International Tundra Experiment Update - April 1998 (No.9)

Chairman's column

By Philip Wookey (Chair)

In this Newsletter you will find a compilation of reports from individual sites (some of them newly established), some news from the IPA (International Permafrost Association) and an update on the next ITEX meeting. The purpose of the Newsletter is not to provide a comprehensive 'state-of-the-programme' report, but rather to give a feel for how ITEX is progressing. You will see from the breadth of material presented here that there are many new and exciting developments within the programme. Where established sites are not mentioned, however, the reader should assume a 'business-as-usual' scenario, with work progressing normally behind the scenes!

ITEX represents something of a paradox just now because it has attained a maturity in terms of progress and output, but the vigour remains undiminished, as we continue to evolve and to welcome the establishment of new sites (ITEX now includes, as part of Dr Dana Bergstrom's research initiatives, a sub-antarctic site on the Australian Macquarie Island; Julia Klein, from the University of California at Berkeley, has also set up ITEX research at 3200 m a.s.l. on the Qinghai-Tibet Plateau in conjunction with the Haibei Alpine Research Station in Menyuan County, Qinghai Province, China).

Since publication of the last Newsletter in May 1996 the original vision of the ITEX founders has materialised very tangibly in the form of two major syntheses of ITEX data sets: (i) the publication of a *Global Change Biology* special issue (Vol. 3, supplement 1, December 1997), and (ii) the meta-analysis and synthesis meeting at NCEAS (the National Center for Ecological Analysis and Synthesis) University of California, Santa Barbara, from 4-9 December 1996 (for which we acknowledge the support of the US National Science Foundation). Follow-up from the NCEAS meeting, and in-depth planning for the next 'phase' of ITEX, took place at the 8th Annual ITEX Workshop (hosted by the Royal Holloway Institute for Environmental Research, Surrey, England) from 19-22 April 1997.

The special issue of *Global Change Biology* focuses on the responses of individual 'ITEX species' to experimental manipulations of temperature, together with comparative analyses of soils and climate across the ITEX sites. The contribution provides an excellent synthesis of ITEX progress over the first 3-4 years of the programme, and has also laid the foundation for subsequent meta-analyses of the broader data set (the first manuscript from this work is soon to be submitted for publication).ITEX is now in a unique position to inform the international scientific debate on the potential responses of tundra plant species and vegetation communities to environmental change.

The circum-polar Arctic and alpine coverage of contrasting tundra environments, all underpinned by a common set of protocols and objectives, provides a broad spatial framework for interpreting responses at various points within individual species ranges. We are now increasingly turning out atten-

tion toward an emphasis on community-level responses to environmental change, coupled with measurements of broader 'ecosystem processes' (you will see this reflected in several of the following Newsletter items). We will not, however, be turning our backs on the original ITEX protocols and species-specific studies (which provide the basis for community changes) although we are looking seriously at ways in which measured variables can be 'streamlined' in the light of our earlier experience. A striking lesson from the programme to date is that, quite apart from the experimental manipulations themselves, the maintenance of ITEX measurements on 'control' (unmanipulated) plots over several years has yielded data of exceptional value in relation to natural inter- and intra-annual climatic variability. With every additional year of measurements the value of the basic dataset increases disproportionally.

Finally, ITEX brings together a unique pool of logistic and scientific expertise from around the world: we also welcome the opportunity to share our experience and to establish connections with interested individuals and research programmes from all branches of the natural sciences and Humanities. ITEX currently works in direct partnership with the IPA (see report below) and we aim, in the coming months, to explore potential links with other programmes such as AMAP (the Arctic Monitoring and Assessment Programme: see http://www.grida.no/ amap/amap.htm) and CAFF (the Programme on Conservation of Arctic Flora and Fauna: see http://www.grida.no/caff). ITEX has/will be represented at the following meetings:

* the GCTE-LUCC Conference (14-18 March, Barcelona, Spain; see http://jasper.stanford.edu/GCTE/LUCC/Conference98.html);
* the International SCANTRAN Meeting - an IGBP Terrestrial Transect for Scandinavia / Northern Europe, and the AMAP/CAFF Workshop (19-25 March, Rovaniemi, Finland; see http://www.urova.fi/home/arktinen/santran.htm);
* INTECOL (19-25 July, Florence, Italy);
* Polar Aspects of Global Change (24-28 August Tromsø, Norway; see http://www.tromso.npolar.no/polaraspects

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ITEX on the Web

The ITEX homepage, www.systbot.gu.se/ research/itex/itex.html, is currently being updated. New pages will include short site descriptions, pictures of species, and publications. Site representatives who have not yet submitted basic information on their site are urged to do so as soon as possible. To see which kind of information is requested, go to the Val Bercla page from the homepage. Send information to:
mikael.stenstrom@systbot.gu.se

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The Next ITEX Meeting:

Pat Webber and Bob Hollister are looking forward to hosting the next ITEX meeting in East Lansing, Michigan. The date for the meeting is January 3 - 9, 1999; so please mark your calendars. We hope to obtain funding to partially support travel to the United States, some conference costs and publication of a proceedings and synthesis volume. After the Barcelona GCTE-LUCC Conference, March 14-18, 1998

(see http://jasper.stanford.edu/GCTE/LUCC/Coference98.html), we will seek a consensus from the ITEX membership on the themes and concept for the 1999 annual meeting. We urge everyone to send ideas to us. By May, 1998 we hope to have a web-site announcing the ITEX meeting.

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News from the International Permafrost Association (IPA):

Permafrost Monitoring and Mapping in the Northern Hemisphere

By Jerry Brown

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Several new monitoring activities are now formally in place to document changes in active layer and temperatures of near-surface permafrost. The Circumarctic Active Layer Monitoring (CALM) network has expanded to 69 sites under the auspices of eleven countries. CALM sites gather data on active layer thickness and in many instances soil temperatures, with a few sites measuring permafrost temperature. Thirteen of the gridded sites are on or in close proximity to the ITEX sites. During 1998 the European Community initiated the project Permafrost and Climate in Europe (PACE). Sites from Svalbard to the mountains of Italy and Spain will monitor permafrost temperatures in boreholes. Data from these sites will be included in the CALM database. Both CALM and PACE are being coordinated with other international research and monitoring programs including SCANTRAN, IGBP NES, and GCOS/TOPS.

A new permafrost map (scale of 1:10,000,000) employs physiographic and landscape classifications to delineate permafrost continuity and ground ice conditions in the Northern Hemisphere, The compilation is based on published maps and on the experience of the four principal authors (O. J. Ferrians, Jr. and J. Brown, USA; J. A. Heginbottom, Canada; and E. S. Melnikov, Russia), colleagues in Russia, and numerous contributing authors from other countries. The color coded units depict estimated permafrost extent by percent area (90-100%, 50-90%, 10-50%, <10%) and an estimate of relative abundance of ice content in the upper 20 meters as percent volume (>20%, 10-20%, <10%). The relative abundance of ice wedges, massive ice, and pingos; and ranges of permafrost temperatures (°C) and thickness (meters) are shown for each landscape unit. Likely occurrence of subsea and relict permafrost and the position of the northern treeline are also shown. Four cross sections in North America and Russia illustrate the vertical extent of the map units. Considerably more detail, including lithologic composition, is presented on the Russian half of the map. Compilation of the map was under the auspices of the International Permafrost Association (IPA); the cartography and printing were performed by the U. S. Geological Survey (available $4.00 plus $3.50 handling as Circum-Pacific Map CP 45 from the USGS, Information Service, P.O. Box 25286, Federal Center, Denver, CO 80225, USA).

Both the map and CALM database should be useful to those concerned with periglacial processes and environments, global climatic change, trace gas budgets, resource development, and protection of the environment. A digital version of the permafrost map, related borehole inventory and the CALM database wilI be part of the IPA CD ROM Circumpolar Active-

layer Permafrost System (CAPS) available at the Seventh International Conference on Permafrost; Yellowknife, Canada, June 1998, and produced at the World Data Center-A for Glaciology, Boulder Colorado.

Browse the IPA WWW home page: http://www.geodata.soton.ac.uk/ipa

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Individual site reports:

ITEX in CANADA:

Current status:

ITEX in Canada continues to grow, with strong links developed between Canadian ITEX researchers and sites and the Ecological Monitoring and Assessment Network (EMAN), administered by the federal Department of Environment (Environment Canada). In this report, I present some of the ITEX highlights of the past 2 years in Canada, and outline new research underway or planned for Alexandra Fiord.

There are 5 ITEX sites in Canada with at least Level 1 studies: Alexandra Fiord, Baker Lake, Bylot Island, Churchill, and Tanquary Fiord (Northern Ellesmere National Park). In addition, there are a number of Sites with ITEX-related research, including: Kluane National Park (David Hik, University of Toronto), Northern Yukon Park (Martin Raillard, Parks Canada, Inuvik), and Daring Lake, Northwest Territories (Anne Gunn, Dept of Renewable Resources, Yellowknife).

The northern and mountain parks within the National Parks system are being approached to become involved in ITEX research, and to begin standard monitoring of plants and climate. These parks are ideal for long-term monitoring of plant responses since there are people on site for most of the year. An ITEX training workshop is being planned for late-summer 1998 to train park personnel in the basic monitoring protocols included in the ITEX manual. The workshop will include monitoring of other ecosystem variables and protocols which have been developed for EMAN in Canada.

ITEX Sites at Alexander Fiord and Bylot Island:

By Greg Henry

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Alexandra Fiord

ITEX studies have been established at Alexandra Fiord, Ellesmere Island since 1992, and ecological research has been conducted at the sites since 1980. Warming experiments and controls are established in 5 communities, ranging from wet sedge meadow to polar semi-desert. Snow addition and removal experiments have also been conducted since 1992 in a late lying snowbed, and were included with OTCs in one community beginning in 1994. Research has been expanded to include studies of effects of nutrient addition and simulated grazing (in and out of OTCs), on growth, reproduction and C:N ratios in ITEX species. Litter decomposition in and out of the OTCs is being measured using a standard litter bag technique. The measurement of C:N ratios in plants and litter is being used to assess the possible change in litter quality, a major feedback to the oligotrophic tundra systems. Much of this work is in conjunction with Dr Anne Tolvanen, University of Oulu.

New research at Alexandra Fiord will begin to address causes and con-

sequences of biodiversity changes in tundra systems. A subset of the ITEX experimental plots will be subjected to additional treatments to alter species and/or functional group densities. Research on the effects of treatments on diversity in soil fungi and arthropods will also begin with new Canadian collaborators.

Bylot Island

At Bylot Island, ITEX research is conducted conjunction with a long-term study of the population dynamics of greater snowgeese, and effects of the snowgeese on the vegetation. Since the summer of 1995, 10 OTC and 10 controls have been established in wet peat polygons, which are dominated by sedges and are the main habitat for the snow geese. Microclimate has been monitored for 2 summers, and biomass estimated at the beginning and middle of the season using with small soil core. The plan is to sample biomass again this year. Esther Lévesque will complete community descriptions using point quadrats this coming summer, and will likely continue ITEX monitoring at the site. For more information about the Bylot Island site and studies contact Dr. Gilles Gauthier (gilles_gauthier@bio.ulaval.ca).

ITEX Sites at: Tanquary Fiord, NWT, Baker Lake, NWT and Churchill, Manitoba:

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Tanquary Fiord, Ellesmere Island National Park Reserve, NWT. Coordinates: Approx. 81°N, 77°W. Site elevation ca. 10m asl. This site was established in the spring 1994, on an uplifted beach ridge, a short distance from the Parks Canada base camp. Thirty marked plants of *Dryas integrifolia* and *Saxifraga oppositifolia* have been monitored for phenological progression by the Parks Canada workers since the site establishment. Park Superintendant Mr. Rene Wissing and Park Wardens Mr. Douglas Clark and Mr. Barry Troke were instrumental in maintaining the ITEX program at this site.

Baker Lake, N.W.T. Coordinates: 64û 10'N; 95û 30'W. Site elevation ca. 60m asl. This partnership with Dr. Richard Staniforth, U.Winnipeg. Three projects are being followed at Baker Lake:

i). The classical ITEX program involving *Dryas integrifolia*, *Saxifraga tricuspidata* (*S. oppositifolia* is absent in this area) and *Cassiope tetragona* has been followed since the spring 1992. Thirty plants of each species growing in three separate but close-by plant communities were marked and have been monitored at least twice a week for phenological progression. In addition, five OTC's were established and phenology of the same three species followed there. The ITEX site at Baker Lake is significant for two reasons. It is an inland site some 400 km west from Hudson Bay coast, and a first class meteorological station has been functional at Baker Lake for more than 30 years.

ii). Impact of snow accumulation on tundra vegetation. In winter up to 8m deep and over 100m wide snowdrift is regularly deposited behind a high and over 1000 m long wooden plank fence. The snow fence was built in 1981 to protect the Baker Lake village against excessive snow deposition.

When the snowdrift gradually melts in summer, it releases the vegetation with a weeks-long delay. As a result the tundra community has changed in composition and vigour. Many vacular species have died out and the phenology of the surviving plants has been altered. We have been recording the timing and shrinking of the snowdrift and the changes with the plant community in the snowdrift zone. Also this project is in its seventh year of monitoring.

iii). Permafrost - active layer monitoring. In summer 1997, courtesy of the Baker Lake community public works, four 3m deep holes were drilled approximately 100m apart perpendicularly to the snow fence. The holes were placed in such a way, that in winter one of the holes is located under the deepest snowdrift while the remaining three holes are situated in the unaffected tundra. In cooperation with Dr. Margo Burgess, Geological Survey of Canada, the holes were professionally wired, with thermistor sensors spaced 50cm apart. Beginning September 1997 the ground temperatures are being monitored every two weeks by a local resident Mr. Orin Durey. The objectives of this study are two-fold: to monitor the ground temperatures as they may be responding to climate change, and to follow the change of the permafrost temperatures in the area where there is a large and long lasting snow deposition. This project was registered with the Circumpolar Active Layer Monitoring Program (CALM).

ITEX site at Churchill, Manitoba.

Coordinates: 58˚ 47'N; 94û 12'W. Elevation ca. 10m asl. This site was established on a rocky coast covered with a fine gravel and sand. It supports a distinct *Dryas integrifolia* - *Saxifraga tricuspidata* community. Phenology of marked plants has been monitored according the same protocol as at Tanquary Fiord and Baker Lake by a local couple, Dianne and Bill Erikson, since 1994. In 1997 a *Saxifraga oppositifolia* population was found and included in the monitoring program.

ITEX in CHINA:

ITEX site on the Qinghai-Tibet Plateau

By Julia Klein

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A new ITEX site has been established at the Haibei Alpine Research Station in Menyuan County, Qinghai Province, China on the Qinghai-Tibet Plateau. The site, located at latitude 37° 29'-37° 45'N and longitude 101û 12'-101û 33'E and at an average elevation of 3200m, is situated in the Datong River valley on the south slope of the Qilian Mountains. The site receives approximately 600mm precipitation per year, with 80% of the precipitation falling during the summer growing season. Annual mean temperature is –2˚ C.

Mesic alpine meadow, dominated by *Kobresia humilis*, *Elymus nutans, Stipa aliena*, *Festuca ovina* and *Carex* spp. and a variety of forbs, is found between 3100-3300m. On north facing slopes and between elevations of 3300-3600 m is a shrub-land system dominated by *Potentilla fruticosa*, *Festuca ovina*, *Kobresia capilifolia*, *Poa* spp. and various forbs. Within each vegetation type (meadow vs. shrub), the relative vegetation functional group com-

position (forbs, sedges, grass, shrubs) is largely determined by the grazing regime to which the site is subjected. Local Tibetan pastoralists graze their livestock (a combination of mostly sheep and yak) on the higher common shrublands during the summer and on privately owned plots within the lower meadow during the winter months.

Conical ITEX chambers have been established in both meadow and shrub sites on areas with different grazing intensity histories. The objective of this research is to examine ecosystem response to climate warming and grazing and to quantify ecosystem-mediated feedbacks to climate warming and to grazing. Any comments, suggestions or questions regarding the new ITEX site should be directed to Julia Klein.

ITEX in ICELAND:

The Icelandic ITEX-project: two subarctic, maritime sites

By Ingibjorg S. Jonsdottir

There are two ITEX sites, at different altitudes, which have been operating in Iceland since 1995 and 1996, respectively. At the low altitude site within Thingvellir National Park at 120 m above sea level, which is below or at the potential mountain birch tree limit, the focus is on the interaction between vascular species and bryophytes and how they respond to climate change. The high altitude site lies 480-500 m above sea level at Audkúluheidi, North West Iceland, and is well above the potential tree limits. At that site the focus is mainly on community responses.

Main funding: The Icelandic Science Foundation.

ITEX in JAPAN (and Japanese research in SVALBARD, NORWAY):

Japanese Activities Linked to the ITEX Programme, 1995-1997

By Hiroshi Kanda

Growth and phenological responses to environmental change (in particular, simulated warming, using the open-top chamber - OTC - system) have been studied in tundra and alpine regions during the period 1995-1997. Standardized methods and materials are employed to quantify both vegetation dynamics and the colonization processes of pioneer plants. Between 1995-1997 studies have been performed as follows:

i). H. Kanda (Natl. Inst.Polar Res.), Y. Minami (Tamagawa Univ.) & N. Wada (Toyama Univ.): Ny-Ålesund, Spitsbergen, Svarbard;
ii). G. Kudo & S. Suzuki (Hokkaido Univ.): Mt. Daisetsu, Hokkaido, northern Japan;
iii). T. Masuzawa & T. Kibe (Shizuoka Univ.): Mt. Fuji, central Japan;
iv). I. Nakashinden (Miyagi Univ.) & S. Fukuyo (Tokyo Univ.Agr.Tech.): Mt.Norikura, central Japan;
v). S. Kojima & N. Wada (Toyama Univ.): Mt. Tateyama, central Japan;
vi). H. Kanda & S. Imura (Natl. Inst. Polar Res.): Japanese Station, Syowa Station, Antarctica.

Related projects are as follows:

i). Vegetation change affected by environmental factors: Y. Minami (Tamagawa Univ.), S. Okitsu (Chiba Univ.) & S. Kojima (Toyama Univ.);
ii). Reproductive processes: T. Masuzawa & T. Kibe (Shizuoka Univ.), S. Nishitani (Nippon Medical School), A. Kume (Hiroshima

Univ.) & N. Wada (Toyama Univ.);

iii). Soil respiration and temperature dependence: Y. Bekku (Natl. Inst.Polar Res.), T. Nakatsubo (Hiroshima Univ.) & H. Koizumi (Natl. Inst. Agro-Environ. Sci.);

iv). Soil arthropod ecology: S. Yoshida (Iwate Univ.).

ITEX in RUSSIA (Franz Josef Land):

ITEX on Franz Josef Land - the Austrian ITEX programme

By Dr. Karl Reiter,

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Project co-ordinator: Prof. Georg Grabherr

Project collaborators: Karl Reiter, Michael Gottfried, Harald Pauli

Funded by the Austrian Ministry of Science and Austrian Science Foundation

Starting: summer 1996

The ITEX - site on Franz Josef Land was established in 1996 by a working group from the Institute for Plant Physiology at the University of Vienna. One explanation why an Austrian group carries out investigations at the northernmost archipelago has its roots in the discovery of this area by an Austrian - Hungarian expedition more than hundred years ago. The hundred year anniversary of this expedition, and the nowadays free assess to that area, provided the starting point, and basis, for revitalizing Austrian high Arctic research.

One aim of the Austrian initiative is now to establish identical monitoring systems in the high Arctic as well as in the high Alps for detecting climate change effects on vegetation. In combination with field experiments adopting the ITEX approach, basic mechanisms of potential reactions of these vegetation types at the limits of plant life should be studied.

Work in the summer 1996 was dominated by baseline studies of the Arctic flora and vegetation communities, and by the establishment of twenty permanent plots following the specifications of the ITEX Manual. Research work in summer 1997 was suspended on Franz Josef Land by the Russian authorities, so the intended treatment of the permanent plots with water and fertiliser (as well as a warming simulation with the help of open top chambers) was not possible.

However, the signs for the future seem more encouraging: the Russian military have now promised to support our work during summer 1998. The Austrian initiative is planned to be maintained for at least ten more years.

ITEX in SWEDEN

ITEX site: Latnja, Northern Sweden

By Ulf Molau

The Swedish ITEX programme is healthy, continuously in operation at the Latnjajaure Field Station in northern Lapland. Two of the Ph.D. students from Göteborg will present their theses this spring, Mikael Stenström and Juha Alatalo, both based mainly on their ITEX-related research at Latnja. The shooting for a new ITEX video ("Climatic Revenge II") was completed this summer by the same skilled photographer and producer as last time, Torbjörn Rosander. The movie, intended for a broader public and TV broadcasting, will hopefully be released around midsummer.

The enormous climatic variation among years seen already in the early nineties, has been even more obvious during the last three years. Using a recently coined climatic terminology for arctic summers (The Good, The Bad and The Ugly; Stenström & Molau, in review) both 1996 and 1997 were "Good", while 1995 was definitley "Ugly". August of 1996 was the warmest on record (i.e., since the turn of the century) and the entire summer of 1997 was the warmest since 1937 in northern Scandinavia. The sequence of two 'Good' years in conjunction must be regarded as an "extreme event", probably unique since the onset of the Little Ice Age in our area. This "pulse" is already visibly manifested in the plant cover, where deciduous dwarf shrubs, particularly *Betula nana*, have increased markedly in canopy height and cover in all unmanipulated control plots during only two years. Grazing pressure has been low in the area, and if grazer populations do not build up rapidly, the sprouting dwarf birches will soon affect the albedo and the growing season. We realize that we are very lucky to have both extremes of summer climate represented within our data sets: at the same time, however, the variability emphasizes the shakiness of short-term data-sets from the Arctic, i.e. three years or less.

The summer of 1997 was the last season of the planned 5-year intensive monitoring of a number of species, viz., *Cassiope tetragona*, *Dryas octopetala*, *Eriophorum vaginatum* and *Saxifraga oppositifolia*. The results of this study were partly (2-3-year data sets) reported in the ITEX Special Issue of Global Change Biology recently, but an analysis of the complete data sets is in preparation. The plots will not be abandoned however, and the OTCs will remain in position and maintained for as long as possible; hopefully, they can be revisited after five more years.

The main focus within ITEX at Latnjajaure is now at the community level. The 'CLIP'(Community Level Interaction Programme) experiment was implemented 1995 and will be running at least until the end of 1999. The set-up is much influenced by the LTER experiment at Toolik Lake, Alaska, with a combination of treatments (here temperature enhancement and nutrient addition) in a fully factorial design. Vegetative growth, flowering, and diversity of life forms are recorded each summer, based on standardized ITEX point-framing methods. While the Alaskan experiment is set up in a typical tussock tundra, the Latnjanian version is implemented as replicate blocks in a rich alpine meadow and in a poor heath community. The results so far show that the communities, as well as their life forms, respond differently to the treatments. A more astonishing result is that the diversity in the field and bottom layers show no correlation at all at this scale.

Are the responses we have measured so far in ITEX OTCs the result of a constant "environmental press" or

are they brought about by the shock (perturbation) from the moment of set-up, i.e., "environmental pulse". In order to elucidate this question, addressed at the 1995 ITEX workshop in Ottawa, another experiment was implemented at Latnjajaure in the summer of 1995. The PAPP (Press And Pulse Programme) will run until the end of the 1998 summer, terminated by destructive harvesting. In addition to the normal OTCs and control plots, this design includes plots where the heating effect is increased stepwise year by year ("Press") and plots subjected to a one-season (1996) substantial heating by Closed-Top Chambers (CTCs; representing "Pulse"). So far, it looks as if the plants of most life forms subjected to the sledgehammer heating in 1996, to which they responded massively, are already back to normal, but the coming summer's harvest will give the hard data.

Within the frame of ITEX, the Latnjajaure operations have diversified in many directions during the past few years. Inga-Svala Jónsdóttir and her group of Ph.D. students (Anna Stenström on *Carex* and Annika Jägerbrand on mosses) have set up parallel experiments at Latnjajaure and at the Icelandic ITEX sites. The "Seed Flux" study implemented in 1995 as an altitudinal transect of cohorts of seed traps has now expanded as to include analysis of the seed bank (Ph.D. student Eva-Lena Larsson, Göteborg University). The Latnjajaure site is also involved in a new EU project, Dynamics of the arctic-alpine tree-line (DART), co-ordinated by Brian Huntley (Durham, UK). Our contribution to the final modelling in this programme is to intensify the seed flux study and to study the impact of a sparse tree-line birch canopy on albedo and snow-melt and, thereby, the length of the growing season. This will be achieved by setting up a 50x50 m "fake forest", based on a mapped tree-line stand nearby, in the mid-alpine region at the station. After the termination year 2001 we will have a good supply of sauna firewood!

In the summer of 1998, Latnja will also be playground for arctic ecologists, testing sampling and experimental methods to be employed during the icebreaker-based Tundra Northwest expedition in 1999. We already (1997) sampled genetic diversity within populations of *Cassiope tetragona* (Ulf Molau), *Dryas octopetala* (Juha Alatalo), *Potentilla nivea* (Bente Eriksen), *Salix herbacea* (Urban Nordenhäll), and *Saxifraga oppositifolia* (Mikael Stenström). The analysis has begun, and screening of 50 tufts of *Cassiope* with six primers revealed substantial genetic variation within a single population. At the same time, some clones appear to be at least 5 m in diameter.

Finally, based on results from most of the activities above and in collaboration with ongoing efforts from physical geographers in the same area, we aim at preparing a digital vegetation map (Hierachial GIS) with information on biomass per unit area and life form composition. With this in hand for the entire catchment area, we will be able to run dynamic vegetation models in climates changing in both warmer and colder directions. We can utilize our detailed, now 8-year meteorological data set from Latnja with all its natural climatic variation within and among seasons, and ramp it in any direction. The negative side of the project, "CyberTundra", is that we will spend more and more time in front of computers and less in the field.

ITEX in the USA, ALASKA:

Consequences Of Global Warming-Induced Changes in Season Length for Plant Phenology, Community Composition, Productivity, and Ecosystem

Carbon Fluxes: Using Alaskan Tundra As A Model System

By Steven F. Oberbauer

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Graduate Assistants: Greg Starr and Eric Pop

Field Season summary 1997: We arrived at Toolik Field Station on May 2 and initiated hand removal of snow from treatments plots on that evening. Snow removal on the primary treatment plots was completed by 3 May. We also initiated a new set of treatments in which we attempted to separate the effects of early season snow removal versus prevention of late season snow accumulation and hard frost. Snow was removed from these plots and destructive plots pairs by 4 May. Complete snow melt on the treatment plots (snow removal and snow removal + soil heating) was obtained within two days of removal of the main snow cover. Snow depths on our site were 65 to 75 cm and considerably higher than normal. Treatment plots were kept snowfree by A-frame, open-ended polyethylene tents. Final snowmelt on the controls did not occur until the end of May giving us an excellent treatment of more than 3.5 weeks.

The remainder of the growing season was characterized overall by warm, clear weather. The treatment plots were covered with open ended A-frame polyethylene tents on 15 August to initiate end of season treatments. Tents successfully prevented hard frosts of treatment plants during the frosts in late August. However, frosts were not common at the end of season; only four frost and two snow storms occurred before we left the site on 5 September.

We continued our seasonal measurements of micrometeorology, quantitative phenology, canopy development, leaf and soil nutrients, and ecosystem carbon fluxes on the treatment plots that we initiated in 1995. The very late season of snow melt gave us a very strong early season treatment effect. However, the relative lack of late season snow and frost diminished the effect of the late season treatments.

Laboratory experiments: We completed two large growth chamber experiments. In one, we tested *Petasites frigidum* and *Salix pulchra* for the effects of photoperiod and temperature on leaf senescence. Secondly, we tested the temperature requirements for bud break of the two deciduous shrubs, *Salix pulchra* and *Betula nana*.

Graduate Student Eric Pop completed his M.S. thesis in December 1997. The thesis is entitled "Modeling bud break in the arctic dwarf deciduous shrubs, *Salix pulchra* and *Betula nana*: testing climate warming scenarios". The work represents successful development of a model to predict bud break of the two dominant deciduous shrubs at our site. With Eric's graduation, Lorraine Ahlquist will come on a the project as a new graduate student.

Greg Starr finished his M.S. thesis in spring 1998. The thesis is entitled "Phenological and physiological responses of *Polygonum bistorta* to a lengthened growing season and soil warming in Alaskan tussock tundra. The work shows that *Polygonum bistorta* was relatively constrained in its phenological and physiological response to lengthened growing season. Starr will continue on the project as a Ph.D. student.

Presentations from the Project:

Pop, E. W., S. F. Oberbauer, and G. Starr. 1997. The effects of extended growing season and soil

warming on plant canopy development in Arctic tundra. ESA Annual Meeting, Albuquerque, NM.

Oberbauer, S. F., G. Starr, and E.W. Pop. 1997. Effects of increased season length and soil heating on carbon exchange of tussock tundra in Alaska. ESA Annual Meeting, Albuquerque, NM.

Starr, G., Oberbauer, S. F., and E.W. Pop. 1997. Phenological and physiological responses of *Polygonum bistorta* to a lengthened growing season and soil warming in Alaskan tussock tundra. ESA Annual Meeting, Albuquerque, NM.

ITEX site at: Barrow Atqasuk, Alaska

By Professor Patrick John Webber

The Webber group is very pleased to announce that in May 1997 they received funding from the U.S. National Science Foundation to continue their experiments at Barrow and Atqasuk sites. This assures funding until the year 2001 and as a consequence we have expanded our measurement program and are reaching beyond the Standard ITEX design to examine the effects of increased temperature on below-ground processes. We also finished point framing all of our research plots. A substantial boardwalk was installed at both field sites in Barrow to minimize disturbance and similar boardwalks are planned for Atqasuk this summer. With long-term funding security we hope others will be able to join us to take advantage of our installations. This coming field season Olga Afonina from the Komarov Botanical Institute, St. Petersburg, will join us to collect information on Bryophyte responses to climate. Lisa Walker completed her Masters degree in December, 1997 and Bob Hollister has almost finished his and will stay on the project for his Ph.D., both theses will be available within a few months.

We are also pleased that the new, five-year, U.S. Arctic System Science/Land Atmosphere Ice Interactions (ARCSS/LAII) project, which is led by Terry Chapin, will use Barrow and Atqasuk as important sites in their,study. The LAII group, which includes Walter Oechel and Skip Walker will be conducting process, gas flux and biodiversity studies over extensive transects across western Alaska. Barrow will be one of the transect anchors. This will greatly increase our understanding of the Barrow and Atqasuk ecosystems and create many opportunities for collaborative efforts on circumpolar ecosystem response to climate change.

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Ecosystem functioning with climate change in subantarctic terrestrial environments: ITEX on Macquarie Island

By Dana Bergstrom

Introduction

Macquarie Island; a MAB Biosphere Reserve (see MAB-NSN Newsletter vol 18) is one of the eight subantartic islands spanning the latitudinal range of 48˚ - 54˚S. The subantarctic zone is currently showing one of the highest rates of climate warming. Within latitudes 45˚ S and 55˚ S, temperatures are estimated to be rising at 0.25˚C per decade. On Macquarie Island there has been a 1˚C increase in mean annual temperature between 1949 and 1987. An ITEX was established in 1994. Next year, we will expand our studies

to Heard Island and hopefully within five years expand to Campbell Island. We also plan to establish a sister program at Casey on the Antarctic Continent.

Macquarie Island studies

The key species contribute significantly to the overall plant biomass on the island and can be found growing across altitudinal gradients in excess of 300 m. Dominant species: *Acaena magellanica* and *A. minor* (*Rosaceae*), *Agrostis magellanica* (*Poaceae*), *Azorella* sp. (*Apiaceae*), *Poa foliosa* (*Poaceae*), *Luzula crinita* (*Cyperaceae*), *Pleurophyllum hookeri* (*Asteraceae*), *Ranunculus biternatus* (*Ranunculaceae*), *Stilbocarpa polaris* (*Araliaceae*). Some of the genera and most of the families are also found in Arctic tundra environments.

The combination of wide ecological amplitude of species, an estimated lapse rate of 1˚C per 100m, and an increases in temperature of approximately 0.025˚C per year means that sites at lower altitude can be broadly considered as temperature forecasts of sites at higher altitudes. A site at sea level potentially represents a 40 year forecast of a site presently at 100 m above sea level and 120 year forecast of a site at 300 m above sea level. In 1996 we installed 4 ITEX level 2 climate stations along this gradient and now have over 16 months or continuous weather data.

Unfortunately the ITEX northern hemisphere design has not withstood the harsh subantarctic climate and at the time of writing this article (Feb 1998) only five of the 20 warming chambers remain intact. Our main problem has been windy conditions with changes in wind speed from zero to 60 knot in 15 sec as a common occurrences. We are now in the process of modifying the OTC design in association with colleagues from the engineering department and we will test the new design in a wind tunnel before our second attempt at installation next summer. However despite set backs we have developed modified ITEX protocols for use in the subantarctic and have chosen taxa either representing major circum-subantarctic distributions or major growth form such as giant grass tussocks of cushion plants.

In 1998 we are hoping to organise a southern hemisphere chapter of ITEX, with focuses on both the Antarctic continent and subantarctic islands. In April/ May we are planning to send out a proposal regarding this to interested people. We intend to then discuss the formation of this group at the SCAR (Scientific Committee for Antarctic Research) Biological Symposium in Christchurch New Zealand in August 1998.

Current members of the team

Dr Dana Bergstrom, PI (Ecosystem function, nitrogen studies), Prof George Stewart and Dr Susanne Schmidt (Nitrogen studies), Craig Tweedie - PhD student (Ecosystem function with altitude), Tore Pedersen - PhD student(Role of invertebrates in soil processes), Justine Shaw (OTC), Wieslawa Misiak - BSc (Seed bank studies)

A more detailed report can be found in MAB-NSN Newsletter vol. 21 May 1997. More information on our subantarctic studies can be found on: www botany.uq.edu .au

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