard staff.

**Spring immigration patterns**

1. **Monitor for returning individuals from 2007-** A total of 468 *L. occidentalis* were marked and released in spruce block 15 during July and August of 2007. On May 5, 2008, monitoring for returning individuals commenced in spruce block 15 and white pine block 9 and continued throughout the summer. Each insect spotted was captured and examined for marks from the previous year. We recaptured a single *L. occidentalis* on June 18, 2008, in spruce block 15. While the return of one insect cannot tell us much, it suggests that *L. occidentalis* may overwinter in the vicinity of the orchard, and has the potential to return to the same orchard they inhabited the previous year. We released approximately 400 marked newly moulted adults at the end of August 2008 into spruce block 15 and will monitor for returning individuals during the spring and summer of 2009.
2. **Edge effect dynamics (artificial edge)-***L. occidentalis* were collected and marked from May 7, 2007, through July 3, 2008. Insects were then released eight times from May 16, 2008, through June 23, 2008, to establish an artificial edge effect on the the western edge of lodgepole pine orchard 307. Orchard 307 was monitored eight times for marked insects from May 22 through June 27. Monitoring ceased at this time due to a Sevin® spray. When a marked insect was observed its code and capture location were recorded. Initially we monitored a subsample of orchard 307 from the ground. Due to tree height and very low recapture rates we altered our monitoring scheme to include every tree in the orchard and started using orchard lifts. In total 342 *L. occidentalis* were marked and released, we recaptured 5.5 % one time, and 0.9% two times. Insects dispersed primarily within the first 10 rows of the orchard. Detailed analysis of data will start following completion of a course in mark-release-recapture experimental design and analysis offered by the Columbia Mountains Institute of Applied Ecology (CMIAE).
3. **Edge effect dynamics (natural population)-***L. occidentalis* were collected and marked and coded as above on eight occasions from lodgepole pine orchard 307 from May 17 through July 3. Monitoring ceased at this time due to a Sevin® spray. The location and the number of insects found on each ramet were recorded. Marked insects were released back onto trees on seven different occasions between May 22 and June 26. The location and code of previously marked insects were recorded. Unfortunately as with the artificial edge project our monitoring system changed throughout this study. A total of 586 seed bugs were captured and released; 4% of the insects were recaptured once, and 0.2% were recaptured twice. Capture and recapture rates were low early in the season, so we were not able to detect an early season edge effect. This is probably due to ineffective sampling methods used for the first half of the study. Some clones were found to harbour far more *L. occidentalis* than others. Detailed analysis of data will start

following completion of the CMIAE course. This study should be repeated next year using the more thorough monitoring methods developed in 2008 as we should be able to increase recapture rates and generate better data.

4. **Re-invasion of sprayed orchards**-Orchard 307 was sprayed with Sevin® on July 4<sup>th</sup> 2008. There was a 4 day restricted re-entry period after this spray, but due to other projects we were unable to monitor it until July 12. Orchard 307 was monitored as a part of another study twice between July 12 and July 16, and during this time we found only four adult insects. Four marked insects released in 307 were found in neighbouring spruce 306 block on July 7<sup>th</sup>. Insects may have dispersed out of the orchard prior to the spray or they may have dispersed out in response to the mechanical disturbance of pesticide application. A more thorough study of the re-invasion of a sprayed orchard should be completed in the 2009 field season.

#### Within orchard dispersal patterns

1. **Dispersal distance and direction from two point sources**-A total of 200 marked *L. occidentalis* were released at 100 and 200 m from the centre of the southern edge of spruce orchard 341 on July 11, 2008. Orchard 341 and the edges of orchards surrounding 341 were monitored daily for 7 days. The ID code and the recapture location were recorded when marked insects were spotted. Eighty percent of the recaptured insects were released at 100 m. Fifty-eight (17%) individuals were recaptured and there were several multiple recaptures, thus we were able to track the movements of several individuals almost daily. Of particular interest was that *L. occidentalis* were observed to favour specific spruce clones, mirroring our findings in pine. Some insects remained on the same favoured clone for the duration of the study, while others moved around the orchard amongst different ramets of the same clone. These data suggest that *L. occidentalis* respond to very specific cues when choosing a host plant, and that the majority of insects dispersing into an orchard may not originate from a great distance. Detailed analysis of data will start following completion of the CMIAE course.
2. **Favoured clones**-Several factors are potentially involved in host selection by *L. occidentalis*. This experiment was designed to determine which factors are important. Clones in orchard 307 were ranked with respect to their *L. occidentalis* occupancy. Three favoured clones were selected and three unfavoured clones were selected. The favoured clones were further subdivided into two groups: those with *L. occidentalis* and those without. Thus there were three treatments (favoured clones with *L. occidentalis*, favoured clones without *L. occidentalis* and unfavoured clones). Six blocks were established in orchard 307 and in each block 1 ramet for each of the 9 permutations (treatment x clone) was selected. Potential host selection factors that we examined were:

##### *Far-range IR, mid-range IR and visual spectra.*

On July 22 2008, in collaboration with the Gries lab at SFU, digital photos of cones were taken with far-IR, mid-IR, and visual wavelength cameras on all trees. Two cone clusters were selected and photographed with all three cameras from the same position. These data were analyzed by Steve Takacs from SFU, however it needs to be re-analyzed as the favoured tree sub-groups were not separated.

##### *Cone length and diameter*

Between August 8-22 2008 5 cones from each tree in each block were sampled, and the diameter and length of each cone were measured using Vernier callipers. Mean cone length and diameter were calculated per ramet. Preliminary observation of the data suggests that there may be a relationship between cone length and attractiveness to *L. occidentalis*.

*Mean cone weight per ramet and cone counts*

During August to early September 2008 staff at the Kalamalka seed orchard collected all of the cones on each ramet, calculated mean cone weight and estimated the number of cones per ramet. These data have not been analysed yet.

*Terpenoid analysis*

On July 29 2008, 5 cones from each tree were sampled, labelled, stored on dry ice and placed into a -20°C freezer. The following day they were packed with dry ice and shipped to Clive Dawson at the Analytical Chemistry Services lab of the B.C. Ministry of Forests and Range, Research Branch, Victoria, BC, for cone terpenoid analysis. Analysis results have recently been received, but we have not had time yet to summarize the results.

**Estimate efficiency of visual monitoring system**

1. **Absolute population density estimation**-On August 13 two teams of two scouts each walked a set path three times in spruce block 15. When insects were spotted they were caught, marked and released. When a marked insect was captured, the number of dots, the time and the location were recorded. This was repeated again on August 14 with a different colour marking. On August 13 and 14, Ward monitored block 15 three times using the visual monitoring system he developed and recorded the time of day and the number of insects he observed. These data will be used in part to calibrate the visual monitoring system to absolute population density estimates which will assist in establishing a quantitative economic threshold. Analysis has not been completed.

**Future directions and plans for field season 2009**

1. Monitor for returning individuals from 2008.
2. Repeat the early season immigration pattern studies using the consistent and more effective monitoring system that was developed half-way through the study in 2008. We will likely be able to detect early season edge effects and have higher capture recapture rates. Repeating this study will enable us to see if favoured clones change from year to year, if they do we will repeat the favoured clone study.
3. A thorough study of the re-invasion of a sprayed orchard.
4. Repeat the estimate of population abundance as there are ways we could improve our sampling methods and increase our recapture rate. This could be done weekly throughout the summer enabling us to detect seasonal fluctuations in population density and refine the economic threshold model.

Additional projects will be decided upon once all analyses have been completed regarding host cues.

## Reproductive biology of *Dioryctria abietivorella* – Interim report October 30, 2008

### Work conducted during April – October 2008

Both field and laboratory-based work was completed during the 2008 field season. Our main objectives for this season were to assess overwintering behaviour, seasonal flight and mating status, reproductive tradeoffs and calling behaviour. All work, unless otherwise stated, was conducted in the Douglas-fir breeding orchards located at the Kalamalka Research Centre (KRC).

### Objective 1: To determine the overwintering location of *D. abietivorella*

To identify where *D. abietivorella* overwinter we installed fifteen ground emergence traps and sampled twenty trees in three Douglas-fir breeding orchards. The ground traps were positioned at the centre of four trees and buried 5 cm into the duff layer. Branch and cone sleeves were placed 1.5 and 3.5 metres high on the north and south face of each tree sampled. Ground emergence traps were monitored every two days, while the branch and cone traps were monitored weekly, between May 5<sup>th</sup> and July 4<sup>th</sup>, 2008. No *D. abietivorella* were caught in any of the traps during this time. Many other insects were trapped in the ground emergence traps including weevils, spiders, beetle larvae and flies. Spruce budworm, *Choristoneura fumiferana*, were commonly found within the branch and cone emergence sleeves. In early spring we took fifteen duff and soil samples from KRA. Neither larvae nor pupal cases were present in any of the samples. Our efforts in 2008 elucidated neither the lifestage nor location of *D. abietivorella* during the winter months. It may be that larvae overwinter in the soil then migrate in the spring to another location to pupate and eclose.

### Objective 2: To determine seasonal flight phenology and reproductive status of *D. abietivorella* adults

Female seasonal flight activity and mating status were monitored using an improved protocol modified from 2007. In June, two black light traps were placed in Douglas-fir blocks at KRC, Vernon Seed Orchard (VSOC) and PRT. The traps, separated by at least 500 m, were hung on a line strung between two trees and positioned in the upper-mid canopy. Traps were run five days a week and monitored twice during that period. Females were captured from June 20<sup>th</sup> to September 19<sup>th</sup>, 2008. The collected females were dissected to assess mating status (presence and number of spermatophores) and to confirm species identification. *Dioryctria abietivorella*, *pseudotsugella*, *reniculelloides*, *okanaganella* and *auranticella* were captured. Multiple mating occurs in females of all species collected. These data will be analyzed to see if there is an effect of season on species composition and mating status.

Male adult flight was monitored weekly using pheromone traps placed in KRC, VSOC and PRT. We also attempted to trap females using volatiles emitted by Douglas-fir foliage and cones that have been shown in previous work to elicit oviposition behaviour (Shu et al., 1997). For this experiment, we used two trap types, white delta and green universal traps. Traps were baited with one of the following volatiles:  $\alpha$ -pinene,  $\beta$ -pinene, limonene and myrcene released from Phero Tech bottle dispensers. Traps were suspended from branches in the upper-mid canopy and checked every three days over a thirty day time period. No *D. abietivorella* were caught in any of the traps. It is likely that *D. abietivorella* responds to a blend of volatiles rather than singular components when searching for hosts. Accordingly our single-volatile traps would prove less attractive than the multiple-component volatile profile of the surrounding Douglas-fir trees.

### Objective 3: To determine when female *D. abietivorella* release pheromone within day, season and over lifetime.

We used several methods to obtain live insects to utilize in experiments. We conducted live trapping with mercury vapour lights at KRC twice in July and once in August. Many of the above-noted *Dioryctria* species were collected but relatively few were *D. abietivorella*. Species identification was not done using genitalia rather using superficial characteristics. We received two shipments of infested Douglas-fir cones from seed orchards in California. Unfortunately,

many of the cones did not contain larvae and many of the larvae found were dead. We attempted to rear larvae out in the field by enclosing infested cones in fine-mesh bags. Although this is a successful technique it is too labour intensive to be used efficiently. We successfully obtained mature larvae by collecting infested cones. Larvae exited the cones shortly after being brought into the lab and were put on diet, placed in a rearing chamber and allowed to continue development. Pupae were collected on a weekly basis, separated by sex and placed into eclosion buckets. Adults were used to assess female calling behaviour, reproductive trade-offs and egg production.

Originally this experiment was to be conducted at various times throughout the season to assess the effect of season on calling behaviour. However, we were only able to rear adult moths in August. This experiment addressed the periodicity of female calling behaviour over a 24-hour interval and how this behaviour is modified by female age. We conducted five trials in total with the first occurring mid-August. Three trials were conducted in the field and two inside KRC. Females were from one of three ages groups: young (0-1 day old), middle (5-7 days) and old (10-12 days). Insects were placed individually in a mesh-capped 7 oz. plastic cup and provided with sugar water. The cup was suspended from a Douglas-fir branch at a height of approximately 1.5 m. Female behaviour was monitored every 30 minutes over a 24-hour period. The same protocol was used for trials inside the research station with minor modifications. During the first indoor trial, we did not provide a host volatile source but did so for the second trial. The presence of foliage seemed to stimulate oviposition behaviour rather than calling behaviour. These data will be analyzed for the effect of age on the timing of calling initiation and duration.

Objective 4: To determine if reproductive trade-offs between fecundity and longevity occur in *D. abietivorella*

This experiment measured the lifespan of male and female adult *D. abietivorella* as well as mated adults. Newly eclosed adults were weighed and placed into cardboard cups with sugar water, either individually or with the opposite sex, and placed in the growth chamber and exposed to Douglas-fir foliage volatiles. Moths were checked daily for mortality and the number of eggs laid by each female was recorded. It does not appear that any of the females paired with males mated, as the eggs laid were not fertile. Mating status of females will be confirmed by dissection. The average adult lifespan is 10 days and this does not appear to differ between the sexes nor if another moth is present in the same cup. This lifespan is shorter than was indicated last year while trying to maintain the colony which may be due to the different rearing conditions (diet versus cone-fed). Season may also have a negative impact. During the calling experiments, which were conducted in August and September, many females were still alive beyond 11 days. The longevity experiments began in late September and ran into late October.

The experiment to determine how egg production may change as a female ages is currently in progress. Female moths in each of the age classes: young (0 days), middle (5-7 days), old (11-12 days) and oldest (16-18 days) are preserved in 70% ethanol. The proportion of eggs in each developmental stage (previtellogenic, vitellogenic and chorionated) will be determined by phase-contrast microscopy.

**Interim Report for the PM TAC – October 15, 2008**  
**Adelgid Studies**  
**Babita Bains (UBC), John McLean (UBC) and Ward Strong (MFR)**

*Background:*

Adelgids (Hemiptera: Adelgidae) are conifer seed orchard pests that threaten the fulfillment of a B.C. Government goal that by 2013, 75% of forestry seed used for regeneration will be supplied from seed orchards (BC Ministry of Forests and Range 2007). Adelgids induce galls on the reproductive and vegetative shoots of spruce trees, reducing the number of future cone sites. Adelgid feeding on the cones and needles of alternate conifer hosts, such as larch and Douglas-fir, can reduce seed extraction efficiency, and cause discoloration and twisting of needles.

Roughly 60% of the spruce seedlings used for reforestation in BC are the product of seed harvested from seed orchards (BC Ministry of Forests and Range 2007a). Orchards are the link between breeding and silviculture, and they are the conduit for packaging the genetic gain. Seed orchards, such as the Kalamalka Seed Orchard, are intensively managed for frequent and abundant seed production. Losses incurred by adelgid pests are of high importance.

*Research goals for 2008:*

The goal of our research is to clarify the role of fundatrices and gallicolae in the gall formation process, to determine if susceptibility to adelgid induced galling has a genetic basis, and to associate the different gall structures with the inducing species.

**1. Verifying the role of fundatrices and gallicolae in gall formation**

Through manipulative laboratory experiments (2007 & 2008) we isolated fundatrices from gallicolae to determine the influence of each life stage on the development of spruce shoots. We found that gallicolae were not able to induce a gall or survive without the influence of their fundatrix mother. Fundatrices without gallicolae did induce early galling symptoms on the shoots but a complete gall was not formed. Upon dissection of those shoots no gall chambers were visible. We have a set of rigorous results for the fundatrix without gallicolae treatment from our 2008 study only because many samples in 2007 were contaminated (gallicolae observed on the treatment buds). A set of controls, that is branches with fundatrices and gallicolae, did form complete galls with developed gall chambers. The study designs were similar for 2007 and 2008 except that in 2007 we had an additional treatment. Gallicolae (as eggs) were switched among fundatrices to determine if unrelated gallicolae and fundatrices could form a gall.

Our results demonstrated that fundatrices and gallicolae are both required to form a complete gall, yet they can be unrelated. Considering the fundatrix is required to stimulate galling it would be sufficient to include only fundatrices in a monitoring system. This supports the current management approach used by the KFC where they use fundatrix densities to recommend spring spraying for adelgid management.

We believe analysis of histological sections of spruce buds, with and without the influence of adelgids, will clarify the effects of the fundatrix and gallicolae on the developing buds. We are currently in the process of analyzing histological samples, prepared in August, 2008 in Dr. Joe Shorthouse's Laurentian University Laboratory, to understand the changes that occur in spruce shoot tissues. Samples of tissues at different stages of bud development were fixed onto slides for examination. Examination will help clarify why there is no relationship between the number of sampled fundatrices and the number of subsequent galls, leading to a stronger action threshold.

We are currently working on a manuscript for the manipulative laboratory experiment describing the role of the fundatrix and gallicolae in gall formation. Babita will meet with Dr. Shorhouse in Sudbury (October, 2008) to discuss the histology project and to develop an outline for a manuscript describing the affects of fundatrices and gallicolae on spruce bud anatomy.

## **2. Determining if there is genetic susceptibility of spruce to gall forming adelgids.**

In July and August of 2007 and 2008, the current year's adelgid galls were assessed (2007: 100% sampling, 1492 trees; 2008: 33%, 497 trees) in a 13-parent incomplete, partial diallel, replicated progeny test with 42 full sibling families. This plantation is located in the north-east corner of KFC and was established in 1995. Damage was quantified by the number of the current year's galls on an individual tree basis. We considered the adelgid attack as a binary attribute (0, 1) following a Bernoulli distribution. A generalized additive linear mixed model was fit to the response variable with logit link function. The model was run with the ASReml software by Fikret Isik (North Carolina State University) with the advice of Yousry El-Kassaby. We found strong evidence of genetic control of susceptibility with modest individual, and high half- and full-sib family narrow sense heritability. Breeding values for each spruce tree parent also suggested that parental susceptibility to adelgid galling could be selected for. The benefits of screening for adelgid galling susceptibility could be used as a screening criterion for parental inclusion into future establishment of seed orchards.

We are currently completing a manuscript draft to include the interpreted data from 2007 and 2008.

B. Bains, F. Isik, B. Jaquish, W. Strong, J.A. McLean, and Y.A. El-Kassaby. Genetic susceptibility of spruce to gall forming adelgids (Hemiptera: Adelgidae).

## **3. Relating adelgid species to the unique gall structure they form.**

In the summer of 2007 we photographed and bagged a variety of adelgid galls at the Kalamalka Research Centre. Emerging alates were collected and identified to species. In 2007 we were able to successfully characterize galls induced by *A. cooleyi*, *A. lariciatus*, *A. abietis*, and *Pineus floccus*. We continued to expand the variety of galls in the summer of 2008. Approximately twenty galls were photographed (Dion Manastyrski), and alates were collected for characterization. The laboratory portion (identifying the emerged alates to species) will be complete by December, 2008. This work will be a contribution to a project (field guide) organized by Robb Bennett.

The use of gall structure to identify adelgid species will be a quick and easy tool for orchard managers, compared to identifying species through alate collections which can be lengthy and tedious laboratory work.

### *Conclusion:*

The increased depth of knowledge of adelgids and their galls will enhance current management, and will lead to new insights in adelgid biology, host response, and possibly provide new avenues for monitoring and pest control.