Canadian Botanical Association/Association Botanique du Canada

Canadian Society of Plant Physiologists/Société Canadienne de La Physiologie Végétale

JOINT ANNUAL MEETINGS/LES CONGRÉS ANNUELS

LONDON 2000

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CBA/CSPP 2000

Bienvenue à l'ABC/SCPV 2000. Nous vous souhaitons une visite agréable, intéressante et profitable. Le comité organisateur local est disponible et prêt à vous aider. Le Secrétariat de la Conférence sera situé au London Convention Centre à la table d'information de la conférence.

Welcome to CBA/CSPP 2000. We hope that you have a pleasant, interesting and profitable visit to London. The organizing committee is here to help you and on-duty members will be wearing identification. The Conference Secretariat will be located at the joint societies' information desk in the Convention Centre.

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Registration and information desk

Saturday 24th June - hours: 16:00-22:00; location: ballroom foyer
Sunday 25th June - hours:8:00-21:00 location: main floor foyer
Mon., Tue., Wed., Information desk open during sessions

Scientific Program

Talks are held in the Convention Centre (details inside).
Posters. Location: Ballroom 2/3 - posters will be up throughout the conference, however, authors will be in attendance on Sunday June 25th from 16:30-18:30. Authors are expected to set up their posters over the lunch hour (12:00-13:30), Sunday June 25th (tacks supplied). Posters should be removed by 12:00 Wednesday June 28th.

Meals

Gratis meals with conference registration are: lunch (daily); opening reception (Sat 24th) hot hors d'oeuvres and cash bar; joint societies banquet (June 27th), hot hors d'oeuvres and cash bar with poster session.

Field Trips

Please see program timetable (page 4) for details

UWO Campus Tour

Monday 25th June, 4:30 - 6:30 (see program)

UWO Herbarium Access

T.B.A.

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James B. Phipps
Vice-President, CBA

Norman P.A. Huner
Vice-President, CSPP

For the Local Organizing Committee:
Mark Bernards, Paul Cavers, Don Hayden, Priti Krishna, Bob van Huystee, Dianne Fahselt, Vicky Lightfoot, Sheila Macfie, Anwar Maun, Tessa Pocock, Jim Traquair, Lorna Woodrow.

SPONSORS AND EXHIBITORS

(As of June 08th 2000)

The Canadian Botanical Association and Canadian Society of Plant Physiologists are deeply grateful to the following sponsors and donors who have each contributed significantly to our joint meeting.

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  The University of Western Ontario
- **Dean of Science, The University of Western Ontario**
- **Anonymous**

PROGRAM

Sat. June 24	Sun. June 25	Mon. June 26	Tue. June 27	Wed. June 28
All Day Field trips Pinery Springwater Depart Convention Centre at 09:00	Registration, Main Foyer Welcoming Remarks 08:15-08:30 Theatre Joint CBA/CSPP Plenary Session 08:30-12:00 Theatre	**CBA:** Contr. Papers: Structure and Development., Salon A Symposium: Sand Dune Ecology, Salon B **CSPP:** Symp. II: Gene Regulation Salon D Contr. Paper Sess. III Gene Regulation, Salon D Contr. Paper Sess. IV, General, Salon E	**CBA:** Contr. Papers: Ecology, Salon A Symposium: Symmetry 2000, Salon B **CSPP:** Symp III: Mycology, Salon D Symp. IV: Enzymes and Proteins, Salon E Contr. Paper Sess. V, Mycology, Salon D Contr. Paper Sess. VI, Enzymes and Proteins, Salon E	CBA:Main Symposium "Systematics and Bioconservation" Salon B CSPP Incoming Exec. Meeting 10:00-12:00 Salon D
	Lunch 12:00-13:30, Ballroom 4/5 Posters Up 12:00-13:30, Ballroom 2/3	CBA Section Meetings: Systematics & Phytogeog. Salon A General Section , Salon B	CBA Section Meetings Struc. & Develop., Salon A Ecology, Salon B	
CBA Outgoing Exec. Meeting 15:30-19:00, Salon E CSPP Outgoing Exec. Meeting 15:00-17:00, Salon D Registration Ballroom Foyer, 16:00-22:00	**CBA:** Contr. Papers Systematics & Phytogeog., Salon A Teaching Workshop, Salon B **CSPP:** Symp. I: Signaling Pathways, Salon D Contr. Paper Sess. I Signaling, Salon D Contr. Paper Sess. II, General, Salon E	Field Trips: Sifton Bog, Meadowlily Woods, A'Nowaghi Depart Convention Centre 13:30 Plant Canada II 13:30-17:00, Salon B Short tour of campus, SFA, depart Convention Centre 16:30	**CBA:** Contr. Papers: Ecology, Salon A **CSPP:** Symp. V: Cell Wall Struc. and Develop., Salon D Contr. Paper Sess. VII, Cell Wall Struc. and Develop., Salon D Contr. Paper Sess. VIII, Photosynthesis, Salon E 16:00-18:00 CBA-AGM: Salon B CSPP-AGM Salon D	Field Trip: Ska-Nah-Doht CBA Incoming Exec. Meeting 13:30-15:30 Salon A
Mixer/Dinner (hot Hors d'ouvres) Cash Bar Balllroom 4/5	Poster Session with hot Hors d'ouvres, cash bar Ballroom 2/3 Plant Canada I Salon B 18:00-20:00 Weresub Lecture Salon B 20:30-21:30	BBQ @ Field Station 18:30-20:00	Cash Bar 18:00-19:00 Ballroom 4/5 Society Banquet Ballroom 4/5 Awards Presentation	

FIELD TRIPS

1. Springwater Forest; June 24, 2000; Full-day field trip, 9am - 5pm

This forest, south of Orwell in Elgin County, is one of the last remaining large stands of old growth of the southern Deciduous Forests of Eastern Canada. It formed an integral part of the holdings of the White family who protected it from serious logging. It continues to be protected by the Catfish Creek Conservation Authority. In the distant past red and white oaks were dominants in the complex, along with beech and sugar maple, but subsequently beech became the dominant tree member. At the present time, if the sapling reproduction layer is an indication, sugar maple appears to be ascending as the major species. There is a rich tree flora, comprising some 30 species, some very southern: tulip tree, black oak, sassafras, sour gum, as well as black cherry, white ash, yellow birch, black maple, red maple, sweet chestnut, basswood and scattered white pine. Growth increments have been channeled into height, not girth, to produce dense stands in which beech can rise to 45 m and scattered pine emerge from the upper canopy to 68 m. These forests provide environment for numerous interesting plants, many of which are Carolinian in character, and are among the most spectacular deciduous forests in the world. The bus will leave from the front of the **Convention Centre** at 9:00 a.m. and return by approximately 5:00 p.m. Bagged lunches will be provided. Leader: Dr. Paul Maycock. Cost: $25.

2. The Pinery; June 24, 2000; Full-day field trip, 9am - 5pm

Pinery Provincial Park, on the shores of Lake Huron about 40 km NW of London includes a major part of an extensive sand dune system extending along the shores. The development of soil and vegetation in the Pinery has taken place following the retreat of the Wisconsin ice sheet; the beaches and sand dune systems are traceable to wave action in glacial lakes. Vegetation on the first and youngest dune ridge is dominated by *Calamovilfa longifolia* and *Andropogon scoparius* and, moving inland, a large increase in the number of species and total ground cover can be observed. Prominent are *Arctostaphylos uva-ursi*, *Sorghastrum nutans*, *Liatris graminifolia*, *Stipa spartea*, *Artemesia campestris and Lithospermum caroliniense*. Earlier tree species to establish include eastern cottonwood, balsam poplar, red cedar and chinquapin oak, while on somewhat older stabilized dunes black, red and white oak, red and white pine be found. Beech and sugar maple characterize 10,000 to 12,000 year old dunes. Bagged lunches will be provided for a noon-time break at a picnic site near the beach, and a short stop at the nature interpretation centre and book shop will be scheduled in late afternoon. A bus will depart from the front of the **Convention Centre**, at 9:00 a.m. and return by approximately 5:00 p.m. Leaders: Dr. Anwar. Maun and Irene Krajnyk. Cost: $25.

3. Sifton Bog; Monday June 26, 2000; Half-day field trip; 1:30pm - 5pm

Sifton Bog is a remarkable example of bog vegetation in the deciduous forest region of southern Ontario. Located in a depression in west London, it has been designated one of five significant natural areas in the city. The bog is one of only a handful of similar isolated features in southern Ontario, far removed from the Boreal forest where such bog vegetation is common. It is considered to be a kettle bog, that is, one formed in a steep-sided hole left by the melting of a large fragment of ice that became imbedded in outwash sediments at the end of the last glaciation. The kettle-hole is surrounded by lowland forest, but most plant species in the bog itself are characteristic of the Boreal forest, with floating *Sphagnum* mats, *Vaccinium* spp. pitcher

plants, cotton grass, black spruce and larch. A walking trail and a boardwalk oriented toward open water provide a view of most bog species. A bus will leave the Convention Centre at 1:30 p.m. and return from the bog at 5:00 p.m. Organizers: Dr. Keith Winterhalder and Mario Tenuta. Cost: $20.

4. Meadowlily Woods; Monday June 26, 2000; Half-day field trip; 1:30pm - 5pm

Lying adjacent to the Thames River in southeast London, Meadowlily Woods ESA is part of one of the largest and least disturbed natural areas in the City, and one of five original Environmentally Significant Areas. London is near the limit of the Carolinian Zone in Canada, and a series of old river terraces cutting through glacial deposits of sandy loams and clay provide habitat for a rich Beech-Maple forest with several Carolinian elements. Ravines dissecting the terraces offer cooler microclimates that support mixed Hemlock-deciduous forests characteristic of habitats further to the north in Ontario. A bus heading for the forest will leave the Convention Centre at 1:30 p.m. and will return from the area at 5:00 p.m. Leaders: Dr. James Phipps and Dr. Jane Bowles. Cost: $20.

5. A'Nowaghi; Monday June 26, 2000; Half-day field trip; 1:30pm - 5pm

A'Nowaghi, including the Kirk-Cousins Management Area, is a Provincially Significant Wetland about a 15-minute drive south of London city centre. Habitats include numerous kettle ponds, swamps, meadows, and beech-maple forest, all of which can easily be visited within a leisurely two-hour walk. The leaders are amateur naturalists who in recent years have been conducting a five-kingdom biosurvey of the A'Nowaghi area for the Kettle Creek Conservation Authority. To date they have developed a database of 400 vascular plants and mosses. They welcome the participation of experts with the identification of additional species, particularly mosses, grasses, sedges and aquatic plants. Plants of interest include yellow mandarin (*Disporum lanuginosum*), beech drops (*Epifagus virginiana*), over 30 *Carex* species (including *C. lurida*, *C. tuckermanni*, and *C. prasina*), three-way sedge (*Dulichium arundinaceum*) and other wetland plants as well as many shrubs and trees with southern affinities (e.g., *Lindera benzoin*, *Hamamelis virginiana*, *Carpinus caroliniana*, *Carya ovata*, etc.). If landowner permission can be obtained, visitors may be interested in an adjacent tamarack swamp with a sphagnum mat and numerous species having bog and fen affinities. A bus will leave the Convention Centre at 1:30 p.m. and return from A'Nowaghi at 5:00 p.m. Leaders: Drs. Kee Dewdney and Pat Dewdney. Cost $20.

6. Ska-Na Doht; Wednesday June 28, 2000; Half-day field trip; 1:30pm - 5pm

Formerly called Longwoods Conservation Area, this is a public park and recreation area that offers a small but very interesting Resource Centre focused on native culture and an impressive reconstructed Neutral Indian village. Nature trails traverse 155 acres of surrounding upland deciduous forests on sandy soils, as well as lowlands and a marsh below the village site. Cost includes transportation plus access to trails and board walks, as well as general and special interest brochures. Following a visit to this area, the bus will stop briefly at Oneida, a native settlement with a small restaurant serving native cuisine of fry bread, corn soup, salt pork and venison. With notice these items could be prepared for take out (or eat-in, in the case of popular demand). There is also a small general store in the village where products such as corn flour are stocked. Buses will leave for Ska-Na Doht from the front of the Convention Centre at 1:30 p.m. and return to London by approximately 5:00 p.m. Leaders: Dr. James Traquair and Dr. Paul Maycock Cost: $15.

Saturday June 24, 2000

REGISTRATION AND FIELD TRIPS

09:00-17:00	All Day Field Trips (Leaving from London Convention Centre) -Springwater Forest (Leader: P.F. Maycock) -Pinery Provincial Park (Leaders: M.A. Maun and I. Krajnyk)
16:00-22:00	Registration, Ballroom Foyer, London Convention Centre
17:00-22:00	Reception/Mixer with Light Buffet Dinner (provided) and Cash Bar Ballroom 4/5

Sunday June 25, 2000, AM

Joint CBA/CSPP Plenary Session

Convention Centre Theatre

Dr. Norman Huner, Department of Plant Sciences, UWO, presiding

08:15-08:30	Welcoming Remarks
08:30-09:30	**Legumes in a Global Context** Dr. Janet I. Sprent Dept. Biological Sciences, University of Dundee, Scotland
09:30-10:30	**Plasmodesmata and the Phloem: Pathways for Local and Global Information Processing in Plants** Dr. William J. Lucas Dept. Plant Biology, University of California, Davis, California
10:30-11:00	Coffee Break
11:00-12:00	**The Effects of Elevated Atmospheric CO_2 on Mycorrhizal Diversity and Functioning** Dr. John Klironomos Dept. Botany, University of Guelph, Guelph ON
12:00-13:30	Lunch: Ballroom 4/5
12:00-13:30	Poster Setup, Ballroom 2/3

Sunday June 25, 2000, PM, CBA

	CBA Contributed Papers: Systematics and Phytogeography, Dr. J. B. Phipps, Presiding, **Salon A**	**Joint CBA/CSPP Workshop: Teaching, Salon B**
13:30-13:50	**How useful is the LEAFY gene for phylogeny reconstruction in the Caesalpinioideae?** (Student Paper) ARCHAMBAULT, A.* & BRUNEAU, A. Inst. de Recherche en Biol. Végétale, Université de Montréal	**Introduction** Laliberté, Sylvie
13:50-14:10	**Genetic analysis reveals distinct races of the parasitic flowering plant** *Arceuthobium americanum*. (Student Paper) JEROME, C. A.* & FORD, B. A., Dept of Botany, University of Manitoba	**Alternatives to traditional lectures.** Presiding: LALIBERTÉ, SYLVIE Université du Québec à Montréal **Demonstration of interactive learning in large "lectures."** Special Contributor: TOM POULSON, Honors College, Florida Atlantic University
14:10-14:30	**Adventitious roots, aerenchymatous phellem and arbuscular mycorrhizal fungi; their role in flood tolerance of *Lythrum salicaria*.** (Student Paper) STEVENS, K. J.*; PETERSON, R. L. & READER, R. J., Dept of Bot., Univ. of Guelph	**Interesting plant labs that work!** Presiding: MAXWELL, CHRISTINE, Trent University
14:30-14:50	**The influence of major collectors on the modern typification process: an example in *Crataegus* (Rosaceae).** (Student Paper) MACKLIN, J.A.* and PHIPPS, J.B. Dept of Plant Sciences, Univ. of Western Ontario	
14:50-15:10	**Coffee Break, Ballroom Foyer**	
15:10-15:30	**Clarification of the species *Crataegus pennsylvanica* Ashe** (Student Paper) MACKLIN, J.A. Department of Plant Sciences, Univ. of Western Ontario	**Turning students on to botany.** Presiding: FREGO, KATE, University of New Brunswick, Saint John
15:30-15:50	**A study of key morphological characters in Canadian Arctic Island Puccinellia (Poaceae)** CONSAUL, L. L.* & GILLESPIE, L. J. Canadian Museum of Nature, Ottawa	
15:50-16:10	**Pucciphippsia in the Canadian Arctic: molecular evidence for intergeneric hybrid status** GILLESPIE, L. J.*, BOLES, R. L. & CONSAUL, L. L. Canadian Museum of Nature, Ottawa	
16:10-16:30	**Coding of insertion deletion events: a case study from the chloroplast trnL intron in the Caesalpinioideae** BRUNEAU, A.* & FOREST, F. Inst Recherche en Biol. Végétale, Univ. Montréal	**Concluding Remarks,** Frego, Kate
16:30-18:30	**Poster Session (Cash Bar and Light Buffet Dinner Provided) Ballroom 2/3** **Canadian Journal of Botany Editorial Board Meeting**	
18:30-20:00	**Plant Canada Meeting, Salon B**	
20:30–21:30	**Weresub Lecture, Dr. Scott Redhead, "Biography of John Dearness"** **Salon B**	

Sunday June 25, 2000, PM, CSPP

CSPP Symposium I: Signaling Pathways, Dr. Priti Krishna, Presiding, Salon D		
13:30-14:30	**MAP Kinase Pathway Regulation: More than One Way to Skin a Cat.** BAUDOUIN, E., BEYERLY, J., JONAK, C., KIEGERL, S., LIGTERINK, W., MESKIENE, I., ZWERGER, K. AND HIRT, H.*. Inst. of Microbiology and Genetics, Vienna Biocenter, Vienna	
14:30-15:00	**Coffee Break: Ballroom Foyer**	
	Contributed Papers	
	Session I, Signaling, Dr. Priti Krishna, Presiding, Salon D	**Session II, General, Dr. John E. Thompson, Presiding, Salon E**
15:00-15:15	**The oxidative burst is accompanied by γ-aminobutyric acid accumulation** JANZEN, DJ; ALLEN, LJ; WONG, RS; BOWN, AW*. Dept Biol. Sci., Brock Univ.	**Interactions of carbon dioxide & phosphorus nutrition with proteoid root formation in white lupin.** (Student Paper: CSPP). CAMPBELL, C.D.*; SAGE, R.F. Dept. of Botany, University of Toronto.
15:15-15:30	**Does γ-aminobutyric acid accumulation function as a plant resistance mechanism against phytophagous insect activity?** (Student Paper) MACGREGOR, KB*[1]; SHELP, BJ[2]; BOWN, AW[1]. [1]Dept of Biol. Sciences, Brock Univ., [2]Hort. Sci. Dept, Univ. of Guelph	**The dynamics and site of nitrate reduction in soybean plants exposed to elevated CO_2** CEN, Y-P*, LAYZELL, DB Dept. Biology, Queen's University
15:30-15:45	**Increased nonphotochemical quenching accompanies the oxidative burst as part of the hypersensitive response in *Asparagus sprengeri*.** (Student Paper) KARNER, J *[1]; BOWN, A[2]; BRUCE, D[2]. [1]Dept. of Physics, Univ. of Guelph, [2]Dept. of Biol. Sciences, Brock Univ.	**A gene localized at the wheat stripe rust resistance locus YR10** LAROCHE, A.*, EUDES, F., FRICK, MM., NYKIFORUK, CL., HUEL, R., CONNER, RL., KUZYK, A., JORDAN M., CHEN, Q. ACHARYA, S. Agric.& Agri-Food Canada, Winnipeg
15:45-16:00	**Involvement of Vacuolar ATPase and ATP Synthase in Aluminum Resistance in an Aluminum Resistant Cultivar of Wheat (*Triticum aestivum* L.).** (Student Paper) HAMILTON, CA*; GOOD, A; TAYLOR, GJ. Dept of Biol. Sciences, University of Alberta	**Tracheary element maturation in *Pinus banksiana* (Lamb.) and *Eucalyptus grandis* (W. Hill ex Maiden) roots.** TAYLOR, J. H.*[1], PETERSON, C. A.[2]. [1]Plant Agriculture, University of Guelph, [2]Dept of Biology, University of Waterloo
16:00-16:15	**Phosphite Disrupts the Acclimation of Yeast to Phosphate-Starvation by Acting at the High-Affinity Phosphate-Transporter Pho84p.** (Student Paper) McDONALD, AE * [1]; NIERE, JO[2]; PLAXTON, WC[1,3]. [1]Depts. of Biol. & [3]Biochem., Queen's Univ., [2]Dept. of Applied Chem., Royal Melbourne Inst. of Tech., Aus.	**Bioaerosol contributions from a ecologically based indoor air biofilter.** (Student Paper) MALLANY, J.*, DARLINGTON, A. AND DIXON, M. Plant Agriculture/ Hort., University of Guelph
16:15-16:30	**Induction of tonoplast H^+-pumping pyrophosphatase by phosphate deprivation of *Brassica napus* suspension cells.** (Student Paper) PALMA, DA* [1]; BLUMWALD, E[2]; PLAXTON, WC[1,3]. [1]Depts. of Biol. & [3]Biochem., Queen's Univ.; [2]Dept. of Botany, Univ. of Toronto	**Insights Into the Plant-microbe Interactions in an Indoor Air Biofilter.** (Student Paper) LLEWELLYN,D.*, DARLINGTON,A. AND DIXON, M. Plant Agriculture/ Hort., University of Guelph
16:30-18:30	**Poster Session (Cash Bar and Light Buffet Dinner Provided) Ballroom 2/3**	
18:30-20:00	**Plant Canada Meeting, Salon B**	

Monday June 26, 2000, AM, CBA

CBA Contributed Papers: Structure and Development Dr. Usher Posluszny, Presiding, **Salon A**		**CBA Symposium: Sand Dune Ecology,** Dr. Anwar Maun, Presiding, **Salon B**	
09:00-09:20	**Occurrence of phi thickenings in gymnosperm roots.** GERRATH, J. M.* & COVINGTON, L. Dept of Biology, University of Northern Iowa	09:00	**INTRODUCTION**
09:20-09:40	**Axillary meristem development in *Arabidopsis thaliana*.** (Student Paper) MIHAJLOVIC, N.* & GRBIC, V. Dept of Plant Sciences, University of Western Ontario	09:05-09:40	**Colonization constraints during primary succession on coastal Lake Michigan sand dunes** LICHTER, JOHN, Duke University
09:40-10:00	**Floral ontogeny of hummingbird-pollinated *Mimulus cardinalis* (formerly Scrophulariaceae s.l.).** (Student Paper) HAZLE, T.* & CANNE-HILLIKER, J., Dept of Botany, University of Guelph	09:40-10:15	**The right time and the right place: using natural experiments avoids the trap of a favorite hypothesis about mechanisms of dune succession** POULSON, TOM, Honors College, Florida Atlantic University
10:00-10:20	**Comparative fruit morphology and anatomy in *Citrullus lanatus* (Cucurbitaceae)** (Student Paper) LECHA, H. B.* & POSLUSZNY, U., Dept of Botany, University of Guelph		
10:20-10:40	**Coffee Break, Ballroom Foyer**	10:15-10:30	**Coffee Break, Ballroom Foyer**
10:40-11:00	**Identifying pre-zygotic breeding barriers in conifers (Pinaceae).** (Student Paper) RISE, M.* & VON ADERKAS, P. Dept of Biology, University of Victoria	10:30-11:00	**Foredune development on subarctic coastal dunes.** HOULE, GILLES, Laval University
11:00-11:20	**Comparative floral development in the Myoporaceae.** (Student Paper) YACOB, L.*, & CANNE-HILLIKER, J. Dept of Botany, University of Guelph	11:00-11:30	**The impact of low great lakes water levels on sand transport through a trough blowout at Pinery Provincial Park, Ontario** BYRNE,* MARY-LOUISE, & BITTON,M. Wilfrid Laurier University
11:20-11:40	**How are cotyledon whorls formed by conifer somatic embryos?** VON ADERKAS, P.*, & HARRISON, L.G. Dept of Biology, Univ. of Victoria, Dept of Chem., University of British Columbia	11:30-11:55	**Burial of plants as a selective force in coastal and lacustrine sand dunes** MAUN, ANWAR, Dept of Plant Sciences, University of Western Ontario
11:40-12:00	**Floral ontogeny and self-pollination in *Teedia lucida* (Scrophulariaceae).** BALE, D. & CANNE-HILLIKER, J.* Department of Botany, Univ. of Guelph	11:55	**CONCLUDING REMARKS** HOULE, GILLES
12:00-13:30	**Lunch (Pick up from Ballroom Foyer)** **CBA Sectional Meetings: Systematics and Phytogeography, Salon A** **General Section, Salon B; Teaching Section, Salon D**		
13:30-17:00 **16:30**	**Half Day Field Trips (see page 4). All leave from London Convention Centre** **Plant Canada Meeting No. II, Salon B** **UWO campus tour; arrives BBQ 18:30**		
18:30-20:00	**Barbecue at Environmental Sciences Western Field Station. Bus leaves front of Convention Centre every half hour starting at 18:00. Return starting at 21:30.**		

Monday June 26, 2000, AM, CSPP

Symposium II: Gene Regulation, Salon D		
09:00-10:00	**Genetic determinants of mRNA decay in Arabidopsis.** GREEN, P. J.*, JOHNSON, M. A., KASTENMAYER, J. P., PEREZ-AMADOR, M. Plant Research Lab, Michigan State University., E. Lansing, MI	
10:00-10:30	**Coffee Break: Ballroom Foyer**	
Contributed Papers		
	Session III, Gene Regulation, Salon D	**Session IV, General, Salon E**
10:30-10:45	**Altered Membrane Lipase Expression Delays Leaf Senescence In Transgenic Arabidopsis.** TAYLOR, C.A., WANG, T., THOMPSON, J.E.* Dept of Biology, University of Waterloo	**Regulation of root water flow in drought-stressed aspen (*Populus tremuloides*) seedlings.** (Student Paper) SIEMENS, J.A.*, ZWIAZEK, J.J. Dept of Renewable Resources, University of Alberta
10:45-11:00	**Brassinosteroids and thermotolerance: a first look into the mechanism.** DHAUBHADEL, S., KRISHNA, P*. Dept of Plant Sciences, University of Western Ontario	**Mechanisms of salt and CT tolerance in black spruce.** (Student Paper) REDFIELD, E.B.*, ZWIAZEK, J.J. Dept of Renewable Resources, University of Alberta
11:00-11:15	**Controls to detect the presence of inhibitors of reverse transcriptase and/or Taq polymerase activity in plant total RNA extracts.** STEWART, S*., NASSUTH, A. Dept. of Botany, University of Guelph	**Induction of traumatic resinosis in Sitka spruce (*Picea sitchensis* (Bong) Carr.) elicited by white pine weevil (*Pissodes strobi* Peck) and simulated white pine weevil attack.** (Student Paper) HUNTER, W.*, PLANT, A. Simon Fraser University
11:15-11:30	**Regulation of Accumulation of Antifreeze Proteins in Winter Rye.** (Student Paper) YU, X-M*; GRIFFITH, M. Dept of Biology, University of Waterloo	**Hydrogen fertilization: bacteria or fungi?** DONG, Z.*, MCLEAN, N., IRVINE, P. Dept of Biology, St. Mary's University
11:30-11:45	**The soybean p60 homologue: a member of the hsp90 chaperone complex?** (Student Paper) KRISHNA, P., QUICK, M.* Department of Plant Sciences, University of Western Ontario	**Oxygen regulation and acetylene reduction of *Acetobacter diazotrophicus* colonies.** DONG, Z.*, CHEN, P. Biology, St. Mary's University, Halifax, N.S.
11:45-12:00	**Tissue Stabs Obtained with Glass Microcapillaries can be used for RT-PCR Detection of Plant Gene Transcripts and Virus RNA.** (Student Paper) MYSLIK, J.*, NASSUTH, A. Dept Botany, University of Guelph	**A Multi-component Phytoremediation System to Remove Polycyclic Aromatic Hydrocarbons from Contaminated Soils.** HUANG, X.-D.*, GLICK, R.B., GREENBERG, M. B. Dept of Biology, University of Waterloo
12:00-13:30	**Lunch (Pick up from Ballroom Foyer)**	
13:30- 17:00 16:30	**Half Day Field Trips (see page 4). All leave from London Convention Centre Plant Canada Meeting No. II, Salon B UWO campus tour; arrives BBQ 18:30**	
18:30-20:00	**Barbecue at Environmental Sciences Western Field Station. Bus leaves front of Convention Centre every half hour starting at 18:00. Return beginning at 21:30.**	

Tuesday June 27, 2000, AM, CBA

CBA Contributed Papers: Ecology Dr. Paul B. Cavers, Presiding, **Salon A**		**CBA Symposium: Symmetry 2000** Dr. D. Barabé, Presiding, **Salon B**	
08:30-08:50	**Biogeography and ecology of the kelp/red algal symbiosis** GARBARY, D. J.* & KIM, K. Y. Dept of Biology, St. Francis Xavier University, & Dept of Oceanography and Inst of Marine Sciences, Chonnam National University	08:30-09:00	**No talks scheduled**
08:50-09:10	**Multiple correlates of vegetation variation in subalpine forests of coastal and interior British Columbia** BRADFIELD, G. E.*, & ZHANG, W. Botany Dept., University of British Columbia	09:00-09:25	**Introduction: Different facets of the problem of symmetry in plants** CHARLTON, A., BARABÉ, D., & POSLUSZNY, U., Biological Sciences, Univ. of Manchester; IRBV- Jardin Botanique de Montréal & Dept of Botany, University of Guelph
09:10-09:30	**Event driven seedling establishment in a semi-desert** KRANNITZ, P. G. Environment Canada, Delta, B.C.	09:25-09:50	**Leaf symmetry: from morphology to molecules** DENGLER, N. G. Department of Botany, University of Toronto
09:30-09:50	**Distribution and ecology of *Hydrocotyle umbellata* in Kejimkujik National Park, Nova Scotia.** VASSEUR, L. Dept of Biology, Saint Mary's University		
09:50-10:10	**Understanding population differentiation in *Silene acaulis*** HERMANUTZ, L.* & INNES, D. Dept of Biology, Memorial University	09:50-10:15	**Floral symmetry: a morphogenetic perspective** LACROIX, C. R. Dept of Biology, University of Prince Edward Island
10:10-10:30	**Plant-size and fruit-position effects on reproductive allocation in *Alliaria petiolata*.** SUSKO, D. J.* & LOVETT-DOUST, L., Dept of Biological Sciences, University of Windsor		
10:30-10:45	Coffee Break, Ballroom Foyer	10:15-10:40	**Coffee Break, Ballroom Foyer**
10:45-11:05	**The effects of achene weight and orientation on germination in three species of aster: *Aster novae-angliae, A. puniceus*, and *A. umbellatus*** RUIT, S. & CHMIELEWSKI, J. G.* Dept of Biology, Slippery Rock University	10:40-11:05	**Genes, cytokinins and floral symmetry** VENGLAT, S. P., BLAHUT-BEATTY, L.M., BONHAM-SMITH, P. C. AND SAWHNEY, V. K.* Dept of Biology, University of Saskatchewan, P.B. I., Saskatoon, Agriculture and Agri-Food Canada, Saskatoon
11:05-11:25	**The ecology of mesic old growth deciduous forests in southern Ontario** MAYCOCK, P. F. Dept of Bot., Univ. of Toronto	11:05-11:30	**Self-similarity of plants as a form of symmetry** PRUSINKIEWICZ, P. Dept of Computer Science, University of Calgary
11:25-11:45	**Light attenuation by limestone rock and its effects on the depth, biomass, and richness of endolithic organisms** MATTHES, U. & LARSON, D. W.* Dept of Botany, University of Guelph	11:30-12:00	**Asymmetry in plant shape, neighborhood competition and compensatory growth.** BRISSON, JACQUES. Institut de Recherche en Biologie Végétale et Jardin Botanique de Montréal **Concluding Remarks**: POSLUSZNY, U.
11:40-12:00	**Damage to cliff ecosystems by rock climbing** LARSON, D. W.* & MCMILLAN, M. A. Dept of Botany, University of Guelph		
12:00-13:30	**Lunch (Pick up from Ballroom Foyer)** **CBA Sectional Meetings: Structure and Development, Salon A** **Ecology, Salon B**		

- Stressed plants would be more prone to mycorrhizal. So why would C_2H_4 inhibit mycorrhizzhon?
- C_2H_4 → larger aerenchyma

So why less colonization, more restriction?

Tuesday June 27, 2000, AM, CSPP

	CSPP Symposium III: Mycology, Dr. Jim Traquair, Presiding, Salon D	CSPP Symposium IV: Enzymes and Proteins, Dr. Mark A. Bernards, Presiding, Salon E
09:00-10:00	**Mycorrhizal fungi and their relationship to the rhizoplane and rhizosphere** PETERSON, R. LARRY. Dept of Botany, University of Guelph	**Novel Applications of Electrospray Mass Spectrometry: Protein Folding and Enzyme Kinetics.** KONERMANN, L.*, KOLAKOWSKI, B.M., SIMMONS, D.A., SOGBEIN, O.O., LEE, V.W.S. Dept of Chemistry, University of Western Ontario
10:00-10:30	**Coffee Break: Ballroom Foyer**	
	Contributed Papers	
	Session V, Mycology, Dr. Jim Traquair, Presiding, Salon D	**Session VI, Enzymes & Proteins, Dr. Mark Bernards, Presiding, Salon E**
10:30-10:45	**Exogenous Ethylene Inhibits the Formation of Arbuscular Mycorrhizae in Pea (*Pisum sativum* L. cv Sparkle).** (Student Paper: CBA) GEIL, R.D.*[1]; GUINEL, F.C.[2], PETERSON, R.L.[1] [1]Dept. of Botany, Univ. of Guelph: [2]Dept. of Biology, Wilfrid Laurier University	**The Role of Arginase in Post-Germinative Loblolly Pine Seedlings: Developmental Regulation and Protein Synthesis.** (Student Paper: CSPP) TODD, C.D.* and GIFFORD, D.J. Dept of Biological Sciences, University of Alberta
10:45-11:00	**Protein toxin(s) and pathogenesis of American ginseng by *Alternaria panax*.** (Student Paper: CBA) QUAYYUM, H.*; GIJZEN, M., TRAQUAIR, J. A. Dept of Plant Sciences, Univ. of Western Ontario, Agric & Agri-Food Canada, London	**Identification and immunolocalization of proteins in the ovular secretions of hybrid larch.** (Student Paper: CSPP) O'LEARY, S.J.*, VON ADERKAS, P. Dept of Biology, University of Victoria
11:00-11:15	**Characterization of the interaction between *Phialocephala fortinii* and *Asparagus officinalis*** (Student Paper: CBA) YU, TREVOR E. J-C.*, NASSUTH, A., PETERSON, R.L. Dept of Botany, University of Guelph	**Purification, characterization and kinetics of a novel flavonol 2-oxoglutarate-dependent dioxygenase from *Chrysosplenium americanum*.** ANZELLOTTI, D. and IBRAHIM, RK.* Biol Dept, Concordia University
11:15-11:30	**Epistomatal chambers in the needles of *Pinus strobus* L. (eastern white pine) function as microhabitat for specialized fungi.** (Student Paper: CBA) DECKERT, R.J.*, MELVILLE, L.H., PETERSON, R.L. Dept of Botany, Univ. of Guelph	**Purification and characterization of banana fruit pyruvate kinase.** TURNER, W.L.* and PLAXTON, W.C. Depts. of Biology and Biochemistry, Queen's University
11:30-11:45	**Decoding regulation of the tip-high calcium gradient and hyphal growth in *Neurospora crassa*.** (Student Paper: CSPP) SILVERMAN-GAVRILA LB*, LEW RR. Biology Dept, York University	**Overexpression of a sulfotransferase leads to delayed flowering in transgenic *A. thaliana*.** VARIN[1]*, L., GIDDA[1], S. and MIERSCH[2], O. [1]Biology Dept, Concordia University [2]Institut of Plant Biochem., Halle, Germany
11:45-12:00		**Mitochondrial driven bicarbonate transport supports photosynthesis.** HUERTAS, I.E.*[1],COLMAN, B.[1], ESPIE, G.S. [1]Dept. of Biology, York University, & Dept. of Botany, University of Toronto
12:00-13:30	Lunch (Pick up from Ballroom Foyer)	

Send Abrazol Block recipe to Zhongming + reference to book –

Tuesday June 27, 2000, PM, CBA

	CBA Contributed Papers: Ecology Dr. Dianne Fahselt Presiding, **Salon A**
13:30-13:50	**Microsatellite analysis of genetic diversity of *Populus tremuloides* in Québec.** (Student Paper) WYMAN[1], J.*; BRUNEAU[1], A. & TREMBLAY[2], F. (1) Institut de recherche en biologie, Québec (2) Dépt Sciences Appliquées, Université du Québec en l'Abitibi-Témiscamingue
13:50-14:10	**Remnant canopy as potential refugia for forest floor bryophytes within a harvested forest.** (Student Paper) FENTON, N. J.* & FREGO, K. A. Dept. of Biology, University of New Brunswick, Saint John
14:10-14:30	**Responses of a low-diversity grassland to soil disturbance & nitrogen addition** (Student paper) PELTZER, D. A.*, WILSON, S. D. & HAGER, H. A. Dept of Biology, University of Regina
14:30-14:50	**Examining the response over time of red spruce (*Picea rubens* Sarg.) to clearcutting of red spruce-balsam fir stands located in Queens County, Nova Scotia.** (Student Paper) REYES, G.* [1,2] & VASSEUR, L.[1]. [1]Dept of Biology, Saint Mary's University, [2]Dept of Biology, Dalhousie University
14:50-15:10	**Coffee Break, Ballroom Foyer**
15:10-15:30	**Impacts of clearcut logging on forest structure and understory vegetation of *Picea rubens* (red spruce) forests of Nova Scotia.** (Student Paper) MOOLA, F.* [1,2] & VASSEUR, L.[1]. [1]Dept of Biology, Saint Mary's University, [2]Dept of Biology, Dalhousie University
15:30-15:50	**Seed size and seedling vigour in *Taraxacum officinale* Weber.** (Student Paper) COLLINS, L. L.*; CAVERS, P. B. Dept of Plant Sciences, University of Western Ontario
16:00-18:00	**CBA Annual General Meeting, Salon B**
18:00-19:00	**Cash Bar, Ballroom 4/5**
18:00-midnight	**Joint CBA/CSPP Banquet and Awards Presentations, Ballroom 4/5**

Check the 3 bottles of BAP. Can we measure the UV absorbance? Can we check out modulation with the 3 bottles? What about a bio assay?

No scheduled talks in Salon B

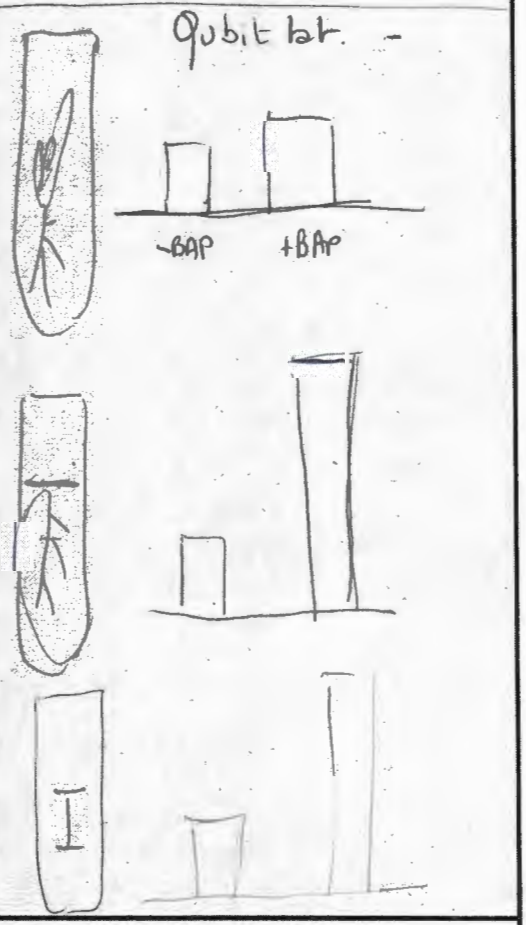
from Zhongming

Nmol / gDW / hr.

40 ml × x ppm / 10^5

= ml C_2H_4 / gDW / hr

22.4 L → 1 mol.



Ask Mr e-mail address of somebody working on cytokinin. "Holler" in England?

Products of degradation of [illegible] BAP synthetic?

$x = \frac{0.1 \times 1}{22.4}$

100 mL = 0.1L → x, mol?

22.4 L ⇒ 1 mol

Tuesday June 27, 2000, PM

Symposium V: Cell Wall Structure and Development, Salon D Dr. Carol A. Peterson, Presiding	
13:30-14:30	**Cell wall signals during cell growth and development: Is the plasma membrane listening?** CARPITA, N*., WYATT, S. E., OLEK, A. T., SHOUE, D. A. Dept. Botany & Plant Pathology, Purdue University, W. Lafayette, IN.
14:30-15:00	**Coffee Break: Ballroom Foyer**

Contributed Papers		
	Session VII, Cell Wall Structure & Development, Dr. Carol A. Peterson, Presiding Salon D	**Session VIII, Photosynthesis, Dr. Don Hayden, Presiding Salon E**
15:00-15:15	**Effects of a microtubule inhibitor on tip growth direction and stability in two root hair mutants of *Arabidopsis thaliana*.** (Student Paper) MACLELLAN, C.L., GALWAY M.E.* Dept of Biology, St. Francis Xavier University	**Photoreduction of H_2O_2 by the cyanobacterium *Synechococcus* PCC 7942 does not require photosystem 1.** MILLER, A.G. Biology Dept, St. Francis Xavier University
15:15-15:30	**Endodermal wall modifications in onion roots: ultrastructure of development.** (Student Paper) MA, F.*, PETERSON, C.A. Dept of Biology, University of Waterloo	**Synergistic Toxicity of 1,2-dihydroxyanthraquinone and Copper to the Higher Plant *Lemna gibba*: Redox Dependent Formation of reactive Oxygen Species (ROS) Mediated by Copper.** BABU, T.S.*, TRIPURANTHAKAM, S., DIXON, D.G., GREENBERG, B.M. Dept of Biology, University of Waterloo
15:30-15:45	**The pathway of calcium movement in onion roots.** CHOLEWA, E., PETERSON, C.A.* Department of Biology, University of Waterloo	**Seasonal photosynthetic acclimation in the old forest lichen *Lobaria pulmonaria*.** (Student Paper) MACKENZIE, T.D.B.* and CAMPBELL, D.A. Department of Biology and Biochemistry, Mount Allison University, Sackville, New Brunswick
15:45-16:00	**Macromolecular Assembly of Potato Ligno-Suberin.** BERNARDS, M.A.* and RAZEM, F.A. Dept of Plant Sciences, University of Western Ontario	**The greening of *Chlorella vulgaris* in response to low PSII excitation pressure is dependent upon the redox-state of the plastoquinone pool.** (Student Paper) WILSON KE*, KROL M, HUNER NPA. Dept of Plant Sciences, University of Western Ontario
16:00-18:00	**CSPP Annual General Meeting, Salon D**	
18:00-19:00	**Cash Bar, Ballroom 4/5**	
19:00-Midnight	**Joint Society Banquet and Awards Presentations, Ballroom 4/5**	

Wednesday June 28, 2000, AM, CBA

Main CBA Symposium: Systematics and Bioconservation, Salon B Dr. P.M. Catling, Presiding	
08:30-08:40	**Introduction:** PAUL CATLING
08:40-09:20	**Contributions of biosystematics to the protection of vascular plant biodiversity in Canada** CATLING, P. M. Agriculture and Agri-Food Canada, Ottawa
09:20-09:50	**The role of conservation data centres in the conservation of Canada's flora** SORRILL, P., Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough
09:50-10:20	**Planning with plants in Illinois** ROBERTSON, K. R. Center for Biodiversity, Illinois Natural History Survey, Champaign, IL..
10:20-10:35	**Coffee Break, Ballroom Foyer**
10:35-11:05	**Floristic data on the island of Newfoundland : their application to conservation** BROUILLET, L.*, LEBRUN, L., HAY, S. & BOUCHARD, A. Institut de recherche en biologie végétale, Université de Montréal, Montréal
11:05-11:35	**The impact of hybridization on the endangered red mulberry (*Morus rubra*): implications for conservation.** HUSBAND, B.C.* & BURGESS, K. Department of Botany, University of Guelph
11:35-12:05	**Can systematists help conserve plants in the next century?** REZNICEK, A. A. University of Michigan Herbarium, Ann Arbor, Michigan
12:05-12:15	**Concluding Remarks**
13:30-17:00	**Half Day Field Trip (Ska-Nah-Doht); see page 5. Leave from front of London Convention Centre**
10:00-12:00	**CSPP Incoming Executive Meeting, Salon D**
13:30-15:30	**CBA Incoming Executive Meeting, Salon A**

LECTURE ABSTRACTS

(ARRANGED BY SESSION)

Joint CBA/CSPP Plenary Session
Sunday June 25, 2000, 08:30-12:00, Theatre

08:30

Legumes in a global context. SPRENT, J.I., Department of Biological Sciences, University of Dundee, DD1 4HN, Scotland, UK.

Leguminosae (Fabaceae), the third largest family of flowering plants, is best known for the ability of some of its members to nodulate and fix nitrogen, which has for millennia (if unknowingly) been exploited in agriculture. However, legumes can be found in all known environments except those which are truly marine. Geographically they are found from the equator to 80°N (but only 50°S). They thrive at high altitudes (7000m in the Andes), in some deserts, flooded areas, and soils with extremely low nutrient supply. Their ability to acquire nutrients in these non-agricultural environments is under-researched and poorly understood. As a result, there is an understandable tendency to generalise from agricultural species, often selected on fertilised soils, to all legumes. However, apart from their reliance on C_3 photosynthesis (no legumes are known to be C_4 or CAM), legumes appear to be able to use the full range of adaptations known for growth in different environments. Using examples from areas such as the Pantanal wetlands of Brazil, the Cape Fynbos of South Africa and the High Arctic, the versatility of legumes will be described. Particular attention will be paid to the acquisition of N (as N_2, NO_3^-, NH_4^+, organic N) and P (by means of endo and ectomycorrhizas, cluster roots and physiological adaptations) and their interactions. The untapped potential of both nodulated and non-nodulated legumes in natural environments will be highlighted.

09:30

Plasmodesmata & the Phloem: Pathways for Local & Global Information Processing in Plants. LUCAS, W.J. Section of Plant Biology, Division of Biological Sciences, University of California, Davis, CA 95616, USA.

Plants have evolved the capacity to traffic proteins (transcription factors) and ribonucleoprotein complexes (RNPC) from cell to cell, via plasmodesmata (PD), resulting in a novel supracellular control system. Plant viruses have been shown to encode movement proteins (MPs) that also interact with PD to mediate the cell-to-cell spread of infectious nucleic acids. The recent identification and characterization of plant paralogs to viral MPs has provided insight into viral evolution and to the discovery that the phloem long-distance transport system mediates the selective translocation of host mRNA molecules. The special PD that interconnect the companion cells to the enucleate sieve tube system of the phloem appear to act as the selectivity filter for exchange of RNPCs between the translocation stream and the surrounding cells. It has also been established that the phloem mediates the systemic delivery of sequence-specific information molecules involved in post-transcriptional gene silencing (RNAi). These recent discoveries will be discussed in terms of (a) the evolution of this RNA-based information superhighway, and (b) the roles likely played by this system in both the integration of developmental and physiological processes, at the organ /whole-plant level, and the activation of the systemic pathogen defense system.

Support for this work was provided by NSF (Grant No. 99-00539) and DOE (Grant No. DE-FG03-94ER20134).

11:00

The effects of elevated atmospheric CO_2 on mycorrhizal diversity and functioning.
KLIRONOMOS, J.N. Department of Botany, University of Guelph, Guelph, ON, Canada, N1G 2W1.

It has been speculated that the forces driving global change, such as atmospheric CO_2, will also alter the diversity and distribution of organisms within ecosystems. Direct effects of CO_2 on vegetation may work to enhance or reduce biodiversity in natural ecosystems. Such changes in diversity are, in turn, expected to alter ecosystem functioning, such as primary productivity and the cycling of nutrients. In my lab we have investigated the effects of elevated atmospheric CO_2 on the species diversity of arbuscular mycorrhizal fungi (AMF) associated with the grass, *Bromus inermis*. Individual plants and soil collected from fourteen different sites across North America were subjected to ambient and elevated CO_2 levels. In twelve of fourteen sites AMF species diversity was reduced by greater than 25% in response to elevated CO2, and in eight sites the reduction was greater than 50%. Only two sites did not lose species diversity in response to elevated CO_2. Furthermore, the efficiency of the mycorrhizal symbiosis, in terms of phosphorous uptake, was lowered in nine of the sites. Further studies determined that such changes in AMF species diversity may negatively affect plant biodiversity, ecosystem productivity and nutrient capture. Overall, these data show that CO_2 can seriously impact below-ground diversity of AMF, which can in turn affect ecosystem functioning.

13:30

How useful is the LEAFY gene for phylogeny reconstruction in the Caesalpinioideae? ARCHAMBAULT, A.*; BRUNEAU, A. Institut de recherche en biologie végétale, Université de Montréal, 4101 Sherbrooke est, Montréal, Québec, H2M 1X4

Traditionally, the basal lineage in the legume family is grouped together in the paraphyletic Caesalpinioideae subfamily. Species in this group are tall tropical trees, making it difficult to obtain flowering material. Moreover, floral morphology and development is extremely diverse within this subfamily. Consequently, the use of molecular characters to better understand evolutionary relationships in this group has proved to be useful. We examined the potential use and limitations of the LEAFY gene for the reconstruction of the phylogeny in the Caesalpinioideae. LEAFY is a nuclear gene coding for a transcription factor protein involved in inflorescence and axillary meristem development. As in other angiosperms studied, in the Caesalpinioideae LEAFY is found as a single copy gene with three exons and two introns. Preliminary results for a partial sequence of LEAFY show that the coding regions are surprisingly variable among tribes of Caesalpinoideae. Characters provided by the exons may give more resolution within tribes Detarieae and Macrolobieae than that obtained from chloroplast sequences. Further, we hypothesize that the intron sequence may be useful at lower taxonomic levels. Our results indicate that LEAFY is likely to be a useful marker for phylogenetic analyses at the family and subfamily levels in the Leguminosae, and in other angiosperm families.

13:50

Genetic Analysis Reveals Distinct Races of the Parasitic Flowering Plant, *Arceuthobium americanum.* JEROME, C.A.*; FORD, B.A. Department of Botany, University of Manitoba, R3T 2N2.

The dwarf mistletoes (in the genus *Arceuthobium*) are comprised of 40 species of vascular plant parasites that infect coniferous host plants. *Arceuthobium americanum* infects two principal hosts, *Pinus banksiana* and *Pinus contorta,* and has the most extensive range of any North American dwarf mistletoe. Based on the lack of apparent morphological and phenological differences between populations of *A. americanum*, past researchers have found no evidence for recognizing subspecific taxa. However, genetic differentiation in this species has likely arisen due to geographic isolation and adaptation of *A. americanum* to different host populations over its extensive range. We have used a molecular tool, AFLP, to analyze the population structure of this species. Our results suggest that *A. americanum* is divided into three distinct genetic races: (1) one that infects *P. banksiana* in western Canada; (2) one that infects *P. contorta* in the Sierra Nevada and Cascade mountain ranges in the U.S.; and (3) a third that infects *P. contorta* throughout the rest of its range in the U.S. and Canada. Within these three races, weak geographic patterning has been observed. Interestingly, parasite populations found on hybrid hosts of *P. banksiana* and *P. contorta* are outliers in their groups. It appears that both geography and host specificity play a role in determining the population structure of this parasite.

14:10

Adventitious roots, aerenchymatous phellem and arbuscular mycorrizal fungi; their role in flood tolerance of *Lythrum salicaria*. STEVENS, K.J.*; PETERSON, R.L.; READER, R.J. University of Guelph, Guelph, ON, Canada N1G 2W1.

Lythrum salicaria (purple loosestrife)is an erect perennial herb of Eurasian origin that is capable of inhabiting dry and flooded areas. Flooded conditions invoke (1) the development of adventitious roots along flooded sections of stem,(2) the formation of a spongy-aerenchymatous phellem in flooded stems and roots,(3) a decrease in arbuscular mycorrhizal (AM) colonization. This study examines the role of adventitious roots, aerenchymatous phellem and AM fungi in flood tolerance of *L. salicaria* under greenhouse conditions. Plants were grown with or without a source of AM inoculum for a 10 week period prior to flooding. To initiate flooded conditions, water levels were raised to one half the stem height and maintained at these levels for a 12 week period. Starting one week after flooding, all adventitious roots were either left on the stems or removed daily and the aerenchymatous phellem was left on or removed daily from a one-internodal region at the stem base. The effects of adventitious root and phellem removal, and the absence of AM inoculum on growth, biomass partitioning and O_2 and CO_2 levels in shoots and roots is assessed.

14:30

The influence of major collectors on the modern typification process: an example in *Crataegus* (Rosaceae). MACKLIN, J.A.* and PHIPPS, J.B. Department of Plant Sciences, The University of Western Ontario, 1151 Richmond St. N, London Ontario, N6A 5B7.

In the first 20 years of the twentieth century over 1000 new North America *Crataegus* species were described by a small number of influential botanists. These botanists included W.W. Ashe, C.D. Beadle, N.L. Britton, W.W. Eggleston and C.S. Sargent. The large number of new species described was the result of keen and hawk-eyed field observation combined with a narrow concept of species. All of these botanists had varying degrees of contact with the international taxonomic community that was actively attempting to standardize the nomenclatural process. An issue of contention was the citation of a type specimen for reference in addition to description when publishing a new name. Britton, Eggleston and Sargent generally cited the type whereas Ashe and Beadle generally did not although Beadle noted that type material had been collected. However, some confusion was generated by the interpretation of what constituted a type specimen. Later taxonomists have benefited from those collectors who cited types in their protologues when interpreting names. The lack of type specimens and/or the failure to examine type specimens that do exist has caused past taxonomists to make poor judgments. Several examples of the confusion generated by these judgments will be given for *Crataegus*.

15:10

Clarification of the species *Crataegus pennsylvanica* Ashe. MACKLIN, J.A. Department of Plant Sciences, The University of Western Ontario, 1151 Richmond St. N, London Ontario, N6A 5B7.

The name *C. pennsylvanica* Ashe has been variously applied to specimens in *Crataegus* series *Coccineae* and series *Molles*. Careful examination of herbarium specimens and fieldwork in eastern North America determined that the names *C. ellwangeriana* Sarg. and *C. tatnalliana* Sarg. were synonyms of *C. pennsylvanica*, the earliest name. This realization extended the geographic range of *C. pennsylvanica*, which is unique in series *Coccineae*. Since Ashe did not cite type specimens the binomial *C. pennsylvanica* required neo- or lecto-typification. A morphometric study on series *Coccineae* revealed that *C. pennsylvanica* is a well-defined species set apart from the main members of the series. The addition of series *Molles* OTUs as outgroups found that *C. pennsylvanica* has a variation pattern intermediate between the two series indicating a possible ancient hybridization event. However, the species *C. pennsylvanica* is best placed in series *Molles* based on morphometric analysis.

15:30

A study of key morphological characters in Canadian Arctic Island *Puccinellia* (Poaceae). CONSAUL, L.L.* and GILLESPIE, L.J. Canadian Museum of Nature, Box 3443, Station D, Ottawa, ON K1P 6P4.

Puccinellia, or Alkali grass, is the most speciose grass genus in the Canadian Arctic, and one that is very difficult to identify. A survey of the main identification keys to the Arctic species revealed inconsistencies among the keys in the characters identifying some species, inconsistencies in the use of the terms describing the characters, and/or lack of clarity in the meaning of these terms. We reexamined several of these characters, including "erose-ciliolate lemmas and glumes," and "thickened pedicels," as an initial step in a larger study aimed at understanding the species delimitation in Arctic *Puccinellia*. The margins of the lemmas and glumes of one to four species, depending on the key used, have been characterized as "erose-ciliolate." Microscopic examination found trichomes on the margins of eight species. However, the trichomes were not ciliolae as typically defined, but were acute marginal cells of variable length (ranging about 20-60 μm), sometimes tipped with a spinule 5-10 μm long. "Thickened pedicels", a key character in distinguishing *P. andersonii*, was unclear as to the part of the pedicel intended. Most species were found to have thickened pedicel apices, but *P. andersonii* and *P. langeana* were also thickened below the apex, with the apex to below apex ratio found to be the best pedicel character distinguishing these two species from the others. This study resolved and clarified definitions of the terms used by previous investigators of arctic *Puccinellia*, contributing to more reliable identifications essential for future studies.

15:50

***'Pucciphippsia* in the Canadian Arctic: molecular evidence for intergeneric hybrid status.** GILLESPIE, L.J.*, BOLES, R.L. and CONSAUL, L.L. Canadian Museum of Nature, PO Box 3443, Station D, Ottawa, ON K1P 6P4.

'Pucciphippsia is a diminutive arctic grass known from Svalbard and several localities in arctic Canada and Russia. The genus is considered to be an intergeneric hybrid between *Phippsia* and *Puccinellia* based on morphological and chromosomal evidence. Two species have been described based on which species of *Puccinellia* and *Phippsia* are considered to be the parental species. In the Canadian Arctic the hybrid is considered to be the cross between *Puccinellia vahliana* and *Phippsia algida*. Previously known from only two collections in the Canadian Arctic, Cornwallis and southern Ellesmere Islands, four additional populations of *'Pucciphippsia* were discovered in 1999 on Axel Heiberg, Devon & Baffin Islands. We examined the hybrid genus along with putative parental species using restriction site analysis of PCR amplified cpDNA. *Puccinellia vahliana* and *Phippsia algida* were found to have unique cpDNA haplotypes, which differ in 7 sites in 4 cpDNA regions examined. Two to five plants of *'Pucciphippsia* from each of five populations were examined Individuals had either the *Pucinellia vahliana* or the *Phipppsia algida* haplotype, with both haplotypes found in three populations and only the *Phippsia* haplotype in two populations. Our cpDNA restriction site data confirms the hypothesis of Canadian Arctic *'Pucciphippsia* as an intergeneric hybrid between *Puccinellia vahliana* and *Phippsia algida.* In addition, hybridization appears to be bidirectional, with both parental species acting as the chloroplast donor.

16:10

Coding of insertion deletion events: a case study from the chloroplast trnL intron in the Caesalpinioideae. BRUNEAU, A.*; FOREST, F. . Institut de recherche en biologie végétale, Université de Montréal, 4101 Sherbrooke est, Montréal, Québec, H1X 2B2.

Sequences from the chloroplast trnL intron often are used for examining relationships at the species levels in various groups of angiosperms. Here we compare trnL sequences sampled from 195 taxa and representative of each of the five tribes and of most generic groups within the Caesalpinioideae to examine generic level relationships in the subfamily. The sequences vary in length, with members of two tribes possessing a large 200 bp insertion relative to the other three tribes. Numerous other small insertion/deletion events occur within the intron, 46 of which are potentially phylogenetically informative. We explore different methods of coding these indels: as separate presence/absence characters; as complex multi-state characters; as missing values. The implications for the homology of these different coding methods are discussed and the effect of the different coding methods on phylogenetic relationships in the Caesalpinioideae are examined. Despite the complexity of indel coding, our results suggest specific hypotheses of relationships in the subfamily, adding new information to the pattern of relationships observed in the Leguminosae.

Demonstration of interactive learning in large "lectures". POULSON, T.L. Honors College, Florida Atlantic University, 5353 Parkside Drive, Jupiter, FL 33458, USA.

My innovation is the use of 1-page worksheets handed out to the class before they are discussed. There is an r^2 of 0.88 for percent of worksheets attempted before class vs. course grade. Each worksheet starts with a 1-point e-mail bonus question that, if answered before class, summarizes the main point. Each uses some mix of leading questions, definitions to write, matching, multiple choice, and statements to complete often in the context of developing and testing hypotheses. To connect with different students I use slides, words, drawings, graphs, and equations. In class, groups of 3-4 students discuss each part of the worksheet for 15 - 120 seconds and come to a corporate answer. Then I solicit answers with rationales, have the class vote by voice on alternatives, and may use mini debates. As I interact with students I analyze the concept. It is at this point that I use a variety of techniques to emphasize or illustrate a point. For immediacy and relevance I use examples from the news, TV, issues in Congress, controversies, and recent articles in SCIENCE and NATURE. For entertainment I use costumes, jokes, cartoons, rhymes, limericks, and compromising stories all with a biological message. I also use examples of fine writing. I involve groups of students in demonstrations and have the whole class do analyses of biological objects. At the end of class each group hands in their worksheets for recording and return. My completed worksheet and all slides and other illustrations are posted on the class web site.

13:30

MAP Kinase Pathway Regulation: More than One Way to Skin a Cat.

BAUDOUIN, E., BEYERLY, J., JONAK, C., KIEGERL, S., LIGTERINK, W., MESKIENE, I., ZWERGER, K. AND HIRT, H.*. Institute of Microbiology and Genetics, Vienna Biocenter, Dr. Bohrgasse 9, A-1030 Vienna, Austria.

Mitogen-activated protein kinase (MAPK) pathways transduce a large variety of external signals in mammals, unicellular eukaryotes, and plants (for review, see Jonak et al. (1999) Cell. Mol. Life. Sci. 55, 204-213). MAPK pathways are minimally composed of a three-kinase-module composed of a MAPK, a MAPK kinase, and a MAPK kinase kinase. MAPK signaling occurs by sequential phosphorylation along the kinase cascade. MAPKs potentially target a large variety of substrates, including transcription factors, cytoskeletal elements, or protein kinases. We have identified two MAPKs involved in stress signaling (Jonak et al. (1996) PNAS 93, 11274-11279; Munnik et al. (1999) Plant J. 20, 381-388). Our studies revealed that the same extracellular stimulus can activate multiple MAPK pathways, indicating that branching into different pathways is a very early event after receptor stimulation. On the other hand, we also observed that the same MAPK pathway can be activated by different stimuli, indicating that the module must also be able to integrate multiple signals. This bewildering complexity can be explained by two recent studies in our lab. The *ZR5* and *MP2C* genes were identified in a yeast-based screen for MAPK regulators. Genetic and biochemical analysis showed that ZR5 is a 110 kDa protein composed of distinct domains with the ability to interact with a MAPKKK, different phospholipids, as well as with heterotrimeric and small G proteins. Our data indicate that ZR5 is an integrom (integrator of a MAPK module), functioning as a MAPK scaffold protein that integrates multiple upstream signaling factors. MP2C is a protein phosphatase 2C (PP2C) that inactivates MAPKs (Meskiene et al. (1998) PNAS 95, 1938-1943). Structure function analysis with other PP2Cs revealed that MP2C is a specific MAPK phosphatase and that a MAPK targeting domain is involved in binding and specifying the substrate. Moreover, the activity of MP2C is strongly inhibited by linolenic acid, the precursor of jasmonic acid, and Ca^{2+} (Baudouin et al. (1999) Plant J. 20, 343-348). These studies indicate that MAPK pathways cannot only be activated through upstream kinases but also through the inhibition of negative regulators such as MP2C.

15:00

The Oxidative Burst is Accompanied by γ-Aminobutyric Acid Accumulation.
JANZEN, DJ; ALLEN, LJ; WONG, RS; BOWN, AW*. Department of Biological Sciences, Brock University, ON L2S 3A1.

GABA (gamma-aminobutyrate) is a 4-carbon non-protein amino acid. It is synthesized via the alpha-decarboxylation of L-Glu catalyzed by L-Glu decarboxylase (GAD). Rapid, stress induced GABA synthesis results from the activation of GAD through increases in cytosolic H^+ or Ca^{2+} levels (Bown and Shelp, Plant Physiol. 1997). The role of GABA is not clear. We have investigated the accumulation of GABA during the oxidative burst, a phenomenon associated with the hypersensitive response to pathogen attack. Mas-7, a G-protein activator, is a well-documented activator of the oxidative burst. On addition to a pH 5.0 suspension of isolated *Asparagus sprengeri* Regel mesophyll cells Mas-7 stimulated a significant increase in GABA accumulation. Within 16 min levels rose from 6.6 nmol. 10(-6) cells to 26.3 nmol. 10(-6) cells. Approximately 65% of the newly accumulated GABA was extracellular. An intracellular fluorescent pH probe was employed to investigate the mechanism of GABA accumulation. Rapid intracellular acidification of 0.45 pH units was observed after Mas-7 addition. Exogenous La^{3+}, a Ca^{2+} channel blocker, completely inhibited the Mas-7 stimulated oxidative burst, intracellular acidification and GABA synthesis. The role of GABA will be discussed.

15:15

Does γ-Aminobutyric Acid Accumulation Function as a Plant Resistance Mechanism Against Phytophagous Insect Activity?
MACGREGOR, KB*[1]; SHELP, BJ.[2]; BOWN, AW.[1]. [1]Department of Biological Sciences, Brock University, ON L2S 3A1; [2]Horticultural Sciences Department., University of Guelph, ON N1G 2W1.

GABA (gamma-aminobutyrate) is a 4-carbon non-protein amino acid. It is synthesized via the alpha-decarboxylation of L-Glu catalyzed by L-Glu decarboxylase (GAD). Rapid, stress induced GABA synthesis results from the activation of GAD through increases in cytosolic H^+ or Ca^{2+} levels (Bown and Shelp, Plant Physiol. 1997). The role of GABA in plants is not clear. In animals it is a signaling molecule and functions as an inhibitory neurotransmitter. We have investigated the hypothesis that GABA accumulation functions as a resistance mechanism against phytophagous insect activity. Two testable predictions of this hypothesis are: (1) insect activity on leaf tissue will increase GABA levels; (2) increased GABA levels will deter feeding. These predictions were investigated using wt tobacco and transgenic tobacco strains overexpressing Petunia GAD or Petunia GAD lacking an autoinhibitory domain. Data will be presented demonstrating that: (1) insect activity increases leaf GABA levels; (2) transgenic plants with an elevated capacity for GABA synthesis deterred feeding; (3) transgenic plants with constitutively higher levels of GABA stimulated feeding.

15:30

Increased Non-photochemical Quenching Accompanies the Oxidative Burst as Part of the Hypersensitive Response In *Asparagus sprengeri*. KARNER, J *[1]; BOWN, AW[2]; BRUCE, D[2]. [1]Dept of Physics, University of Guelph, ON N1G 2W1; [2]Dept of Biological Sciences, Brock University, St. Catharines, ON L2S 3A1.

The hypersensitive response is characterized by external alkalinization, internal acidification, Ca^{2+}, Cl^-, and K^+ ion fluxes, conversion of O_2 to $O_2^{\cdot-}$ (the oxidative burst), and cell death. The G-protein activator mastoparan and its analogue Mas7 are known to elicit the oxidative burst, external alkalinization, internal acidification, and cell death, while also causing changes in photosynthetic parameters; a rapid increase in nonphotochemical quenching is followed by a slow release of photochemical quenching (Allen et al., 1999, Plant Physiology 119: 1233-1241). It is not known whether these fluorescence changes are a part of the hypersensitive response. Butyric acid was used, in the absence of Mas7, to induce internal acidification, which led to the oxidative burst and the increase in nonphotochemical quenching. This suggests that these events are connected, and that the fluorescence changes are not due to a specific effect of Mas7. This notion is supported by the fact that the Ca^{2+} channel blocker lanthanum, which prevents the Mas7-induced oxidative burst and internal acidification, also blocks changes in fluorescence. It is unclear whether the fluorescence changes result directly from internal acidification or from an unknown signal that is part of the hypersensitive response (such as Ca^{2+} influx or loss of reductant). However, it is clear that the fluorescence changes are coincident with the oxidative burst, and both appear to be part of the hypersensitive response.

15:45

Involvement of Vacuolar ATPase and ATP Synthase in Aluminum Resistance in an Aluminum Resistant Cultivar of Wheat (*Triticum aestivum* L.). HAMILTON, CA*, GOOD, A AND TAYLOR, GJ. Dept of Biological Sciences, University of Alberta, Edmonton AB, T6G 2E9.

Two aluminum-induced proteins (RMP51) have recently been discovered in an Al-resistant cultivar (PT741) of wheat, and shown to segregate with the Al resistance phenotype. The purified peptides share sequence homology with the B subunit of the vacuolar H+ATPase (V-ATPase) and the alpha and beta subunits of ATP synthase. Aluminum induces activities of both V-ATPase and ATP synthase in a dose-dependent manner. In contrast, activity of the plasma membrane ATPase (P-ATPase) is reduced, even under relatively low-stress conditions. To determine whether or not this is a general phenomenon, responses of cellular ATPases to Al stress were examined in a variety of Al-resistant and Al-sensitive cultivars. Induction of V-ATPase and ATP synthase was only observed in PT741, the Al-resistant cultivar in which induction of these proteins was originally observed. To test the hypothesis that V-ATPase and/or ATP synthase contribute to Al resistance, the effects of altered ATPase activity levels on the Al resistance phenotype in yeast are being measured. We hypothesize that V-ATPase mutants, and not ATP synthase mutants, will be hypersensitive to Al. Complementation experiments are underway to confirm the role of the missing V-ATPase subunits. We hope this will restore the wild-type phenotype of V-ATPase mutants and confirm that V-ATPase is required for Al resistance. We expect these experiments to provide evidence suggesting that maintenance of vacuolar membrane energization is essential for Al resistance. This may reflect a requirement for transport across the tonoplast or for maintenance of cytoplasmic pH for Al resistance.

16:00

Phosphite Disrupts the Acclimation of Yeast to Phosphate-Starvation by Acting at the High-Affinity Phosphate-Transporter Pho84p. McDONALD, A.E. * (1), NIERE, J.O. (2), PLAXTON, W.C.(1,3) - Depts. of Biology(1) & Biochemistry(3), Queen's University, Kingston, ON K7L 3N6; Dept. of Applied Chemistry(2), Royal Melbourne Institute of Technology, Melbourne, Australia.

Phosphite (Phi), a reduced form of phosphate (Pi) in which -H replaces an -OH bonded to the P atom, is the active ingredient of an agricultural fungicide that is widely used to control crop infection by pathogenic *Phytophthora* sp. Our recent studies of *Brassica* sp. revealed that by disrupting their Pi-starvation response, low Phi levels are quite toxic to Pi-starved plants. Here we report the influence of Phi on the Pi-starvation response of *Saccharomyces cerevisiae*. Evidence of an active Pi-stress response in this yeast was provided by Pi-repressible acid phosphatase (rAPase). Several lines of evidence show that Pi-starved yeast respond to Phi in a manner similar to Pi-starved plants. Phi (0.1 mM) disrupted the growth and derepression of rAPase in Pi-starved yeast, but not in Pi-sufficient yeast. Recent work has focused on discovering Phi's site and mode of action. Several yeast mutants defective in gene products required for the derepression of rAPase (i.e. the PHO regulon) have been investigated. Studies on a pho84 disruption mutant (in which the high-affinity Pi-transporter is non-functional) have revealed that this strain is immune to Phi's deleterious effects on growth and rAPase expression. Studies on a pho85 disruption mutant (in which the expression of rAPase is constitutive) indicate that a pathway other than the PHO regulon may also impinge on rAPase expression. Phi therefore represents a valuable tool with which to elucidate aspects of the signal transduction pathway by which yeast and plants respond to Pi stress at the molecular level. (Supported by NSERC)

16:15

Induction of Tonoplast H+-Pumping Pyrophosphatase by Phosphate Deprivation of *Brassica napus* Suspension Cells. PALMA, D. A. *[1], BLUMWALD, E.[2], AND PLAXTON, W.C.[1,3] Depts. of Biology[1] & Biochem[3], Queen's Univ.; Dept. of Botany[2], Univ. of Toronto.

One fascinating feature of plant bioenergetics is that under conditions of depleted ATP (e.g. during Pi starvation or anoxia) PPi may serve as an autonomous energy donor for several alternative cytosolic reactions and ion pumps. Moreover, Pi or anoxia stress has been reported to induce various glycolytic 'bypass' enzymes including PPi-dependent phosphofructokinase. By examining pH-dependent fluorescence quenching of acridine orange, assays of ATP versus PPi hydrolysis, and immunoblotting of purified tonoplast vesicles we now provide evidence for a significant induction of tonoplast H+-PPiase during Pi-starvation of *B. napus*. The ratio of PPi:ATP fluorescence quench magnitude and PPiase:ATPase specific activity was about 2-fold greater in tonoplast vesicles isolated from Pi-starved vs. Pi-sufficient *B. napus*. Furthermore, Pi stress caused a marked increase in the amount of a tonoplast 65 kDa anti-(H+-PPiase) IgG immunoreactive polypeptide, whereas the amount of a 57 kDa anti-(H+-ATPase) IgG immunoreactive polypeptide was unchanged. Together with the selective maintenance of cytosolic PPi pools, these data indicate that Pi-starved *B. napus* preferentially employs the tonoplast H+-PPiase to maintain vacuolar acidity, thus conserving limited ATP. We will also present preliminary fluorescence quench evidence for a tonoplast PEP translocator, which would facilitate the bypass of ADP-limited cytosolic pyruvate kinase during Pi-stress via a previously characterized Pi-starvation inducible vacuolar PEP phosphatase. (Supported by NSERC)

15:00

Interactions of carbon dioxide and phoshorus nutrition with proteoid root formation in white lupin (*Lupinus albus*). CAMPBELL, C.D.*; SAGE, R.F. University of Toronto, Department of Botany, 25 Willcocks St. Toronto ON M5S 3B2.

Rising atmospheric CO_2 is one of the most important components of global change, particularly with regard to plants. Nutrient acquisition strategies generally involve an investment of fixed carbon, and so should respond to changing atmospheric CO_2; one such strategy is the formation of proteoid roots. These are dense clusters of rootlets that secrete organic acids that in turn promote phosphorus solubility, facilitating its uptake by the plant. An increase in atmospheric CO_2 might lead to an increase in proteoid root formation, giving white lupin and plants like it an ecological advantage in the decades to come. In my thesis, I examined the change in proteoid root formation in white lupin (*Lupinus albus*) at varying levels of CO_2. I grew plants hydroponically, in solution with (+P) and without (-P) phosphorus, at three levels of CO_2: low (similar to those present during glaciation events), ambient and high (predicted levels in the next 50 years). Results showed that –P grown plants in all CO_2 treatments produced more proteoid roots than the controls at the same CO_2 level; the difference was most pronounced at high CO_2. The increase in atmospheric CO_2 at the end of the Pleistocene may have increased the importance of proteoid roots in nutrient acquisition, and this importance may grow further at high CO_2. In addition, because proteoid roots render phosphorus more available to both lupins and plants growing near them, changes in their production have the potential to change phosphorus cycling in an ecosystem.

15:15

The Dynamics and Site of Nitrate Reduction in Soybean Plants Exposed to Elevated CO_2. CEN, Y.-P.*; LAYZELL, D. B. Dept. Biol., Queen's Univ, Kingston, Ont K7L 3N6.

In soybean plants, nitrate reduction is known to occur in both roots and shoots, but little is known about how environmental factors regulate the site of reduction. To test the effects of elevated atmospheric CO_2 (360 and 700 ppm) on the magnitude and site of nitrate reduction, a gas exchange method was developed that measures the difference between CO_2 (CER) and O_2 (OER) exchange of intact roots, leaves and stems plus petioles. These data were used to calculate the diverted reductant utilization rate (DRUR = 4*(CER+OER), units of moles e- min^{-1}) in the presence and absence of NO^{3-}. The difference in DRUR of plant tissues + and - N was combined with plant growth data to calculate the rate of NO^{3-} reduction in various parts of the plant during the light and dark periods. These gas analysis measurements were combined with 15N increment data to assess the net transport of reduced N from the site of reduction to the site of utilization.

15:30

A Gene Localized at the Wheat Stripe Rust Resistance Locus Yr10. LAROCHE, A.*, EUDES, F., FRICK, M.M., NYKIFORUK, C.L., HUEL, R., CONNER, R.L., KUZYK, A., [1] JORDAN, M., CHEN, Q. and ACHARYA, S Agriculture and Agri-Food Canada, Lethbridge Alberta, T1J 4B1 and [1]Winnipeg, Manitoba, R3T2M9, Canada.

Stripe rust (yellow rust), which is incited by *Puccinia striiformis* Westend. f.sp. tritici Eriks., is one of the most serious leaf diseases of wheat in the world. Stripe rust can cause yield losses in wheat that exceed 75%. Although numerous disease resistance genes have been isolated in dicots recently, only a few have been reported in monocots. The stripe rust resistance locus Yr10 is located on chromosome 1B in Moro and originates from the Turkish line PI 178383. Two full length NBS-LRR genomic sequences 4B and 4E have been isolated. Based on RT-PCR results, sequence 4B appears to be expressed while 4E is not. These results were further corroborated by promoter analysis that showed the presence of conserved specific promoter sequences in clone 4B which were deleted in clone 4E. The expressed NBS-LRR sequence had a perfect linkage in segregating populations totalling 874 lines. A full-length cDNA sequence of 2.5 kb was isolated by RT-PCR and this cDNA sequence was identical to the sequence of genomic clone 4 B with the exception of two nucleotides. The conserved NBS region of clone 4B was used to probe Southern blots of DNA originating from ten wheat lines carrying different stripe rust resistance genes. Results suggested that NBS sequences are present in wheat lines and that the probe might be useful to identify polymorphic DNA fragments linked to different stripe rust resistance genes. Taken together, RT-PCR and segregation results suggest that the expressed sequence represents the gene conferring the stripe rust resistance attributed to Yr10.

15:45

Tracheary Element Maturation in *Pinus banksiana* (Lamb.) and *Eucalyptus grandis* (W. Hill ex Maiden) Roots. TAYLOR, J. H.*[1], PETERSON, C.A..[2]. [1]Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1. [2]Department of Biology, University of Waterloo, Waterloo, ON, N2L 3G1.

The tracheary elements of the xylem are responsible for the axial transport of water and ions. While it is known that tracheids and/or vessel members mature some distance from the tip, the factors influencing this distance are unclear. In addition, it is unknown if commonly used anatomical features (i.e., lignin deposition) are indicative of the point at which the tracheary elements become functional. In the present study, the impact of the type of root tip (white, brown, or ectomycorrhizal) and rate of root growth on the distance behind the tip at which the tracheary elements became functional in *Pinus banksiana* (Lamb.) and *Eucalyptus grandis* (W. Hill ex Maiden) was investigated. These results were compared to measures of lignification. It was found that the tracheary elements matured much closer to the tip (less than 0.5 mm) in the slower growing brown and ectomycorrhizal roots than in the white root tips (over 1.5 mm). Within the white roots, however, the rate of root growth did not correlate with distance of element maturation from the tips. It was also noteworthy that the deposition of lignin occurred before the tracheary elements were functional, and that this discrepancy was exaggerated in the more rapidly growing white roots. It is clear that a functional test of xylem maturity is preferred to detect tracheary element maturity.

16:00

Bioaerosol Contributions from a Ecologically-Based Indoor Air Biofilter.

MALLANY, J.*, DARLINGTON, A. and DIXON, M. Plant Agriculture/ Hort., University of Guelph, Bovey Building, Guelph, Ontario, N1G 2W.

A novel attempt in dealing with the accumulation of volatile organic compounds (VOCs) indoors may be the inclusion of ecologically based air biofiltration systems. Such systems attempt to remove VOCs from the air stream by circulating ambient air through a complex ecosystem including plants and microbes. While the efficacy of such system to remove (VOCs) from indoor air has been shown numerous times, there is little data on the microbial impact that large amounts of plant mass may have in a partially sealed environment. Such an impact would be magnified in a ecologically based system such as this one, where the distribution of bioaerosol would be enhanced by the air circulation through the system. To this end, the bioaerosol load of a building was monitored during the construction of an ecologically based air biofiltration system and compared to an adjacent building and two outdoor measurements. Viable fungal spore colonies were collected on Rose Bengal Agar and bacterial colonies were collected on Trypic Soy Agar, both using a Rueter Centrifugal Bioareosol Sampler. The inclusion of higher plants, moss or the initiation of the ventilation system did not significantly increase the bioaerosol load when compared to the adjacent building. The exhaust stream of the system showed only slightly elevated levels of both molds and bacteria. Despite this the elevated bioaerosol loads in the exhaust stream did not represent problematic concentrations nor could the prolonged use of the system significantly increase the building load.

16:15

Insights into the Plant-Microbe Interactions in an Indoor Air Biofilter.

LLEWELLYN, D.*, DARLINGTON, A. and DIXON, M. Plant Agriculture/Hort., University of Guelph, Bovey Building, Guelph, Ontario, N1G 2W.

Biofiltration has been proposed as an alternative to ventilation for maintaining indoor air quality. Research on plant-based prototype biofilters has revealed that mosses may provide an excellent substrate for microbial degraders of volatile organic compounds (VOCs). As a living substrate, mosses may be able to impact on the microbial populations through the non-specific production of oxygen and through specific plant-microbe interactions. If oxygen is limiting biofilm microbial activity, a photosynthetic substrate may augment the oxygen supply from within the biofilm, thus enhancing biodegradation. This was examined by exposing biofilters to 5-day light and dark treatments. The presence of light had no detectable influence on methylethylketone and toluene degradation. Screening tests were performed on two native (Ontario) moss species as candidates for a biofilter substrate: *Anomadon minor* and *Eurhynchium riparoides*. Preliminary results showed that *E. riparoides* biofilters could maintain steady state toluene removal of about 50% while *A. minor* biofilters could not remove more than 10%. When methylethylketone (MEK) was present in addition to toluene, *E. riparoides* biofilters could only remove about 20% of the toluene while MEK removal was about 50%. Subsequent isolation experiments revealed that the fungus, *Fusarium oxysporum*, was partially responsible for the MEK degradation. The fungus may have been inhibiting other toluene-degrading microbes. Overall results revealed that a living moss substrate can have a substantial impact on both microbial diversity and density.

09:00

Occurrence of phi thickenings in gymnosperm roots. GERRATH, J.M.* and COVINGTON, L. Department of Biology, University of Northern Iowa, Cedar Falls, IA 50614-0421, USA.

Phi thickenings are deposits of bands of lignin in the tangential walls of root cortical cells, just external to the endodermis. Their presence has been reported in a handful of angiosperms and gymnosperms, but a systematic survey of their occurrence has never been undertaken. Roots of eighteen species of gymnosperms representing all the major groups were hand sectioned, stained with phloroglucinol (a lignin stain), and examined for the presence of phi thickenings using light microscopy. Phi thickenings were absent in the species we examined representing the Cycadaceae, Gnetaceae, Pinaceae and Podocarpaceae, and were present in the Ginkgoaceae, Araucariaceae, Taxaceae, and Cupressaceae (s.l.). Our results, when combined with literature reports, indicate that the occurrence of phi thickenings is consistent within a family, and shows a very close correlation with current hypotheses of phylogenetic relationships within gymnosperms.

09:20

Axillary meristem development in *Arabidopsis thaliana*. MIHAJLOVIC, N.*; GRBIC, V.. Department of Plant Sciences, University of Western Ontario,1151 Richmond St., London, Ontario, Canada, N6A 5B7.

Axillary meristems (AMs) form in axils of leaves and give rise to branches. Branching is one of the most important determinants of the plant form. Understanding of mechanisms of AM formation would ultimately allow us to control the branching pattern of the plant, which could have applications in agriculture, forestry and horticulture.The process of branching is poorly understood. Two patterns of AM formation, basipetal and acropetal, have recently been morphologically and anatomically described (Hempel and Feldman, 1994 and Grbic and Bleecker, 2000, respectively). Yet, the initiation of AM development as well as factors controlling this process, are still unknown.One approach to determine mechanism(s) underlying branch development is to assess factors suspected to be involved in AM development. For example, auxin is known to prevent development of already formed axillary buds in a phenomenon named apical dominance, but its effect on AM formation was not investigated. Also the leafy mutant of *Arabidopsis* has a prolonged period of branch formation whose pattern of initiation is unknown. An alternative approach for study of AM formation is by genetic analysis of plants that have altered branching phenotype. Zurich is one such mutant that lacks AMs but otherwise develops normally. In this research, we attempted to address the role of auxin and LEAFY gene product in AM development. In addition, we have analyzed the genetic basis of the Zurich ecotype.

09:40

Floral ontogeny of hummingbird-pollinated *Mimulus cardinalis* (formerly Scrophulariaceae s.l.). HAZLE, T.* and CANNE-HILLIKER, J. Department of Botany, University of Guelph, Guelph, ON. N1G 2W1.

Speciation in the hummingbird-pollinated *M. cardinalis* group is hypothesized to have occurred through divergence in floral form that led to a shift in breeding system. This effectively reproductively isolates the species. Previous studies on this group have provided extensive genetic, phylogenetic and natural selection data which allow for a rare opportunity to now study and interpret ontogenetic changes as sources of evolutionary novelties in floral form. Subsequently, a hypothesis can be generated of speciation involving specific changes in functional morphology and breeding system. In this study, as a constituent of the study involving both species, various floral developmental states of the hummingbird-pollinated *M. cardinalis* were examined and an ontogeny was interpreted. The adaxial calyx lobe initiates with a rim-like primordium followed by the simultaneous initiation of the remaining four calyx lobes. Five separate petal primordia initiate simultaneously. Four stamen primordia appear to initiate simultaneously on the floral apex, shortly after corolla initiation. Gynoecium initiation occurs after the outer three whorls are well established. The young, cylindrical corolla tube becomes laterally compressed during development. The laterally compressed style becomes dorso-ventrally compressed adjacent to the stigma. The bases of the abaxial filaments thicken at the region of insertion on the corolla tube forming an apparent nectar gate through which nectar is available. Meiosis in anthers occurs when the corolla tube is about 5mm in length and filament length equals anther length. Ovule initiation coincides with the start of style elongation.

10:00

Comparative fruit morphology and anatomy in *Citrullus lanatus* (Cucurbitaceae) LECHA, H. B.* and POSLUSZNY, U. Department of Botany, University of Guelph, Guelph, Ontario, N1G 2W1.

Citrullus (Cucurbitaceae) is a genus of economic importance largely due to one species, *Citrullus lanatus. C. lanatus* consists of both the cultivated (var. *lanatus*) and wild (var. *citroides*) forms of watermelon. The fruits of the two varieties differ strikingly in keeping quality once they have matured. Fruits of the cultivated watermelon can be satisfactorily stored for 2-4 weeks only. In contrast, wild watermelon fruits native to Southern Africa can remain intact and fleshy for over a year after abscission from the parent plant. The objective of this study is to investigate the role of fruit morphology and anatomy in the keeping quality of watermelon fruits. Comparative fruit morphology and anatomy of the cultivated and wild watermelon were examined using Cryo-scanning electron and light microscopy. Scanning electron microscopy showed that a layer of wax covers the epicarp of both varieties. However, the fruits differ in the positioning of the stomata on the fruit epicarp. In the cultivated watermelon fruit, stomata occur on the surface of the epicarp. In contrast, the stomata in the wild watermelon fruit are sunken in depressions on the epicarp. The sunken stomata facilitate the development of stomatal wax plugs after fruit abscission. Light microscopy revealed some significant differences in the pericarp anatomy of the two varieties. The implications of these findings in determining keeping quality of watermelon fruits will be considered.

10:40

Identifying pre-zygotic breeding barriers in conifers (Pinaceae). RISE, M.* and VON ADERKAS, P. Department of Biology, University of Victoria, PO Box 3020 STN CSC, Victoria, B.C. V8W 3N5.

Pre-zygotic reproductive barriers may prevent conspecfic hybridization within the Pinaceae. Upon entering the micropyle of the conifer ovule, pollen must germinate and penetrate through nucellar tissue and cells of the megagametophyte to effect gamete delivery and fertilization of an egg cell. Intergeneric pollen-megagametophyte interactions *in vitro* demonstrate that cells of the megagametophyte, including neck cells, jacket cells, prothallial cells and egg cells, do not prevent penetration by pollen tubes of unlike genera. However, intergeneric crosses *in vivo*, by means of supplemental pollination, demonstrate an inability for pollen to germinate in association with an ovule of an unlike genus. At receptivity, Larch (*Larix* x *eurolepis*) and Douglas fir (*Pseudotsuga menziesii*) female cones were hand pollinated with like pollen or unlike pollen from either Interior spruce (*Picea glauca* x *engelmanii*), White pine (*Pinus monticola*), Larch (*Larix x eurolepis*) or Douglas fir (*Pseudotsuga menziesii*). Dissection of Larch and Douglas fir female cones at fertilization demonstrated like crosses allow for pollen germination, nucellar penetration and fertilization while unlike crosses do not. Foreign pollen may be deterred either by the nucellus or by ovular secretions that flood the micropyles of conifer ovules.

11:00

Comparative Floral Development in the Myoporaceae. YACOB, L.*; and CANNE-HILLIKER, J. Botany Department, University of Guelph, Guelph, Ontario, N1G 2W1, Canada.

The Myoporacaeae is a diverse angiosperm family with a predominantly Australian distribution. The family consists of *Eremophila* (214+sp), *Myoporum* (35+ sp), *Diocirea* with four species in central Australia and four monotypic genera, *Bontia* occurring in the West Indies and northern South America, *Pentacoelium* from China, Japan and Taiwan, *Glycocstis* and *Calamophoreus* from central Australia. The aim of my study is to characterize the genera based on analyses of comparative floral ontogeny using representive species. The study of floral ontogeny includes examination of the origin of floral symmetry and architecture, the origin of corolla and stamen form and characterization of the inflorescence types with the family. Ontogenetic data have been obtained for *Myoporum tetrandrum* and *Eremophila glabra*. *Myoporum tetrandrum* is bee pollinated. The early stages of calyx, corolla and stamen development are bilateral while the older stages are radially symmetric. Calyx, corolla and androecial development are initially abaxial to adaxial with the adaxial perianth lobes strongly repressed in early development. Also, the adaxial stamens in mature flowers are longer than abaxial ones. *Eremophila glabra* is bird-pollinated. The calyx is bilateral throughout development with the two lateral lobes reduced in size. The corolla is initially radially symmetric but becomes a strongly zygomorphic mature corolla. Stamens develop abaxially to adaxially, yielding didydamous stamens in the mature flower.

11:20

How are cotyledon whorls formed by conifer somatic embryos? VON ADERKAS, P.*, HARRISON, L. G. Centre for Forest Biology, Department of Biology, University of Victoria BC V8W 3N5. Department of Chemistry, University of British Columbia, 2036 Main Mall, Vancouver BC V6T 1Z1.

Earlier work on whorl formation by a unicellular alga, *Acetabularia*, has led to substantial physicochemical evidence pointing towards a reaction-diffusion mechanism generating the whorl pattern. Is this an oddity, found only in some unicells, or is it relevant to general mechanisms of patterning in multicellular plants? To address this question, we studied formation of whorls of cotyledons in somatic embryos of hybrid larch, *Larix* x *leptoeuropaea*. These average 6 cotyledons; but, as for *Acetablularia* whorls, the number is variable. What determines it? The number is sensitive to the concentration of a cytokinin, benzylaminopurine (BAP), in the culture medium. Preliminary studies of embryo diameter versus number of cotyledons provide evidence that there is a constant spacing between adjacent primordia, so that a larger embryo produces more cotyledons. It is not yet clear whether BAP affects embryo size or (potentially more significant for mechanistic studies) the spacing between adjacent cotyledons.

11:40

Floral ontogeny and self-pollination in *Teedia lucida* (Scrophulariaceae). BALE, D. and CANNE-HILLIKER, J.* Department of Botany, University of Guelph, Guelph, ON. N1G 2W1.

Teedia lucida is a subshrub native to South Africa that produces fleshy fruits when grown in the absence of pollinators. Floral morphology is consistent with pollination in the field by tabanid flies or anthoporid bees. The purple corollas have a cylindrical bent tube and outspread lobes. Flowers initiate on an apex that gives rise to a pair of bractlets prior to initiation of five sepal primordia. Five petal and four stamen primordia initiate simultaneously, but stamens enlarge more rapidly than petals prior to initiation of the gynoecium. Ovules and the stigma form concurrently with a short style. The terminal stigma becomes laterally displaced due to curvature of the style. Production of stigmatic exudate and dehiscence of anthers occur before the corolla opens. Because curvature of the corolla tube places the adaxial, epipetalous stamens directly above the adaxially facing stigma, pollen falls on the apex of the stigma and adheres to the exudate. Self- pollination thus occurs in bud. Pollen begins germination within eight hours as the corolla opens. The copious exudate drips form the stigma and mixes with nectar at the base of the corolla.

09:00

Colonization constraints during primary succession on coastal Lake Michigan sand dunes. LICHTER, J. Department of Botany, Duke University, Durham, NC 27708, USA.

Primary succession on coastal Lake Michigan sand dunes is generally presumed to be driven by autogenic environmental change associated with dune stabilization and gradual soil development. However, succession may also be influenced by chance seed dispersal and infrequent environmental conditions conducive to seed germination and seedling establishment. A prograding sequence of dune-capped beach ridges bordering northern Lake Michigan offers an opportunity to document patterns of primary succession and development of a mixed pine-oak forest, and to experimentally determine whether soil development or probabilistic colonization constraints control the rate of succession. The results of reciprocal seed-addition and seedling-transplant experiments suggest that dune succession is better described as the transient dynamics of probabilistic colonization and competitive displacement rather than as the result of gradual soil development. The seed-addition experiments demonstrated intense seed and seedling desiccation as well as differential seed predation. Few seeds of any species germinated that were not watered, and few seeds of late-successional pine and oak escaped predation that were not protected with exclosures. Of the viable pine seeds that were watered and protected from predation during their first growing season, 40% germinated and established seedlings. Of these seedlings, 22% survived four years with most mortality occurring during the first year. Tree colonization of young sand dunes, which strongly affects the rate of succession, thus depends on interacting constraints and may occur only when stochastic weather conditions, fluctuating densities of rodent seed predators, and chance seed dispersal coincide to favor successful dispersal, germination, and establishment.

09:40

The right time and the right place: using natural experiments avoids the trap of a favorite hypothesis about mechanisms of dune succession. POULSON, T.L. Honors College, Florida Atlantic University, 5353 Parkside Drive, Jupiter,Florida, USA 33458.

At the southern end of L. Michigan at Miller IN, where Cowles and Olson also worked, there can be a meter a year of sand deposition on the foredune front and new dunes start only every 25-100 years. Here I find two spatial scales of succession. From the beach inland, the low dunes show the classic primary successional progression of increasing species diversity and total biomass associated with improvement of availability of water and nutrients. I view this as a community scale facilitation due to the collective effect of many species. The local fire climax oak savanna continues from several hundred to 8000+ years and is maintained by a collective inhibition by many species of forbs and graminoids and black oak. Together these act as a "guild of arsonists" (sensu Platt) that promotes initiation and spread of fire and so inhibits succession to a more mesic community. Only the species-by-species replacement scale is discussed in the literature and at this scale the most important species (frequency + local density + impact per individual) are marram grass, cottonwod, jack pine, and black oak. Contrary to texts and Olson's oft reproduced figure, these species are not a facilitation sequence and there is no evidence for the tolerance model. Rather, direct inhibition is important (marram and pine) and cottonwod has indirect + and - effects on succession. In addition, each establishes individualistically, based on a Gleasonian model not even considered by Connel and Slatyer, based on propagule dispersal, seed mass, and juvenile root/shoot ratios.

10:30

Foredune development on subarctic coastal dunes. HOULE, G. Département de biologie and Centre d'études nordiques, Université Laval, Sainte-Foy, Québec, G1K 7P4.

Subarctic coastal dunes differ from lower latitude dune systems by several characteristics. For instance, the snow cover lasts seven months per year with significant impact on the rate of sand transport and sedimentation. In fact, most of the sand deposited on the foredune (13 cm/year) occurs during fall storms. Plants thus have little influence on this process. Sand deposition on the upper beach, where embryo dunes develop, occurs during the growing season and *Honckenya peploides* plays a major role in trapping sand. Substrate salinity and salt spray decrease with distance from the upper beach as in lower latitude dune systems; however, the temporal pattern of these variables is quite peculiar. Climatic conditions restrict the number of species that take part into the succession on subarctic coastal dunes: for example, the ephemeral high tidemark community of lower latitude dune systems is lacking. In the short term, embryo dunes facilitate the establishment of foredune species, but the long-term implication of this process is not clear since embryo dunes often are flattened out by ice push during the winter and spring. There is no evidence of interspecific competition on the foredune; in fact, the presence of *Lathyrus japonicus* may ameliorate the performance of the major foredune grass, *Leymus mollis*. Embryo dunes do not appear to play a direct role in foredune development. Instead, as the foredune develops, it appears to cover the embryo dunes which then become 'fossilized'. This scenario is different from that proposed for lower latitude foredune development.

11:00

The impact of low Great Lakes water levels on sand transport through a trough blowout at Pinery Provincial Park, Ontario. BYRNE, M-L.* and BITTON, M. Dept. of Geography and Environmental Studies, Wilfrid Laurier University, Waterloo, Ontario, N2L 3C5.

The purpose of this paper is to document sand transport through a trough blowout during a period of low Great Lakes water levels. Measurements were made by trapping sand in Rosen style traps installed at the mouth and crest of the blowout and by measurements of surface elevation change using erosion pins. The traps were emptied every 2 to 4 weeks and compared to previous measurements taken in the mid 1990s when Great Lakes water levels were higher. The comparison illustrates that there are significantly larger volumes of sand entering the system during low levels. Evidence of transport during the low water level period is in agreement with the earlier measurements that showed volumes of sand moved during the winter months appears to be greater than the volumes moved during the summer. Also, the erosion pin data reveal that there are variations in the patterns of erosion and accretion on the dune surface that occur seasonally. These patterns appear to differ during times of low water levels from times of high water levels.

11:30

Burial of plants as a selective force in coastal and lacustrine sand dunes. MAUN, M. A. Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7.

Coastal sand dune systems are highly dynamic because of a wide variety of environmental stresses such as low levels of soil moisture and nutrients, sand accumulation and salt spray. The most important stress is probably burial in sand because complete burial curtails the photosynthetic capacity of the plant, increases the respiration rate and alters the microclimate around the plant. The plant must not only survive the new environment but also muster enough energy to grow through the sand deposit. However, all foredune plant species have developed adaptations to withstand certain threshold levels of sand burial. They not only survive burial but their growth is also stimulated by it. What are the causes of this stimulation? There is mounting evidence that a buried plant is influenced by multiple factors: increase in soil volume around the base of the plant, increase in nutrients, activity of mycorrhizal fungi associated with roots of dune plants and reactive growth by the plant in response to burial. Conversely, as soon as a sand dune stabilizes and sand accretion ceases, there is a marked decline in vigour and density of foredune populations. The phenomenon has been called the "*Ammophila* problem". However, this decline is not confined to *Ammophila* alone because it occurs in both monospecific and mixed populations of all perennial foredune plant species. Several possible single factor hypotheses have been proposed for the last 100 years which seem plausible under the conditions of study but have little or no experimental bases. The phenomenon of decline in non-accreting sites and then rejuvenation in response to burial is complex and probably due to the interaction of several of these factors.

Genetic Determinants of mRNA Decay In *Arabidopsis*. GREEN, P. J.*, JOHNSON, M. A., KASTENMAYER, J. P. and PEREZ-AMADOR, M. Plant Research Lab, Michigan State Univ., E. Lansing, MI 48824.

DST elements are mRNA instability sequences that are highly conserved in the 3' untranslated regions of unstable Small-Auxin-Up-RNAs. We devised a strategy to isolate mutants of Arabidopsis defective in DST-mediated mRNA decay. Two mutants, dst1 and dst2, were isolated that elevated the level of DST-containing reporter transcripts. These and other characteristics of dst1 and dst2 indicate that they harbor mutations in trans-acting factors involved in DST-mediated mRNA decay. These mutants should serve as powerful tools for exploring the molecular mechanisms governing recognition of specific mRNAs for degradation in plants particularly when coupled with genomic approaches. Because sequence-specific mRNA decay mechanisms likely interface with general mRNA decay pathways, we are also investigating potential RNase components of the general mRNA decay machinery.

10:30

Altered Membrane Lipase Expression Delays Leaf Senescence in Transgenic *Arabidopsis*. TAYLOR, C.A., WANG, T., THOMPSON, J.E.* Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1.

A cDNA clone encoding a lipase that is upregulated in senescing Arabidopsis leaves has been isolated by screening a cDNA expression library. The cDNA contains the lipase consensus sequence, ITVTGHSLGG, and encodes an amino acid polypeptide with a molecular mass of ~ 50 kDa. The abundance of the lipase mRNA increases as the leaves of Arabidopsis begin to senesce, and expression of the gene is also induced by treatment with ethylene. Deesterification of membrane lipids and ensuing loss of membrane structural integrity are well established early events of plant senescence, and the expression pattern of this lipase gene suggests that it may play a central role in mediating the onset of senescence. This contention is supported by experiments with transgenic Arabidopsis plants in which levels of the senescence-induced lipase protein have been reduced by expressing the lipase gene in its antisense configuration under the regulation of a constitutive promoter. The transgenic plants showed delayed leaf senescence and enhanced yield of seed.

10:45

Brassinosteroids and Thermotolerance: A First Look into the Mechamism. DHAUBHADEL, S. and KRISHNA, P.* Department of Plant Sciences, The University of Western Ontario, London ON N6A 5B7.

Brassinosteroids are plant growth-promoting compounds that exhibit structural similarities to animal steroid hormones. Recent studies have indicated that brassinosteroids are essential for proper plant development. In addition to a role in development, several lines of evidence suggest that brassinosteroids exert anti-stress effects on plants. However, the mechanism by which they modulate plant stress responses is not understood. We have demonstrated that *Brassica napus* and tomato seedlings grown in the presence of 24-epibrassinolide (EBR) are significantly more tolerant to a lethal heat treatment than are control seedlings grown in the absence of the compound. An analysis of heat shock proteins (hsps) in *B. napus* seedlings by Western blot analysis indicated that the hsps did not preferentially accumulate in EBR-treated seedlings at the control temperature. However, following heat stress, hsp accumulation was higher in EBR-treated than in untreated seedlings. The higher accumulation of hsps in EBR-treated seedlings raises the possibility that hsps contribute, at least in part, to thermotolerance in EBR-treated seedlings. A search for factors other than hsps, which may directly or indirectly contribute to brassinosteroid-mediated increase in thermotolerance, was carried out using the differential display technique. Of the several differentials isolated by this approach, six were studied in detail. Their 5' regions were determined by 5' RACE, and the expression patterns of corresponding mRNAs in untreated and EBR-treated seedlings were determined by Northern blotting. The identities and possible functions of the encoded proteins will be discussed.

11:00

Controls to Detect the Presence of Inhibitors of Reverse Transcriptase and/or Taq Polymerase Activity in Plant Total RNA Extracts. STEWART, S. and NASSUTH, A. Dept. of Botany, University of Guelph, 50 Stone Rd. East, Guelph, Ontario, N1G 2W1.

Total RNA extracts from plants often contain inhibitors of reverse transcriptase and/or Taq polymerase activity and thus would test negative in an RT-PCR assay even when template is present. DNA primers were designed to detect mRNA encoding the large subunit of ribulose bisphosphate oxygenase carboxylase (RubiscoL) or malate dehydrogenase (MDH). Amplification with the RubiscoL primer pair produces fragments of the same size on both mRNA and DNA. Amplification with the MDH primer pair differentiates between mRNA and DNA templates since the amplified region spans introns, thus producing different-sized fragments. Therefore, the RubiscoL primer pair can be used to test Taq polymerase activity while the MDH primer pair can be used to test Taq polymerase and reverse transcriptase activity, and in addition, DNA contamination and mRNA degradation. Amplification with both primer pairs was possible on extracts from cane, leaf and/or bud tissues from grape, apple, peach, apricot, plum, raspberry, strawberry and wheat. In addition, primer pairs were used successfully in multiplex RT-PCR assays for the simultaneous detection of control mRNA and viral RNA.

11:15

Regulation of Accumulation of Antifreeze Proteins in Winter Rye. YU, X-M*; GRIFFITH, M. Department of Biology, University of Waterloo, Waterloo, ON N2L 3G1.

During cold acclimation, winter rye accumulates six antifreeze proteins (AFPs) that modify the growth of ice and are important components of winter survival. The individual AFPs are similar to three classes of pathogenesis-related (PR) proteins: glucanases, chitinases, and thaumatin-like proteins. Our objective in this study was to identify both hormonal and environmental regulators of AFP accumulation by examining factors known to regulate the synthesis of both cold-responsive and pathogen-induced proteins. Our results show that AFPs accumulated in the leaf apoplast of winter rye plants exposed to drought and ethylene at 20° C. In contrast, plants treated with abscisic acid (ABA), salicylic acid (SA) or snow molds at 20° C accumulated PR proteins with no antifreeze activity. We conclude that there are families of genes encoding glucanases, chitinases and thaumatin-like proteins in which different genes are expressed in response to different stimuli. In winter rye, one set of genes encoding PR proteins responds to pathogens, ABA and salicylic acid (SA) and plays a role in disease resistance. A second set of genes is induced by low temperature, drought, and/or ethylene and functions in both disease resistance and freezing tolerance. We have also shown that ethylene is produced by winter rye plants subjected to cold or drought, so ethylene may be involved in the signalling pathway. To our knowledge, this is the first demonstration of the involvement of ethylene in the regulation of proteins associated with freezing tolerance.

11:30

The Soybean p60 Homologue: a Member of the hsp90 chaperone complex?
KRISHNA, P. and QUICK, M.* Department of Plant Sciences, The University of Western Ontario, London ON N6A 5B7.

The 63 kDa protein, p60, is a component of the hsp90-based chaperone complex, which is required for the proper folding of steroid hormone receptors and protein kinases in animal cells. The p60 protein plays a transient role in receptor maturation by providing a link between hsp90 and hsp70. To determine if the plant homologue of p60 is a component of the plant hsp90 chaperone system, we used a monoclonal antibody prepared against avian p60 to immunoprecipitate the plant homologue from wheat germ lysate. A protein with an approximate molecular mass of 70 kDa was specifically immunoprecipitated by the antibody and it was complexed with plant hsp90. Amino acid sequence analysis of the protein band at the 70 kDa position indicated that a protein with partial amino acid sequence identical to the soybean GMSTI was present at this position. These results indicate that the 70 kDa protein is the plant homologue of p60 and suggest that plant p60 may be a cochaperone of hsp90 in plant cells (Krishna, unpublished results). To further characterize this protein in plants, the DNA sequence of a novel soybean cDNA encoding a p60 homologue was determined. Southern blot analysis revealed that a multigene family encodes the p60 homologue in soybean. An analysis of the expression of plant p60 transcripts in response to various stresses revealed that the transcripts accumulate to higher levels upon exposure of the plants to heat stress. Current experiments are directed towards studying the interaction of plant P60, expressed and purified from bacterial cells, with plant hsp90.

11:45

Tissue Stabs Obtained with Glass Microcapillaries can be used for RT-PCR Detection of Plant Gene Transcripts and Virus RNA. MYSLIK, J.*, NASSUTH, A. Dept. of Botany, University of Guelph, Guelph, Ontario, N1G 2W1.

A protocol for the detection of plant gene transcripts and virus RNA from tissue stabs without a time-consuming RNA extraction procedure is described. Tissue stabs (0.78 mm in diameter) of fresh intact wheat leaves were taken using glass microcapillaries, placed into an RNase inhibitor (SUPERase.In, Ambion), and directly subjected to a one tube RT-PCR (method modified from Brandt et al. 1999). This technique has been used to successfully amplify sequences of malate dehydrogenase (MDH), Rubisco, wheat streak mosaic virus (WSMV) and -1,3; 1,4-glucanase from wheat leaves. The amplification is due to the presence of RNA and not DNA, since reactions without reverse transcriptase do not amplify. We are currently in the process of testing other plants, as well as different plant parts. This technique will allow localization of gene expression to different areas of the plant.

References:

1. Brandt, S., Kehr, J., Walz, C., Imlau, A., Willmitzer, L., and Fisahn, J. (1999) A Rapid method for the detection of plant gene transcripts from single epidermal, mesophyll and companion cells of intact leaves. The Plant Journal 20: 245-250.

10:30

Regulation of Root Water Flow In Drought-Stressed Aspen (*Populus tremuloides*) Seedlings. SIEMENS, J.A.* & ZWIAZEK, J.J. Department of Renewable Resources, University of Alberta, 4-42 Earth Sciences Bldg., Edmonton, AB, Canada T6G 2E3.

The effects of mild drought stress, severe drought stress, and drought stress recovery on root water flow and shoot water relations were studied in trembling aspen *(Populus tremuloides* Michx.) seedlings grown in a controlled environment growth room. The fluorescent tracer dye, 3-hydroxy-5,8,10-pyrenetrisulphonate (PTS_3) was used to detect changes in the proportion of cell-to-cell and apoplastic water flow under water deficit stress. The effects of water deficit stress on the function of water channels (aquaporins) were studied using mercuric chloride ($HgCl_2$), a known water channel blocker. We tested the possibility that root respiration inhibition as a result of water deficit stress results in water channel closure to prevent water loss from cells under conditions of severe water stress. Increasing drought stress caused a decrease in stomatal conductance, transpiration, shoot water potential, root flow rate, and in the proportion of cell-to-cell root water flow. Seedlings showed rapid recovery from the effects of severe drought stress. $HgCl_2$ inhibited root flow and cell-to-cell flow rates more in control roots compared with drought-stressed roots. The results are discussed in relation to root respiration under drought stress. Possible regulation mechanisms of plant water relations in drought-stressed plants by the root water channels are discussed.

10:45

Mechanisms of Salt and CT Tolerance in Black Spruce. REDFIELD, E.B.*, ZWIAZEK, J.J. Department of Renewable Resources, University of Alberta, 4-42 Earth Science Building, Edmonton Alberta T6G 2E3

Extraction of petroleum from oil sands in Alberta results in vast amounts of tailings. Production of Composite Tails (CT) offers a means of reducing the volume of tailings. However, CT contains high concentrations of Na^+ and Cl^-, and retains water, making deposits vulnerable to waterlogging. One species for use in such areas is black spruce (*Picea mariana* (Mill.) B.S.P.). It is flood tolerant, so identification of salt tolerant individuals could allow screening of planting stock. Salt affects plants through water deficit and ion toxicity. Research in a growth chamber and in a CT deposit examined drought resistance and salt tolerance in black spruce. Water relations parameters derived using Pressure-Volume curves described the response of seedling tissue to water deficit stress. The CT field experiment found several parameters (lower relative water content at turgor loss point; lower osmotic potential at turgor loss point; lower maximum bulk modulus of elasticity; and higher osmotic amplitude for turgor maintenance) could predict damage in seedlings exposed to salinity. In the growth chamber, seedlings were exposed to iso-osmotic solutions of Na_2SO_4 and NaCl, and iso-ionic (for Na^+) solutions of Na_2SO_4 and NaCl. Those exposed to NaCl suffered more damage than the Na_2SO_4 seedlings, indicating that Cl^- was more injurious than either osmotic stress or Na^+. As with CT exposed seedlings, water relations parameters predicted damage to osmotically stressed Na_2SO_4 seedlings. However, this did not hold true for NaCl seedlings because of additional damage caused by Cl^-. Thus the utility of such characteristics for screening planting stock will depend upon the Cl^- content of tailings substrates.

11:00

Induction of Traumatic Resinosis in Sitka Spruce (*Picea sitchensis* (Bong) Carr.) Elicited by White Pine Weevil (*Pissodes strobi* Peck) and Simulated White Pine Weevil Attack. HUNTER, W.*, Plant, A. Simon Fraser University 8888 University Drive, Burnaby BC, V5A 1S6.

Sitka spruce (*Picea sitchensis* (Bong) Carr.) possess a system of vertical and horizontal resin ducts within the bark, representing an important constitutive defense against insects and their associated pathogens. The white pine weevil (*Pissodes strobi* Peck), a major pest of spruce in British Columbia, oviposits in galleries mined within the xylem. The larvae consume the phloem, thereby girdling the leader and ultimately resulting in stem deformities. As a response to wounding, spruce undergo an induced, defensive traumatic resinosis response. Traumatic resinosis involves, but may not be limited to, the formation of resin canals that become embedded in the xylem and the production of oleoresin in a terpene specific manner. Sitka spruce trees were subjected to either weevil attack (1998) or simulated weevil attack (achieved by drill wounding in 1999) to determine whether this traumatic resinosis response was accompanied by the induced expression of terpene synthase genes. Wounded and non-wounded branches were examined histochemically to determine the extent of traumatic resin canal formation and used for RNA dot-blot or Northern hybridization analyses with terpene synthase specific cDNA probes. Data indicate that weevil wounding and drill wounding elicited the accumulation of terpene synthase mRNA in both laterals (1998) as well as laterals and leaders (1999), respectively. Traumatic resin canals were formed in wounded branches following weevil wounding and drill wounding, and in both leaders and laterals following drill wounding. These data provide additional evidence for a vigorous and rapid induced resinosis response to insect attack in Sitka spruce.

11:15

Hydrogen Fertilization: Bacteria or Fungi? DONG, Z.*, McLEAN, N. and IRVINE, P. Department of Biology, St. Mary's University, Halifax, N.S., Canada B3H 3C3.

Experiments have shown that growth enhancement of non-legumes occurs after rotation with legumes. Although this phenomenon is generally attributed to nitrogen fertilization of the soil, there are other factors that are additionally responsible. Work done to determine the agent responsible has implicated fungi. More recent studies have shown that hydrogen treated soils have plant growth-promotion properties. This suggests that the hydrogen released from HUP- nodules may account for the long-standing mystery of benefit from crop rotation involves legume plants. To link hydrogen with the fungal plant growth-promoter, the effects of antibiotics and fungicides on hydrogen treated soils were assessed. Addition of antibiotics significantly eliminated the hydrogen uptake ability and plant growth-promotion effects of the hydrogen treated soils. While addition of fungicides did not significantly affect the hydrogen uptake ability of hydrogen treated soils. The addition of 36 mg/L of Benomyl lead to an increase in plant growth in hydrogen treated soils. These results indicate that the growth enhancement agent in hydrogen treated soils and soils near nodules is bacterial in nature rather than fungal.

11:30

O_2 Regulation and Acetylene Reduction of *Acetobacter diazotrophicus* Colonies. DONG, Z.*, CHEN, P. Dept of Biol., St. Mary's Univ., Halifax, N.S., Canada B3H 3C3.

Acetobacter diazotrophicus can grow on dinitrogen as sole N source on a solid medium under 21 kPa oxygen, after initial growth with starter nitrogen in the medium. The large quantities of extracellular polysaccharides found around the colonies growing in air. This slime layer impedes diffusion of oxygen to the bacteria within, and represents a crude physical barrier against excessive oxygenation. Provided the population of bacteria is sufficiently dense inside the colony on agar, some fixation of nitrogen could occur. The determining factor is whether the cells, by their collective respiration, can lower the oxygen tension in their own vicinity to a certain level. This hypothesis is supported by the experiments on the growth of the colonies under different oxygen tensions and different fixed nitrogen supplies. Oxygen shock experiments also support the hypothesis. To further test if this pellicle is a physical diffusion barrier, acetylene reduction assay was carried under different acetylene concentrations. Acetylene reduction is presumptive evidence for the presence of nitrogenase, and provides an indirect measure of nitrogenase activity. It is generally believed that in the presence of 3 to 10 percent of acetylene the measurement of acetylene reduction provides an assay for total nitrogenase activity. However, *Acetobacter diazotrophicus* colonies on plate require much higher partial pressure of acetylene to saturate their nitrogenase activity.

11:45

A Multi-Component Phytoremediation System to Remove Polycyclic Aromatic Hydrocarbons From Contaminated Soils. HUANG, X.-D.*, GLICK, R.B. and GREENBERG, B. Department of Biology, University of Waterloo, Waterloo, ON N2L 3G1 Canada.

The level of persistent organic contaminants such as polycyclic aromatic hydrocarbons (PAHs) in the environment are increasing due to anthropogenic release related to industrial activities. Their toxicity, mutagenicity and carcinogenicity are of significantly environmental concern. Clearly, effective remediation processes for aromatic organic contaminants would be valuable. Phytoremediation has the potential to be an effective route for remediation of persistent organic contaminants. Plants can provide a large amount of biomass as a sink for the contaminants. Further, plants can work synergistically with contaminant-digesting rhizobacteria and mechanical remediation. A phytoremediation multiple processes system for removal of persistent organic contaminants of PAHs in soils was developed in our laboratory. The system was composed of land farming (aeration and light exposure), bioremediation (inoculation of PAH degrading bacteria) and phytoremediation (growing plant with plant growth promotion rhizobacteria). It resulted in an enhanced physical, photochemical, microbiological and phyto-biological remediation. The land farming, aeration and light exposure, was effective for removal of smaller compounds; bioremediation with bacteria was effective for removal of relatively soluble compounds; plants with rhizobacteria together effectively remediated insoluble and soil bound compounds. We were able to use this technique to remediate creosote up to 3 g/kg in contaminated soils. The results showed that more than 90% of creosote was removed from soil within a four month period in a laboratory setting. Therefore, we believe that this multiple process system could be an optimal solution for remediating persistent aromatic organic contaminants from soils. The three major advantages to this process are: it is faster than any individual process; it is economically sound; and cleanup and restoration occur simultaneously.

08:30

Biogeography and ecology of the kelp/red algal symbiosis. GARBARY, D. J.* & KIM, K. Y. Department of Biology, St. Francis Xavier University, Antigonish, Nova Scotia, Canada, B2G 2W5 & Department of Oceanography and Institute of Marine Sciences, Chonnam National University, Kwangju 500757, Korea.

A kelp/ red algal symbiosis is described from nature based on extensive collections from the San Juan Islands, Washington. Kelp gametophytes were found as endophytes in the cell walls of seventeen species of red algae in three different kelp communities. Host red algae were mostly filamentous (e.g., *Pleonosporium vancouverianum*) or polysiphonous (e.g., *Polysiphonia paniculata*). The kelp gametophytes completed vegetative and reproductive development in the hosts with gametangia formed at the host surface and with sporophytes up to several mm in height being produced while still attached to the host. To date, none of the kelp gametophytes from nature have been identified to genus or species, although the gametophyte of *Nereocystis luetkeana* is a potential candidate for the symbiosis. Preliminary observations from Nova Scotia and the Isle of Man have not found the association in the Atlantic Ocean. Laboratory studies in Korea successfully reconstructed the symbiosis in the red alga *Aglaothamnion oosumiense* using zoospores of *Undaria pinnatifida* but not *Laminaria religiosa*. Here we outline the development of the symbiosis and discuss the potential adaptive significance of the kelp/red algal interaction.

08:50

Multiple correlates of vegetation variation in subalpine forests of coastal and interior British Columbia. BRADFIELD, G.E.*, & ZHANG, W. Botany Dept., University of British Columbia, Vancouver, V6T 1Z4.

This project examined the interrelationships among environmental factors, natural disturbances, and vegetation variation in subalpine forests of interior and coastal British Columbia. The interior study was conducted in a 20,000 ha wilderness subalpine forest in southern Wells Gray Park. At the landscape scale, a low correlation between polygon attributes and physical terrain features indicated a weak linkage between historical disturbance patterns and topography. At the plant community scale, Detrended Correspondence and Regression Analysis indicated that abiotic and disturbance variables explained relatively low percentages of total vegetation variation; greater variation was explained by soil properties pointing to the key role that soil processes play in subalpine forests. At the tree population scale, the size and age structures and radial growth rates of the two dominant species – *Picea engelmannii* and *Abies lasiocarpa* – were related to environment and disturbance conditions. In the coastal study, vegetation variation and tree growth in *Tsuga mertensiana - Abies amabilis* dominated forests were related to environment and disturbance conditions in 7 habitat-types: closed forest, avalanche edge forest, avalanche track meadow, scree forest, scree meadow, parkland tree islands, and parkland heath. Canonical Correspondence Analysis indicated a vegetation continuum from closed forests to avalanche and scree meadows. Significant differences in radial growth rates of trees were attributed to differences between species and among size classes and habitat-types. The overall results provide a quantitative basis for addressing scientific and public sector concerns that future management strategies should more closely mimic natural processes.

09:10

Event driven seedling establishment in a semi-desert. KRANNITZ, P.G. Environment Canada, 5421 Robertson Rd., RR #1 Delta, B.C., V4K 3N2.

Establishment of plant species in extreme environments often occurs in cohorts of seedlings following a serendipitous coincidence of benevolent conditions. I documented one such occurrence following a wildfire in 1993 in a shrub-steppe community in southern British Columbia. In 1994, 1995 and 1997, plant density and percent cover were measured in 298 small permanent plots across a range of fire severity from "unburned" to "intense", and under grazed and ungrazed conditions. In 1994, seedlings of the perennial bunchgrass *Stipa comata* had established with greater densities in the more severely burned and ungrazed plots. The perennial bunchgrass *Sporobolus cryptandrus* had established best in "moderately" burned and grazed plots. Establishment can be attributed to a decrease in the alien *Bromus tectorum*, a winter annual grass that is well known for outcompeting other seedlings for scarce early season soil moisture. More severely burned plots had fewer *B. tectorum* individuals and it is these plots that had a greater number of bunchgrass seedlings. Establishment of *S. comata* was more dependent on the removal of *B. tectorum* than *S. cryptandrus*. It is hypothesized that the wildfire destroyed *B. tectorum* seeds in the severely burned plots, providing the native bunchgrasses an opportunity to establish. This is interesting in that *B. tectorum* is blamed for fueling a fire cycle in the intermountain region of the US that has converted thousands of acres of shrub-steppe to annual grassland.

09:30

Distribution and ecology of *Hydrocotyle umbellata* in Kejimkujik National Park, Nova Scotia. VASSEUR, L. Department of Biology, Saint Mary's University, Halifax, NS B3H 3C3.

Hydrocotyle umbellata is a clonal macrophyte of lake shores of America. It is listed as endangered in Canada. Most of the Canadian populations are found in Kejimkujik National Park. The objectives of this study were 1) to revisit the sites that were identified in the 1980's around the Kejimkujik Lake and 2) to initiate a study on the ecology of a few of these populations. The results of 1999 show that most of the populations have increased in size since 1983 with densities of 88 to 432 individual ramets/m2. The number of flowers per quadrat also varied with a mean of 108 flowers/m2. Unprotected/public populations had trampling damage on 18% of the plants versus 5% for the other sites. The results showed that 1) genets have a continuous growth, 2) ramets are produced at a rate of one per two-three weeks and 3) flowers are not consistently related to a vegetative ramet or the largest ramet. In September 1999 plants were still in their flowering period and seeds were yet to be formed. The data suggest that the populations are currently maintained solely by clonal propagation and seeds cannot reach maturity because of the limited length of the growing season. However, under longer growing seasons, it may be possible for the plant to sexually reproduce and thus disperse in other locations.

09:50

Understanding population differentiation in *Silene acaulis*. HERMANUTZ, L.*; INNES, D. Department of Biology, Memorial University, St. John's, NF, A1B 3X9.

Silene acaulis shows a patchy distribution on the island of Newfoundland, with populations growing on ultramafic (serpentine), mafic, limestone and siliceous substrates. The distribution of the specific substrates is highly disjunct, with little opportunity for gene flow due to large intervening distances among populations. All sites have been ice-free for »10, 000 years (ice-free ages range from 13.7 ka BP to 10.1 ka BP). Using variation at the PGI allozyme locus we determined: 1) the degree of genetic differentiation among populations distributed across the island; and 2) if the pattern of genetic differentiation was associated with specific substrates, degree of geographic isolation or ice-free site age. Populations sampled from the 21 sites were highly differentiated, but there was no relationship between genetic distance and geographic distance, substrate type or site age detected. Historic patterns of deglaciation appear to explain the distribution of alleles, such that eastern and western sections of the island were recolonized separately. High levels of genetic differentiation within these sections appears to be due to the lack of gene flow combined with founder effect and random genetic drift, rather then the formation of distinct substrate ecotypes.

10:10

Plant-size and fruit-position effects on reproductive allocation in *Alliaria petiolata*. SUSKO, D.J.*, and LOVETT-DOUST, L. Department of Biological Sciences, University of Windsor, Windsor, ON, N9B 3P4.

We examined the development of ovules and components of reproductive yield as they related to plant size and fruit position within plants of *Alliaria petiolata* from three sites. We found that both factors affected fruit and seed production, and patterns of ovule fate. Larger plants were more fecund than their smaller counterparts, while proximally-positioned flowers within an inflorescence produced more seeds. Maternal investment was regulated according to plant mass at two levels: among fruits (small plants had significantly lower fruit-set than did large plants), and within fruits (small plants had significantly fewer ovules and significantly higher proportions of aborted ovules per fruit than did large plants). All absolute measures of reproduction had positive linear relationships with plant size, but the existence of a threshold size for flowering was not found. Most proportional measures of reproduction were independent of plant size. Small plants produced the same relative proportions of total seed number and total seed mass per unit plant dry mass as large plants. Therefore, proportional reproductive allocation did not vary with plant size. However, small plants produced proportionately more flowers per unit dry mass. Small plants may be maximizing their overall fitness through increased allocation to male function (flower production).

10:45

The effects of achene weight and orientation on germination in three species of aster: *Aster novae-angliae, A. puniceus, and A. umbellatus.* RUIT, S. and CHMIELEWSKI, J.G.* Department of Biology, Slippery Rock University, Slippery Rock, PA, USA 16057.

The effects of achene weight and orientation on both the likelihood of an achene germinating or the time taken by an achene to germinate were examined among three wetland species, specifically *Aster novae-angliae*, *A. puniceus*, and *A. umbellatus*. Achenes of *A. novae-angliae* and *A. umbellatus* which germinated, irrespective of orientation, were on average heavier than those which did not germinate. All achenes of *A. puniceus* germinated irrespective of size or orientation. The time taken for achenes to germinate was not correlated with achene weight for either *A. puniceus* or *A. umbellatus*, irrespective of orientation. However, the time taken by achenes of *A. novae-angliae* to germinate was negatively correlated with achene weight, that is, as weight increased, germination time decreased for achenes sown in each orientation. The likelihood of an achene germinating was not affected by orientation for any of the species. Further, the time taken by achenes to germinate did not differ among orientations for either A. puniceus or *A. umbellatus*. Achenes of *A. novae-angliae* oriented in the pappus up position took significantly longer to germinate than did those oriented otherwise. The ecological significance of the various differences reported are yet to be determined.

11:05

The ecology of mesic old growth deciduous forests in southern Ontario. MAYCOCK, P.F. Department of Botany, University of Toronto, Erindale Campus, Mississaga, Ontario L5L 1C6.

Twelve mesic old growth forests were selected from the quantitative data bank of 230 Southern Deciduous Forest stands at the Plant Ecology Laboratory, University of Toronto, Mississauga. Half of the stands form a part of the Springwater forest complex south of Orwell and the remainder, including a stand from the Backus Tract near Port Rowan, are scattered through the region. As old growth forests are an increasingly uncommon natural phenomena, and quantitative studies of such systems are rare, the twelve stands were subjected to critical analysis of compositional, structural and environmental characteristics. These stands include 250 vascular species, 31 of which can grow to tree stature, and 219 of which are shrubs, herbs, lianas and other understorey elements. The mean number of species per stand is 87, but richness varies considerably, from 55 to 127. Comparisons will be made to other mesic old growth systems throughout the north temperate zone. It is imperative that detailed quantitative studies be made available for research and conservation efforts.

11:25

Light attenuation by limestone rock and its effects on the depth, biomass, and richness of endolithic organisms. MATTHES, U.; LARSON, D.W. * Cliff Ecology Research Group, Department of Botany, University of Guelph, Guelph, Ontario,N1G 2W1.

To investigate if light attenuation in limestone rock constrains the distribution and abundance of endolithic photoautotrophic organisms, we examined light intensity profiles in 25 rock samples containing endolithic algae and cyanobacteria. Samples were collected from three representative cliff sites along the Niagara Escarpment in southern Ontario. Photosynthetically active radiation profiles were generated by manufacturing cavities in the bottom of thick slabs of surface rock and enclosing radiation sensors in the cavities. The flat layer of limestone between the sensor and a light source was then abraded in steps of approximately 0.5mm. We examined the correlations between physical characteristics of the rock and light attenuation, and between light attenuation and the depth, relative biomass, and taxonomic richness of endolithic organisms. The depth at which 0.01% of available light remained varied from 2.1mm to 4.5mm at different sites, but there was large within-site variability on intermediate and small spatial scales. In contrast, the depth of endolithic organisms was homogeneous within sites but different among sites (1.1mm to 3.5mm). While the endolithic organisms all have access to measurable light, there was no correlation between the limit of their depth penetration and threshold quantum flux densities, suggesting more complex controls of endolithic distribution and abundance.

11:40

Damage to cliff ecosystems by rock climbing. LARSON, D.W.*, MCMILLAN, M.A. Cliff Ecology Research Group, Department of Botany, University of Guelph, Guelph, On., Canada, N1G 2W1.

Cliffs represent an important class of refuge habitats. Increasingly, however, recreational rock climbing is being carried out in these areas and it is possible that the growth of this sport will seriously impact cliff ecosystems in the future. Some recent studies have shown large impacts of climbing on cliff organisms, but other studies have not. This study was carried out to try to resolve these controversies in a way that would help generate appropriate land use policies. Cliffs of the Niagara Escarpment were sampled in Halton County. Twenty-five transects were established in areas exposed to climbing, and another twenty-five in areas not climbed. Percent cover, density, and frequency were measured for lichens, bryophytes, vascular plants and land snails. Both analysis of variance and canonical correspondence analysis were applied to the data. For each of these groups of organisms, climbing had a clear and pronounced negative effect. The effects were observed regardless of whether cliff edges, cliff faces, or talus slopes were considered. The results show that rock climbing has a consistently damaging effect on the structure of cliff ecosystems. It appears that it will be impossible to preserve the structure and function of cliff ecosystems unless rock climbing is controlled.

09:00

Different facets of the problem of symmetry in plants. CHARLTON, W. A., BARABE, D.*, POSLUSZNY, U. Biological Sciences, University of Manchester; IRBV- Jardin botanique de Montréal; Department of Botany, University of Guelph.

Symmetrical patterns in nature have been a fascinating research subject for a long time. In botany, the problem of symmetry of forms can be analysed at different hierarchical levels : from molecules to organisms. We draw attention to two aspects of symmetry which should respond to analysis in this wide perspective. (1) The phenomenon of phyllotaxis provides an empirical and theoretical framework in which to study spiral symmetry at different organizational levels. Recent developments in molecular biology and genetics have brought new methods of analysis and new data to the research area of phyllotaxis. However, to determine precisely which phyllotactic parameters are under direct genetic control, it would be useful to analyse the data in the theoretical framework of a particular model of phyllotaxis. A theoretical model will allow us to analyse the data in a rigorous framework, and to formulate precise hypotheses. (2) Asymmetry, sometimes extreme, at the cell, histogenetic, or organ level, can be a normal part of development of a symmetrical structure. This we are calling cryptic asymmetry. It is probably a rather general phenomenon which has not yet been adequately recognised, but deserves further study.

09:25

Leaf symmetry: from morphology to molecules. DENGLER, N.G. Department of Botany, University of Toronto, Toronto, ON M5S 1A1

Leaves express polarity in relation to three major axes or planes of symmetry: 1) the longitudinal axis (proximo-distal asymmetry), 2) the medial plane (dorsiventral asymmetry), and 3) the transverse plane (left-right asymmetry). During leaf development, these asymmetries develop in the context of overall shoot and phyllotaxis symmetry. I became interested in leaf symmetry through working on the whole shoot phenomenon of anisophylly and, in this presentation, I review some of the natural variation in leaf symmetry and what is known about a few of the genes that play a role in regulating dorsiventral asymmetry. Leaves of genera such as *Allium* appear to lack dorsiventrality: leaves are cylindrical and unifacial (in the sense that histological differentiation is radially symmetrical). Developmental studies indicate that leaves arise on the shoot apical meristem as dorsiventral structures, and only secondarily become cylindrical. Although much is known about natural variation in leaf morphology and development, the identification of mutant phenotypes which resemble unifacial leaves (phantastica in *Antirrhinum*, pinhead/zwille, argonaute and phabulosa in *Arabidopsis*)have raised a number of interesting questions. When is dorsiventrality determined during leaf development? Is expression of "dorsiventrality genes" necessary for formation of the wildtype leaf blade? What is the relationship between morphological dorsiventrality and histological markers?

09:50

Floral symmetry: A morphogenetic perspective. LACROIX, C. R. Department of Biology, University of Prince Edward Island, 550 University Avenue, Charlottetown, PEI, C1A 4P3.

Changes in floral symmetry are often the result of variations in the number and character of floral organs that are initiated at early stages of development. Early stages of initiation of primordia on a floral meristem can therefore reveal possible mechanisms by which slight variations in developmental sequences generate new or modified forms. Two floral models (*Hibiscus* and *Philodendron*) will be used to explore the relationship between variations in early stages of floral development and floral symmetry. *Hibiscus rosa-sinensis* floral varieties known as 'double' produce a number of stamens as well as petaloid and intermediate floral organs in a region normally designated for stamen production in 'simple' or typical flowers. Although these two varieties share a few early stages of development, their symmetry will differ significantly at maturity because floral organs in 'doubles' are initiated in unusual places on the floral meristem. Some members of the genus *Philodendron* also display cases where floral organs belonging to different categories are initiated in unusual places. In this situation, the initiation of different floral organs on the same floral whorl show how 'potential' morphogenetic gradients at the level of the inflorescence can lead to changes in floral symmetry.

10:40

Genes, cytokinins and floral symmetry. VENGLAT, S. P., BLAHUT-BEATTY, L.M., BONHAM-SMITH, P. C. and SAWHNEY, V. K.*. Deaprtment of Biology, University of Saskatchewan, Saskatoon, SK, S7N 5E2, Plant Biotechnology Institute, 110 Gymnasium Place, Saskatoon, S7N 0W9, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, S7N 0X2.

The symmetry of a flower is determined by a number of parameters including, the number, size, shape, and the position of floral organs in the flower. We are investigating the role of hormones, especially cytokinins, in gene-controlled floral organ number and the position of organs in a flower. The *clavata1-1* (*clv1-1*) mutant in *Arabidopsis thaliana* has an increase in floral apex size and in floral organ number. We have shown that exogenous cytokinins (CKs) induce an increase in floral organ number in *Arabidopsis* and *Brassica rapa* wild type (WT) flowers. As well, young inflorescenses and leaves of the *clv1-1* mutant of *Arabidopsis* contain 8 and 12 times more dihydrozeatin (DZ) respectively, than WT tissues. This suggests that the *CLV1* gene negatively regulates CK levels in the floral apex which in turn affect its size and organ number. The role of CKs in floral organ number is further supported by the observations that in the *altered meristem program1-1* mutant, an over-producer of CKs, there is an increase in floral organ number. In *Antirrhinum majus* flowers, which have a dorsi-ventral asymmetry, the growth of the dorsal stamen is suppressed. Exogenous CKs partially induce the growth of this organ and stimulate the formation of additional chimeric stamens in whorls 1 and 2. These observations are interpreted in terms of CKs affecting the expression of the *CYCLOIDEA* gene, one of the genes that controls asymmetry in *Antirrhinum* flowers.

11:05

Self-similarity of plants as a form of symmetry. PRUSINKIEWICZ, P. Department of Computer Science, University of Calgary, Calgary, Alberta, Canada T2N 1N4.

In its most intuitive setting, symmetry is defined as the invariance of form with respect to a group of geometric transformations. These transformations are usually restricted to rotations, reflections, translations and their combinations, but they also may include scalings (similarities). Although self-similarity does not retain all the formal properties of symmetry, both notions can be used to characterize geometric objects in a related way. For example, a reflection maps the left half of a bilaterally symmetric leaf onto its right half, whereas a similarity maps a branching structure (e.g. a compound inflorescence, a compound leaf, or a tree crown) onto its smaller components. The geometric notion of self-similarity has its topological counterparts in paracladial and recurrence relations, which deal with the numbers of branches in the whole structure and its parts, rather than with the geometric properties. In my presentation, I will: (a) Compare the definitions of symmetry, self-similarity (Mandelbrot), paracladial relations (Lindenmayer and Frijters), and recurrence relations (Herman, Lindenmayer and Rozenberg); (b) Discuss the pioneering studies of the relations between the whole plant and its parts by Troll, Arber and Oldeman from the perspective of these definitions; (c) Link self-similarity to the formal description of plant development expressed using L-systems; (d) Analyze the relationship between self-similarity and allometry in compound plant structures; and (e) Present a practical application of self-similarity and paracladial relations to the descriptive modeling of plant architecture according to limited data sets.

11:30

Asymmetry in plant shape, neighborhood competition and compensatory growth. BRISSON, J. Institut de recherche en biologie végétale et Jardin botanique de Montréal. 4101 est, rue Sherbrooke. Montréal. Qc. Canada. H1X 2B2.

Plant growth and shape are generally affected by close proximity of neighbors. While reduction in overall plant growth has always been commonly used as an indication of competitive intensity, asymmetry in plant canopy or root system is rarely considered in neighborhood competition studies. Yet, both growth and asymmetry do not need to be correlated and, in fact, may reveal different aspects of plant response. For example, if a plant was able to compensate for competitive pressure from neighbors by growing its resource-acquiring structures into directions of lesser interference, there would be no reduction in growth but an important asymmetry in shape. Our simulation model of plant competition suggests that a compensatory growth and the resulting asymmetry in space acquisition play an important role in plant population dynamics. In a population of plants with compensatory growth, available space would be better utilized, overall performance would be higher, and the change from a clumped to a regular distribution due to density-dependant mortality would be delayed. Circumstantial evidence supporting compensatory growth lies in the importance of morphological asymmetry due to neighbor proximity. In a study on the canopy area of Sugar maples (*Acer saccharum*) with respect to their neighbors, the asymmetry observed was consistent with compensatory growth. Other evidences suggest that neighborhood competition in plant populations can not be fully understood without considering morphological plasticity in response to neighbors.

Mycorrhizal Fungi and their Relationship to the Rhizoplane and Rhizosphere.
PETERSON, R.L. Department of Botany, University of Guelph, Guelph, ON, N1G 2W1.

The majority of vascular plant species form mutualistic associations with mycorrhizal fungi so that the interaction between their roots and the rhizosphere is often mediated through fungal hyphae. Various mycorrhizal types are characterized by the particular taxonomic group of fungi involved in establishing the symbioses and the morphogenetic changes that occur in both symbionts during mycorrhiza formation. Features of the rhizoplane trigger responses in fungal hyphae that involve binding to the root surface, enhanced hyphal growth, differentiation of specific structures and penetration of the root. Bacteria on the rhizoplane interact with fungal hyphae and in the case of ectomycorrhizas, enhance mycorrhiza formation. The establishment of the nutrient exchange interface between root cells and fungal hyphae involves structural and physiological changes in both partners. All mycorrhizas form a complex branched mycelium emanating from the root surface and extending into the rhizosphere. The extraradical mycelium is involved in acquisition of various nutrients from the soil solution or from nutrient sources usually not available to roots. This mycelium also plays a role in soil aggregation and in the formation of fungal reproductive structures. Fungal hyphae secrete various substances into the rhizosphere that may enhance nutrient uptake and deter pathogenic organisms. Factors in the rhizosphere including nutrient levels, acidity and heavy metals affect mycorrhiza development and functioning.

10:30

Exogenous Ethylene Inhibits the Formation of Arbuscular Mycorrhizae in Pea (*Pisum sativum* L. cv Sparkle). GEIL, R.D.*[1]; GUINEL, F.C.[2], PETERSON, R.L.[1]
[1]Dept. of Botany, University of Guelph: Guelph, ON, N1G 2W1; [2]Dept. of Biology, Wilfrid Laurier University: Waterloo, ON, N2L 3C5.

Little is known about the role of phytohormones in the establishment of arbuscular mycorrhizae (AM). However, Ishii et al. (1996) have recently reported that ethylene can either promote or inhibit (depending on the concentration) the formation of AM in trifoliate orange trees. Additionally, ethylene is a known inhibitor of nodulation (legume-rhizobia symbiosis), a process that shares many similarities with the AM symbiosis. For these reasons, the effect of a suspected inhibitory level of ethylene was investigated to help elucidate the role of this hormone in regulating the formation of AM. Exogenous application of 5.5 ppm ethylene to the rhizosphere causes a significant reduction in arbuscular colonization of pea roots by the AM fungus *Glomus aggregatum*. Ethylene treatment did not affect the number of appressoria formed, however, it did cause some appressoria to develop abnormally. Deformation of appressoria correlates with a reduction of AM fungal entry into the root tissue, resulting in less arbuscular colonization. Deformed appressoria were swollen and extensively branched. Additionally, extraradical fungal hyphae exposed to the ethylene treatment often exhibited considerable branching. Colonization generally proceeded normally provided the fungal hyphae breached the epidermis.

10:45

Protein Toxin(S) and Pathogenesis of American Ginseng By *Alternaria panax*. QUAYYUM, H.*; GIJZEN, M. and TRAQUAIR, J. A. Department of Plant Sciences, University of Western Ontario, London On N6A 5B7; and SCPFRC, Agriculture and Agri-Food Canada, 1391 Sandford Street, London ON N5V 4T3, Canada.

Alternaria panax Whetzel causes leaf and stem blight of American ginseng (*Panax qinquefolius* L.). The conidial germination fluid collected from droplets incubated for 48 h on detached ginseng leaves was shown to be toxic in detached leaf and whole plant bioassays. It induced water-soaked, brown lesions on ginseng leaves characteristic of foliar symptoms induced by this fungal pathogen in ginseng gardens. The conidial germination fluid did not produce visible symptoms on leaves of *Hedera helix* L., *Aralia* sp., *Schefflera* sp., *Fatsia* sp., and *Dizygotheca* sp., (also genera in the family Araliaceae). The toxic activity of the germination fluid was destroyed by heat and treatment with proteinase A. The toxic activity of the fluid was retained by an ultrafiltration membrane with a pore size of 30 kDa. Partial purification of the toxic protein(s) was performed by fast performance liquid chromatography (FPLC) using a Superdex 75 gel permeation/filtration column. Bioactive fractions were eluted as a single peak. By comparison with protein standards the size of the protein(s) was estimated as 35 kDa.

11:00

Characterization of the Interaction Between *Phialocephala fortinii* and *Asparagus officinalis.* YU, T. E. J-C.*; NASSUTH, A.; PETERSON, R.L. Department of Botany, University of Guelph, Guelph, ON, N1G 2W1.

Phialocephala fortinii is a sterile dematiaceous Hyphomycete that exhibits different effects on host roots depending on plant species and conditions under which the association is formed. *P. fortinii* appears to have little host specificity and can form intracellular root associations that range from beneficial to parasitic with many plant species. *Asparagus officinalis* (asparagus) is a herbaceous perennial known to have associations with various soil fungi. Roots of this species have a dimorphic suberized exodermis characterized by short and long cells; short cells exhibit delayed deposition of suberin in comparison to long cells. *Asparagus* seedlings were inoculated with *P. fortinii* and roots were either examined directly by cryo-SEM or cleared first and examined by light microscopy. Aerial surface hyphae were conspicuously ornamented while hyphae on the epidermal surface of the root had smooth or rough walls. Hyphal coiling was observed at the epidermal surface. Entry between epidermal cells was observed on cleared roots, with hyphal coiling occurring in epidermal cells, short cells and the cortex, but never into the long cells or the vascular cylinder. Microsclerotia were present in epidermal cells and short cells. The relationship between available phosphorus in comparison to the level of colonization, shoot phosphorus, and biomass accumulation was also determined.

11:15

Epistomatal Chambers in The Needles Of *Pinus strobus* L. (Eastern White Pine) Function as Microhabitat for Specialized Fungi. DECKERT, R.J.*, MELVILLE, L.H. and PETERSON, R.L. Department of Botany, University of Guelph, Guelph, ON N1G 2W1.

The stomatal complex of eastern white pine (*Pinus strobus* L.) possesses a feature of uncertain function: the epistomatal chamber. The chambers are formed by the subsidiary cells overarching the guard cells and are normally occluded with epicuticular wax. Morphologically distinct fungi resembling black yeasts are frequently observed within the epistomatal chambers submerged in the wax occlusions. Histochemistry shows the fungal hyphae are viable and sheathed in a complex polysaccharide matrix. Experimental covering of the branches prevents colonization of the stomata, indicating that the inoculum originates exogenously. Preliminary investigation into the distribution of the fungus in Ontario shows an uneven distribution. The fungus is absent in areas of alkaline soil and/or urban-industrial regions of poorer air quality. Ecologically, the epistomatal chamber is proposed to be an ecotone between the phylloplane and the interior of the needle, possessing the survival advantages of both with a minimum of the disadvantages. The presence of stomatal fungi may influence the response of host trees to aerial pollutants, affect transpiration and prevent pathogen ingress.

11:30

Decoding Regulation of the Tip-High Calcium Gradient and Hyphal Growth in *Neurospora crassa.* SILVERMAN-GAVRILA, LB* and LEW, RR. York University, Biology Department, 4700 Keele Street, Toronto ON M3J 1P3.

A tip-high cytosolic calcium gradient is required for hyphal elongation in *Neurospora crassa* (Silverman-Gavrila and Lew 2000 Protoplasma. In press). The source of the calcium appears to be intracellular stores as there is no net transplasma membrane calcium flux at the elongating hyphal tip (Lew 1999 Eur J Cell Biol 78:892-902) and modification of ion fluxes across the plasma membrane using voltage clamp is without effect on tip growth (Silverman-Gavrila and Lew 2000). To decode the internal mechanisms which generate and maintain the tip-high calcium gradient we first identified calcium regulators which affect hyphal growth and morphology then determined how they modify cytosolic calcium using fluorescent dyes and ratio confocal microscopy. Cyclopiazonic acid (a known inhibitor of the endoplasmic reticulum calcium ATPase) inhibits growth and increases cytoplasmic calcium in the basal region (10-25 microns behind the hyphal tip). 2APB (an inhibitor of IP3-induced calcium release) inhibits hyphal elongation and dissipates the tip high calcium gradient (0-10 microns from the tip). We conclude that the tip-high calcium gradient is internally maintained by cooperation between sequestration by endoplasmic reticulum behind the tip and IP3-induced calcium release from tip-localized vesicles. We are presently screening additional agonists/antagonists: IP3, adenophostin, heparin, and cADPribose to confirm our conclusions, and will present their effects on hyphal elongation and the tip-high calcium gradient.

11:45

Novel Applications of Electrospray Mass Spectrometry: Protein Folding and Enzyme Kinetics. KONERMANN, L.*, KOLAKOWSKI, B.M., SIMMONS, D.A., SOGBEIN, O.O., LEE, V.W.S. Department of Chemistry, The University of Western Ontario, London, ON, N6A 5B7.

Electrospray ionization (ESI) mass spectrometry (MS) has become a standard method for the analysis of biomolecules. This presentation will focus on some novel (and somewhat unusual) applications of ESI MS: (i) The ESI charge state distribution is a highly sensitive probe for structural changes of proteins. Therefore ESI MS is a powerful tool for studying protein folding/unfolding reactions in solution. We have developed techniques for monitoring the kinetics of protein folding reactions. This approach allows the detection and structural characterization of short-lived folding intermediates. It also provides direct information on folding mechanisms. Additional structural information can be obtained when these experiments are coupled with on-line isotopic pulse labeling. (ii) Using a similar approach, the kinetics of enzymatic reactions can be monitored. Many traditional techniques in enzymology require the use of artificial chromophoric substrates. Therefore it is often difficult to obtain information on reactions involving the natural, i.e. biologically significant substrates of an enzyme. ESI MS-based kinetic measurements obviate the need for chromophoric substrate and they provide direct information on mechanistically important reaction intermediates. (iii) Most biochemists are familiar with stopped-flow spectroscopy as a technique for studying the kinetics of fast reactions in solution. Again, the use of optical techniques for monitoring the chemical changes in the reaction mixture represents a severe limitation of this technique. Very recently we have succeeded in developing a stopped-flow ESI mass spectrometer for the direct real-time analysis of the reaction mixture by mass spectrometry. Various applications of this novel approach will be discussed.

10:30

The Role of Arginase in Post-Germinative Loblolly Pine Seedlings: Developmental Regulation and Protein Synthesis. TODD, C.D.* and GIFFORD, D.J. Department of Biological Sciences, CW 405 Biological Sciences Building, University of Alberta, Edmonton, AB, T6G-2E9.

As seeds germinate storage protein hydrolysis provides a nitrogen source to the developing seedlings. In the conifer seed these proteins are found primarily in the living megagametophyte tissue. Following germination of loblolly pine seeds there is a major influx of free amino acids from the megagametophyte to the seedling. A major component of this pool is arginine, which is transported rapidly and efficiently without prior conversion. In the seedling the enzyme arginase is responsible for liberating nitrogen, in the form of urea, from free arginine. Using antibodies raised against an arginase subunit a full length cDNA was isolated from a loblolly pine expression library. This represents the third plant arginase cloned from plants and the first from a conifer. Using this clone and the antibodies as tools, developmental regulation of arginase enzyme activity, protein levels and RNA accumulation in the seedling was investigated. In loblolly pine seedlings arginase activity increases due to de novo synthesis of the protein following germination and is temporally coordinated with increases of free amino acids, including arginine. Plant arginases have been reported to be associated with mitochondria. The N-terminal deduced amino acid sequence of the loblolly pine arginase cDNA suggests a possible mitochondrial location. The nature of the mature protein and its implications for arginase localization will be presented.

10:45

Identification and Immunolocalization of Proteins in the Ovular Secretions of Hybrid Larch. O'LEARY, S.J.*; VON ADERKAS, P. Department of Biology, University of Victoria, P.O. Box 3020 STN CSC, Victoria, BC, V8W 3N5.

In hybrid larch (*Larix kaempferi* X *L. decidua*) a secretion fills the micropylar canal of the ovule during a brief period coinciding with sexual maturation of the egg. The secretion contains a variety of compounds including proteins. These proteins range in mass from 12 - 97 kDa, as determined by SDS-PAGE. Run in one dimension, there are approximately 12 bands clearly resolved. However, 2-D gel electrophoresis indicates that some proteins are present in a number of isoforms. Reversed phase HPLC also demonstrates that the protein compliment of the droplet is both substantial and complex. Gas phase N-terminal amino acid sequencing is being used to identify proteins isolated from the droplet based on sequence homology with previously described proteins reported in sequence databases. A 33 kDa protein from the larch secretion has been putatively identified as xyloglucan endotransglycosylase (XET) by this method. Western blot analysis with the polyclonal antibody anti-Pse m I indicates that this antibody has strong affinity for XET, and only XET, in the larch secretion. Anti-Pse m I is currently being used to localize the origin of XET production and secretion into the micropyle by immunolocalization in fixed ovular tissues. Preliminary results indicate that XET is being produced in the secretory cells lining the apical region.

11:00

Purification, Characterization and Kinetics Of A Novel Flavonol 2-Oxoglutarate-Dependent Dioxgenase From *Chrysosplenium americanum.* ANZELLOTTI, D. and IBRAHIM, RK.* Biol Dept, Concordia University, Montreal, Canada H3G 1M8.

A 2-oxoglutarate(2OG)-dependent dioxygenase [EC 1.14.11-] that catalyzes the 6-hydroxylation of partially methylated flavonols (PMFs) was purified to near homogeneity by FPLC on Superose 12 and Mono Q columns, as well as 2-OG-Sepharose- and immunoaffinity columns. The Mr of the native & denatured flavonol 6-hydroxylase (F6H) was 42 and 45 kDa, respectively suggesting a monomeric protein. The enzyme exhibits strict substrate specificity for position 6 of PMFs, and similarity to other dioxygenases in its dependence on 2-OG and Fe^{2+} for catalytic activity and reactivation. Substrate interaction kinetics and product inhibition studies suggest an ordered, sequential (TerTer) reaction mechanism, where 2OG is the first substrate to bind, followed by O_2 and the flavonol substrate, with the product release occurring in the reverse order. Internal amino acid sequence information indicated its relatedness to other plant flavonoid dioxygenases, that will facilitate its cDNA cloning and its further characterization both at the molecular and biochemical levels. The involvement of this enzyme in PMF synthesis in this plant and its biotechnological significance will be discussed.

11:15

Purification and Characterization of Banana Fruit Pyruvate Kinase. TURNER, W.L.* and PLAXTON, W.C. Depts. of Biology and Biochemistry, Queen's University, Ont, K7L 3N6.

Associated with the burst of CO_2 release at the onset of banana ripening (the 'respiratory climacteric') is a marked decrease in the [PEP]/[pyruvate] ratio. Thus activation of cytosolic pyruvate kinase (PKc) and/or PEP carboxylase (PEPC) is the initial response of glycolysis at the climacteric. As a first step to formulating a model for the regulation of the PEP branchpoint in climacteric fruit, we previously determined the kinetic/regulatory properties for homogenous banana PEPC (Law & Plaxton (95) Biochem. J. 387:807; (97) Eur. J. Biochem. 247:642). The aim of the present study was to purify and characterise banana PKc. It was purified 498-fold to homogeneity and a final S.A. of 59.7 µmol of pyruvate produced/min/mg protein. Immunological and heat stability studies confirmed the final preparation represented PKc. Gel filtration and SDS-PAGE analysis indicated the enzyme was a homotetramer composed of 57 kDa subunits. Optimal activity occurred at pH 6.9 although catalytic efficiency (V_{max}/K_m) was equivalent at pH 7.5. Hyperbolic saturation kinetics were observed with PEP and ADP at pH 6.9 and 7.5. Catalytic efficiency for the alternative nucleotide diphosphate UDP, was 32% of that determined for ADP. Glutamate and ATP were the most effective inhibitors. Aspartate functioned as an activator by reversing PKc's inhibition by glutamate. A model for coordinate regulation of banana PKc and PEPC is presented. This highlights the critical role of glutamate and aspartate in reciprocally balancing the anaplerotic replenishment of either oxaloacetate or 2-oxoglutarate, drained from the TCA cycle during protein synthesis. (supported by NSERC)

11:30

Overexpression of a Sulfotransferase Leads to Delayed Flowering in Transgenic *A. thaliana*. VARIN, L. *[1], GIDDA, S. [1] and MIERSCH, O. [2] [1]Biology Department, Concordia University 1455 de Maisonneuve West, Montreal, Canada H3G 1M8. [2]Institut of Plant Biochemistry, Weinberg 3, 06120 Halle, Germany.

Considering the important role of mammalian sulfotransferases (ST) in the modulation of the biological activity of hormones, our research interest is to elucidate the biological function of plant STs in the modulation of growth and in the control of developmental processes. Recently, we initiated a functional genomics project with the objective of characterizing the biological function of the 13 sulfotransferase coding genes from *A. thaliana*. We have shown previously that AtST1 catalyzes the sulfonation of 24-epibrassinosteroids. Furthermore, we demonstrated that the sulfonation of brassinosteroids abolishes their biological activity. In the present communication, the results obtained with the AtST2 gene will be presented. AtST2 encodes a protein having 325 amino acids with a predicted molecular weight of 35,000Da. The AtST2 protein shares 40% sequence identity with the flavonol STs of *Flaveria chloraefolia* and 45% identity with the *A. thaliana* and *B. napus* 24-epibrassinosteroid STs. Overexpression of the AtST2 gene leads to delayed flowering in transgenic *Arabidopsis thaliana.* In contrast, the expression of AtST2 in the antisense orientation leads to an early flowering phenotype suggesting that AtST2 is modifying an endogenous molecule involved in the control of flowering.

11:45

Mitochondrial Driven Bicarbonate Transport Supports Photosynthesis. HUERTAS, I.E.*,COLMAN, B., ESPIE, G.S. Dept. of Biology, York University, Toronto, ON M3J 1P3 & Dept. of Botany, University of Toronto, Mississauga ON L5L 1C6.

Nannochloropsis gaditana possesses a bicarbonate transport system which causes a high internal inorganic carbon (Ci) accumulation and a subsequent release of CO_2 to the medium. HCO_3^- uptake is activated by light but it can also continue for short periods in the dark. In this study, bicarbonate transport in cell suspensions of *N. gaditana* has been investigated by mass spectrometry in the presence of inhibitors of linear electron transport and mitochondrial respiration. Ci transport and photosynthetic O_2 evolution were affected by either inhibitors of mitochondrial respiration chain, such as cyanide and rotenone, or inhibitors of Krebs cycle e.g. arsenite. O_2 was also required to support bicarbonate uptake in the dark since CO_2 efflux progressively increased with O_2 concentration in darkened cells and the absence of O_2 completely suppressed CO_2 efflux, demonstrating that O_2 consumption during respiration was involved in the occurrence of bicarbonate transport in darkness. Internal carbonic anhydrase activity was not influenced by O_2. These results indicate that the supply of energy for bicarbonate transport was dependent on mitochondrial ATP production. In the presence of 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU), cells were able to take up bicarbonate in darkness, but this capacity was subsequently restricted. These responses are indicative of a respiratory control of photosynthetic electron transport in unicellular algae.

13:30

Microsatellite analysis of genetic diversity of *Populus tremuloides* in Québec.

WYMAN, J.* [1]; BRUNEAU, A. [1]; TREMBLAY, F. [2] [1] Institut de recherche en biologie végétale 4101 rue Sherbrooke est Montréal, Québec H1X 2B2. [2]Département des Sciences Appliquées, Unité de Recherche et de Développement Forestier de l'Abitibi-Témiscamingue, Université du Québec en l'Abitibi-Témiscamingue, C. P. 700, Rouyn-Noranada, Québec J9X 5E4.

In order to ensure that diversity is conserved as natural stocks of trembling aspen (*Populus tremuloides*) are exploited, it is important to establish existing genetic diversity. A relatively new class of genetic markers known as microsatellites are now available for several plant species. Microsatellites are short sequences (1-5 bp) that are repeated in a tandem fashion, abundant and highly polymorphic. Four microsatellite loci were analysed with the ABI prism DNA sequencer in a population of *P. tremuloides* from northern Québec. Preliminary analysis indicates that compared to autoradiographic methods resolution is significantly increased, with detection of up to twice the number of fragments. Using only four loci we were able to establish that what would appear to be ramets of a single clone were in fact separate individuals. It would appear however that for the analysis of genetic diversity, traditional Wright statistics may not be appropriate. Each fragment detected does not necessarily represent a single allele. Increased resolution has made it evident that certain fragments represent ''sub-loci'' in which heterozygosity may be established, as opposed to treating all fragments as alleles. Analysis of several more populations in northern Québec is ongoing. The use of automated fluorescence detection as opposed to Southern blotting and autoradiography increases both the precision and the accuracy of analysis where alleles may differ in size by as little as one or two bases. Microsatellite markers may have applications in the identification of clones, hybrids, mapping and marker-assisted early selection.

13:50

Remnant canopy as potential refugia for forest floor bryophytes within a harvested forest. FENTON, N.J.*; FREGO, K.A. Dept. of Biology, University of New Brunswick (Saint John), Saint John, New Brunswick, E2L 4L5.

Forest harvest in New Brunswick produces a heterogenous pattern of substrate disturbance and canopy removal, and threatens the forest floor bryophyte community (especially hepatics). A mosaic of patches with various degrees of disturbance is created when young trees are spared, and merchantable trees are removed. Bryophytes may survive in patches with remnant canopy which presumably experience less micro-climatic change than patches with no remnant canopy or those which have experienced catastrophic substrate disturbance. This study was undertaken to assess the potential for these patches to act as refuges for vulnerable bryophytes, i.e.: (1) to compare the bryophyte communities in remnants with different canopy types, and (2) to relate patterns in the bryophyte community to environmental features within the remnants. Eleven belt transects through potential refuges of four remnant canopy types were sampled five years after clear-cutting. As the intermediate hypothesis predicts, richness and total bryophyte cover were highest in remnants with low (<1.5m) coniferous trees and lower for remnants with greater or lesser remnant canopy. However, opportunistic invaders were common in the low remnants, while tall (>5m) remnants contained few invaders and many potentially vulnerable species (e.g. hepatics). The distribution of the bryophyte community appears to be related to variables associated with remnant canopy (e.g. presence of trunks) and substrate disturbance (e.g. mineral soil). These results indicate that patches of immature trees act provide refuge from both substrate disturbance and micro-climatic change associated with canopy removal and may play a role in conservation of vulnerable bryophyte species within a clear-cut.

14:10

Responses of a low-diversity grassland to soil disturbance and nitrogen addition. PELTZER, D.A.*, WILSON, S.D. and HAGER, H.A. University of Regina, Regina, Saskatchewan, S4S 0A2, Canada.

Community stability is often thought to increase with species diversity, but despite an abundance of theoretical and empirical studies of diversity stability phenomena no consensus has emerged on the generality of this relationship. We examined community stability, productivity, and resource availability in a low-diversity grassland dominated by two introduced perennial grasses, *Agropyron cristatum* and *Bromus inermis*. Three levels of soil disturbance (no disturbance, 50% bare ground, 100% bare ground) and four levels of nitrogen (no N added, 5 g $N/m^2/yr$ added, 15 g $N/m^2/yr$ added, or sawdust added at a rate of 400 $g/m^2/yr$ to immobilize N) were applied in factorial combinations to 120, 5 x 15 m plots for six years. In the first year of the experiment, seeds of over 50 local native prairie species and woody plants were added to the plots to increase the local species pool. Adding N had the expected results of increasing plant standing biomass and soil available N. Soil disturbance reduced plant standing biomass and increased soil available N. The species composition and hence community stability of this species-poor grassland was relatively stable across both N additions and soil disturbance treatments with *A. cristatum* and *B. inermis* dominating the community in all treatment combinations. In contrast to results from previous studies, our results suggest that low diversity communities can be surprisingly stable in the face of environmental changes.

14:30

Examining the response over time of red spruce (*Picea rubens* Sarg.) to clearcutting of red spruce-balsam fir stands located in Queens County, Nova Scotia. REYES, G.*[1,2] and VASSEUR, L.[1] [1]Deaprtment of Biology, Saint Mary's University, Halifax, NS B3H 3C3; [2]Department of Biology, Dalhousie University, Halifax, NS B3H 4J1.

The importance of seed rain and advanced regeneration as factors contributing to red spruce (*Picea rubens*) re-establishment following clearcutting of red spruce stands located in Nova Scotia was examined. Transects were established across stands harvested 0, 2, 4, and 20 years ago (n=3 per age class). Four transects originated from the eastern edge and 4 from western edge of each clearcut. All transects began from within an adjacent mature stand to 105 m into each clearcut. Three, even-aged mature stands (>100 years old) were used as reference sites. Seed rain was collected monthly from September to November 1999. Seedling percent cover, number of stems, and seedling age were measured along each transect using 1 m^2 quadrats. Seed rain significantly decreased with increasing distance from the forest edge. Total seed dispersal was greater at the September collection period, with the majority of seeds falling near the eastern edge of the mature stands. During the October and November collection periods, seed rain within the mature stands decreased to levels observed in the 0, 2, and 4 year-old clearcuts. Percent cover increased with stand age, with no significant differences among transects originating from the east or west. The number of seedlings per m^2 decreased following harvest (from 32 to less than 5 seedlings per m^2). Advanced regeneration accounted for more than 50% of re-established stems. Maritime conditions may allow for the relatively high advanced regeneration success and the rapid recolonisation of red spruce following harvest in the Queens County region of Nova Scotia.

15:10

Impacts of clearcut logging on forest structure and understory vegetation of *Picea rubens* (red spruce) forests of Nova Scotia. MOOLA, F.*[1,2] and VASSEUR, L.[1]
[1]Department of Biology, Saint Mary's University, Halifax, NS B3H 3C3; [2]Department of Biology, Dalhousie University, Halifax, NS B3H 4J1.

In 1999, we examine the impacts of clearcutting on the understory biodiversity of red spruce forests. We studied changes in forest structure and species composition following clearcutting in replicated 2, 5, 20, and 70 year (n=3 to 5) clearcuts and mature (n =8) stands in Nova Scotia. Stands 20 years old and younger originated from harvests with mechanical skidding, whereas the 70-year stands were hand-felled and the trees horse-skidded. The mature stands originated from wildfire. Percent cover of understory plants were recorded in ten 1 m^2 quadrats established randomly within three 400 m^2plots in each stand. In addition, soil development, substrate condition and stand structural characteristics (e.g. course and fine woody debris) were measured in all the quadrats. While most understory species were common to stands of all ages, several understory herbs (e.g. *Trillium undulatum*, *Oxalis montana*) were restricted to or significantly more frequent in mature forests characterized by large trees, decomposing logs, and coniferous needle litter. Early successional species (e.g., *Solidago* spp., *Epilobium angustifolium*) were dominant in the understory for ca. 5 years after clearcutting. Canonical correlation analysis (CCA) showed that the first axis is most strongly correlated with the intensity of canopy disturbance. Axis 2 of the CCA reflected a successional gradient characterized by increasing stand age, canopy development, and the reduction of fine woody debris on the forest floor. CCA analysis indicates that compositional differences in the understory of managed and unmanaged red spruce forests reflect the intensity of disturbance and changes in stand structure resulting from forest management.

15:30

Seed size and seedling vigour in *Taraxacum officinale* Weber. COLLINS, L. L.*; CAVERS, P. B. Department of Plant Sciences, University of Western Ontario: 1151 Richmond St. N, London, ON, N6A 5B7.

Taraxacum officinale Weber is an herbaceous perennial species found in lawns, ditches, waste places and fields where it can be considered a nuisance as it can reduce crop yield and detract from the aesthetic value of these areas. This study focussed on the relationship between time of seed production and seed size; seed size and seed germination; and seed size and seedling vigour. Bulk collections of seeds were made from a lawn population on the main campus of the University of Western Ontario 11 times throughout 1999. Only one site of collection was chosen to reduce the chance of genotypic effects. Seed size was found to vary with the time of year of seed production, the heaviest seeds being produced in the spring and late fall. The lightest seeds were produced in July and August. Larger seeds had greater viability, gave greater total germination percentages, and resulted in larger seedlings after three weeks of growth under greenhouse conditions.

Cell Wall Signals During Cell Growth and Development: Is The Plasma Membrane Listening? CARPITA, N., WYATT, S. E., OLEK, A. T., and SHOUE, D. A. Dept. Botany & Plant Pathology, Purdue University, W. Lafayette, IN 47907, U.S.A.

Plant biologists are currently exploring how signals at the cell surface are propagated via transduction pathways and how the signals trigger developmental programs. The cellular scaffolding used to convey signals between cells or within a single cell is much less understood. The cytoskeleton, plasma membrane, and cell wall form an integrated lattice that physically connects the nucleus and the chromosomes within with cytosolic components, with the cell surface, and even with neighboring cells. This architecture of this scaffolding may determine how cells are committed to a developmental program during differentiation and how cells capture positional information from their surface and from neighboring cells. Cell walls contain surface markers that foretell patterns of development and mark positions within the plant, they contain components for signaling and communication by symplastic continuity through plasmodesmata, and they maintain molecular continuity with the plasma membrane and cytoskeleton. In the context of the plant cell wall-plasma membrane-cytoskeleton continuum, one relatively uncharacterized link is that between the plasma membrane and the cell wall. Evidence that the link is a dynamic one comes from observations that the plant plasma membrane can be induced to bind firmly to its cell wall. The molecules that are responsible for this adhesion are still unknown, but several candidate proteins that reside in the membrane-wall interface have been identified. My presentation will review the current status of our knowledge of this continuum and the molecules that comprise it.

15:00

Effects of a Microtubule Inhibitor on Tip Growth Direction and Stability in Two Root Hair Mutants Of *Arabidopsis thaliana*. MACLELLAN, C.L., GALWAY, M.E.* Department of Biology, St. Francis Xavier University, Antigonish, NS, B2G 2W5.

Cylindrical, tip-growing root hairs are useful for investigating cell growth and shape formation due to their simple shape and accessibility. Recently it was reported that in root hairs, microtubules help maintain growth direction and restrict growth to one site at the hair tip. Oryzalin, a microtubule inhibitor, makes normal *Arabidopsis* root hairs wavy and also induces multiple sites of tip growth in some hairs. We applied oryzalin to roots of rhd3 mutant seedlings, which have short, wavy root hairs, and to rhd4 mutants, which have short, bulging hairs, to further clarify the nature of the tip growth defects in these mutants. Hair growth direction was most affected in the already-wavy rhd3 hairs; more rhd3 hairs lost control of growth direction and grew towards the root, compared to rhd4 and normal hairs. This additive effect supports the hypothesis that the wavy phenotype of rhd3 hairs is related to the altered distribution of microtubules previously detected in the hairs by electron microscopy. As expected, oryzalin induced additional growing tips in a similar proportion of wild type and rhd3 hairs, but induced additional tips in four times as many rhd4 hairs, thus revealing an instability in tip growth that is likely related to the slower and more variable growth rates of rhd4 hairs. (Supported by NSERC)

15:15

Endodermal Wall Modifications in Onion Roots: Ultrastructure of Development. MA, F.*, PETERSON, C.A. Department of Biology, University of Waterloo, Waterloo, ON N2L 3G1.

The endodermal cells of onion roots develop through states I, II and III, characterized by the formation of Casparian bands, suberin lamellae and tertiary walls, respectively. During early stages of the state I development, the tight association of the plasma membrane to the radial walls is established prior the deposition of detectable electron dense materials (presumably suberins and lignins). This phenomenon favours the involvement of protein(s) during Casparian band formation. Suberin lamellae are initiated earlier on the inner tangential walls than on the outer tangential walls, and earlier in the primary pit fields than elsewhere. Along the radial walls, suberin lamellae extend towards the Casparian bands from both tangential sides. At the band region, the bound plasma membrane is separated from the wall by an unknown mechanism as the lamellae progress until the new walls become complete. This result contradicts an earlier postulation that the original plasma membrane remains bound to the Casparian band and becomes detached from the remainder of the membrane when the suberin lamella develops (which implies de novo formation of plasma membrane). Cellulosic tertiary walls are laid down afterwards. Dictyosomes and profiles of endoplasmic reticulum apparently contributed to the construction of the wall modifications, which is especially likely during states II and III. At all developmental stages, the plasmodesmata in endodermal walls remain intact.

15:30

The Pathway of Calcium Movement in Onion Roots. CHOLEWA, E., PETERSON, C.A.* Department of Biology, University of Waterloo, Waterloo, ON, N2L 3G1.

Onion (*Allium cepa* L.) roots are ideal for a study of the radial pathway of calcium transport because they lack laterals which can create transient, apoplastic bypasses. These root systems did not have any major apoplastic bypasses, as shown by their inability to translocate an apoplastic, fluorescent dye applied to the roots. Calcium did not move into the transpiration stream at the root tip where the endodermis was immature (as is commonly assumed). It did enter the xylem in an older region where the endodermis was mature, and in an even older region where the exodermis was also mature. Compartmental elution indicated that the exodermal Casparian bands were impermeable to calcium; thus, a symplastic pathway of movement through this layer is indicated. By extension, a symplastic pathway through the endodermis is also proposed. The roots' responses to various inhibitors were consistent with calcium entry into cells by channels, and exit by calcium-ATPases. A model of the major pathway of calcium movement from the ambient solution into the xylem of the onion root will be presented.

15:45

Macromolecular Assembly of Potato Ligno-Suberin. BERNARDS, M.A.* and RAZEM, F.A. Department of Plant Sciences, University of Western Ontario, London ON, Canada, N6A 5B7.

During the early stages of suberization an intractable phenolic polymer is laid down in the carbohydrate (primary) cell wall. In its simplest form, the macromolecular assembly of this polymer requires the biosynthesis of monomers, their transport to the cell wall and finally their polymerization. We have demonstrated that in wound healing (i.e., suberizing) potato tubers the phenolic polymer that is formed is largely hydroxycinnamic acid based (Bernards et al., JBC 270:7382, 1995), and therefore different from a typical monolignol-based lignin, as has been supposed for many years. Accordingly, we now refer to the phenolic polymer synthesized during suberization as "ligno-suberin" to distinguish it from a typical lignin. In an analogous fashion to that proposed for the polymerization of monolignols during lignification, however, the formation of ligno-suberin is hypothesized to involve a peroxidase/hydrogen peroxide system. We have isolated the peroxidase that is putatively involved in this process, and begun to characterize it at the biochemical level (Bernards et al., Plant Physiol. 121:135, 1999). In doing so we have asked the question: where does the hydrogen peroxide required for the process come from? Using diphenyleneiodonium (DPI), an inhibitor of hydrogen peroxide generation in vivo, we have demonstrated that (1) hydrogen peroxide is required for ligno-suberin formation and (2) the most likely source is an NAD(P)H-dependent oxidase system.

15:00

Photoreduction of H_2O_2 by the Cyanobacterium *Synechococcus* PCC 7942 Does Not Require Photosystem I. MILLER, A.G., Biology Department, St. Francis Xavier University, Antigonish, N.S. B2G 2W5.

Synechococcus PCC 7942 photoreduces O_2 at rates as high as 30% of the rate of photosynthetic CO_2 fixation. One role of this O_2 photoreduction is to prevent photoinhibition of photosystem 2 (PS2) but there is a need for the cells to detoxify the resultant H_2O_2. Recent work in my laboratory has shown that *Synechococcus* PCC 7942 decomposes H_2O_2 using catalase and by a photoreductive route. In chloroplasts the photoreduction of H_2O_2 involves the ascorbate peroxidase pathway, with ascorbate being regenerated by reduction of mondehydroascorbate at PS1. Photoreduction of H_2O_2 by *Synechococcus* PCC 7942 does not require PS1. There is no inhibition by the PQ antagonist DBMIB, no Emerson enhancement and no requirement for the active transport of inorganic carbon into the cells. The latter process is necessary to relieve a block on electron flow to PS1 that occurs in the absence of accumulated inorganic carbon within the cells. The photoreduction of O_2 itself shows all the features expected for PS1 involvement. It is postulated that a plastoquionol peroxidase occurs in *Synechococcus* PCC 7942.

15:15

Synergistic Toxicity of 1,2-dihydroxyanthraquinone and Copper to the Higher Plant *Lemna gibba*: Redox Dependent Formation of reactive Oxygen Species (ROS) Mediated by Copper. BABU, T.S.*, TRIPURANTHAKAM, S., DIXON, D.G. AND GREENBERG, B. Department of Biology, University of Waterloo, ON N2L 3G1, Canada.

Electron transport is one of the vital processes of any living cell, especially in chloroplasts and mitochondria. Perturbations in electron transport could alter the redox-status of a cell. In this study, we examined the co-toxicity of a polycyclic aromatic hydrocarbon, 1,2-dihydroxyanthraquinone (1,2-dhATQ), and a heavy metal, Cu^{2+}, on the higher plant *Lemna gibba*. Photosynthesis, electron transport, activity of the enzymes involved with oxidative stress and growth were monitored to assess the mechanism, nature and extent of toxicity. Using chlorophyll a (Chl a) fluorescence and a P700 assay, 1,2-dhATQ was found to inhibit electron transport at the cytochrome b6/f (Cyt b6/f) complex. Conversely, Cu^{2+} alone (at the concentrations employed) was found to have little effect on photosynthesis. When Cu^{2+} was combined with 1,2-dhATQ, there was an increase in transient and steady-state Chl a fluorescence quenching relative to the inhibited fluorescence quenching caused by 1,2-dhATQ alone. Treatment of isolated thylakoid membranes with 1,2-dhATQ inhibited O_2 consumption using methyl violegen as the electron acceptor. However, Cu^{2+} plus 1,2-dhATQ resulted in active O_2 consumption with or without methyl viologen as an electron acceptor. Among the activity of enzymes involved with the oxidative stress, superoxide dismutase (SOD), ascorbate peroxidase (APX) and glutathione reductase (GR), only GR activity was drastically enhanced in the mixture treatment. At the whole organism level, the mixture treatment caused a synergistic inhibition of growth. From these data we conclude that 1,2-dhATQ renders the plastoquinone pool to a highly reduced state by inhibiting at Cyt b6/f. When Cu^{2+} is administered to plants arrested in such a reduced state, there is a catalytic transfer of electrons from reduced plastoquinone to O_2, thereby forming ROS. This type of catalytic mechanism of ROS formation by Cu^{2+} could become very harmful to living cells under any environmental stress conditions where the redox status of the cell is altered.

15:30

Seasonal Photosynthetic Acclimation in the Old Forest Lichen *Lobaria pulmonaria.* MACKENZIE, T.D.B.* and CAMPBELL, D.A. Department of Biology and Biochemistry, Mount Allison University, Sackville, New Brunswick E4L 1G7

A lichen is an association between a fungus and an algal photobiont whose photosynthesis provides energy to maintain the association. *Lobaria pulmonaria* is an epiphyte lichen usually found in deciduous forests. This lichen must acclimate to large annual changes in illumination because of seasonal opening and closing of the leaf canopy. Low-light quantum efficiency of electron transport, estimated by chlorophyll fluorometry, was at minimum in late winter (open canopy) and at maximum in late summer (closed canopy). The saturating light for electron transport and the potential for photoprotective dissipation of excessive light energy was maximal in winter and minimal in summer. In contrast seasonal changes in gross CO_2 uptake were small and did not track changes in light availability and capture. Therefore, changes in light harvesting and energy transfer at the earliest stages of photosynthesis apparently minimise seasonal changes in ultimate CO_2 fixation. These changes in light use were similar in three deciduous sites, suggesting a seasonal shift from light-stress in winter to light-limitation in summer. This physiological shift was also supported by large seasonal changes in chlorophyll and RUBISCO content. In contrast the amplitude of these physiological and biochemical changes were greatly depressed in an unusual population growing in an evergreen site. This suggests that photosynthetic acclimation in *L. pulmonaria* is driven by local leaf canopy status.

The Greening of *Chlorella vulgaris* in Response to Low PSII Excitation Pressure is Dependent Upon the Redox-State of the Plastoquinone Pool. WILSON, K.E.*, KROL, M., HUNER, N.P.A.. Department of Plant Sciences, University of Western Ontario, London, ON, N6A 5B7.

When cells of the unicellular green alga *Chlorella vulgaris* are grown under conditions which elicit high PSII excitation pressure, the cells exhibit dramatically decreased chlorophyll and LHCII accumulation compared to cells grown under low PSII excitation pressure conditions. Cells grown at 5°C and 150 micromol m^{-2} s^{-1} have a Chl a:b of 11.5, a large xanthophyll cycle pigment pool, and a xanthophyll epoxidation state of 0.45. Visually these cells are yellow in colour. The high PSII excitation pressure can be relieved by maintaining the same irradiance but transferring the cells to 27°C. Following such a shift there is a rapid increase in cellular Chl content, a decrease in the Chl a:b to 4.5, and an increase in LHCII abundance. We have examined this greening process over a 12 h period following transfer. Not only is there an increase in Chl and LHCII abundance, but there is an accompanying increase in thylakoid proteins representative of PSII, PSI and the cytochrome b/f complex. The addition of the electron transport inhibitor DBMIB inhibited this greening process. However, in the presence of DCMU chlorophyll biosynthesis and LHCII accumulation were comparable to control cells. The putative sensor responsible for controlling this greening phenomenon appears to reside between the DCMU binding site of PSII and the DBMIB binding site on the Cytochrome b/f complex.

08:40

Contributions of Biosystematics to the Protection of Vascular Plant Biodiversity in Canada. CATLING, P.M. Agriculture and Agri-Food Canada, Eastern Cereal and Oilseed Research Centre, Saunders Bldg., Central Experimental Farm, 960 Carling Ave., Ottawa, Ontario, Canada, K1A 0C6.

A major aspect of bioconservation in Canada is the protection of biodiversity of vascular plants, a living capital supporting the health and welfare of people. Legislation protecting species at risk provides justification for programs and funding. Species and infra-specific taxa, including races, are priorized by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) based on reports including information on taxonomic and ecological status. This work requires capabilities for classification, identification, inventory, and research. Training in field biology, biosystematics and ecology is essential. Since floristic manuals and rare flora studies are available for most provinces and territories, it may seem that the classification and identification capability at the species level is adequate, yet many new globally rare species have been discovered over the past several years and species limits in many groups, including some that are economically important, remain unclear. Patterns of genetic variation within species are generally poorly understood and status reports are not available for races of widespread plants, although some exist for animals. Official lists of species at risk are currently incomplete. Despite significant progress over the last few decades, a great deal of biosystematic work is necessary to adequately protect the biodiversity of Canadian vascular plants. Increasing support for practical research relating to national and international obligations will help to address the need. Biosystematic work aimed at biodiversity protection is advantageous in both teaching and research since it provides testable hypotheses relating to evolution and ecology. This leads to continuing opportunities for innovation and discovery.

09:20

The role of Conservation Data Centres in the conservation of Canada's flora. SORRILL, P. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, P.O. Box 7000, 300 Water Street, Peterborough, Ontario K9J 8M5.

Conservation Data Centres (CDC's or Natural Heritage Programs) are a relatively new initiative in Canada, though they have been in existence for several decades in the United States. There are more than 80 CDC's in the Western Hemisphere all of which share data and use standard methodologies to gather and store information. Currently there are seven CDC's in Canada, covering all Canadian provinces. Each Canadian CDC employs at least one full-time botanist whose job involves assigning conservation status ranks to plant species, compiling databases on rare plant populations in their jurisdiction, and inventory, monitoring and other field studies on rare plant populations. Conservation status ranks are assigned to plant and animal species and vegetation communities at the global (granks), national (nranks), and subnational (provincial or state; sranks) scales. These ranks are used to set conservation priorities. Information on species of conservation concern is databased by CDC's and disseminated to natural resource managers and others involved in biodiversity conservation using a variety of methods including the world wide web. The Association of Biodiversity Information Canada (ABI-Canada) is an umbrella organization helping to coordinate and support the work of Canadian CDC's. ABI-Canada has coordinated several multi-jurisdictional projects including the national status assessment of Canadian orchids and ferns. CDC botanists need to work closely with other professional botanists in Canada as well as the amateur botanical community in order to enhance the conservation of Canada's native flora.

09:50

Planning with plants in Illinois. ROBERTSON, K. R. Center for Biodiversity, Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820 USA.

Most of the natural landscape of Illinois has been converted to agricultural fields and urban areas, and Illinois ranks 49th out of the 50 states in the percentage of pre-European settlement vegetation remaining today. As a consequence, Illinois has become a leader in the preservation of its natural heritage. In 1963, the Illinois Nature Preserves Commission was founded, and today there are ~300 officially protected nature preserves encompassing 16,000 hectares. The need to prioritize areas for acquisition and preservation led to the development of the Natural Divisions of Illinois in 1973 and the Illinois Natural Areas Inventory, which was conducted in the mid-1970s. The latter gave rise to a database that portended TNC's Natural Heritage databases. The Illinois Plant Information Network (ILPIN) is a species-based database started in the mid-1980s and has been linked to geographic information systems (GIS) for various plant biodiversity studies. GIS has also been used to generate atlases and analyses of forest and wetland resources in Illinois. The Illinois Natural History Survey has completed data entry from herbarium labels into a database, with limited access via the internet. A recent effort in Illinois is the Critical Trends Assessment Program, an on-going process to evaluate the State's environment. A methodology to rather rapidly assess floristic and natural community integrity is the Floristic Quality Index, which now has statewide coverage.

10:35

Floristic data on the island of Newfoundland : their application to conservation. BROUILLET, L.*, LEBRUN, L., HAY, S. & BOUCHARD, A. Institut de recherche en biologie végétale, Université de Montréal, Montréal, QC.

Increasingly, floristic data are databased and georeferenced. Databases are linked to GIS, providing the capacity for species and biodiversity mapping at various scales. It is then possible to relate floristic information with other kinds, such as socio-political parameters, the location of parks, etc., to synthesize distribution patterns, to assess threats or to effect gap analyses. We will use our work on the island of Newfoundland as an example of the application of floristic data to conservation, at the scale of the province and of national parks. We used some 40,000 floristic data points available for about 800 native taxa from the island. Large knowledge gaps still remain. Nevertheless, using a coarse grid size (100 km), it is possible to obtain a picture of the distribution of species richness. It is highest on the west coast of the island with biodiversity hotspots around the Bay of Islands and Bonne Bay. National parks protect about 80% of the native flora and 56% of the rare vascular plants, in parts because Gros Morne NP is located within this hotspot of diversity. Within each park, the distribution of rare elements is analyzed. Current practical problems encountered with floristic analyses in Canada will be discussed.

11.05

The impact of hybridization on the endangered red mulberry (*Morus rubra*): implications for conservation. HUSBAND, B.C.* and BURGESS, K. Department of Botany, University of Guelph, Guelph, Ontario N1G 2W1.

Hybridization has long been viewed as a mechanism of plant adaptation and speciation. More recently it has been considered a potential cause of extinction, particularly for rare species; however, little is known regarding the extent of hybridization or the fate of rare species that hybridize with more abundant congeners. Here we report results from molecular (RAPD) and ecological studies designed to investigate the extent and impact of hybridization between red mulberry (*Morus rubra* L.), an endangered tree in Canada, and the introduced white mulberry (*Morus alba* L.). Using species-specific genetic markers, we show that the frequency of hybrids differs among the three sympatric populations we examined, in accord with the local abundance of parental species. With respect to leaf morphology, most hybrids resemble white mulberry, which is consistent with the observation that hybrids contain a higher proportion of white markers than red and with the asymmetrical fitnesses of offspring from reciprocal crosses between red and white mulberry trees. Our results suggest that viable hybrids are sired mostly by red mulberry, despite the numerical dominance of white mulberry pollen, but that backcrosses most likely occur with white mulberry. We outline a research program necessary to determine whether the red mulberry genome is actually at risk as a result of this interaction.

11:35

Can Systematists Help Conserve Plants in the Next Century? REZNICEK, A.A. University of Michigan Herbarium, North University Bldg., Ann Arbor, Michigan 48109 U.S.A.

Systematics, and the information it provides are essential to rare plant conservation. But more and more systematists in universities and museums know little about plants in nature. Coupled with this is that much of the science now involved with conservation activities is provided by people working at the landscape level, rather than with species and their habitats. The necessary systematic component to this overview is often poorly represented. Indeed, conservation efforts for rare plants in our fragmented landscapes may even be blunted by input that suggests communities of small size and with small rare plant populations are not viable "in perpetuity." Without the active input of the systematic community, we might have fine protected representative landscapes, but lose much of our heritage of rare plants. Even beyond this is the fact that the concept of "in perpetuity" is flawed. Sadly, contributions of the academic systematics community now are often only historical, systematists having collected specimens that are now being databased, making them easily useable by others. To ensure that systematists can help save rare plants requires that morphological systematics and floristics be maintained as an academic discipline functional in research and teaching. We need to cast our systematic and floristic studies into the framework of hypotheses, rather than retreating into stylized jargon. Morphological systematics must be represented in national meetings, granting agencies, and public forums. And in the conservation process, we need to go beyond the role of data providers and summer employees for bureaucrats and managers to enfranchised participants.

POSTER ABSTRACTS

P1-CSPP student poster.

MURRAY, J. D.*, PAULS, K. P., AND SCHAAFSMA, A., University of Guelph, Department of Plant Agriculture, N1G 2W1. **Dissection of Potato Leafhopper Injury Types in the Common Bean: Differential Expression of Potato Leafhopper Induced Leaf Burn and Leaf Curl in Some Genotypes.**

The typical presentation of potato leafhopper injury in beans includes necrosis at the leaf margins (leaf burn or hopperburn) and downward curling or "cupping" of the leaves. The most common method employed by bean breeders to assess degrees of resistance to the potato leafhopper involves assessing damage in unprotected plots using an index that incorporates the characters of leaf burn, leaf curl, and stunting. While these indices are practical in field breeding, it is useful to examine these characters separately in order to assess the interrelationships and their relative importance. The population used for this study consisted of 108 recombinant inbred lines derived from a cross between a susceptible Dutch Brown Ontario cultivar Berna and an experimental resistant line EMP419, generated by several cycles of recurrent selection at CIAT. Relationships between the various types of leafhopper induced injury types, seed coat colour and growth habit are presented. Leaf burn and leaf curl were significantly correlated (0.38-0.64, $p<0.001$). However, several RILs exhibited differential expression of leaf burn and leaf curl, which opens the possibility of genetic dissection of these traits. If this were possible the relative importance of these traits with respect to yield under potato leafhopper pressure could be determined.

P2-CSPP student poster.

GAUCHER, C.[1,2]*, MAUFFETTE, Y.[1], DIZENGREMEL, P.[2], CHEVRIER, N.[2]. [1]Département des Sciences Biologiques, Université du Québec à Montréal, CP 888, Succ A, Montréal, Québec, H3C 3P8 [2]Laboratoire de Biologie Forestière, UA INRA, Université Henri Poincaré, Nancy I, B.P. 239, 54506 Vandoeuvre, France. **Physiological effects of an ozone gradient on sugar maple seedlings.**

Tropospheric ozone (O_3) is one of the most damaging gaseous pollutants that affects vegetation. Its concentration increases by 1 or 2% a year and it is estimated that ozone level will reach around 200 $nL.L^{-1}$ by the year 2100. We report on the effects of an O_3 gradient on the biomass, Rubisco activity, glucose 6-phosphate dehydrogenase (G6PDH) and phosphoenolpyruvate carboxylase (PEPC) activities of sugar maple (*Acer saccharum* Marsh.) seedlings. Two year-old seedlings were exposed to 0, 50, 100, 150, 200 and 300 $nL.L^{-1}$ of O_3 during 98 days in open-top chambers. Our results show a decrease of the biomass with increasing O_3, especially after 98 days. No relationship was observed between Rubisco activity and ozone. G6PDH and PEPC activities increased over time with increasing O_3 concentrations. G6PDH is a key enzyme of the oxidative pentose phosphate pathway which lead to NADPH production. This enhanced production of NADPH may be provided to glutathione reductase (GR, one of the enzymes of the detoxication ascorbate-glutathione cycle) to allow a high level of GSH regeneration. This ensures an efficient functioning of the detoxication cycle in the seedlings. In C_3 plants, PEPC has anaplerotic function such as the replenishement of the tricarboxylic acid cycle. Enhanced PEPC activity has also recently been reported in response to different stresses and may supply the repair mechanisms with carbon skeletons. We conclude that the observed changes help the sugar maple seedlings to cope with oxidative stress.

P3-CSPP student poster.

TODD, C.D.*, STARCHUCK, C. D., STONE, S. L. and GIFFORD, D.J. Department of Biological Sciences, CW 405 Biological Sciences Building, University of Alberta, Edmonton, AB, T6G-2E9. **Utilization of Stored Nitrogen in Loblolly Pine Seedlings: Movement of Nitrogen from Arginine Following Germination**.

In the loblolly pine seed the megagametophyte harbours the majority of the seed storage proteins, the major nitrogen reserve of the seed. Following germination these proteins are hydrolyzed and the products, free amino acids, are rapidly and efficiently transported to the expanding cotyledons. Arginine is the most prevalent amino acid in the megagametophytic storage proteins and accounts for approximately half the stored nitrogen. The enzyme arginase is responsible for liberating nitrogen from arginine once it has entered the seedling. Increases in arginase-activity, -protein and -mRNA levels coincide with arginine accumulation in the cotyledons. HPLC analysis of seedling free amino acid pools indicate that while arginine is abundant in the cotyledons following germination, it is primarily asparagine which accumulates in the hypocotyl and radicle. This implies development of a vascular system capable of translocating amino acids following germination. Accumulation of asparagine likely provides a secondary nitrogen store and may function as a sink for excess nitrogen accumulating in the cotyledons, allowing arginine hydrolysis to continue. As such, it appears that arginine and arginase are a crucial component of early seedling nitrogen metabolism releasing nitrogen for immediate assimilation into compounds required for rapid seedling growth as well as contributing to nitrogen stores in the hypocotyl and radicle to be used during post-germinative growth.

P4-CSPP student poster.
RAZEM, F.A.*, and BERNARDS, M.A. Department of Plant Sciences, The University of Western Ontario, London, Ontario, N6A 5B7. **MACROMOLECULAR ASSEMBLY DURING SUBERIZATION OF POTATO TISSUE: IS HYDROGEN PEROXIDE REQUIRED FOR THE POLYMERIZATION OF THE PHENOLIC COMPONENTS?**

Plants undergo suberization during their normal growth and in response to stress conditions such as wounding. Although "suberin" has not been purified, suberized cells have been shown to contain both poly(phenolic) and poly(aliphatic) domains. The poly(phenolic) domain of suberized potato tubers was originally thought to resemble lignin until it was demonstrated that hydroxycinnamate-derivatives such as N-feruloyl tyramine were also part of the polymer. The unique nature of this poly(phenolic) domain is reflected in the new term ligno-suberin, used to describe it. The macromolecular assembly of ligno-suberin involves the synthesis of appropriate monomers, their transport to the site of polymerization and finally their assembly into a 3-D polymeric network. The polymerization step has been hypothesized to occur via a peroxidase/H_2O_2 mediated free radical coupling process albeit to date without any definitive proof. In potatoes, where peroxidase induction and the generation of H_2O_2 in response to wounding and pathogen attack have been observed, no connection has been made between them during suberization. Here we confirm the presence of an H_2O_2 generating system in suberizing tissues namely an NADPH-dependent oxidase. When suberized tissues were pre-incubated with low mM concentrations of the NADPH oxidase inhibitor diphenyliodonium (DPI), H_2O_2 production was either blocked or reduced significantly in a dose-dependent manner. Furthermore, wound-induced tissues that were incubated with DPI accumulated new soluble phenolic-like compounds not seen in controls. These compounds may be the result of the accumulation of unpolymerized phenolics or their degradation products. These experiments shed some light on the macromolecular assembly of potato ligno-suberin and provide additional supportive evidence for its unique character.

P5-CSPP student poster.
LORTEAU, M.A., FERGUSON, B.*; GUINEL, F.C. Wilfrid Laurier University, Biology Department, Waterloo, N2L 3C5. **Reduction of pea nodulation by cytokinin treatment**.

Sparkle, a freezer pea, was inoculated with *Rhizobium leguminosarum* 3 days after planting (3 dap) and treated with benzylaminopurine (BAP) 4 and 6 dap. Concentrations ranging from 0.5 μM to 25 μM were used and the nodules counted 24 dap. Concentrations higher than 10 μM were inhibitory and nodulation was blocked with 25 μM BAP. A light microscopy study on 17 day-old plants was undertaken to localize the stage(s) of nodule development most sensitive to 15 μM BAP. Infection threads were able to form and to enter the outer cortex. The threads grew abnormally, mostly parallel to the root surface; they formed loops and intertwined. Cell division centers were rarely seen in the inner cortex. Absorbance measurement at 600 nm showed that BAP did not have any effect on the bacteria; cultures grew well with concentrations similar to those used on plants. Non-inoculated plants (6 day-old) treated with 25 μM BAP produced ethylene, about 0.07 ppm/g DW/h. We proposed that cytokinin, a known activator of the enzyme ACC synthase, inhibits indirectly nodulation by making the plant produce more ethylene. We are testing that hypothesis by checking if BAP-treated plants to which are added ethylene inhibitors form nodules.

P6-CSPP student poster.
POULIS, B.* and VON ADERKAS, P. Graduate Centre for Forest Biology, University of Victoria, Victoria, BC V8W 3N5. **Douglas fir ovular secretion proteins.**

In Douglas fir (*Pseudotsuga menziesii*) a postpollination/prefertilization ovular secretion exudes from the nucellar tip into the micropylar canal. This secretion has been collected for protein analysis from dissected female cones. Analysis of this drop by SDS-PAGE shows the presence of many different proteins with molecular weights ranging from approximately 10 kDa to 130 kDa. The proteins were separated and collected into separate fractions using RP-HPLC. MALDI-TOF mass spectrometry, amino acid analysis, and sequence analysis have been performed on several isolated ovular secretion proteins. This represents the first protein analysis in ovular secretions of Douglas fir.

P7-CSPP student poster.
GRAHAM, T. Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1.
Ozonation: An effective tool for the remediation of recirculating hydroponic nutrient solutions.

Ozone has been used for nearly a century to disinfect and control organic compounds in municipal and industrial water streams. In recent years, concern over greenhouse effluent, and its impact on surrounding ecosystems, has lead to the need for the development of closed loop irrigation systems. These systems would eliminate, or greatly reduce, the amount of nutrient solution reaching the external environment. However, these systems can also lead to the accumulation of organic compounds and enhance pathogen proliferation. The question then is, can the application of ozone to the nutrient solution of a closed loop irrigation system adequately address the potential problems associated with the use of recirculated irrigation systems? The poster presented outlines research that is being done to determine the efficacy of ozone as a control agent in a recirculated greenhouse setting.

P8-CSPP student poster.
YANG, X.*[1], FICKER, C.[2], SMITH, M. L.[2] and BERNARDS, M.A.[1] [1]Department of Plant Sciences, University of Western Ontario, London, ON, Canada N6A 5B7. [2]Biology Department, Carleton University, Ottawa, ON, K1S 5B6. **Isolation of an antifungal compound from *Impatiens balsamina* using bioactivity-guided fractionation**

Preparations from the aerial parts *of Impatiens balsamina* (Balsaminaceae) have been used traditionally for antifungal, antirheumatic, antipruritic and antitumor purposes for many years in China. While several natural products from this genus have been identified, none have been linked with the medicinal properties associated with this herb. Using bioactivity-guided fractionation based on the brine shrimp (*Artemia salina*) lethality test, a single compound (LC50=26.0 µg/ml.) was isolated from a 95% EtOH extract of the aerial parts of *I. balsamina* and subsequently identified as 2-methoxy-1,4-naphthoquinone (MNQ). The structure of MNQ was confirmed by UV, GC-MS, and ^{1}H and ^{13}C NMR spectroscopy. The antifungal activity of MNQ was evaluated using eight fungal strains, including *Candida albicans* a1-1 and al-2, *C. albicans* CN1A and D10 (both are fluconazol and Amphotericin B resistant strains), *Fusarium oxysporum, Aspergillus fumigatus, Microsporum gypseum*, and *Trichophyton mentagrophytes*. The minimal inhibitory concentrations (MICs) found were 0.62, 2.50, 0.62, 1.25, 1.25, 0.31, 0.62 and 1.25 µg/ml, respectively. This study provides the first scientific evidence that *I. balsamina* contains ingredients associated with its medicinal properties.

P9-CSPP student poster.

HODSON, J.*; KHAN, M. U.; WILLIAMS, J. P. Department of Botany, University of Toronto, 25 Willcocks Street, Toronto, Ontario M5S 3B2. **Acyl-exchange is involved in the fatty acid desaturation and lipid biosynthetic pathway in canola leaves.**

Fatty acid desaturation and lipid biosynthesis in leaves play a crucial role in the growth and physiology of the whole plant, but despite this, the pathway is still not well understood. It is generally assumed that *de novo* fatty acids are esterified to phosphatidylcholine (PC) whereupon desaturation can occur. PC may then be used in the synthesis of other polyunsaturated lipids. We are investigating this pathway in the leaves of Canola, a major oilseed crop in Canada, and our results suggest an acyl exchange occurs between PC and an acyl-CoA pool in the endoplasmic reticulum. This exchange results in the biosynthesis, via the Kennedy pathway, of polyunsaturated diacylglycerol (DAG) that may be used directly for polyunsaturated lipid biosynthesis. Wild type Canola has only a small amount of oleic acid in PC, making accurate determinations on this fatty acid, the precursor to all polyunsaturated 18C fatty acids in the leaves, difficult. The use of a *Brassica napus* mutant with an increased amount of oleic acid in its lipids allows for more information on the initial fatty acids involved in desaturation and lipid synthesis. Data from radiotracer analyses of the molecular species of both wild type and mutant phospholipids support the occurrence of an acyl exchange. Positional distribution analyses using phospholipase A2 are now being conducted that will shed further light on this process by allowing us to determine if there is a preferred sn-position for exchange, and if fatty acids are exchanging randomly, or in a pre-determined way.

P10-CSPP student poster.

BURIAN, T. Z.*; SUMMERS, P. S.; WERETILNYK, E. A. Department of Biology, McMaster University, Hamilton, ON, L8S 4K1. **Purification and properties of *S*-adenosyl-L-methionine: phosphomethylethanolamine *N*-methyltransferase from spinach leaves.**

In spinach (*Spinacea oleracea*), phosphocholine (P-choline) is produced by three sequential *N*-methylations of phosphoethanolamine (PEA) involving at least two *S*-adenosyl-L-methionine (SAM)-dependant methyltransferases. One enzyme *N*-methylates PEA□ phosphomethylethanolamine (PMEA), phosphodimethylethanolamine (PDEA), P-choline (PEA *N*-methyltransferase or PEAMeT) and a second enzyme uses PMEA as a substrate but not PEA (hence 'PMEAMeT'). We have purified PMEAMeT over 500-fold using a seven-step purification strategy: $(NH_4)_2SO_4$ fractionation followed by chromatography on DEAE Sepharose, Phenyl Sepharose, High Q, Sephacryl S-100, Mono Q and Protein Pak SW-300. Gel filtration by SW-300 produced a single, unimodal peak of PMEAMeT activity. Fractions associated with this peak had at least six polypeptides as resolved by SDS-PAGE. Of these polypeptides, only two could be photoaffinity cross-linked by [^{3}H]-SAM (31 kDa and 50 kDa). Evidence that both [^{3}H]SAM-binding polypeptides contribute to PMEAMeT activity was provided by including PMEA or PDEA in the photoaffinity labelling assay. In the presence of either phosphobase, [^{3}H]SAM binding is prevented, indicating that PMEA and PDEA are suitable substrates. Notably PEA is not used by either species and Mono Q can partially separate the 31 and 50 kDa polypeptides. We suggest that, in addition to PEAMeT, spinach has two discrete enzymes that convert PMEA to P-choline. While increased P-choline synthesis is required for osmotic adjustment in water-stressed spinach, the contribution of PMEAMeT activity to this increase is unknown.

P11-CSPP student poster.

COMPAROT, S., PIDGEON, C., REID, D. M.* Dept. of Biological Sciecnes, Univeristy of Calgary, Calgary, Alberta T2N 1N4, Canada. **The effect of jasmonic acid on superdioxide dismutase activity in light- and dark-grown *Arabidopsis thaliana*.**

The effect of jasmonic acid on superoxide dismutase (SOD) activity was studied in light- and dark-grown seedlings of *Arabidopsis thaliana*. SOD activity was found to be higher in dark-grown than in light-grown seedlings. Treatment of light-grown seedlings with jasmonic acid (JA) caused the activity of SOD to be increased in a dose-dependent manner; treatment of dark-grown seedlings caused little change in SOD activity. The separation of superoxide dismutase isoenzymes by native gel electrophoresis indicates that JA primarily affects the activity of the Cu/Zn-SOD. Even the highest concentration of JA did not change the activity of the Fe- or Mn-SOD. While jasmonic acid may have a direct influence on SOD transcripts, we propose that it more likely causes a light-dependent increase in superoxide formation which in turn, causes higher SOD activity. The jasmonic acid-stimulated increase in SOD activity may only be detected in light-grown seedlings because of the high basal level of activity found in etiolated seedlings. The question is now whether other antioxidant enzymes are activated in response to a jasmonic acid treatment. We are currently studying the effects of jasmonic acid on other elements of the antioxidant response in light- and dark-grown seedlings.

P12-CSPP

NUNES, C.; MINHAS, J. S.; SHEORAN, I. S.; FAROOQUI, N.; SAINI, H. S.* Université de Montréal, Institut de recherche en biologie végétale, 4101 rue Sherbrooke est, Montreal, QC. H1X 2B2. **Modulation of invertase activity and gene expression in wheat anthers in relation to water stress-induced male sterility in wheat.**

Grain yield of wheat is highly vulnerable to water deficit during pollen formation. Stress during meiosis in the microspore mother cells, causes male sterility and thus a failure of grain set. The injury is not due to the desiccation of reproductive organs, but probably originates from an indirect effect of water deficit in vegetative tissues. Working back from the observation that stress impairs starch accumulation in pollen grains, we have found that stress-induced arrest of male gametophyte development is preceded by a specific inhibition of the activity of the key sugar-cleaving enzyme, invertase, in the anthers. Both the cell wall and vacuolar isoforms of the enzyme are affected, and the inhibition is accompanied by disturbances in carbohydrate metabolism and distribution within anthers. A group of anther-expressed invertase cDNAs representing cell-wall and vacuolar isoforms were cloned used to study the molecular regulation of invertase activity. The expression of these genes, as determined by northern analysis and quantitative PCR, was developmentally regulated and differentially affected by meiotic-stage water deficit. In addition, *prima facie* evidence suggests that an inhibitor of invertase may be partially responsible for the drop in the enzyme acitivity.

P13-CSPP

DJIANA, R.[1]; ATTIEH, J.[1]; SPARACE S. A.[2]; SAINI, H. S.*[1]. [1]Université de Montréal, Institut de recherche en biologie végétale, 4101 rue Sherbrooke est, Montreal, QC. H1X 2B2. [2]McGill University, Plant Science Department, 21 111 Lakeshore Road, Ste Anne-de-Bellevue, Qc., H9X 3V9, Canada. **Biochemical and molecular characterization of a novel route for detoxification of the glucosinolate hydrolysis products, and its implications for plant defenses against biotic stress.**

Crucifer plants accumulate thioglucosides called glucosinolates, which, upon tissue disruption through herbivory or infection, are degraded into a variety of toxic products including thiocyanate (CNS^-), isothiocyanates (ITCs), and HS^- ions, which provide defense against insects and pathogens. Little was known about the fate of the these products until we recently demonstrated (Plant Cell Environ 2000, 23:165-174; Archiv Biochem Biophys 2000, *in press*) that glucosinolate-containing plants possess closely related enzymes that methylate CNS^-, HS^- and organic thiols ($R\bar{o}S^-$) to volatile CH_3SCN, CH_3SH and $R\bar{o}SCH_3$. The latter have putative roles in plant-herbivore communication. We purified five enzyme proteins with thiol methyltransferase activity — the first thiol methyltransferases reported in plants. They have distinct molecular masses, pH optima and kinetic properties. Two highly homologous cDNAs encoding these proteins have been cloned and characterized. One of the cDNAs has been expressed in *E. coli,* and the kinetic characterization of the recombinant protein is in progress. This work could lead to novel biotechnological approaches to improve plant defenses against insects and pathogens.

P14-CSPP student poster.

KAUP, M.T.*; THOMPSON, J.E. University of Waterloo, Department of Biology, 200 University Avenue W., Waterloo, Ontario, Canada, N2L 3G1. **Diacylglycerol Acyltransferase is Expressed During Natural and Induced Senescence of *Arabidopsis thaliana* leaves.**

Senescence is the stage in plants that precedes death. It is characterized by dissolution of cellular membranes attributed to the action of lipolytic enzymes and the accumulation of lipid metabolites within the bilayer. It has been previously proposed that fatty acid (FA) equivalents released during senescence are metabolized via the glyoxylate cycle and converted to phloem-compatible carbon. However, it is not known whether the fatty acids are metabolized directly by the glyoxylate cycle or whether there is an intermediate stage as triacylglycerols (TAG). TAG would serve as a relatively inert holding molecule for disruptive lipids such as free fatty acids. Diacylglycerol acyltransferase (DGAT) catalyzes the final acylation in triacylglycerol (TAG) synthesis in oilseeds. In the present study, it has been established that DGAT is up-regulated during natural senescence and ethylene induced senescence of *Arabidopsis thaliana* leaves. This suggests that an alternative pathway for lipid released during senescence is indeed a possibility. That is, instead of direct metabolism of the lipid released from membranes during senescence into phloem-compatible carbon, free fatty acids may be temporarily stored as TAG. As senescence progresses, TAG fatty acids would subsequently be mobilized through the glyoxylate cycle to phloem-mobile carbon.

P15 CSPP

COLMAN, B.[1] HUERTAS, I.E.* [13], ESPIE, G.S.[3]and LUBIAN, L.[2] [1]Dept.of Biology, York University, Toronto, M3J 1P3 CANADA. [2]Instituto de Ciencias Marinas de Andalucia (CSIC) Poligono Rio San Pedro s/n. 11510,Cadiz, SPAIN. [3]Dept.of Botany, University of Toronto, Mississauga,L5L 1C6, CANADA. **Active CO_2 uptake by the marine alga *Nannochloris*.**

CO_2 uptake by the marine green alga *Nannochloris maculata* has been studied by mass spectrometry. No external carbonic anhydrase (CA) was detected but internal CA was present. Cells incubated in light with 100 µM dissolved inorganic carbon in ASW at pH 8.0, caused a rapid drop in [CO_2] of the medium to levels below equilibrium and adding bovine CA to the medium restored the CO_2-HCO_3- equilibrium. Darkening of the cells caused an increase in [CO_2] in the medium, indicating an extracellular accumulation of unfixed inorganic carbon. Rapid CO_2 uptake in light against a concentration gradient indicates a selective and active uptake of CO_2. This alga does not take up bicarbonate by active transport. The enigma of this alga' s dependence solely on free CO_2 in a marine environment will be discussed.

P16

LEONARDOS, E.D.*[1], SAVITCH, L.[2], HUNER, N.P.A.[2], and GRODZINSKI, B.[1] [1]Dept. of Plant Agriculture, Div. of Hort. Sci., University of Guelph, Guelph, ON, N1G 2W1. [2]Dept. of Plant Sciences, University of Western Ontario, London, ON, N6A 5B7.
Photosynthesis, export and C partitioning in source leaves of winter wheat.

Morning leaf photosynthesis (Pn) and immediate ^{14}C export (Exp) rates were measured in plants acclimated (grown) at 20 or 5°C, 250 µmol m^{-2} s^{-1} PPFD and ambient CO_2. Plants grown at 20°C were also stressed for 12h at 5°C prior to measurements at 5°C. Pn and Exp were lowest in the 5°C-stressed plants. At ambient CO_2, Pn in 20 and 5°C-acclimated plants were similar to each other at 250 and 1000µmol m^{-2} s^{-1} PPFD, respectively, but Exp rates were markedly reduced in the 5°C-acclimated plants. Even so, Pn and Exp in both groups were significantly enhanced at high CO_2 (900 µl l^{-1}) indicating that Exp was not sink limited in cold-acclimated plants. Interestingly, high CO_2 did not increase Pn and Exp in the 5°C-stressed plants.The fate of ^{14}C fixed during morning feedings was followed during the subsequent afternoon and night period. The 20°C-acclimated plants exported 50-100% more ^{14}C daily than the 5°C-acclimated plants which retained the most ^{14}C in leaves. The 20°C-acclimated plants exported approximately 80% of the ^{14}C fixed during morning feeds, whereas the 5°C-acclimated plants exported 55%, respectively. This relative difference between the two groups was maintained regardless of whether leaves had been exposed to high light and/or high CO_2. The 5°C-stressed plants compensated for their low morning Exp rates by exporting more ^{14}C during the chase period (66-78% of ^{14}C fixed), but total export was still lower than in the 5°C-acclimated plants. Respiration rates were highest in the 5°C-stressed plants.

P17-CSPP student poster.

MISKIEWICZ, E.*; IVANOV, A.G.; HUNER, N.P.A. Department of Plant Sciences, University of Western Ontario, London, Ontario, N6A 5B7. **Structural and functional adjustments in the photosynthetic apparatus of the cyanobacterium *Plectonema boryanum* in response to growth temperature and irradiance.**

We have performed a structural and functional characterization of the photosynthetic apparatus of the filamentous cyanobacterium, *Plectonema boryanum* UTEX 485 grown under various conditions of temperature(°C)/irradiance (μmol m^{-2} s^{-1}). Immunoblotting analysis indicated that *P. boryanum* cells grown at either 15/150 or 29/750 possess smaller phycobilisomes (PBS) due to the progressive loss of the terminal phycocyanin subunits of the PBS rods. Moreover, an increase in the contents of plastoquinone A and cytochrome f on a Chl a basis was associated with increasing growth irradiance at growth temperatures of either 15 or 29°C. However, the relative content of the D1 polypeptide of the PSII reaction centre exhibited minimal changes, and the level of ATP synthase was approximately 50% higher in cells grown at 15/150 compared to cells grown at any other conditions. Growth of *P. boryanum* at either 15/150 or 29/750 resulted in a decrease in the photooxidation level of P700 under far red illumination as well as an increase in the rate of dark reduction of $P700^+$ indicating increased rates of the cyclic electron transport around PSI as compared to cells grown at either 15/10 or 29/150. Furthermore, the typical fast reduction of $P700^+$ followed by its reoxidation induced by either a single or multiple turnover flash of white actinic light was not detected in cells grown at either 15/150 or 29/750. These adjustments in the photosynthetic apparatus may play a role in the maintenance of photosynthetic energy balance under low growth temperature and/or high growth irradiance.

P18-CSPP

KUJAT, S. L. and OWTTRIM, G.W.* Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, T6G 2E9. **Redox regulation of RNA helicase expression.**

In photosynthetic organisms it is becoming evident that light driven shifts in redox potential act as a sensor that initiates alterations in gene expression at both the level of transcription and translation. This report provides evidence that the expression of a cyanobacterial RNA helicase gene, *crhR*, is controlled at the level of transcription and mRNA stability by a complex series of interacting mechanisms that are redox regulated. Transcript accumulation correlates with a net reduction of the plastoquinone pool, when *Synechocystis* is cultured photoautotrophically or photomixotrophically and subjected to darkness and/or electron transport inhibitors or illumination that preferentially excites PSII. Redox-modulation of crhR mRNA stability also regulates transcript accumulation through a mechanism which responds to the cellular redox state and not specifically plastoquinone or signaling by photoreceptors. Our data are consistent with CrhR RNA helicase activity functioning as a linker between redox regulated transcription and translation. The potential for translational regulation of redox-induced gene expression through RNA helicase catalyzed modulation of RNA secondary structure will be discussed.

P19-CSPP student poster.

GERHARDT, K.* and GREENBERG, B. Dept. of Biology, University of Waterloo, Waterloo, Ontario, N2L 3G1. **Photomodification of Ribulose-1,5-Bisphosphate Carboxylase/Oxygenase (Rubisco) by Ultraviolet-B (UVB) Radiation and UVB Acclimation Via Flavonoid Diglycoside Synthesis.**

There is growing concern that decreases in the ozone layer may result in increased levels of UVB reaching the earth's surface, thereby increasing the potential for damage to susceptible biological targets such as proteins, DNA and membranes. Proteins are susceptible to photodamage due to UVB absorption by aromatic acid residues, particularly tryptophan (Trp). As a model system, UVB exposure of Rubisco, the primary carbon-fixing enzyme in plants, was examined. UVB radiation causes formation of a specific photoproduct that is a covalent crosslink between a large and small subunit within the holoenzyme. The mechanism of this photoproduct formation involves photolysis of a Trp residue. *In vitro* experiments, using purified Rubisco and active oxygen quenchers and scavengers, suggest that the mechanism of photoproduct formation proceeds via a reactive oxygen species pathway. Since UVB has always been present in the environment, plants have evolved ways to detect incident UVB and to mitigate damage to their molecular targets by employing acclimation mechanisms. Soybean, grown to maturity in field experiments, did not accumulate Rubisco photoproduct, suggesting acclimation. One mechanism by which plants can prevent UVB from reaching sensitive targets in the mesophyll is to synthesize flavonoids, which act as UVB screens, in the epidermis. UVB irradiation of *Brassica napus* (canola) results in the accumulation of specific flavonoid diglycosides that have been linked to cultivar UVB-sensitivity. Consequently, another objective of this study was to determine if flavonoid biosynthesis is correlated with the prevention of Rubisco photoproduct formation *in vivo*; this would suggest that flavonoids prevent UVB-induced damage to Rubisco in acclimated plants.

P20-CSPP student poster.

POCOCK, T.*[1], HURRY, V. M.[2], SAVITCH, L.[1] and HUNER, N.P.A.[1] [1]University of Western Ontario, London, Ontario, Canada N6A 5B7. [2] Umeå Universitet, Umeå, Sweden. **The correlation of freezing tolerance and resistance to low temperature photoinhibition in winter and spring wheat.**

Winter wheat (*Triticum aestivum* L.) has the ability to maximize its freezing tolerance through the process of cold-acclimation. In contrast, spring wheat exhibits limited freezing tolerance. Five winter and five spring wheat cultivars of unknown freezing tolerance were arbitrarily selected for this study. They were grown and developed at 20-23°C and 250 and 800 mmol photons $m^{-2}s^{-1}$ (20/250, 20/800) and at 5°C and 250 and 50 mmol photons $m^{-2}s^{-1}$ (5/250, 5/50). The resistance to low temperature photoinhibition for each cultivar grown under all 4 conditions was measured as changes in photochemical efficiency (Fv/Fm). Freezing tolerance (LT_{50}) was determined by controlled freezing tests and compared with field survival data. Both winter and spring wheat grown at 5/250 were more resistant to photoinhibition when compared to respective plants grown under the 3 other growth regimes. However, a comparison of averaged winter and spring wheat data indicate that winter wheat grown at 5/250 and 23/800 were more resistant to photoinhibition than their spring wheat counterparts despite cultivar variation. Maximum freezing tolerance was only acquired by winter wheat cultivars grown under cold-acclimation conditions of 5/250. A good correlation was found between resistance to photoinhibition and freezing tolerance. The winter wheat cultivars ranked identically in freezing tolerance whether LT_{50} values or field survival data were used. These data confirm previous studies that compared extreme winter and spring cultivars and strongly suggests the use of resistance to photoinhibition as a tool to predict freezing tolerance in wheat.

P21-CSPP

KROL, M.*; WILSON, K.E. ; MISKIEWICZ, E.; HUNER, N.P.A. Department of Plant Sciences, University of Western Ontario, London, Ontario, N6A 5B7. **Relationship between grana formation and phosphorylation of D1 protein of PSII reation centre in wild-type and the *Chlorina f2* mutant of barley.**

Phosphorylation of the D1 protein of the PSII reaction centre in higher plants may function as a protective mechanism during the repair of damaged D1 proteins. Following damage, the D1 protein migrates from the granal to the stromal thylakoids. However, in mosses, liverworts and ferns phosphorylation of D1 protein does not appear to be necessary because they do not develop grana stacks. The aim of the present study was to examine whether the accumulation of phosphorylated D1 is dependent upon the grana structure in angiosperm chloroplasts. Etiolated wild type and chlorina f2 barley seedlings were exposed to continuous illumination at either 5 or 20°C. It has previously been demonstrated that the process of Lhcb2 accumulation and grana formation are retarded at low temperature (5°C) or high light (800 μmol m^{-2} s^{-1}) conditions. During the early stages of chloroplast development in wild type seedlings, there is no accumulation of phosphorylated D1, as estimated using an anti-phosphothreonine antibody. When the period of chloroplast development was extended by exposing the seedlings to high light or low temperature, phosphorylated D1 remained undetectable until Lhcb2 accumulation began. Interestingly, in chlorina f2 barley seedlings, which do not accumulate Lhcb2 due to a lack of chlorophyll b, the phosphorylated form of D1 was never detected. Thus, the accumulation the phosphorylated form of D1, appears to correlate with Lhcb2 accumulation, grana formation, and hence, the developmental stage of the chloroplast.

P22-CSPP student poster.

BAERLOCHER, M.; IRELAND, R. J.; CAMPBELL, D.A.* Biology, Mount Allison University, Sackville, N.B., E4L 1G7. **Annual patterns of photosynthesis in a Fundy *Spartina* marsh.**

We are tracking annual cycles of photosynthesis and growth in leaves of *Spartina alterniflora* in a recently established Bay of Fundy salt marsh, at Peck's Cove, New Brunswick. Previous work has shown active internal cycling of nitrogen reserves from over-wintering roots and rhizomes up to expanding leaves in spring, followed by translocation of amino acids back down to the roots and rhizomes in late summer and early fall. Our goal is now to determine the interactions between this nitrogen cycling and annual photosynthesis, since much of the leaf nitrogen is invested in the photosynthetic system. We are using chlorophyll fluorescence to estimate the photochemical yield of photosystem II electron transport [(Fm'-Fs)/Fm'], under ambient field conditions at low tide. Measuring began in May of 1999 and will continue until May of 2001. Approximately every two weeks (Fm'-Fs)/Fm' is measured every four centimetres along 6 representative leaves at three subsites. A fully factorial ANOVA on data to date shows that electron transport varies significantly ($p<0.001$) with position along the leaves, sub-site and day of year. We are now working to correlate this data with the timing of nitrogen translocation, leaf expansion and protein turnover. In general photosynthesis increased steadily from early May, reached a peak in high-summer (July-August), and decreased to inactivity by mid to late October.

P23-CSPP

IVANOV, A.G.*[1,2], SANE, P.V.[1], ZEINALOV, Y.[3], MALMBERG, G.[1], GARDESTRÖM, P.[1], HUNER, N.P.A.[2], ÖQUIST, G.[1] .[1] UPSC, Department of Plant Physiology, University of Umeå, Umeå S-901 87; [2] Department of Plant Sciences, University of Western Ontario, London, Ontario, Canada N6A 5B7; 3 Institute of Plant Physiology, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria. **Photosynthetic electron transport adjustments in overwintering Scots pine (*Pinus sylvestris* L.)**

Winter-induced inhibition of photosynthesis in Scots pine is accompanied by a 65% reduction of PSII photochemical efficiency. In contrast, PSI oxidation measured *in vivo* as a decrease in $\Delta A_{820}/A_{820}$ ($P700^+$) revealed only 40% inhibition of PSI redox capacity under the same conditions. This was accompanied by a 3.7-fold higher intersystem electron pool size and 4-fold faster re-reduction kinetics of $P700^+$ suggesting greater ability for cyclic electron transfer around PSI in winter-stressed needles. In addition, Q_A^- re-oxidation was markedly slower and the Q_B-band in the thermoluminescence glow curve was missing in winter pine needles. The total adenylates content in winter pine needles was 3-fold higher than in summer pine. However, winter pine exhibited a 2.7 fold lower ATP/ADP ratio compared to that in summer pine. The potential of photosynthesis to recover from winter stress was studied by exposure of winter pine to room temperature (20°C) and an irradiance of 100 μmol m^{-2} s^{-1}. The photochemical efficiency of PSII recovered fully within 28-30 h. In parallel to that, P700 oxidation also recovered gradually to the values registered in summer pine needles. The recovery of intersystem electron pool size and the electron pool size available from stromal sources recovered considerably faster reaching values similar to that registered in summer pine needles in the first 4 h of recovery. In contrast, the rate of $P700^+$ re-reduction remained notably faster during the measuring recovery period. Thus, we show for the first time by *in vivo* measurements, that PSI function, unlike PSII, is partially preserved throughout the winter in Scots pine and undergoes faster recovery from winter stress.

P24-CSPP student poster.
PADHAM, A. K.*, SMITH, M. D. and THOMPSON, J.E. University of Waterloo, Waterloo, Ontario, Canada N2L 3G1 **Isolation and Partial Characterization of 3 Lipase Genes from *Phaseolus vulgaris* Leaves.**

Lipases are involved in the turnover of membrane lipids and the breakdown of lipids during senescence. Northern blot analysis using a heterologous lipase clone as a probe indicated that a lipase is up-regulated in *Phaseolus vulgaris* leaves during senescence. Degenerate lipase primers were designed based on the amino acid sequences of lipase clones from carnation and other species. These primers were used to amplify lipases from total RNA isolated from senescing *Phaseolus vulgaris* leaves using RT-PCR. Three partial-length clones were obtained all of which corresponded to lipases as determined by comparison to protein databanks. Northern blots indicate that two of the partial clones are expressed in young leaves and are up-regulated during the last stages of natural leaf senescence. Sequence data indicate that these two partial clones correspond to different genes. The third partial lipase clone appears to be up-regulated during natural leaf senescence and sequence analysis indicates that it may correspond to a galactolipase gene. Collectively, these data indicate that there are a number of lipases in *Phaseolus vulgaris* leaves which appear to be differentially expressed during development. Lipases from *Phaseolus* leaves have been described on a biochemical level, but this is the first report on the isolation of genes for such enzymes.

P25-CSPP student poster.
THOMAS, K.* and PAULS, K. P. Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada, N1G 2W1. **Examination of Pathogenesis and Ethylene-related Gene Expression in Tomato, during Infection with *Verticillium dahliae*.**

Ethylene biosynthesis increases in tomato (*Lycopersicon esculentum*) leaves following infection with *Verticillium dahliae*, contributing to wilting, chlorosis and leaf abscission. To identify stress-related genes expressed during this process, three-week-old plants were inoculated with a *Verticillium* spore suspension by a root-dip method. 72 hours post inoculation (hpi), total RNA was extracted from leaves of infected and control plants, and reverse transcription performed. Differential display and subtraction hybridization are being used to isolate cDNAs upregulated during infection. Several differentially expressed bands have been identified and are being cloned for sequencing. Ultimately, promoters for the genes corresponding to these cDNAs will be isolated from genomic DNA, and used to drive expression of bacterial enzyme ACC (1-aminocyclopropane-1-carboxylic acid) deaminase in transgenic tomato plants. Additionally, the expression of ACC synthase (ACS) following inoculation with *Verticillium* is being examined. ACS is the key regulatory enzyme in the ethylene biosynthetic pathway and is encoded by a multigene family in tomato. The presence of three members of the family, *LE-ACS2*, *LE-ACS6* and *LE-ACS7*, in tomato leaves between 2hrs and 96 hpi, is being tested by Northern blot analysis.

P26-CSPP

TAMOT, B.*, MOFFATT, B.[1], GLICK, B.[1]and PAULS, K. P. Department of Plant Agriculture, Biotechnology Division, University of Guelph, Guelph, Ontario, Canada N1G 2W1. [1]Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. **The use of Tomato ACC- Deaminase Transgenics to Examine the Sensitivity of Seedling Development to Ethylene.**

Surface sterilized seeds of tomato transformed with a bacterial ACC deaminase gene driven by either the 35S promoter, the rolD promoter or the prb-1b promoter were germinated in presence or absence of 1-aminocyclopropane-1- carboxylic acid (ACC) in the dark, in the light, or in UV-B for 12 days to monitor the effects of ethylene on hypocotyl and root development. Nontransgenic tomato germinated in the dark in the presence of various amounts of ACC (from 0 to 20 μM) exhibited dose dependent inhibition of root and hypocotyl growth. Transgenic seedlings containing the 35S/ACC deaminase on 20 μM ACC had significantly longer hypocotyls and slightly longer roots than nontransgenic seedlings when germinated in the dark or light. The rolD/ACC deaminase transgenic seedlings grown on 20 μM ACC showed intermediate hypocotyl growth compared to nontransgenic and 35S/ACC deaminase transformed seedlings but had root lengths equivalent to untransformed tomato seedlings. The hypocotyls and roots of the prb-1b/ACC deaminase transgenic lines were similar to those on nontransgenic seedlings on 20 μM ACC in the dark and in the light. Seeds of both nontransgenic and transgenic tomato lines germinated under UV-B without ACC had shorter hypocotyls and longer roots than those grown in white light. A 50% reduction in root growth occurred in 35S, rolD and prb-1b ACC deaminase transgenics and in the nontransgenic on 20 μM ACC in UV-B. However, no difference was recorded in hypocotyl growth. Our results clearly suggest that root growth (elongation) is much more sensitive to inhibition by ethylene than hypocotyl growth(elongation) in the dark, in white light and in UV-B.

P27-CSPP student poster.

YEO, T W.* and GRBIC, V. Department of Plant Sciences, University of Western Ontario, 1151, Richmond St., London, Ontario, Canada, N6A 5B7. **Genetic analysis of 3 late-flowering aerial rosette-bearing ecotypes in *Arabidopsis*.**

The development of *Arabidopsis* is divided distinctly into the vegetative and the reproductive phases. Here, we report our analysis of three late-flowering ecotypes, CS 6657, CS 6660 and CS 6774, in which the transition to floral development is prolonged in both the primary shoot apical meristem and the axillary meristems under inductive long-day photoperiod. The prolonged vegetative state leads to the formation of aerial rosettes in the axials of leaves at the nodes of the primary shoot axis. Effects of vernalisation on the timing of flowering of the ecotypes revealed that CS 6657 has a late-flowering phenotype without formation of aerial rosettes and CS 6660 was early-flowering with normal axillary meristem development. CS 6774 did not respond to vernalization treatment and it reminded late-flowering with aerial rosettes. Segregation of the aerial rosette phenotype is observed in the F2 population from the crossings of each of the ecotypes with *Landsberg erecta* early flowering strain. From the genetic analysis performed, we propose that different alleles are involved in the formation of aerial rosettes. These alleles will be further characterised through genetic analysis and mapping.

P28-CSPP student poster.

MARTIN, M.*, KOHALMI, S. E. Dept. of Plant Sciences, University of Western Ontario, London, Ontario, N6A 5B7. **Analysis of a Floral Developmental Protein Using a Two-Hybrid Method.**

In *Arabidopsis thaliana* the initiation of floral meristems and floral organs as well as the establishment of organ structures have been found to be regulated by a large number of developmental genes and proteins. However, there is still relatively little information on how such proteins actually carry out their already identified regulatory roles. Several of the proteins involved in and required for floral development have distinct as well as diverse roles. We believe that it is possible that these roles are mediated and characterized by molecular interactions with other proteins. Consequently, as a first step in the characterization of such diverse functional roles we decided to identify protein-protein interactors of important developmental regulators. This in turn will hopefully lead to a more in depth understanding of the diverse functional roles mediated by individual proteins. For this study we made use of the yeast GAL4-two-hybrid system to identify protein-protein interactors of an *A. thaliana* gene involved in floral development. Analyses of mutants in this gene have shown that it is an essential component in three critical processes during floral development including the very early establishment of the floral meristem, the specification of flower organ identity which involves the temporal and spatial regulation of other floral homeotic genes and the development of ovules and seeds. To do so, the coding sequence was obtained from an *Arabidopsis* cDNA library by PCR and directionally cloned into a "bait" vector specific for the GAL4-based two-hybrid system. The outcome of the screen and the initial characterization of a protein interactor will be presented and discussed.

P29-CSPP

CONSTABEL, C. P.* and CHRISTOPHER, MC. Department of Biological Sciences, University of Alberta, Edmonton, Canada, T6G 2E9. **Genomics Approaches to the Identification of Defense Genes from Hybrid Poplar.**

Many plants are very active in their own defense against herbivores, and in response to tissue damage rapidly accumulate toxic or anti-nutritive proteins, for example protease inhibitors and oxidative enzymes. Hybrid poplar (*Populus trichocarpa* x *deltoides*) leaves have been previously shown to have a strong transcriptional response to wounding and simulated herbivory. Since induced defenses are generally based on transcriptional activation of defense genes, by studying changes in gene expression a global picture of the defense response can be obtained. To achieve this objective, we are single-run sequencing random cDNAs from a library constructed from mRNA of wound-induced hybrid poplar leaves. Database comparisons using BLAST searches are being used to identify potential functions for the expressed sequence tags. A number of known defense proteins have been identified, including trypsin inhibitors and chitinases. This genomics approach should lead to the discovery of novel defense-related genes, as well as identify known pathways and genes that were not previously known to be involved in poplar defense.

P30-CSPP

SUN, G. L.*; LIU, J.; REID, L.M.[1]; LEE, E.; KASHA, K. J.; PAULS, K. P. Crop Science Bldg, Department of Plant Agriculture, University of Guelph, Guelph, Ontario, N1G 2W1, Canada. [1]Eastern Cereal and Oilseed Research Center, Agriculture and Agri-Food Canada, Ottawa, Ontario K1A 0C6, Canada. **An Integrated RFLP, RAPD, SSR and AFLP Linkage Map of Ontario Corn and Its Use for Tagging *Fusarium* Resistance Gene (s).**

A combined RFLP, RAPD, SSR and AFLP linkage map was constructed using F2 population from a cross between an inbred (CG62) that is susceptible to *Fusarium graminearum* and an inbred (CO387) that carries genes for silk and kernel forms of resistance to this pathogen. The map contains 19 RFLPs, 67 RAPDs, 34 SSRs and 41 AFLPs markers. The 161 markers are distributed among 10 linkage groups. A preliminary evaluation of the silk and kernel *Fusarium* resistance of these lines was carried out in Ottawa in 1999 and co-segregation analysis between markers and target traits was made using Mapmarker/QTL. The analysis identified 2 QTLs associated with kernel resistance genes, and 6 QTLs associated with silk resistance genes. A co-segregation analysis that assumed that silk resistance is determined by a single disease resistance gene identified two RAPD markers, BC119-1 and BC535-1 flanking the resistance locus at a distance of 22.3 cM and 32.8 cM, respectively. Nine markers associated with the disease resistance loci were cloned and sequenced to produce sequence characterised amplified regions (SCARs). These SCAR markers were tested against F2, and F5 populations of CG62 x CO387, as well as breeding lines with different backgrounds of resistance. We believe these markers will be useful for marker-assisted selection of *Fusarium* resistant corn in the future.

P31-CSPP student poster.

ZHOU, N.*, BATE, N. J., PARKIN, I. Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, Sk, S7N-0X2. **Development of *Thlaspi arvense* as a model Crucifer for the isolation and identification of cold-stress related genes.**

The weedy crucifer plant species *Thlaspi arvense* has the ability to withstand extremes in temperature and to sustain rapid growth at sub-optimal temperatures. We are attempting to develop *T. arvense* as a model system for cold tolerance and as a source of useful genes for cold tolerance in Brassicas. Cold acclimation of *T. arvense* seedlings followed by freezing tests showed that *T. arvense* had a greater ability to respond to low temperature than *B. napus*. The maximum freezing tolerance obtained with *T.arvense* was -19.3°C in this study, this is much lower than the published data for Arabidopsis estimated using the same method. CBF is a transcription factor found to switch on a number of genes involved in the cold response of Arabidopsis, southern blot analysis indicated the organization of CBF of *T. arvense* is similar to that of Arabidopsis. Three clones from a *T. arvense* genomic library containing CBF homologues have been identified and will be used for further investigation of the sequence of CBF homologues and CBF expression pattern in *T. arvense*. Additionally, a cold shock subtraction library of *T. arvense* was created to identify low temperature responsive genes at an early stage of cold acclimation and analysis of the library has been initiated.

P32-CSPP

LI, W.*, MASILAMANY, P., KASHA, K. J. and PAULS, K. P. Biotechnology Division, Department of Plant Agriculture, University of Guelph, Ontario, Canada N1G 2W1.

Factors Affecting Multiple Shoot Induction in Seedling Apical Meristem Explants of *Zea mays* L.

Currently most corn transformation protocols use embryogenic callus because this type of tissue has many targets for transformation. However,embryogenic callus induction in corn is highly genotype specific which limits the application of corn transformation technology to a few inbreds. In the present research, media, environmental and genotypic factors affecting multi-shoot cultures of Ontario corn genotypes were investigated. The results demonstrated that 4-5 cm seedling produced the highest number of multi-shoots.Proline addition to the multi-shoot induction medium significantly increased shoot induction frequency. Continuous low light stimulated multi-shoot induction. The highest number of shoots occurred when the medium contained 30 g/L sucrose, 3 g/L proline, 2 mg/L BAP and 1 mg/L 2,4-D. Multi-shoots were induced by this culture system from 45 maize inbreds and hybrids and approximately 70% of the genotypes produced more than 20 shoots/explant. Mature plants were recovered from the multi-shoot cultures but for some genotypes a large percentage of plants developed a terminal ear instead of a tassel. This phenomenon disappeared in the next generation. Decreasing the BAP supplement during multi-shoot culture increased the frequency of normal plants. An inheritance study of the regeneration trait suggested it was controlled by dominant genes. This culture procedure is efficiently applicable to corn regeneration that may be a useful target for transformation.

P33-CSPP student poster.

PAYNE, C.*, KOHALMI, S. E. Dept. of Plant Sciences, University of Western Ontario, London, Ontario, N6A 5B7. **Developing New Electroporation Methods for *Arabidopsis thaliana*.**

Currently the preferred methods for the introduction of DNA into plants are those employing the plant pathogen *Agrobacterium tumefaciens*. Not surprisingly, *Agrobacterium*-based transformation protocols are being developed for a steadily growing number of plant species foremostly dicots but also an increasing number of monocots. However, *Agrobacterium* is not appropriate for all transformation purposes. Alternatively, particle bombardment or PEG-mediated transformation methods have been developed to introduced DNA into plants. These techniques usually involve the use of plant tissues (such as whole leaves or leaf discs) or protoplasts as the initial transformation target. Drawbacks to the use of these methods include the purchase of expensive equipment and enzymes, and the considerable time required to regenerate whole plants. We are trying to develop plant transformation methods for *Arabidopsis thaliana* that do not require the use *Agrobacterium*, but still offer high efficiency transformation, low cost, and that minimize the time required to generate whole plants. We concentrate our efforts on the use of electroporation and the testing of transformation parameters in combination with different target plant tissues. The presentation will include an outline and rationale of the procedures as well as an initial analysis and characterization of the transgenic plants.

P34-CSPP

HOOVER, G. J., LI, W., PAULS, K. P.*. Dept. of Agriculture, University of Guelph, Guelph Ontario Canada. N1G 2W1. **Modification of *Agrobacterium* Vectors For Use In Corn Transformation.**

The Cauliflower Mosaic Virus 35S RNA promoter (CaMV35S) is a strong promoter that has been used extensively in vectors constructed for *Agrobacterium* mediated transformation of dicot plants. However when transforming monocot plants gene expression driven by the CaMV35S promoter has met with only moderate success. One of the biggest problems with this promoter in monocots is that gene expression is sometimes silenced in the latter stages of development. The objective of this study is to modify our *Agrobacterium* vectors in order to increase the efficiency of selecting transformants obtained from co-cultivation of corn tissue with *Agrobacterium*. Our main strategy was to identify promoter elements, for use in the *Agrobacterium* mediated corn transformation vectors, that will drive tissue-independent expression of the Beta-Glucuronidase (GUS) reporter gene cassette to an equal or better degree than the CaMV35S. We constructed three different GUS gene cassettes in two different plasmid backbones (pIG121 and pCambia) driven by the rice actin promoter, corn ubiquitin promoter and a tomato retro-transposon promoter sequence. These new constructs were then tested by particle bombardment and *Agrobacterium* infection for their ability to drive GUS expression in young corn leaves, corn coleoptile and corn multi-shoot calli. The results of these experiments demonstrated that, within the pIG121 backbone, the maize ubiquitin promoter sequence can drive the expression of the GUS gene cassette at approximately 50 fold greater efficiency over that of the CaMV35S promoter in corn multi-shoot callus culture. The promoter sequence for the rice actin gene, within the pIG121 backbone, has also showed promise under the same conditions since it was able to drive GUS expression at approximately the same level as the CaMV35S promoter. These results suggest that the maize ubiquitin and rice actin promoter elements woud be good candidates for driving the expression of selectable markers in corn leading to improvements in the efficiency of selecting transformed corn shoots.

P35- CSPP student poster

SIEGER, S.M.*, WILSON, K.E., KRONZUCKER, H.J., HUNER, N.P.A. Dept of Plant Sciences, Univ. of Western Ontario, London, Ontario, N6A 5B7. **The accumulation of chlorophyll precursors in low-temperature grown *Chlorella vulgaris*.**

The unicellular green alga *Chlorella vulgaris* minimizes photoinhibitory stress by changing the size of the light-harvesting complex (LHCII) around photosystem II (PSII), thereby maintaining a balance between light absorption and the utilization of excitation energy driving photosynthetic electron transport. Given that the genes coding for LHCII polypeptides reside in the nucleus, interorganellar communication must occur between the chloroplast and the nucleus during photosynthetic acclimation. This study tested the hypothesis that the chlorophyll precursors Mg-protoporphyrin (MgPP) and Mg-protoporphyrin monomethyl ester (MgMMe) act as such signaling molecules. The pool of MgPP and MgMMe (MgPP(Me)) was quantified spectrofluorometrically from cultures of *C. vulgaris* grown under conditions that alter the redox state of PSII. Under steady-state growth conditions, MgPP(Me) accumulated at 5C/150 micromol/m^2/sec (5/150), but not at 27/150. The amount of MgPP(Me) rapidly decreased during the first 8 hours of a high to low redox shift (5/150 to 27/150), while the precursors remained undetectable during a low to high redox shift (27/150 to 5/150) of the same length. These results suggest that MgPP(Me) are likely not involved in the signaling process between the chloroplast and nucleus.

P36 -CBA

BARABE, D.*, BRUNEAU, A., FOREST, F. Institut de recherche en biol. végét. Jard. botanique de Montréal, Université de Montréal. **Correlation between developmental morphology and molecular phylogeny in the floral evolution of the Aroideae (Araceae)**

In the intermediate zone of the inflorescence of genera of Aroideae with unisexual flowers one can find flowers with male and female characteristics. Until now, two types of developmental sequences of atypical flowers (also called bisexual) have been recognized : the Philodendron type and the Cercestis type. In the Philodendron type, bisexual flowers generally consist of functional carpels and staminodes inserted on the same whorl. In the Cercestis type, the gynoecium and stamens are inserted on two different whorls. These different ontogenetic patterns could represent two different pathways in the evolution of unisexual flowers in this subfamily. There seems to be a correlation between the types of bisexual flowers and the phylogeny of the genera. The genera that have the same type of unisexual flowers form a monophyletic group. For example, a developmental morphological study shows that the atypical bisexual flowers in the genus *Montrichardia* are more similar to *Philodendron* than to those of *Cercestis*. Our molecular phylogenetic analysis of 33 genera of Araceae, based on sequences from the chloroplast trnL intron and spacer region, indicates that *Montrichardia* belongs to the same clade as *Philodendron*. *Cercestis* appears in another clade. These results indicate a weak correlation between floral development and phylogeny, suggesting that careful homology assessment of floral characters are needed before these can be used in phylogenetic analysis of the Araceae.

P37 - CBA student poster.

DAVIDSON, C.J.* and VON ADERKAS, P. Department of Biology, University of Victoria. P.O. Box 3020, Victoria, B.C. Canada. V8W 3N5. **Modelling pattern from cellular processes in *Schizaea pusilla*.**

Plant tissues exhibit patterns and structures that are determined by coordinated cell division and elongation. Cell divisions in the filamentous gametophyte of the fern *Schizaea pusilla* Pursh. can be a basis for modelling its overall morphology. Lindenmayer systems allow for the modelling of plant morphology based on details of individual cell divisions. I hypothesized that a stochastic L-system based on cell division could model the growth of *Schizaea pusilla*. Structures such as rhizoidophores, antheridia and knots were characterized with light microscopy, DAPI staining, and scanning electron microscopy. Stochastic L-systems were developed for sporelings, branching and overall plant development, but due to computer limitations only models for branching and sporelings could be tested. The L-system for overall morphology considered the knot-filament complex to be the repeating unit. This implies that knots are an integral component of the gametophyte's development, which contrasts with the historical characterization of *Schizaea pusilla* as completely filamentous. Stochastic L-systems do model branching in fully grown gametophytes better than in sporelings, but in both cases a context-sensitive L-system may better model these systems.

P38 CBA

STRICKER, M.A.W., YOUNG, J. P.* and RYAN, D.[1] Biology Program, University of Northern British Columbia, Prince George, BC V2N 4Z9 and [1]Gitsegukla Band Council, 36 Cascade Avenue, South Hazelton, BC V0J 2R0. **The effect of nitrogen fertilizer on morphological and anatomical features in hemp (*Cannabis sativa* L.).**

Hemp (*Cannabis sativa* L.) plants were grown under controlled conditions to test the effect of different rates of nitrogen fertilizer on morphological and anatomical features. Ammonium sulphate (21:0:0) was applied at rates of 25, 50, 100, 200, or 400 kg N/ha. Morphological characters such as stem height, internode number, length and diameter, and leaf and stem fresh weight increased with increasing levels of nitrogen. Anatomical characters such as tissue area of primary phloem (bast fibres), tissue area of secondary xylem (hurd fibres), number and cell wall width of primary phloem fibres, and chlorophyll a and b concentration were all positively influenced by nitrogen. It is suggested that gross morphological characters can be used as indicators of fibre quality in hemp. The "optimum" growth of hemp seems to have been achieved when nitrogen was applied at rates between 100-200 kg N/ha.

P39 - CBA

LALIBERTÉ, S.*[1], CAMPEAU, N.[1] and NAULT, A.[2,1] [1]GREFI, Département des sciences biologiques, Université du Québec à Montréal, Qc, H3C 3P8; [2] Biodôme de Montréal, Qc, H1V 1B3. **Intra- and interpopulation variability in somatic embryogenesis potential of American ginseng.**

The potential to express somatic embryogenesis (SE) was tested in seeds from 4 natural populations of American ginseng (*Panax quinquefolium*) in Québec, near the northern limit of its distribution range. Seeds were collected from 7 to 12 mother-plants in each population and were stratified before excision of zygotic embryos. Two series of experiments were performed, using either whole embryos or cotyledons as explants. Embryos were cultivated on MS medium including 4g/L Gelrite, NAA and BAP, at 27°C in darkness, while cotyledons were under a 16-hour photoperiod at 29°C in presence of 2,4-D and BAP. After 8 weeks in culture, explants were scored for SE expression. The frequency of SE varied from 0 to 100% between mother-plants, with population means from 19.3 to 52.5%. For both explant types, there was significant intrapopulation variation for SE frequency among mother-plants (with one exception), as well as significant variation between populations. Although the global mean (combining all populations) of SE frequencies is quite similar in embryos and cotyledons series, respectively 33.3% and 36.4%, the pattern of variation among populations differs between the two types of explants. Results might reflect a mother-plant component of SE potential and a genetic variability between populations for this factor.

P40 -CBA student poster

CHARBONNEAU, J.*, and LALIBERTÉ, S. GREFI, Département des sciences biologiques, Université du Québec à Montréal, Qc, H3C 3P8. **Developmental control of meristematic nodules of jack pine *in vitro* .**

The production of meristematic nodules from zygotic embryos (ZE) of jack pine (*Pinus banksiana* Lamb.), a species of high economic importance, is a promising way of *In vitro* propagation. The objectives of the project were to establish the optimal conditions of seed imbibition before excision of ZE, for nodule formation, and to study the morphogenetic patterns obtained during *In vitro* proliferation of embryos. Sixteen treatments varying according to light conditions, temperature and duration of imbibition were applied to seeds from a mixed seedlot. The ZE were cultivated in liquid medium (1/2 SH + 14µM K+ 10µM BAP) under agitation, for four weeks. The differentiation of nodules and callus from embryos occurred between the 2nd and 3rd week of culture. In darkness the frequency of nodule formation was sigificantly higher at 28°C than at 4°C for 24 hours of imbibition, while it was higher at 4°C for the 72 hours period. Light inhibited significantly nodule formation in 16, 24 and 48-hour treatments, at 28°C. The 24-hour imbibition at 28°C and in darkness induced the highest morphogenetic response from the embryos, with 28% of nodules and 24% of calli. This treatment was chosen for the analysis of evolution, during the 4-week culture period, of cell cycle and absolute amount of nuclear DNA both in nodules and calli. The fluctuations of these parameters, measured by flow cytometry, reflect the morphological changes of these structures.

P41 - CBA

FAHSELT, D.*and MAZDIA, S. University of Western Ontario, Dept. of Plant Sciences, London, Ontario N6A 5B7. **Hyphal intrusion of foreign fungi into lichens.**

Using field emission scanning electronmicroscopy hyphal surfaces were examined in six lichens, *Lasallia papulosa* (Ach.) Llano, *Xanthoria elegans* (Link.) Th.Fr., *Peltigera aphthosa* (L.) Willd., *Stereocaulon depressum* (Frey) M. Lamb, *Umbilicaria mammulata* (Ach.) Tuck. and *U. cylindrica* (L.) in Duby. and in material of the same species associated with pathogenic or saprobic fungi. In samples infected by each of *Mullerella pygmaea* (Körber) D. Hawks., *Marchandiomyces corallinus* (Roberge) Diederich & D. Hawks., *Lasiospheriopsis stereocaulicola* (Lindsay) O. Eriksson & R. Sant. and a Penicillium-like fungus, some hyphae were found that differed from those of the lichen mycobiont in size, septation, surface texture or inclination to collapse. Detectable pathogen hyphae were uncommon in some diseased lichens, in fact no candidates were detected in *S. depressum* infected with *Arthonia stereocaulina* (Ohlert) R. Sant., although extensive mycelia of *L. stereocaulicola* were evident in the same lichen. The extent of visible colonization by extraneous fungi was greatest in recently killed *U. mammulata*.

P42 - CBA student poster.

BEGORA, M.D.* and FAHSELT, D. University of Western Ontario, Dept. of Plant Sciences, London, Ontario N6A 5B7. **Photostablility of phenolics in four species of macrolichens.**

Ultraviolet-absorbing secondary products of lichens are assumed to be photostable, but for the first time, the photolability of representative compounds was tested. Intact thalli of *Cladina uncialis*, *C. rangiferina*, *Umbilicaria mammulata* and *Peltigera aphthosa* were exposed to high intensity UV-A/B as were substances extracted in acetone. In both cases lichen substances were separated on thin-layer plates. Thin-layer banding patterns of compounds extracted from *U. mammulata*, *C. rangiferina* and *P. aphthosa* were not altered by UV, but banding patterns of *C. uncialis* extracts began to change after approximately 25 minutes of exposure, indicating differences among lichen products in regard to photostability. No visible effect on banding patterns was observed following UV-exposure of intact thalli suggesting that the thallus may be involved in maintaining phenolic integrity. The concentrations of usnic acid in intact dead and live thalli of *C. uncialis* exposed to UV were compared denistometrically after scanning on a transilluminator to determine whether metabolic activity affected usnic acid levels, and significantly lower levels were found in killed thalli. Quantitative comparisons of wet and dry thalli revealed that hydrated thalli contained lower concentrations of usnic acid, and suggested it is more susceptible to degradation when the thallus is wet.

P43 - CBA

TRAQUAIR, J. A.*; WHITE, G. J. Southern Crop Protection and Food Research Centre, Agriculture and Agri-Food Canada, 1391 Sandford Street, London ON N5V 4T3.
Antagonism of *Botrytis cinerea* by basidiomycetous wood-decay fungi.

Botrytis cinerea Per.:Fr. is an insidious fungal pathogen of cultivated North American ginseng (*Panax quinquefolius* L.) on which it causes leaf blight, fruit rot and crown rot. Many melanized (black) sclerotia are produced by *B. cinerea* on infected ginseng stems. They survive the winter in crop debris and protective straw mulch in artificial shade gardens. Twenty-six aphyllophoraceous, wood-decaying Basidiomycetes and four agaricoid, straw- or thatch-decaying Basidiomycetes were screened for antagonism of *B. cinerea* hyphae and sclerotia *In vitro*. The greatest inhibition of *Botrytis* colony and hyphal growth was observed in confrontations with *Irpex lacteus* (Fr.: Fr.) Fr., *Trametes versicolor* (L.: Fr.) Pilat, *and Chondrostereum purpureum* (Pers.: Fr.) Pouzar. Hyphal interference and necrotrophic hyperparasitism were detected as coagulation and degeneration of *Botrytis* cytoplasm and invasion of hyphae, conidiophores and conidia during confrontations with these three Basidiomycetes separately in slide cultures observed with the light microscope. Sclerotia of *B. cinerea* were hyperparasitized in straw mulch inoculated with *I. lacteus*, *T. versicolor*, and *C. purpureum*. These hyperparasites were shown also to degrade cellulose, lignin and melanin in colorimetric screening assays on agar media and not to affect the growth of ginseng seedlings in inoculated straw mulch. These results indicate that *I. lacteus*, *T. versicolor*, and *C. purpureum* are promising candidate biocontrol agents for *Botrytis* blights because they can colonize crop debris and straw mulch on ginseng beds, and reduce the inoculum levels of *B. cinerea* surviving from year to year in the shade gardens.

P44 - CBA student poster

ZELMER, C. D.* and PETERSON, R.L. Dept. of Botany, University of Guelph, Guelph, ON, N1G 2W1 **Symbiosis between *Cypripedium reginae* (Showy Lady Slipper Orchid) seedlings and fungi: substrate and strain dependence.**

Our objectives were to study the effects of substrate and fungal strain on the ability of *Cypripedium reginae* seedlings (protocorms) to form pelotons indicative of orchid mycorrhizal symbiosis. Two experiments were performed. The first experiment utilized a single isolate of *Epulorhiza repens* (isolated from wild *C. reginae*) with 5 different carbohydrate sources at each of two different concentrations added to a base of Harvais medium. Protocorms were examined for peloton formation using a light microscope. The fungal isolate was able to form pelotons within the protocorms on all substrates offered except inositol. Hyphal features and frequency of peloton formation differed between media, but was mostly consistent between different concentrations of the same carbon source. Starch and cellulose produced the greatest numbers of pelotons. There were no obvious differences in the growth of the protocorms between treatments. In the second experiment, *C. reginae* seedlings were inoculated with one of three *Epulorhiza* isolates (isolated from wild *Cypripedium* spp.). Seedlings were grown on one of 10 media for a total of 30 substrate/fungus combinations. Protocorms were assessed as in the previous experiment. All three fungi colonized the orchid protocorms and formed pelotons, however, none were able to colonize the protocorms on all substrates. Fungal isolates differed in their ability to form pelotons on the substrates used. Regardless of medium or fungus, there was no obvious growth of the seedlings during the 80 day experiment. Under the conditions of these experiments, peloton formation in *C. reginae* appears to be both substrate and fungal isolate dependent.

P45 - CBA student poster

RESENDES, C.*; GUINEL, F.C. Wilfrid Laurier University, Department of Biology, Waterloo, Ontario, N2L 3C5. **Control of mycorrhizae formation and of metal accumulation in a pea mutant.**

E107 is a pleiotropic pea mutant characterized by a reduced ability to form nodules and mycorrhizae, as well as by an abnormal accumulation of metals causing the presence of necrotic spots. There is growing evidence suggesting that the processes of nodulation and mycorrhization are under similar methods of control. Previous grafting studies conducted on E107 inoculated with rhizobia have shown that reduced nodule formation is shoot-controlled. We hypothesized that reduced mycorrhizal formation is similarly controlled by the shoot. A grafting study was conducted and the results supported a shoot-controlled low mycorrhization. The control of metal accumulation in E107 shoots was also examined; the metal levels were determined in the shoots of grafted plants by inductively-coupled plasma-atomic emission spectroscopy. Excessive metal uptake was found to be shoot-controlled. Furthermore, it was observed that E107 plants grown in the presence of mycorrhizal fungi appear to have a reduced amount of leaf necrosis. It was thought that this would be correlated with a decrease in metal accumulation, but surprisingly ion analysis showed that mycorrhizal E107 plants generally have higher levels of accumulation. Thus, our results further emphasize a link existing in the pathways controlling nodulation and mycorrhization. They however uncover that, in E107, necrosis is not the best diagnostic tool for metal accumulation.

P46 - CBA student paper

CATHERALL, J.M., YOUNG, B.W., TACKABERRY, L.E., EGGER, K.N. and MASSICOTTE, H.B.* University of Northern British Columbia, Prince George, BC, Canada V2N 4Z9. ***Pterospora andromedea*: Morphological and molecular assessment of mycorrhizae from plants growing in a coniferous forest ecosystem in central British Columbia.**

Pterospora andromedea (subfamily Monotropoideae) is a curiously impressive epiparasitic species that has attracted numerous ecological and morphological investigations. This achlorophyllous species, the only member of its genus, has a complex mode of nutrition, receiving photosynthates from neighboring trees via shared fungi. To explore the mycorrhizal associations within its northern range, plants were sampled from 4 sub-boreal forest locations near Prince George, BC. Site-associated trees varied but included *Pinus contorta*, *Picea* spp., and *Populus tremuloides*. A minimum of 5 root clusters per location were collected over 10 weeks. Mycorrhizae were assessed morphologically (light microscopy) and by molecular analysis (PCR-RFLP and DNA sequencing). All methods showed that individual root clusters (often several hundred tips) consisted of fungal monocultures. Only one fungal morphotype was characterized for all tips; this mycorrhizae produced a white mantle (sometimes mauve to darker blue), short bristle-like verrucose cystidia, no clamps, and rhizomorphs. One molecular fragment pattern was identified (using the enzymes Alu, Hnf and Rsa) from 58 root tips. Three identical sequences (using a portion of the 28S region of the ribosomal DNA) and submission of one to GenBank suggest that this variant is likely *Rhizopogon subcaerulescens*. Further sequencing of root tips as well as a hypogeous fungus found on one location will hopefully confirm these findings.

P47 - CBA

BOUCHER, A.*; ARNASON, J. T.; CHAREST, C.; PHILOGENE, B. University of Ottawa. 30 Marie Curie, Ottawa, ON, K1N 6N5. **Effect of mycorrhizal colonization of maize roots on *Diabrotica virgifera virgifera* (Coleoptera: Chrysomelidae).**

The purpose of this study was to analyze the impact of mycorrhizal colonization by *Glomus intraradices* on maize (*Zea mays* L. hybrid Pioneer 3921) resistance to the Western Corn Rootworm (WCR), *Diabrotica virgifera virgifera* (Coleoptera: Chrysomelidae). In 2 seperate greenhouse trials, artificially infested maize plants were grown with (M+) and without (M-) addition of a soil based mycorrhizal inoculum. In order to determine plant response to the mycorrhizal treatment the following parameters were evaluated at plant maturity: height, stalk circumference, root and shoot masses. Root damage was also evaluated at maturity. Hydroxamic acid and Hydroxycinamic acid amide levels in M+ and M- roots will also be compared to investigate the possibility of secondary compound induction by mycorrhizae. Adult WCR masses and head capsule diameters were recorded at time of emergence to determine insect repsonse to mycorrhizal colonization. In the 1998 greenhouse trial where root colonization was estimated at 25.1%, stalk circumference, plant height and shoot fresh mass were significantly larger for M+ plants than M- plants. In the 1999 greenhouse trial, emerging adults from M+ treatments had a significant decrease in head capsule diameter and marginally significant decrease in total body mass. These results suggest a possible reduction in WCR development and increased maize resistance to WCR damage due to mycorrhizal colonization.

P48 - CBA student poster

OTFINOWSKI, R. *; MAUN, A. Department of Plant Sciences, University of Western Ontario, London, Ontario, N6A 5B7. **The role of environmental heterogeneity in stage transitions of *Cirsium pitcheri* (Compositae), an endangered plant of the Great Lakes.**

Cirsium pitcheri (Torr. ex Eaton), Pitcher's Thistle (Compositae) is endemic to the sandy shores and dune complexes of the Great Lakes, occupying early successional habitats ranging from active beaches and blowouts, through partially stabilized dunes, to stabilized sandy meadows. Dune environments are characterized by periodic disturbance events, such as fluctuating water levels, re-routing of river outwash channels, and movement of sand. Natural disturbances contribute to the spatial heterogeneity of dune habitats. For example, differences in source and rates of erosion, sorting, and deposition of sandy materials can affect substrate water holding capacity, organic matter content, and mineral concentrations. In the present study, we are investigating the spatial and temporal variability of dune environments and their influence on life history of *C. pitcheri*. Using unmanipulated, native plants from three study populations on Manitoulin Island, Ontario, we are interested in demonstrating correlations between physical and biological aspects of plant microenvironments and plant transitions from seedlings to flowering adults. Transition models, consisting of survivorship and fecundity data of individual plants, will be constructed to predict growth rates of selected study populations. Predicted growth rates will be correlated with measured physical and biological variables, including physical and nutrient soil properties, to determine which parameters explain the greatest amount of variability in stage transitions within and among study populations. Possible correlations between stage transitions and plant environments will be examined at several spatial scales, including consideration of distinct "habitat types" within the dune complexes.

P49 - CBA student poster

NOEL, L.; HERMANUTZ, L.* Department of Biology, Memorial University, St. John's, NF, A1B 3X9. **Defining critical habitat for the recovery of rare plants.**

Braya longii and *B. fernaldii* (Brassicaceae) are endemic to limestone barrens of the Great Northern Peninsula (Newfoundland), and have been designated as endangered and threatened respectively, due to habitat loss to quarrying. These arctic-alpine plants cannot persist without disturbance that generates vegetation-free gaps allowing colonization. Thus, understanding the effects of disturbance on seedling recruitment and persistence is imperative for defining critical habitat for conservation of appropriate habitat for recovery actions. This study compares the seedling recruitment and persistence between 1) the two braya species; 2) anthropogenic and natural disturbance regimes; and 3) substrate types at 5 sites. In each site distribution of substrate type, level of disturbance, and size classes of braya were mapped. There was no significant difference between the braya species in all size classes in response to natural disturbance indicating similar management strategies are appropriate. Seedling density is higher in anthropogenically disturbed sites but persistence is higher in naturally disturbed sites for both species. Substrates of intermediate disturbance encompass a high density of braya, yet are found in small, scattered patches on the landscape representing only a small percentage of the available habitat. Other substrates, such as limestone gravel and boulder gravel, have lower densities of braya, but are more prevalent on the landscape. To ensure the long-term preservation of these rare braya species it will be crucial to include areas of intermediate disturbance in the Recovery Plan.

P50 - CBA student poster

SINCLAIR, A. * and CATLING, P.M. Department of Biology, University of Ottawa, 30 Marie Curie Private, P. O. Box 450, Station A, Ottawa, Ontario, Canada K1N 6N5 and Biological Resources Division, Agriculture and Agri-Food Canada, Central Experimental Farm, Ottawa, Ontario, Canada K1A 0C6. **New Strategy May Save the Medicinal Plant, Goldenseal.**

Goldenseal (*Hydrastis canadensis* L.), a native North American woodland herb with medicinal and potential crop value, is threatened in Canada. Recovery from the threatened category is desirable, but how? Should we promote a climax view and thus minimize all disturbance and protect only relatively large woodlands? All recorded sites were surveyed to evaluate recent population growth. Populations evidently remained stable or increased slightly. Linear regression suggested no significant relationships between goldenseal and most environmental characteristics. Lack of significance of natural area size suggested adequate protection in relatively small areas. Number of young stems significantly increased with increasing phosphorus which is associated with disturbance. Primary pollinators were abundant generalist bees. Pollination experiments suggested self-compatibility and self-pollination in absence of flower visitors. Fruit was removed quickly and dispersal agents were common. Reproduction and dispersal thus appeared non-limiting. Transects were set out within goldenseal habitat to obtain frequencies of goldenseal stems and neighbourhood points near paths and edges. Chi-square tests indicated that goldenseal is significantly associated with paths and edges suggesting a positive disturbance effect. Natural disturbances such as fire and flooding in deciduous woodlands have been suppressed. Furthermore, extinct and extirpated fauna may have also promoted population growth by creating disturbed patches. Viewing mature deciduous woodlands as a natural series of dynamic patches leads to a new management strategy for rare woodland herbs: we should (1) not necessarily minimize all disturbance; (2) consider protecting small areas as well as large ones; and (3) imaginatively test benefits of simulating past disturbance.

P51 - CBA student poster

ROSS, A.L.* and FREGO, K.A. Department of Biology, University of New Brunswick, PO Box 5050, Saint John, New Brunswick, E2L 4L5, Canada. **Comparison of bryophyte communities in spruce plantations vs naturally regenerating forests in New Brunswick, Canada.**

The impact of forestry on native forest species may be greatest in the most intensively managed stands: tree plantations. To address concern for loss of bryophyte biodiversity within managed forests, we compared community composition and associated environmental features among three tree regeneration classes: (1) naturally regenerating forests, (2) cutover plantations (spruce plantations established on recently harvested forests), and (3) afforested fields (spruce plantations established on agricultural fields) across a range of ages in the Acadian Forest Region of New Brunswick, Canada. Abundance of all bryophyte species, substrates, microtopographical features, and canopy were measured as percent cover in 26 stands: 6 afforested fields, 8 cutover plantations, and 12 naturally regenerating forests. Soil and structural attributes were characterized for each stand to account for intra-regeneration class variability. Multivariate analyses indicated that bryophyte community composition and environmental features differed significantly among regeneration classes. Plantations had lower bryophyte species richness, evenness, and diversity (H'), however cutover plantations had the highest total bryophyte cover. Low substrate diversity, as well as microtopographic and canopy homogeneity, characterized the plantations. (These community and environmental patterns were most pronounced in afforested fields.) The bryophyte community of plantations was composed of a subset of species found within the naturally regenerating forests: many liverworts and epixylic mosses were absent, presumably because their very specific habitat requirements are not satisfied within the homogeneous plantation environment.

P52 - CBA - student poster

TUNGATE, K.D.*, SUSKO, D.J., and RUFTY, T.W. Department of Crop Science, North Carolina State University, Raleigh, NC 27695-7620. **Reproductive response of *Senna obtusifolia* to low nutrition.**

Senna obtusifolia [sicklepod] is a troublesome weed in many agronomic cropping systems in the southeastern U.S. The agronomic crops range from maize to N2-fixing soybean and peanut, which are supplied with very different fertility regimes. The purpose of this series of experiments was to characterize the growth and reproductive output of sicklepod plants grown under different nutrient availability. Three nutritional levels were established by different frequencies (7 d, 2 d, 1 d) of additions of modified Hoagland's solution over a 120 day period. Plants grown at higher nutrient conditions had larger total leaf area, aboveground vegetative biomass, reproductive biomass, and number of fruits per plant than plants grown at low nutrient conditions. Total number of seeds and total seed biomass per plant also tended to increase with increased frequency of nutrient addition. Seeds from plants grown at each nutrient level were sieved into small (< 2.4 mm diameter) and large (> 2.4 mm) seed-size classes. In general, the endogenous N content of seeds increased as seed size increased and with increased frequency of nutrient addition. The total percentage germination of seeds did not differ significantly among seed size classes or nutrient treatments. However, the rate of germination was significantly faster for seeds derived from low nutrient plants than medium or high nutrient plants. We conclude that increased seed nutrient content stimulates rapid germination.

P53 - CBA student poster

QADERI, M. M.*, CAVERS, P. B., BERNARDS, M.A. Department of Plant Sciences, The University of Western Ontario, London, Canada N6A 5B7. **Seedbank dynamics of Scotch thistle, *Onopordum acanthium* L.**

Cypselas (seeds) of Scotch thistle exhibit intermittent germination, which is of great concern to agriculturists since these cypselas germinate unpredictably over a long period of time. To better understand this phenomenon, we evaluated the effects of soil type, burial depth and collection time on the emergence patterns of two populations of Scotch thistle cypselas. From each of four collections (1996), five lots of 200 cypselas each were placed on the surface or buried at depths of 3 or 15 cm in both sand and silt-loam soils (i.e., field conditions) and emergence was recorded monthly throughout the experiment (Aug. 1996 - Sept. 1999). Emergence was intermittent over the three years with a higher total percentage from silt loam (17 %) than from sand (9 %). Also, emergence was significantly higher from the 3 cm depth (18 %) than from the surface (8 %). After retrieval, ungerminated cypselas from all depths in silt loam had higher percent germination (89 %) under controlled conditions than those from sand (66 %), yet a significant number still did not germinate until scarified. We have begun to investigate the underlying basis for this differential germination by measuring several chemical properties of the seed coats (waxes, lignins, phenolics) of cypselas that were exhumed from soils after emergence (early germinaters) vs. cypselas that remained ungerminated in the incubator but germinated after scarification (cutting 1 mm from the cotyledonary end). With these findings we hope to better understand the factors contributing to intermittent germination.

P54 - CBA

LAPOINTE, L.*; ROUTHIER, M-C. Département de biologie, Université Laval, Ste-Foy, Qué., G1K 7P4. **Impact of tree leaf phenology on growth rates and reproduction of two spring ephemerals, *Trillium erectum and Trillium grandiflorum* (Liliaceae).**

We investigated the impact of overstorey tree leaf phenology on growth rates and reproduction of two spring ephemerals, *Trillium erectum* and *T. grandiflorum* (Liliaceae). Temperature, overstorey canopy closure, and *T. erectum* phenology were monitored in three locations following a latitudinal gradient in Québec. Biomass allocation patterns and plant growth rates were also monitored for the three populations as well as for a T. grandiflorum population. Different signals appear to induce the development of spring ephemerals and tree leaves, tree phenology being more under genetic control. In northern areas, time between initiation of *T. erectum* development and canopy closure is shorter than in southern areas, reducing the time available to accumulate reserves before canopy closure. Differences in biomass allocation patterns were noted between the different T. erectum populations. From a south-north gradient, investment to reproduction, total plant mass and annual growth rate decreased while SLA and stem height increased indicating shade acclimation. The development of *T. grandiflorum* in spring starts one week later than for *T. erectum* from the same location, thus explaining its biomass allocation pattern similar to more northern *T. erectum* populations. The length of the high light period in early spring seems to be determinant for spring ephemerals growth and reproduction and may explain the northern limit of distribution of some spring ephemerals, such as *T. grandiflorum.*

P55 - CBA - student poster

GAUCI, R.*; LAPOINTE, L. Département de biologie, Université Laval, Ste-Foy, Qué., G1K 7P4. **Carbon translocation within female *Rubus chamaemorus* clones.**

Rubus chamaemorus (cloudberry) is an herbaceous clonal plant with a dioecious habit. The plant is abundant in acid bogs in the north eastern part of Canada. The investment into underground rhizomes is massive and these rhizomes remain functional for many years. Many of the ramets along the rhizomes are sterile and ramets are often very distant from each other. Despite a low flower frequency, fruit abortion is high. We wanted to know to what extent sterile ramets translocated carbon to the fruit and if there was a competition between the rhizome and the fruit for the carbon fixed by the fertile ramet. Both sterile and fertile ramets were radiolabelled with 14C throughout the fruit development period. Fruit and rhizomes were then analysed for the abundance of radiolabelled 14C. Autoradiograms clearly showed that the fruit is a very important sink for the fertile ramet and that most of the carbon fixed by the fertile ramet is translocated to the fruit. Once the fruit has completed its development, the fertile ramet translocates carbon to the rhizome while the sterile ramets continuously translocate carbon to the rhizome, often over very long distances (meters), but never in direction of a fertile ramet. Therefore, fruit development only relies on carbon fixed by the fertile ramets while both type of ramets contribute to the rhizome growth and carbohydrate storage. The small leaf area of the fertile ramets in comparison to the size of the fruit might thus explain a significant fraction of the fruit abortion rates.

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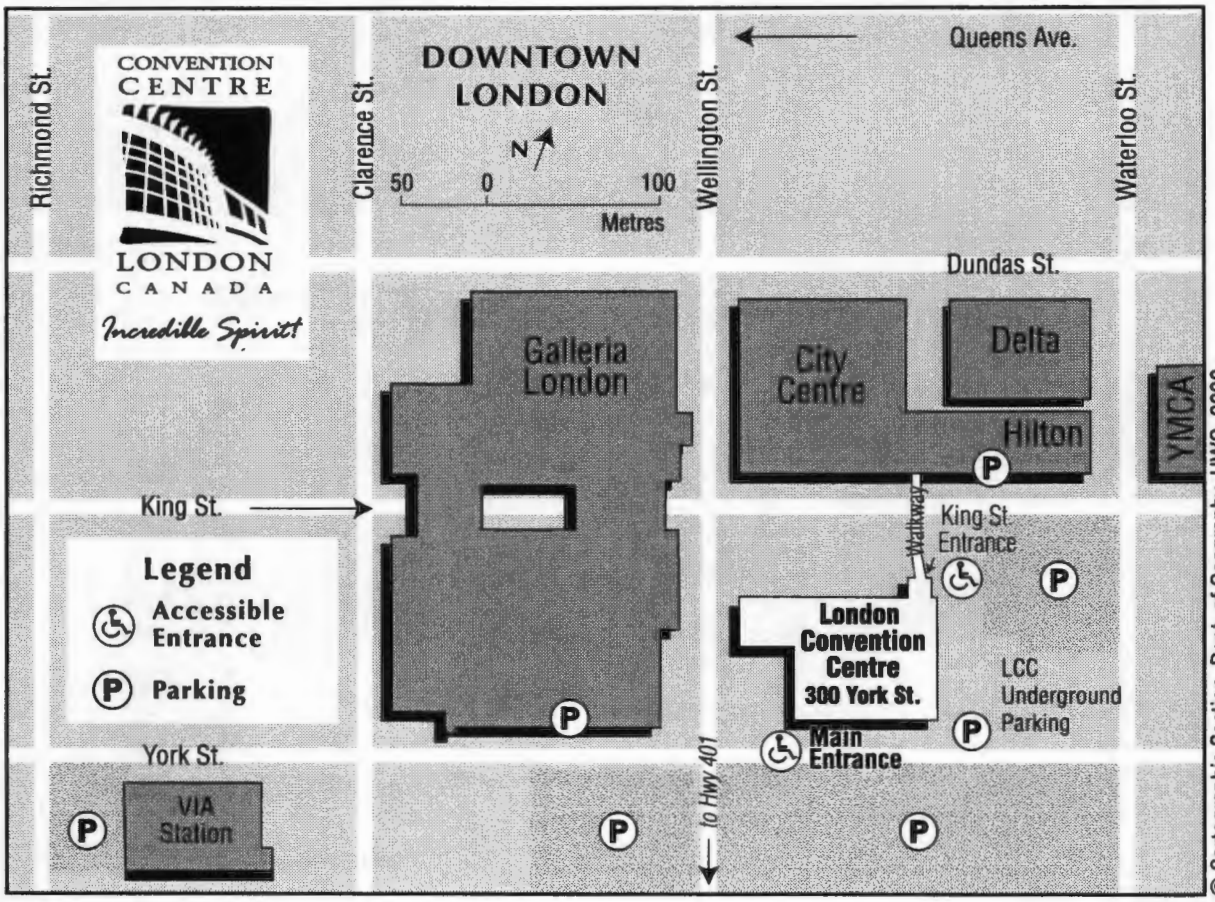
MAPS

DISTANCES

London to:	Km
Barrie	240
Chatham	110
Goderich	100
Hamilton	125
Kitchener	110
Montreal	720
Niagara Falls	195
Ottawa	565
Owen Sound	210
St. Catharines	180
St. Thomas	30
Sarnia	100
Stratford	60
Sudbury	540
Toronto	190
Windsor	195
Chicago	630
New York	840



London Convention Centre
Floor Plan