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Information

SNOW ECOLOGY: A REPORT ON A NEW INITIATIVE

Snow plays a key role in the ecology of much of Earth's surface, especially in circumpolar and high-altitude regions where ecosystems are under increasing stress from global changes in climate and local human development. Until recently, our knowledge of snow has been restricted to areas of study associated with specific physical, chemical, and biological disciplines. Although this research has resulted in a significant progress in understanding snowpack dynamics, there has been no concerted attempt to integrate the results of these studies to further our knowledge of snow as a life-support milieu and as a component of larger terrestrial ecosystems. In order to develop a better understanding of snow ecology through interdisciplinary studies, a nucleus of research workers from both the physical and biological sciences recently formed the Snow Ecology Working Group (SEWG). The SEWG was approved as a contribution of the International Commission on Snow and Ice (ICSI) to the International Geosphere-Biosphere Program (IGBP) at the ICSI Bureau Meeting in Vienna in August 1991. ICSI is a commission of the International Association of Hydrological Sciences (IAHS).

The objectives of the Working Group are to:

(1) facilitate exchange of knowledge and expertise on snow and snow-covered systems between researchers in the physical, chemical, and biological sciences;

(2) develop a conceptual framework for snow ecology as a science and an experimental method for the study of snow and snow-covered systems;

(3) develop conceptual and applied comprehensive models for the processes, states, evolution and stability of snow ecosystems,

(4) produce documents which outline the conceptual framework of snow ecology, the state of the science and appropriate experimental methods; and

(5) organize an international conference with emphasis on the methodology and application of the conceptual framework to the development of models which explain the evolution of snow and snow-related ecosystems.

To achieve these objectives, a Snow Ecology Workshop was convened by SEWG in Quebec City, 3–7 June 1993. The Workshop was sponsored by the Natural Sciences and Engineering Research Council of Canada, Hydro-Québec, the Canadian Polar Commission, the Institut national de la recherche scientifique (Université du Québec), and the Department of the Environment of the Government of Quebec (Environnement Québec). The workshop was attended by university and government researchers and graduate students; the 20 participants included climatologists, physicists, chemists, microbiologists, plant ecologists, and invertebrate and large mammal ecologists.

The format of the Workshop consisted of state-of-the-science reviews followed by in-depth discussions on the linkages and feedback mechanisms between the physical, chemical, and biological phenomena in snow. The reviews on the first day of the workshop traced the physical progression of snow from snowfall and snow cover formation on a global scale to snow metamorphism on the ground, snow redistribution and sublimation in forested and open environments, the melt of snow and chemicals contained in the snow to the interaction between the snow chemistry and the biological components of snow (microbes, invertebrates, and mammals). The reviews on the second day considered the life cycles and habitats of snow microbes such as bacteria, algae, fungi, and small invertebrates; the accumulation of organic debris; and the relationship of larger life forms such as spiders, collembola, and large plants to snow in alpine and arctic ecosystems. The reviews of the third day were devoted to the larger mammals that live in and on snow, with special emphasis on the caribou.

In this manner workshop participants developed specific hypotheses on how the physical, chemical, and biological components interact and modify each other in order to produce the multiphase, multilife-form milieu we know as the snow cover. It is now evident that the snow cover is a ecosystem which evolves in response to meteorological and biological inputs and, in return, fundamentally changing these factors.

Certain considerations may be drawn from information presented at the workshop. One is that as a ecosystem, snow may be considered analogous to a lake and as an interdisciplinary science, snow ecology may be considered analogous to limnology. The snow ecosystem functions at three critical levels that are defined by boundaries at the snow-air and snow-soil interfaces:

(1) Supranival—above snow, including large plants and animals and the atmosphere;

(2) Intranival—within snow, including small plants, microbes, invertebrates, small mammals and snowpack properties; and

(3) Subnival—below snow, including small plants and animals, microbes, invertebrates, and the soil.

A further consideration of this concept of snow as an ecosystem is that the snow cover is the mediator between micro-organisms, plants, animals, chemicals, atmosphere, and soil. As a mediator, snow has several functions:

(1) Energy Bank—snow stores and releases energy; snow stores latent heat of fusion and sublimation and crystal bonding forces. The bonding forces are applied by atmospheric shear stress, drifting snow-particle impact and the impact of animals walking over the snow cover. The intake and release of energy at various times of the year thus makes snow a variable habitat for intranivean organisms and is a cause of their migration within the snow environment.

(2) Radiation Shield—cold snow reflects most shortwave radiation and absorbs and re-emits most thermal infrared radiation. Its reflectance of shortwave radiation is a critical characteristic of the global climate system. As snowmelt progresses, the snow cover reflects less shortwave radiation due to a change in its physical properties. This reflectance can be additionally reduced in the order of 10% by in situ life forms such as populations of red snow algae.

(3) Insulator—as a porous medium with a large air content, snow has a high insulation capacity and plays an important role protecting microorganisms, plants, and animals from wind and severe winter temperatures. Its insulation can result in strong temperature gradients that fundamentally restructure the snow composition and provide opportunities and constraints for organisms that live in the snow cover. In windswept areas specific organisms take advantage of enhanced snow cover insulation

where vegetation is relatively dense; however, their further interaction with this vegetation is presently unknown.

(4) Reservoir—snow is a reservoir for water, chemicals, and organic debris that provides habitat and food sources for various life stages of microbes, invertebrates, and small mammals. The physical and chemical properties of snow, especially radiation penetration, gas content, temperature, wetness, porosity, pH, inorganic chemistry, and organic debris content control intranivean biological activity and in turn are influenced by the behavior of nivean organisms.

(5) Transport Medium—snow moves as a particulate flux as it is relocated by the wind in open environments or intercepted by vegetation in forests. It moves as a vapor flux because of sublimation, resulting in transport to colder surfaces or to the atmosphere. During melt, snow moves as meltwater in preferential pathways within the snowpack to the soil or directly to streams and lakes. These transport phenomenon are taken advantage of by certain snow organisms but can also cause limitations to the success and survival of their populations.

(6) Host for a Food Web—a food web which occurs both within the snow cover and at the snow-atmosphere and snow-soil interfaces involves many families and species of organisms. Within the snow cover, snow algae are primary producers grazed upon by primary consumers including protozoa and small invertebrates. Smaller forms such as the fungi and bacteria are decomposers and some invertebrates are probable detritivores. The invertebrates are in turn preyed upon by other invertebrates and small mammals. Small mammals become the prey to larger mammals, which either hunt them on the surface or dig into the snow cover to retrieve them. Large and small mammals also graze upon plants that protrude into the snow cover or are buried by it. Leachates from organic substrates are an important feature in this food web, particularly in the effect of plant residues and animal wastes upon microbial activity.

These snow ecosystem functions occur over time scales that are diurnal, seasonal, and decadal. Furthermore the functions have important spatial interactions at three scales:

(1) Plot/Microscale—variation from centimeters to meters both vertically through the pack and horizontally across the snow cover, correlated strongly to individual plants, meltwater flow paths, terrain discontinuities, soil properties, food webs, and local populations of intranivean inhabitants;

(2) Landscape/Mesoscale—variation from tens of meters to kilometers, correlated strongly to the communities of the largest vegetation forms, elevation, slope, aspect, orography, and exposure to the wind;

(3) Regional/Macroscale—variation from tens to thousands of kilometers, correlated strongly to persistent synoptic weather patterns, continental wind flows, location with respect to the poles, oceans, lakes, and continental scale biomes.

After consideration of the critical issues in separate fields of snow investigation, and identification of the major linkages between living things and the physical and chemical properties of snow, the participants raised the following questions regarding snow as an ecosystem:

(1) Can we devise tests of hypotheses regarding the structure and function of snow ecosystems?

(2) Do snow ecosystems have a series of quasi-stable states?

(3) What scales of states and processes are important from micro- to macroscale?

(4) Do snow ecosystem variables and states cycle over time? Are these cycles correlated and do they enhance or dampen each other?

(5) How may we scale snow ecosystem variables over space and time? How do we go from microscale to macroscale, diurnal to seasonal and decadal?

The SEWG intends to answer these questions as part of multidisciplinary studies occurring in various snow biomes. For more information regarding participation in these working group activities please contact Professor H. Gerald Jones, Institut national de la recherche scientifique-eau, Université du Québec, Ste-Foy, Québec, Canada, G1V 4C7. FAX 1-418-654-2562.

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SECOND INTERNATIONAL CONGRESS OF ARCTIC SOCIAL SCIENCES (ICASS II)

The triennial conference of the International Arctic Social Sciences Association (IASSA)

Conference Themes

"Unity and Diversity in Arctic Societies" is a broad theme that encompasses all aspects of arctic social sciences, arts, and humanities. We welcome contributions relating to behavioral, psychological, cultural, anthropological, archaeological, linguistic, historical, social, legal, economic, environmental, and political subjects as well as health, education, the arts and humanities, and related subjects. Papers on these themes will be organized into plenary and concurrent sessions to be held in Rovaniemi. Papers dealing with the special subtheme "Ethics of Eco- and Ethno-Tourism" will be presented at the Kautokeino sessions. Only paid-up members of IASSA are allowed to participate in the congress.

Conference Location

The main part of the congress will be held in Rovaniemi, Finland, from 28-31 May 1995. The special session on "Ethics of Eco- and Ethno-Tourism" will be held from 2-4 June in Kautokeino, Norway. Accommodation in Kautoekino is extremely limited, thus participation in the special session is restricted to approximately 100 participants.

Costs

Participants are expected to pay their own travel, accommodations, and local costs. A conference fee of about $100 will be charges to cover organizational and printing costs. Student and other special rates will be available. We also hope to provide travel grants to reduce the costs for some participants. Details about costs, registration, and accommodation will be announced.

Further information

If you are interested in participating, please contact the IASS Secretariat at Arctic Centre, University of Lapland, P.O.Box 122, FIN-96101 Rovaniemi, Finland Tel. 358-60-324-759; fax 358-60-324-77; e-mail mpretes@roisrv.urova.fi