

Minutes of the FGC Pest Management Technical Advisory Committee

Monday, 11 December 2006: 2:00 – ~3:15 PM PST

(correction – Monday 12 Feb 2007 ~10:30-11:30 AM)

Teleconference

<p>Present: Robb Bennett (Chair), BC MoFR Dave Kolotelo, BC MoFR David Reid, BC MoFR Ward Strong, BC MoFR Jim Corrigan, BC MoFR Dan Gaudet, Vernon Seed Orchard Company Staffan Lindgren, UNBC Jack Woods, SelectSeed Roger Painter, BC MoFR Chris Walsh, BC MoFR</p>	<p>Coast pest management Nursery and seed pest management Ministry orchards MoFR pest management research Interior pest management Interior industry orchards University pest management research Forest Genetics Council FGC (guest) Guest</p>
<p>Regrets: Peter de Groot, CFS Sault Ste Marie Tim Crowder, Timberwest Forest Company</p>	<p>CFS pest management research Coast industry orchards</p>

ACTIONS:

Kolotelo, Painter, Bennett	Letter RE: TSC seed testing funding
Bennett	Circulate project reports
Bennett	Transfer documents to new website
Corrigan	Circulate adelgid data to PM TAC
Strong	Pesticides trials – discuss germination tests needs with Kolotelo
Bennett et al.	Develop 2007/08 field guide work plan
Strong	IR proposal workplan focussed on <i>Leptoglossus</i> deliverables
Strong	Clarify details of adelgid proposal
Strong & Bennett	<i>Dioryctria</i> pheromones workplan, letter of student support
Strong	<i>Dioryctria</i> pheromones bulk production
Bennett	Safe handling procedures for pesticides trials cones and seeds

IMPORTANT DATES:

Final draft of 2007/08 budget request to be completed through e-mail correspondence by **2 March**, sent to Jack Woods by **5 March**, presented to FGC on **14 March**. Formal meeting to be called before 2 March if necessary.

CALL TO ORDER at 2:00 PM followed by brief outline of the meeting agenda. Minutes and action items from 11 December 2006 meeting were then reviewed.

BUSINESS ARISING FROM 11 DEC MINUTES.

- **Organize *Fusarium* manuscript for FGC Extension Note (Bennett, Kolotelo).**
Contract with Mike Peterson has been organized.
- **Prepare letter regarding Tree Seed Centre seed testing funding (Kolotelo, Painter, Bennett).** Carry forward. TSC has contributed \$2.5k towards fungal assay work in current fiscal year.
- **Circulate project annual reports (Bennett).** Carry forward. No progress to report.
- **Transfer documents to new website for posting/storage (Bennett).** Carry forward. No progress to report.
- **Circulate ConeSys backgrounder (de Groot).** Done.
- **ConeSys – orchardists’ comments to de Groot (Corrigan).** Done.

- **Develop *Synanthedon* proposal (Strong).** Done, see below.
- **Pursue *Contarinia/Mayetiola* proposal with SFU lab (Bennett).** Done, see below.
- **Circulate adelgid data to Pm TAC (Corrigan).** Carry forward. No progress to report.
- **Pesticides trials – discuss germination tests needs with Kolotelo (Strong).** Carry forward. No progress to report.
- **Develop 2007/08 field guide work plan (Bennett *et al.*).** In progress. See below.
- **Pesticides trials – contact Arborjet & PMRA (Bennett).** Done.
- **Continue 2006/07 proposals development (Strong *et al.*).** Done, see below.

2007/08 PROJECTS DEVELOPMENT (See Table 1 and attached document prepared by Strong. Additional comments follow immediately below.)

- **Infrared – host finding research & expansion of IR capabilities (SFU).** Proposal outline received from Gries lab (separate document attached) highlights expansion of current *Leptoglossus* work to cover many major obligate conophytic insects. General agreement to support work at financial level suggested by Gries but support will be contingent upon receiving detailed workplan focussed on completion of *Leptoglossus* work with clear deliverables (e.g. IR-based traps/lures). **Strong will request focussed workplan from Gries lab.** In conjunction with this work, Gries lab has also submitted a request (attached) for funding to upgrade the current IR capabilities (specifically, to purchase a camera with near-IR sensitivity and a spectroradiometer. PM TAC members were generally supportive but felt there was insufficient information in the request to allow a decision to be made. Subsequently, on 14 February) Bennett, Lindgren, & Strong discussed the request with Gries; issues were clarified and agreement was reached between them to put forward a request for \$35k (see e-mail note summation attached).
- **Adelgid species composition study (UBC).** No major concerns expressed. General agreement to support full funding. **Strong will clarify details of proposal as per de Groot comments.**
- ***Leptoglossus* mark/release/recapture study.** Although interest remains high in this project, no lab or student appears currently willing/able to take on the work. Put on hold for now and revisit next year after another year of *Leptoglossus* IR work has been completed. Funding request for 2007/08 deleted (unless something changes in next couple of weeks!).
- ***Dioryctria* studies.** General agreement expressed for the following work with *Dioryctria*. Strong will pursue life history study in-house using tech support funding. Pheromone work will be pursued with University of Alberta (Dr. Maya Evenden & graduate student). Molecular work (east vs west populations of *D. abietivorella*) dropped for now. Manufacturer will be approached to supply bulk quantity of *Dioryctria* pheromones to cover operational and research needs for several years. **Strong will develop workplan and contract for pheromone work, Bennett will write student support letter if required. Strong will discuss bulk production with PheroTech, Synergy, and or Bedoukian.**
- ***Synanthedon* review & research.** This work will be done in-house by Strong. No budget request.
- **Technical support & lab operations.** General agreement expressed for stated need for contractual technical support and funding requested for travel, materials, and supplies.

- **Pesticides trials.** Pesticides trials will commence at the end of February 2007. General support expressed for workplan and budget (see attached). Crowder has expressed concerns over lack of foliar application treatments in the current workplan. Bennett is trying to focus on one set of applications (injections) in the current year to help avoid some of the confusion that has occurred with previous trials. **Bennett will ask manufacturer for recommendations regarding handling of treated cones during assessments, seed extraction, and germination tests.**
- **Field Guide.** Workplan is still in development. General support expressed for Bennett's request of \$30,000 to cover projected contractor expenses in 2007/08. **Bennett will provide workplan outline prior to submission of budget request for approval.**

Table 1. Draft 2007/08 Pest Management Subprogram budget request.

Pest Management TAC			
Draft budget request - 2007/08 fiscal yr.			
			Subtotals
Ongoing proposals			
1	<i>Leptoglossus</i> host finding	SFU - Gries	31,920
2	Pesticides trials	BCFS - Bennett	11,850
3	Adelgids – species composition	UBC - McLean	42,120
4	Field Guide development	BCFS – Bennett	30,000
MoF Research Program			
1	Tech support	Strong BCFS	28,640
2	Lab operations (travel, materials, supplies)	Strong BCFS	20,000
3	<i>Dioryctria</i> pheromones studies	UoA – Evenden	24,995
4	<i>Dioryctria</i> pheromones bulk production	BCFS – Strong	10,000
5	Infrared detection capability	SFU – Gries	35,000
Salaries			
			170,000
	TIB (Bennett) & RB (Strong)		0
			170,000
TOTAL			395,525

ADJOURN. Teleconference session was adjourned at approximately 4:00 PM PST. (correction – adjourned at approximately 11:30 AM)

Minutes compiled by R. Bennett, 14 February 2007.

ATTACHMENT

RESEARCH PROPOSALS, SEED ORCHARD PEST MANAGEMENT

Submitted to the Pest Management Technical Advisory Committee
Feb 12 2007

Ward B. Strong, Ph.D.

[Bennett note: Comments in red in this and subsequent attachments are from Peter de Groot review prior to the 12 Feb discussion.]

I. ONGOING COMMITMENTS: We have commitments to continue the following projects; funding should automatically flow to them.

Pesticide trials.

Our trials in 2006 have been less than promising, so we are contemplating dropping all the active ingredients used previously. The most promising alternative on the horizon is emamectin benzoate. This systemic compound is registered in the US, and an injectible formulation is under development. There is a strong initiative already underway among MoFR foresters, landscape pest management folks, seed orchard personnel, and PMRA people, to bring this product to Canada, test it, and register it under URMUR.

Pesticide trials in 2007 will be spearheaded by Robb Bennett. Two compounds will be tested by injection only: emamectin benzoate and imidacloprid. These will be tested on Cwr and Fdc at Cowichan Lake Research Center, and on Fdi and Sx at Kalamalka Research Center. Approvals have been obtained, equipment and formulations are here or on their way, tree selections will be made by mid-March, and applications completed by April 1.

Comment: Agree that this needs to be funded. We still need to address foliar applications some time soon, but I think this is going in the right direction.

Budget request: Robb...??

***Leptoglossus* IR host-finding.**

Gries lab, Simon Fraser University. Exploring visual host-finding techniques. This is a continuation of 2006 work. There's an excellent chance of developing a trap for monitoring, and potential alternative control methods will come to light as a result of this research. Gerhard has submitted a proposed plan (attached).

Budget request: \$31,920

Comment: The proposal as submitted is far reaching and goes well beyond *Leptoglossus*. I am in favour of finishing off the *Leptoglossus* work and bringing it to a practical solution (tool) for pest managers (if possible) and not funding new work until the *Leptoglossus* work has been completed. We need to ask Gerhard for a more focussed proposal.

Adelgid species composition.

McLean lab, UBC Vancouver. Examine life history, interorchard dispersal, density/damage relationship of adelgids important to seed orchards, with particular emphasis on *Adelges cooleyi* and *Adelges lariciatus*. Babita Bains has already been trained as an undergrad on this project, and started a Master's degree under expectation of continued funding. She has submitted a research proposal with background information (attached).

Comment: I am in favour of this work and have made some comments on the proposal itself. The budget seems a little rich to me.

Budget request: \$42,120

II. OTHER PROJECTS TO CONSIDER

Leptoglossus MRR.

This project made good progress last year: we have developed a working MRR technique, have preliminary data, and concrete ideas on how to improve the technique. Questions to be addressed were discussed at the Dec 12 meeting and met with general agreement. Unfortunately, Bob LaLonde at UBC-O has not enthusiastically sought out a grad student to take this large project on. Bob has a heavy teaching load, plus he is very attracted to purely theoretical stuff (and this is more or less applied), so his interest seem to be modest at best. I don't see much possibility for this project to fly with UBC-O this year. Sylvie Desjardins, the mathematics professor at UBC-O, is still interested, has leftover money from last year, and has identified an undergrad who might be interested in using last year's data to do some modelling. Thus this project may not die completely, and we might squeeze a little more information from 2006 data. I will be meeting with Bob and Sylvie on the 15th to discuss these things.

I would like to continue searching for a collaborator on this project. Robb suggested that Bernie Roitberg's lab might be interested. Other suggestions gratefully accepted.

Budget request: \$10,000 to start a Fall student in the off chance we find a collaborator

Comment: Pursue other collaborator's but Bernie (who was on my PhD committee and supervisor to Bob LaLonde) has never struck me as that interested in the practical end of things, but more so than Bob. Good luck with this. If money and or time is tight this year, I would consider getting as much out of the 2006 study as possible, spend 2007 looking at where this could go and finding a collaborator, with the goal of resubmitting this for 2008.

Dioryctria.

1. Life history, population dynamics, alternative control methods (pheromones).

Maya Evendon at UA (Edmonton) is enthusiastic about working with Dioryctria. She has a student graduating in April who is interested in starting an M.Sc. project this fall, and can start the Dioryctria work this summer as a technician or summer student. If the Caroline's GPA is >3.5, she can get a TAship and does not need a guarantee of funding. If her GPA is <3.5, Maya's department needs a guarantee of funding for 32 months, which of course we can't provide, but perhaps we can provide a guarantee that we will support applications to the FGC for that period of time. Caroline's GPA will likely be between 3.4 and 3.5, so this might be moot; if it's 3.4 Maya will fight it with her department. Caroline is already writing a mock Dioryctria grant proposal as a class project. She is also considering a funded project with Jens Roland on butterfly conservation in the Rockies, so everyone please send Jens negative thoughts!

We have left the project relatively open until funding and grad status are confirmed. The project will potentially encompass life history traits, mating behaviour, and pheromone control techniques. Maya wrote the following email regarding her interests:

1. Caroline and I are very interested in the research you have proposed. Caroline would be interested in having a balance between basic and applied studies so that she doesn't pigeon hole herself into a certain job area post graduation. I think the two pronged approach you outlined fits well with her aspirations. Caroline has a significant amount of experience in entomology as she has worked for me and Gary Judd in Summerland. She also conducted a directed research project in my lab on a fruit orchard moth pest. However, she is interested in conservation and field biology too, and likes to take a holistic approach. She mentioned comparing the phenology of Dioryctria from wild and managed stands as a possibility.

2. I am very interested in the diapause question that you propose. As you saw in Montreal, I have been working on the impact of reproductive diapause on male pheromone response in a moth pest of ash trees in Edmonton. As a result, I have become interested in plasticity of behaviour of diapause-bound and non-diapause

insects, so that approach to figuring out *Dioryctria* would be very appealing to me.

3. I have lots of experience in the development of mating disruption and attracticide formulations. This part of the project would seem to be a natural extension that I feel could be very exciting. Although much of the initial work could be conducted in the lab, it might also require at least some field assays (any comments on that possibility, Caroline?). We have EAG capability and wind tunnel/olfactometer for behavioural studies.

Budget request: Assuming Caroline can start grad studies in May.

Salary: \$20,991 p.a. x 8/12 months = \$13,995

Travel: to Vernon on and off for 4 months: \$6,000

Materials & supplies: insect rearing, cages, growth chambers, etc: \$5,000

Total: \$24,995

Comment: Good contacts, Maya is excellent, lots of promise, but I do not get a sense of what is being proposed here. Pick one topic, life history, pheromones, or population dynamics, and submit a proposal. This is too vague to review properly. I appreciate the situation with the student, etc, but this needs more work.

2. *Clarification of differences between Western and Eastern populations of D.a. SPELL OUT!!*

I've been talking with Amanda Roe (now in Minneapolis) and Richard Trudel. Richard says that our newly described pheromone worked poorly catching moths in Eastern Canada. Phenologically the adults look identical. It would be easy to look at mitochondrial DNA as part of Amanda's broader research interests to determine the phylogenetic status of the two populations. Since this is of little direct interest to BC, I would suggest allotting "seed" money only.

Budget request: \$3,000

Comment: what will the seed money be for?

3. *Pheromone commercial production development*

We still have no source of pheromone or lures for *D.a.* I have tried to contact Cam Oehlschlager at Chem Tica, but have had no response. Phero Tech may be interested on a one-off production basis: we order a big batch to last 5 years or so, and they don't have to stock it, store it, etc. I would like to be able to wave some money in front of their faces to back this up.

Budget request: \$10,000

Comment: I would support this.

4. *Differential volatility of pheromone components.*

Trying to determine how the moths increase the volatility of the c25 Pentaene, a waxy substance of low volatility. For various practical and theoretical reasons, Jocelyn Millar felt this project had low potential of useful or interesting results, and bowed out. However, he was interested enough to contact a French research who had discussed the issue with me in Montreal. He might eventually bite the bullet, but for this year, this project is on hold.

Synanthedon.

Orchardists have ongoing concerns about the impact of *Synanthedon* on their orchards. Though I've seen little relation between tree vigour and attack rates, orchardists remain concerned. They use the only control method known, digging them out with a screwdriver, which is expensive. I'm still getting pressure for a solution, by which the orchardists mean an alternative control technique. I think an in-house project is appropriate. I have outlined the following research plan:

1. Literature search

2. Moth populations:

--Is it just *Synanthedon* or are *Dioryctria* involved? Larval surveys, rearing

- What species of S or D? ID of adults
 - Are moth population densities changing year by year? Trapping program with a few traps in each orchard, multi-year project standardized between years.
3. Tree health/vigour. Investigate for both big mature trees and young establishing trees:
- What proportion of trees have been broken off due to pitch moths? Orchard surveys, talk to orchardists.
 - Do pitch moths influence tree health and vigour? Orchard surveys: correlation between pitch moth numbers and tree health. Exclusion studies on young trees: perhaps with bole sprays of Sevin or physical removal at first sighting; compare with non-excluded trees.
 - Do pitch moths reduce cone set or seed yield? [NOT INTERESTED-- suddenly this becomes a big project with seed extractions, etc, and I am so skeptical that low pitch moth densities affect seed yield that I'm not willing to do it]
4. Control methods:
- Is digging out pitch moths an effective control method? Part of exclusion study above.
 - Do digging wounds attract more PM? Surveys, observations.
 - Can trees be protected with stem sprays? Part of exclusion study above.

Budget request: None (in-house, covered in the next two requests)

Comment: This issue needs to be addressed and hopefully resolved once and for all. I agree it is a lot of technical work but we need to do it. I fully support this.

Technical help on a contractual basis.

Anna Milner, who worked part-time for me in 2006, has agreed to return for 6 months on a contractual basis, starting April 1. She thinks favourably of returning on a yearly basis. This opens the possibility of her hiring additional workers as needed (rather than me writing separate contracts for every person), perhaps including Caroline from UA for her first year of field work. There will be no conflict with BCGEU seniority lists, since Research Branch does not hire auxiliaries nor maintain a seniority list. There could be a conflict in classifying her a contractor since contractors are supposed to provide their own equipment, office, etc. However, this is not really possible in this case, there is a tacit understanding of this by the other BCGEU staff, and there is a precedent with field work done here by a contractor, using BCMOF tractors and other equipment. I do not believe there will be any union issues.

Budget request:

Anna's rate \$22/hr (equivalent to loaded rate for junior Auxiliary, at a base pay of about \$17/hr) x 40 hrs/wk x 26 wks = \$22,880
 Additional on-call help: \$18/hr (equivalent to co-op student at base pay of \$14/hr) x 20 hr/wk x 16 wk = \$5,760

Total: \$28,640

Comment: Seems more like an internal issue than one for PMTAC but then again I'm on the outside looking in.

Kal lab operations: travel, materials, supplies.

Budget request:

Travel: \$10,000. I ran out of travel money in 2006/7, and plan to travel at least as much in 2007/8.
 Materials/supplies: \$10,000. This is much less than previous years because the lab is now mostly set up.
 TOTAL: \$20,000

BUDGET SUMMARY:

Pesticide trials:	Robb's
Leptoglossus IR:	31,920
Adelgids:	42,120
Dioryctria biology, pheromones:	24,995
Dioryctria western vs eastern:	3,000
Dioryctria pheromone production	10,000
Technical assistance	28,640
<u>Travel, materials, supplies</u>	<u>20,000</u>
TOTAL	160,675

Outline of Research Proposal [Bennett comment: SFU/Gries lab – Infrared radiation work]

General Comment: There is absolutely no doubt in my mind that the Gries lab has the imagination, expertise and ability to conduct these important and potentially ground-breaking studies. However, this proposal lacks a timetable, explicit deliverables and outcomes, and does not address the practical applications of this work to seed orchard pest management.

The work is far too ambitious for a one-year project. If we fund this for one year, how much longer will it take? Probably it will take many years. Will the funding agency be under some obligation to continue? At the very least I would like to see a time-table and which insects will be examined first. While this is important research, it is very fundamental and long term. I would give higher priority to projects that have more immediate benefits pest management benefits to the seed orchard managers in BC.

Collaborative research between members of the Gries-laboratory at Simon Fraser University and colleagues at the BC Ministry of Forests and Range has shown (i) that cone-feeding Western conifer seed bugs, *Leptoglossus occidentalis* (Hemiptera: Coreidae), are attracted to infrared (IR) radiation from conifer cones and (ii) that stronger IR emission from cones than from foliage reveals cones like candles on a Christmas tree. This research provides impetus to investigate IR-emission from cones of diverse conifer species and IR-perception of cone-feeding bugs, midges and moths. We propose to: (i) obtain thermographs of developing cones of white pine, Douglas-fir, spruce, hemlock and western red cedar; (ii) spectroradiometrically determine IR wavelengths emitted by these cones; (iii) bioassay response of *Contarinia* and *Mayetiola* midges, *Megastigmus spermotrophus*, *Strobilomyia neanthracina*, *Cydia*, *Dioryctria* and *Barbara* moths and *Conophthorus* spp. to high IR radiation in field experiments; (iv) investigate through electro-retinograms and behavioural bioassays the IR-wavelengths most attractive to target insects; and (v) develop IR-based baits and traps for mass trapping target species in conifer seed orchards

Budget (2007)

Graduate Student (or Research Assistant Student) Salary: \$11,000

Salary supplement for Stephen Tákacs: \$7,000

Field travel : \$2,000

Materials and laboratory supplies (12 person-months @ \$450 per month): \$5,400

1-Month training in overseas lab that specializes on electro-retinogram and single-cell recordings of retinula cells: \$5,000

Administrative overhead (5%): 1,520

Grand total : \$31,920

Justification for New Instruments

[Bennett comment: SFU/Gries lab request for support for IR equipment upgrades]

General Background

Electromagnetic wavelengths in the human visual range are between 0.400-0.700 μm . Shorter and longer wavelengths are termed ultraviolet (UV) and infrared (IR).

Across the animal kingdom, wavelengths as low as 0.312 μm (UV) and as high as 11 μm (far-IR) are detected (Briscoe & Chittka 2001). Regular photoreceptors are not capable of detecting mid- to far-IR because wavelengths $> 1.2 \mu\text{m}$ are not sufficiently energetic to induce chemical transformation of retinal pigments, such as *cis*-retinal to all-trans retinal, which is required for stimulus reception and neural processing. However, several insects and vertebrates are known to possess the capability of detecting mid-wave (3-5 μm) and long-wave (7-12 μm) IR through a specific IR-sensitive sensory system (Campbell et

al. 2000). For instance, fire beetles, *Melanophila acuminata*, have IR detecting pit organs which are most sensitive in the mid-IR range (2-4 μm) which is the peak emission range associated with forest fires (Schmitz & Bleckmann 1998).

The view that insects have limited, blue-shifted color vision is being questioned (Smith 2000; Briscoe & Chittka 2001; Rodriguez-Girones & Santamaria 2004). Evidence for red receptors is accumulating especially for higher orders, such as the Coleoptera, Hymenoptera, Lepidoptera and Diptera (Kevan et al. 2001; Briscoe & Chittka 2001). Many species in these insect orders might also have near-IR receptors.

IR Perception by Western Conifer Seed Bugs

Collaborative research between members of the Gries-Laboratory at Simon Fraser University and colleagues at the BC Ministry of Forests and Range has shown (i) that cone-feeding Western conifer seed bugs are attracted to IR radiation from conifer cones and (ii) that stronger IR emission from cones than from foliage reveals cones like candles on a Christmas tree. These results have provided impetus to investigate IR-emission from cones of diverse conifer species and IR-perception of cone-feeding bugs, midges and moths. Results of this research will ultimately allow the development of IR-based lures and traps for mass trapping target insect pests in conifer seed orchards.

Justification for New Instruments

To accurately measure the IR radiation emitted by cones and perceived by cone-feeding insects, two instruments are needed: (1) a **near-IR thermographic camera** and (2) a **spectroradiometer**.

A **near-IR camera** provides a contextual infrared picture of what is within an insect's possible field of vision. It measures conventional light radiation *and* radiation associated with heat. Mid- and long-wave IR thermographic cameras, in contrast, measure only radiation associated with heat. The capability of detecting near-IR will give the opportunity to discern wavelengths that are outside the human visual system, but likely are within the visual system of many insects because near-IR wavelengths are detected by opsin-based visual systems commonly present in insects.

A **spectroradiometer** with a sensitivity range of 0.3 – 1.2 μm will allow us to determine specific electromagnetic wavelengths emitted by cones and perceived by cone-feeding insects either with their visual or IR wavelengths detectors.

The combined information obtained by the near-IR thermographic camera and the spectroradiometer will allow us (i) to fully investigate the cone-derived electromagnetic cues exploited by cone-feeding insects and (ii) to design an effective lure.

Novel Pest Management Opportunity

The discovery of cone-derived IR radiation as a foraging cue for Western conifer seed bugs has opened the door for a novel control tactic within Integrated Pest Management Programs for these insects. Moreover, we predict that the same IR-foraging cue, or a modification thereof, is exploited by a wide range of cone-feeding insects, including (but not limited to) *Contarinia* and *Mayetiola* midges, *Megastigmus spermotrophus*, *Strobilomyia neanthracina*, *Cydia*, *Dioryctria* and *Barbara* moths and *Conophthorus* spp. beetles.

Pheromone-based tactics aim at disorientation of mate-seeking males, but do not prevent gravid females from entering orchards and ovipositing on developing cones. Diverting gravid female insects away from cones and attracting them into traps with IR cues could help alleviate the damage inflicted by their seed-feeding offspring.

The discovery of IR emission in the 3-5 μm range from cones has become possible due to a \$40,000 mid-range IR thermographic camera purchased within the context of Gerhard Gries' NSERC-Industrial Research Chair. Obviously, the purchase of this IR camera has also paid dividends for the seed orchard industry. However, the information obtainable from this camera may have been only a fraction of what is needed to develop *optimal* IR lures. For reasons outlined above, a near-IR thermographic camera and a spectroradiometer will be most valuable instruments to develop optimal trap lures for cone-feeding insects. The instruments we would like to purchase are expensive (~\$150,000) but they will allow us (i) to fully explore an intriguing phenomenon and (ii) to develop a new pest management tactic. We contend that the investment is well justified in light of all the seed losses it will help prevent in years to come.

We trust you will give our request for an equipment contribution careful consideration. We will explore all avenues to obtain matching funding for any contribution the BC Ministry of Forests and Range may decide to make.

References:

- Briscoe AD; Bernard GD (2005) Eyeshine and spectral tuning of long wavelength-sensitive rhodopsins: no evidence for red-sensitive photoreceptors among five Nymphalini butterfly species. *Journal of Experimental Biology* **208**: 687-696.
- Briscoe AD & Chittka L (2001) The evolution of color vision in insects. *Annual Review of Entomology* **46**:471-510.
- Campbell AL; Naik RR; Sowards L et al. (2002) Biological infrared imaging and sensing. *Micron* **33**: 211-225.
- Kevan PG; Chittka L; Dyer AG (2001) Limits to the salience of ultraviolet: Lessons from color vision in bees and birds. *Journal of Experimental Biology* **204**: 2571–2580.
- Rodriguez-Girones MA & Santamaria L (2004) Why are so many bird flowers red? *PLoS Biology* **2**: 1515-1519.
- Schmitz H & Bleckmann H. (1998) The photomechanic infrared receptor for the detection of forest fires in the beetle *Melanophila acuminata* (Coleoptera: Buprestidae). *Journal of Comparative Physiology A-Sensory Neural and Behavioral Physiology* **18**: 647-657.
- Smith CUM (2000) *Biology of sensory systems*, John Wiley & Sons: Chichester, England. Pp 445

Budget*

1. near-IR thermographic camera: ~ \$100,000
2. Spectroradiometer (sensitivity range: UV to far-IR): ~50,000

* Prices are based on phone conversations and company homepages; we are awaiting quotes from respective suppliers

Text of 14 Feb e-mail message re Justification for new IR instruments.

-----Original Message-----

From: Bennett, Robb G FOR:EX [mailto:Robb.Bennett@gov.bc.ca]

Sent: Wednesday, February 14, 2007 10:59 AM

To: DeGroot, Peter; Strong, Ward B FOR:EX; Reid, David J FOR:EX; Crowder, Tim FOR:IN; Kolotelo, Dave FOR:EX; Dan Gaudet; Woods, Jack FOR:IN; Staffan Lindgren; Corrigan, Jim E FOR:EX

Cc: Painter, Roger O FOR:EX

Subject: Revised budget request for IR equipment purchase.

Folks -- on our Monday teleconference we discussed the request from the Gries lab at SFU to support purchase of a near-infrared camera and a spectroradiometer in the amount of ~\$150,000. General support for the concept was expressed by PM TAC members but enough questions were raised that it was clear that we weren't clear on important details of the justification presented. Staffan, Ward, and myself were tasked with discussing this with Gerhard Gries and returning a recommendation to the PM TAC.

We met with Gerhard this morning and, following an excellent discussion with him, agreed on the following:

- Gries will be able to use FGC financial support to lever additional funds from his NSERC Industrial Chair
- Spectroradiometer (~\$50,000) is, at this point, the critical piece of equipment needed immediately

- Spectroradiometer is critical to development of trap/lure for *Leptoglossus* (similar to how GC-EAD equipment has been critical to development of pheromone systems) in current year workplan (and other cone and seed insects later)
- Near-IR camera is important but not immediately critical for advancement of *Leptoglossus* work
- Near-IR camera equipment suitable for our research needs may be available at substantially lower cost than suggested in the proposal.

Based on this we (Ward, Staffan, and myself) support the following budget request:

- **\$35,000 be contributed towards acquiring required spectroradiometer equipment (with remainder of necessary funds to be levered by Gries through his Industrial NSERC chair)**
- **No funds to be requested in 2007/08 for IR camera equipment.**

In the coming months, the Gries lab will further investigate and refine the near-IR camera equipment needs and, if necessary, approach PM TAC for camera equipment support in 2008/09 budget planning cycle.

Robb Bennett, PhD
 Chair - Pest Management Subcommittee
 BC Forest Genetics Council
 BC Ministry of Forests
 7380 Puckle Road
 Saanichton BC V8M 1W4 CANADA

250 652-6593 fax 652-4204

Proposal for adelgid studies in the Kalamalka seed orchard

For comment by Dr. Ward Strong

January 16, 2007

Babita Bains & Dr. John McLean

Over 250 million trees are planted annually in British Columbia and a great effort goes into producing seedlings that will produce more lumber of higher quality than naturally regenerated trees. For most conifer species there are extensive tree selection and breeding programs in use. The parent trees selected for seed orchards are products of lengthy selection programs and of great investment.

Adelgids (Hemiptera: Adelgidae) feed on conifers and induce galls on the shoots of spruce trees. Although adelgid damage is not significant until populations are large, population build-ups can be fast and erratic. Galling of reproductive buds produces galled cones with swollen scales, swollen bracts, and no seeds. This directly affects seed production whereas galling of vegetative buds indirectly causes a reduction in the number of potential sites for future cone production on trees. Reduction in seed and cone crops can be severe and costly, hence understanding and controlling adelgid populations is important for seed orchard managers.

Adelgids have been monitored in seed and cone orchards for many years, however there are many unanswered questions regarding their life history and management. A stronger understanding of the life stages and behaviors of adelgids would be beneficial for management of these pests.

Understanding what species are present, and general abundances, would provide orchard

managers with valuable information required for control. In 1996 Rory McIntosh monitored adelgid populations by trapping alates in up and down four-way-Malaise traps in the Kalamalka seed orchard. McIntosh collected weekly catches for six months. In the summer of 2006 I sorted, counted and identified adelgids from the 1996 McIntosh collection. I determined what species were present and adelgid abundances for Kalamalka in 1996. **What happened to these and can you provide us with the information?**

Trapping adelgids from March until September (2007) would give me the opportunity to determine the species composition in the Kalamalka seed orchard and estimate gallicolae and sexuparae migration times. Identifying the dominant species and migration times would provide orchard managers with information for possible spraying times and help identify possible threats of building populations. I am also interested in creating thorough morphological descriptions (as was done for the 1996 McIntosh collection) of all adelgid species present in the orchard and have corresponding barcodes for each species. A general trapping program is described below.

A. Adelgid trapping using up and down four-way-Malaise traps

- In April/May traps will be set up in the orchard. Traps will stay up until the end of the field season **Which is when?**
- Number of traps and locations will be determined with the input of orchard managers and Dr. Ward Strong.
- Trap catches will be collected weekly and preserved in ethanol (preferably 95%).
- Adelgids will be sorted and counted.
- A proportion of the adelgids from each trap will be prepared as slide mounts for identification to species. **You should have at least some of your identifications confirmed by Bob Footit.**

In addition to determining species composition and flight times of gallicolae and sexuparae, Dr. Ward Strong has emphasized that characterizing movement within the orchard is also important. Strategically selecting trap sites and directionality of catches would help us understand adelgid movement between crops **Explain as it is not clear to me how this would work?** Further discussion regarding this will include input from orchard managers.

The possibility of identifying adelgid species from gall characteristics could be a useful tool in the field. For the Kalamalka seed orchard I would be interested in creating an illustrated guide of the different adelgid species and the galls they form **Excellent idea. I don't know enough about the distribution and species of the adelgids but it would seem to me that one orchard would not have all the species, and to make the field guide more widely applicable, you should examine other orchards as well. Perhaps do the Kalamalka orchard in the first year only (since you have lots of other things to do in 2007 and see where you field guide work goes).** Gall characterization would require rearing gallicolae alates, identification of alates to species, and carefully observing and photographing gall shape, colour and other characteristics that could possibly differentiate galls formed by different species. An illustrated guide could provide managers with a quick and easy tool for identification of species in the field and could possibly avoid the lengthy process of slide mounting adelgids for identification under a microscope. Details are provided below.

B. Characterize galls for each spruce tree species and adelgid species present in the Kalamalka seed orchard:

- Collect galls that look different and rear the gallicolae alates.
- Identify the alates (prepare slide mounts) from each gall and determine if different species produce specific characteristics.
- This could also be a good way to ensure only one species is emerging from a single gall.
- The number of gallicolae to emerge would also be counted.

Supplementary work I could do in the Kalamalka seed orchard includes exploring gall induction

by *Adelges* spp. Research has been done with *Pineus* spp. and it would be of interest to compare the two genera. I am interested in looking at the role of fundatrices in gall development, look at distances of fundatrices from expanding bud bases, determine how many gallicolae are found per gall and per gall chamber and if there is any relationship to gall size. Research to better understand adelgid life history, behaviours and habits could better guide the decision making process in adelgid management **Please explain in specific terms how your research below this will help pest management as it may not be immediately obvious to some.** Details for these possible experiments are listed below.

- C. Determining if fundatrices play a role in the development of galls:
- I will select 40 (or more) shoots infested with one fundatrix each
 - 20 fundatrices will not be disturbed, the other 20 shoots will be monitored and eggs will be moved to 20 uninfested branches as they are produced by the fundatrix.
 - If eggs are successfully transferred to uninfested shoots I will be able to monitor gallicolae development and determine if gallicolae can induce galling without fundatrices.
- D. Determining if gallicolae can induce galls on shoots that are not infested by their mothers but infested by another fundatrix:
- I will select 45 (or more) shoots infested with one fundatrix each
 - Each shoot will be isolated from the others (no direct contact)
 - 15 fundatrices will not be disturbed.
 - The remaining 30 fundatrices eggs will be switched among them carefully and strategically (ie. branches A and B eggs will be swapped, C and D, etc).
 - Eggs will be moved once eye spots have developed on the embryo.
- E. Distance between fundatrices and the base of the expanding buds will be measured for all the shoots used in C and D (above) to determine if there is an average distance between fundatrices and buds. This could also allow me to look into competition between fundatrices settled on the same branch, determine if offspring of a single fundatrices only occupy one bud or is it possible that offspring gall multiple buds and can the offspring from two fundatrices gall a single bud. There is also no evidence showing what determines which bud gallicolae prefer – is it random or determined by the fundatrix?
- A select number of branches that are infested with fundatrices will be identified and tagged for sampling.
 - Distances between fundatrix and bud base will be measured for all fundatrices on a tagged branch.
 - Regular observation of branches will carried out (ie. which buds are galled, how many fundatrices on the branch, if more than one fundatrix is present did crawlers emerge from each fundatrix and how many galls were induced.
 - Once gall development appears complete I will clip galls and collect emerging gallicolae (branches will be kept in water spikes to avoid drying of galls and forced gallicolae emergence).
 - Emerged gallicolae will be identified and counted.
- F. Determining number of gallicolae per gall and per chamber:
- I will select 20 shoots infested with one fundatrix each.
 - Fundatrices would be monitored in the lab (branches kept in water spikes) and not disturbed.
 - Once all nymphs have started feeding on the expanding bud (no visible crawlers) the gall will be measured for length and circumference and dissected.
 - Starting at the base of the gall, working clockwise up the gall, needles will be peeled back and the number of gallicolae in each chamber counted. This would need to be done under the microscope.

- Comparing the number of gallicolae for *Adelges* spp. versus *Pineus* spp. could be of interest (comparing different species).

There are multiple research possibilities to further our knowledge of adelgids. However, it is important that I pursue a research program that will provide useful information for management of adelgid pests in the Kalamalka seed orchard and in other orchards in western Canada. I look forward to feedback and input on the research possibilities presented here.

Outline of Budget for Babita's Study

Salaries

Babita Grad Student Stipend (12 months)	18300
Summer Assistant ex Kalamalka? ~10000 seems rich to me	10000

Travel and Accommodation

Accom: 6 months Babita (@1000)	6000
BB what is BB? - to/from Vernon (2 trips)	700
Supervisor visit	1000
Conferences ESBC, WFIWC, SISCO	1500

Consumables

Block Heater explain, I know this isn't for a car. , chemicals, supplies	1500
Traps (ex JM)	0

Approx. Request	39000
UBC overhead 8%	3120

Total	42120
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Babita Bains (M.Sc. Candidate)

Dr. John McLean (Supervisor)

U.B.C. Forest Sciences
2424 Main Mall
Vancouver, BC, Canada
V6T 1Z4

Test of systemic insecticides for cone and seed insect control (2006)

Outline: For the purpose of minor use registration of new systemic pesticides for the management of cone and seed insects, test injectable formulations of emamectin benzoate and imidacloprid against cone and seed insects of Fdc, Fdi, Sx, and Cwr in south coastal and southern interior BC.

Background

Recent changes in regulations have restricted the number of systemic pesticides available for insect management in conifer seed orchards. Only two registered insecticides remain: dimethoate and acephate (Acecaps). A current review of organophosphate insecticides by the federal Pest Management Regulatory Agency (PMRA) could result in further restrictions on those last remaining products.

This project will test the efficacy of new systemic insecticides that could be registered for minor use against conifer cone and seed insects. Two products show particular promise: imidacloprid (IMA) and emamectin benzoate (EB). IMA is registered in Canada for a variety of other uses, a prerequisite for additional minor use registration. EB is being widely tested in Canada for a number of “major use” purposes including control of mountain pine beetle, invasive wood borers, and various defoliators.

The Pest Management Regulatory Association is aware (and supportive) of our proposed work with IMA and EB. Research agreements are in place with the manufacturer and supplier of the IMA and EB formulations and injection equipment.

Objectives:

1. Test injectable formulations of the systemic insecticides IMA and EB against cone and seed insects in Douglas-fir (Fdc/Fdi), western redcedar (Cwr), and interior spruce (Sx). Target pests are: Douglas-fir cone gall midge, redcedar cone midge, spruce midge, cone maggots, spruce seedworm, fir coneworms, and seed wasps.
2. Co-ordinate and co-operate with PMRA and formulation manufacturer in the preparation of efficacy data for registration purposes.

Trial logistics:

	Application*	When	# trees
Imidacloprid	single injection as per manufacturer’s experimental recommendation	Pre budburst	10
Emamectin benzoate	single injection as per manufacturer’s experimental recommendation	Pre budburst	10
Control	Water	Pre budburst	10

* Should initial efficacy assessment indicate little or no pest control, a second series of injections will be planned for early fall 2007 (monitor 2008 cone crop for effects)

Total trees per species tested = 30

Total cone samples per tree = 20 (10/tree early summer, 10/tree @ harvest)

Total cone samples = 120 (4 species X 3 treatments X 10 trees)

Fdc & Cwr trials should be initiated at end of February; Fdi & Sx trials should be initiated by end of March.

RESPONSIBILITIES

- Tree selection, treatment applications, sample collections to be carried out by Tree Improvement Branch staff (Bennett & Corrigan) with input from Research Branch (Strong re: trials set-up, tree breeders for access to research plantations).
- Initial efficacy assessments work to be carried out by contract (except germination tests – Tree Seed Centre).
- Data analysis to be carried out by Research Branch (Strong).

TRIALS SETUP

- Prior to budburst, ten trees per treatment will be selected from trees in research clone banks or breed arboreta (1 treatment = injection of one of IMA, EB, or water control) at Cowichan Lake Research Station (Fdc & Cwr) and Kalamalka Forestry Centre (Fdi & Sx). Trees will be flagged, labelled, and mapped as to treatment.
- In late February (Fdc & Cwr) and late March (Fdi & Sx) treatments will be applied using formulations and injection hardware supplied by Arborjet Inc.

ASSESSMENT

- Assessment for phytotoxic effects (visual assessment) and of cones on all trial trees to be done twice through growing season: mid growing season (for ½ cone cut assessment) and at or just prior to harvest (seed assessment).
- ½ cone cut assessments – *Contarinia*, *Strobilomyia*, & *Kaltenbachiola* assessments to be based on 10 cones per tree, collected mid to late July for *Contarinia* and late June or early July for *Strobilomyia* & *Kaltenbachiola*. Each 10 cone sample collected & bagged/labelled separately by TIB staff and courier shipped (styrofoam & coolant) for immediate assessment to contractor. If necessary ones can be stored at 0 °C for up to a month before assessment.
- Seed assessments – 10 cones per tree, collected at or immediately prior to harvest, each sample bagged/labelled separately, shipped to appropriate facility for seed extraction, cleaning, & x-rays. Filled seed to be saved for germination testing by Tree Seed Centre (germinations tests by treatment and species – i.e. maximum of 12 germination tests).

ASSESSMENT DATA TO INCLUDE

- Douglas-fir: filled seed, empty seed, damaged seed, gall midge galls, # larvae (coneworm, seed wasp), germination test results
- Spruce: filled seed, empty seed, damaged seed, # larvae (cone maggot, coneworm, seedworm, seed wasp) , germination test results
- Redcedar: filled seed, empty seed, damaged seed, # larvae (cone midge) , germination test results

ANALYSIS

- Raw data compilation (½ cone count assessments & all seed data (*Megastigmus*, filled, empty, partials, etc)) to be completed by 31 Dec 2007. Statistical analyses completed late Jan 2008 using standard tests for significance (Zar, J.H. 1984. Biostatistical Analysis. 2nd ed. Prentice-Hall, Englewood Cliffs, New Jersey, 718 pages).

REPORTING

- Project report due 31 March 2008

BUDGET:

• ½ cone assessments contract	
120 hours @ \$50/hr (120 samples @ 1 hr/sample)	\$6,000
• extraction costs	
120 samples @ \$25/sample	\$3,000
• germination tests	
12 tests @ \$25/test (3 treatments X 4 species)	\$300
• Miscellaneous supplies and equipment	\$2,000
• Admin cost (5%)	\$550
Total cost	\$11,850