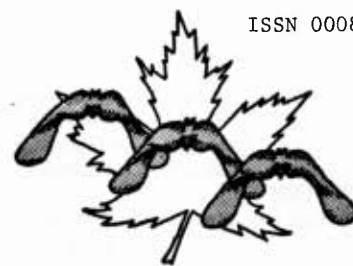


BULLETIN

L'ASSOCIATION BOTANIQUE DU CANADA



July 1979

Volume 12 Number 3

Waterloo

THE 1979 ANNUAL MEETINGS

ABSTRACTS

Symposium I - Documenting Plant Form and Development

Patterns of development in conidial fungi
G.T. COLE

Department of Botany, University of Texas,
Austin, Texas

Investigations of developmental aspects of microfungi has necessitated the correlation of data obtained from light- and electron - microscopic studies. This is particularly well illustrated by comparative examinations of the dynamic aspects of conidiogenesis using the time-lapse light microscope, and ultrastructural features of fixed stages of conidium and conidiogenous cell ontogeny using the electron microscopes. Such studies have clarified developmental concepts of the Hyphomycetes and Coelomycetes and provided valuable taxonomic data.

Pollen grains and biosystematics.

C. W. CROMPTON

Biosystematics Research Institute, Agriculture
Canada, Ottawa, Ontario.

Pollen morphology is shown to have taxonomic significance and has proven useful in indicating or denying biosystematic relationships in the following groups: Plantago, Tamarix, Trifolium, Clarkia, Urtica and Suaeda spp.

The adaptive significance of morphologies is reviewed and environmental and economic aspects of hayfever and crop plants respectively are discussed.

Fluorescence Microchemistry of Cereal Grains
R.G. Fulcher and S.I. Wong

Ottawa Research Station, Agriculture Canada,
Ottawa

For rapid and routine analysis of cereal grains and their constituents, fluorescence microscopic methods invariably permit much greater sensitivity than equivalent bright field methods. This is due in part to a high level of contrast in sections treated with fluorochromes, and in part to the high fluorescence intensity which is now characteristic of many fluorescent reagents and reaction products. In addition, large numbers of fluorochromes devised recently for spectrofluorometric and chromatographic assays are in many instances directly applicable to microscopic specimens. This permits a degree of chemical specificity which is not generally characteristic of most standard microscopic stains. Examples of several fluorochromes will be demonstrated, including tests for vitamins, phenolics, proteins, β -glucans, and lipids.

Modern chromatographic techniques for studying the roles of growth regulators at different phases of plant growth and development.

R. WIGHTMAN Biology Dept. Carleton Univ. Ottawa

The development of Gas-Liquid Chromatography (GLC) and High Performance Liquid Chromatography (HPLC) for the qualitative and quantitative analysis of the growth-regulating substances in plant tissues will be reviewed. It will be shown how recent improvements in both GLC and HPLC offer rapid procedures for separating all the growth regulators normally present in plant extracts, and when these methods are combined with Mass Spectrometry for conclusive identification of each substance, these modern physico-chemical techniques provide plant physiologists with very reliable methods for analysing the growth regulator status of a plant, or plant organ, at any stage in its growth and development. These methods are also very suitable for examining the changes in growth regulators in plants responding to changing environmental conditions. Many examples will be given to illustrate the successful use of these modern analytical procedures for investigating the roles of growth regulators in the growth and development of plants.

Time of appearance of biocharacters during Siluro-Devonian time
H. P. BANKS Div. Biol. Sci. Cornell Univ.
Ithaca N.Y. 14853.

Megafossils of the first vascular plants permit the recognition of 7 generic assemblage zones during Late Silurian - Devonian time (Banks, in press). Plants in the time range 410 - 395 million years ago were leafless, rootless, homosporous, dichotomous, probably centrarch and bore terminal sporangia. Between 395 - 380 mya lateral sporangia and exarchy were added. Between 380 - 370 mya profuse branching, over-topping, various enations, microphylls, adaxial sporangia, leaf traces, paracytic stomata, dehiscence mechanisms, complex fertile lateral branch systems and incipient heterospory were evolved. Subsequent time spans 370 - 365, 365 - 359, 359 - 349, 349 - 345 saw the evolution of successively more advanced characteristics e.g. cambium, arborescent habit, whorled appendages, megaphyllous leaves, complex fructifications, root systems, certain heterospory, seed megaspores, seeds. Most of these biocharacters will be illustrated.

Landmark events in early angiosperm evolution
J.A. DOYLE, Department of Botany, University of California, Davis, Ca. 95616, U.S.A.

The first definite records of angiosperms are monosulcate pollen grains with reticulate-columellar and granular exine structure from the probable Barremian (mid-Early Cretaceous) of England and Africa, and simple leaves with a hierarchy of vein orders and both pinnate (dicot) and apically closed (monocot) venation patterns from correlative or slightly younger (Aptian) strata of North America and Siberia. Tricolpate pollen, basic to modern dicot subclasses except Magnoliidae, appears in the Aptian of Africa-South America and the early Albian of Laurasia. The expansion of tricolpates in the middle to late Albian of Laurasia coincides with the appearance of apparently aquatic peltate leaves, pinnatifid and later truly compound leaves (ancestral Rosidae?), and palmately lobed leaves (ancestral Hamamelidales?), and the first local dominance of angiosperms. The first members of the triangular triporate Normapolles complex, which includes probable ancestors of many Amentiferae, appear in the middle Cenomanian (early Late Cretaceous) of Europe and North America.

Interactions between fungi and plants through the ages
K.A. PIROZYNSKI Paleobiology Division, National Museums of Canada, Ottawa, Ontario

Ninety five percent of present-day plants are symbiotic partnerships with fungi. These partnerships involve different kinds of fungi, and were established in different geological times and in different geographical areas. Each appearance of a new partnership was a "milestone" event in the history of plants: each was a macroevolutionary leap brought about by the merging of different genomes, and each gave rise to physiologically and ecologically distinct groups of plants.

The Progymnospermopsida and the classification of gymnosperms
W.N. STEWART, Emeritus Professor, Department of Botany, University of Alberta, Edmonton, Alberta.

The concept of the gymnosperms (plants with "naked" seeds) as a natural group was first conceived more than 125 years ago. By 1948 fossil evidence was available indicating that the two major evolutionary lines, cycadophytes and coniferophytes, of the Gymnospermae were independent; that the Class was not a natural group. The Progymnospermopsida established in 1960 provides a plexus of Devonian vascular plants, Aneurophytales and Archaeopteridales, from which cycadophytes and coniferophytes evolved. It is suggested that the time has come to reinstate the Gymnospermae as a natural unit in the classification of seed plants.

The origin and evolution of conifers.
R. A. STOCKEY, Department of Botany, University of Alberta, Edmonton, Alberta, T6G 2E9.

During the last several years there has been an increased emphasis on the study of conifer evolution including various aspects of their reproductive biology. The occurrence of similar stelar features as well as trends in the evolution of reproductive structures still point to cordaitalean affinities for the Coniferales. The evolutionary history of such families as the Pinaceae, Araucariaceae and Taxodiaceae are beginning to be elucidated as well as that of certain extinct families including the Cheirolepidaceae and the Voltziaceae. Systematic investigations of fossil cone vasculature and resin canal distribution, leaf cuticles, seed integuments, and embryo structure have not only increased our knowledge of conifer evolution but have also led to changes in our views on the systematics of extant conifer groups.

The evolution of dinoflagellates
G.L. WILLIAMS and J.P. BUJAK
Atlantic Geoscience Centre, Dartmouth, N.S.

Two approaches can be taken to reconstruct the paths of dinoflagellate evolution. First, the physiology, biochemistry and morphology of modern dinoflagellates may be examined, but it is often difficult to distinguish morphologically primitive from advanced characters in the modern biosphere. The second approach concerns the fossil record, but one problem here is the incompleteness of this record since most recognizable fossil dinoflagellates belong to the Order Peridinales which is only one of several orders that are widespread today. Many palynomorphs of uncertain origin (acritarchs) may also be dinoflagellates since it is known that some living dinoflagellates produce cysts similar to certain acritarch taxa. Despite these limitations progress is being made to reconstruct dinoflagellate evolution. The earliest recorded dinoflagellate is Silurian, but no recognizable dinoflagellates occur again until the Late Triassic. Following this, dinoflagellates have an abundant fossil record and several lineages can be traced through the Mesozoic-Cenozoic. These are briefly reviewed.

Ecology Section

Temporal stability of neighbour relationships, and grassland community evolution
L.W. AARSSSEN, P.B. CAVERS and R. TURKINGTON
Dept. of Plant Sciences, University of Western Ontario, London, Ontario and Dept. of Botany, University of British Columbia, Vancouver, B.C.

Surveys of three old pastures near London, Ontario, over a period of two years revealed three categories of interspecific plant associations—stable, seasonal, and random. Mechanisms for producing these three categories are discussed but their real significance comes when they are put into an evolutionary context. In this vein they are defined in relation to community evolution and are considered as counterparts to stabilizing, directional and disruptive selection pressures in species evolution. Because *Trifolium repens* had more random associations than any other species, it is proposed as a major 'driving force' in directing community evolution. It is suggested that seral stages in secondary grassland succession are manifested through seasonal and random associations, while stable associations characterize the approach to disclimax.

Plant community patterns in the vicinity of Sudbury, Ontario.

B.D. AMIRO

Biology Department, Laurentian University, Sudbury, Ontario

To date, several researchers have worked on specific problems in the Sudbury area (Can. J. Bot. 38:307-312, 1960; Can. J. Bot. 55:1038-1042, 1977; New Phytol. 72:329-342, 1973). However, a comprehensive study of vegetation has not been undertaken in the context of a disturbed ecosystem. To investigate community patterns, 142 sites were quantitatively sampled in the Sudbury area. From these sites, nine major plant community types were defined with the aid of Hierarchical Cluster Analyses and Principle Coordinates Analyses. These community types are then discussed with respect to other factors such as logging, fires, sources of pollution and soil pH. (This work was supported by the Mickel District Conservation Authority and the President's Research Fund, Laurentian University, Sudbury, Ontario.)

The major natural plant communities of South Carolina

WADE T. BATSON

Department of Biology, University of South Carolina, Columbia, S.C. 29208

A verbal and pictorial description of the major plant communities in South Carolina with consideration of their former and present extents, their endangeredness where such exists, their dominant and rare species and steps now in progress for conservation of both types and species.

An ordination study of epiphytic bryophyte communities in Capilano Canyon, British Columbia

G.E. BRADFIELD and N.C. KENKEL

Department of Botany, University of British Columbia, Vancouver, B.C.

Bryophytes are sensitive indicators of the environment and their distributions often reflect variation over a range of microhabitat conditions. In this study, coverage data for 14 bryophyte species growing between ground level and 2m on Douglas fir, western red cedar and western hemlock, were analysed with multivariate methods for elevational and substrate related effects. In the results, a few dominant species at particular substrate-elevation combinations were responsible for the main patterns observed. Of the 3 conifers studied species richness was highest on Douglas fir and lowest on cedar; hemlock appeared to support the most distinctive epiphyte communities.

Patterns in tidal marsh vegetation on the Fraser Delta, British Columbia

G.E. BRADFIELD and G. PORTER

Department of Botany, University of British Columbia, Vancouver, B.C.

Pacific tidal marshes form valuable ecological resources yet information on the composition and structure of the vascular plant communities in inter-tidal areas is scarce. Work is in progress to collect quantitative data on plants and environment that will lead to a better understanding of local marshes and eventually enable comparison with coastal marshlands in other parts of the world. Two sites in the Fraser Delta—one at Ladner marsh, the other at Brunswick Point—and two sites at Boundary Bay, are being studied. These sites represent a range of vegetation-types from predominantly fresh-water to predominantly salt-water influence. Initial interest is in describing patterns and gradients in the vegetation in response to changing environmental conditions. A long term objective is a comprehensive classification of tidal marsh vegetation for British Columbia.

Continuing studies on the antecology of *Diapensia lapponica* L.: Succession.

R. T. Day and P. J. Scott

Department of Biology, University of New Brunswick, Fredericton, N. B. and Memorial University of Newfoundland, Biology Department St. John's, Newfoundland.

Primary and secondary succession of soil polygons was studied on the alpine barrens of the Hawke Hills, S.E. Nfld. The general trend is from bare ground to patchy vegetation, to closed snowbank communities and then to krumholtz or ericaceous heath. *Diapensia* is colonized by vascular and nonvascular epiphytes. Deterioration of larger *Diapensia* plants may lead to intensification of frost churning, possibly to the point where a new frost pocket is formed. Typical "weed" species were unable to colonize patterned soil but elements of the natural flora quickly establish on human disturbed soils, such as carparks. This evidence suggests that patterned soil is a particularly hostile niche, more so than nonpatterned soil.

Vegetation analysis of the Eardley Escarpment, Catineau Park, Québec.

D. GAGNON and A. BOUCHARD, Institut botanique de l'Université de Montréal et Jardin botanique de Montréal.

The plant communities of the strong south facing slopes of the Eardley Escarpment were quantitatively sampled using Whittaker's methodology. The vegetation data of 66 quadrats were submitted to Bray and Curtis polar ordinations on the graphs of which are clustered several types of Sugar Maple, Oak and Pine communities. On the Escarpment's lower slopes are found Sugar Maple-Bitternut Hickory stands, the most southern type of Sugar Maple community in Québec. Most other stands are Oak or Pine dominated xeric communities. Jack Pine communities occupy the exposed, recently burnt, high summits. Rare Quercus alba and Juniperus virginiana communities are restricted to steep south facing slopes and contain rare species such as Helianthus divaricatus, Polygonum douglasii and Rhus aromatica, found only in the Ottawa Valley within Québec.

(This work was supported by grants from the National Capital Commission and the NSERC.)

A study of the floristics and plant ecology of Mont St-Bruno, Co. Chambly, Que.

L. Gratton and C. Hamel

Laboratoire de botanique appliquée, Université du Québec à Montréal.

Mont St-Bruno belongs to the Montereian Hills series in the St-Lawrence Lowlands of southern Quebec. During the summer of 1976, a survey of its flora was undertaken and more than 520 vascular plants were identified. The richness of this relatively limited area of less than 9 square kilometers results from the variable environmental conditions encountered on the mountain which present a great variety of habitats including a small bog. The transitional nature of the region also enhances the diversity of the flora. In the summer of 1977, the ecological situation of the forest stands of Mont St-Bruno was studied by using the Braun-Blanquet cover-abundance method. A total of 145 relevés were made and later on, sorted out by tabular comparison; as a result, 7 different forest associations were recognized.

Low level radiation in the Canadian Arctic. E.A. HUTCHISON¹, J. SVOBODA¹ and H.W. TAYLOR²
Department of Botany and Dept. of Physics, University of Toronto.

Little attention has been devoted to the problem of low level radiation in the Canadian Arctic compared to work done in Alaska, Greenland and Euroasian Arctic. Yet the limited data available suggests that the man-induced radiation is retained and concentrated under arctic conditions. Since deeper soils are absent, vegetation is primarily attached to bedrock and exposed to natural radioactivity. In addition, cosmic ray bombardment is more intense in Northern regions than elsewhere. Radioactive fallout, both past and recent, persists in arctic lichens and cushion plants, while in temperate zones it is being readily transferred to soils. Bioaccumulation of radioisotopes takes place via the chain: lichens→caribou→man. The recent crash of the Soviet Cosmos 954 satellite contributed little to the general background however local hot spots due to the dispersal of innumerable mac-

roscopic particles covered area of hundreds km². New data on the background and fallout activities in soils, lichens and higher plants are presented and the implications of the radioactive burden for arctic Biota are discussed.

Population dynamics of Cakile edentula on an environmental gradient

P.A. KEDDY

Department of Botany and Genetics, University of Guelph, Guelph, Ontario

The annual plant Cakile edentula (Brassicaceae) grows along an environmental gradient stretching from open sand beach to vegetated dune. At the dune end of the gradient C. edentula populations are not self-sustaining and are maintained only by the annual input of pods from the beach end of the gradient. This conclusion is based upon a two year study of natural populations on Martinique Beach, Halifax County, Nova Scotia. Plant density was highest near the middle of the gradient. However, survivorship and reproductive output were both highest on the beach, and decreased significantly with distance landward. At the dune end of the gradient, mortality greatly exceeded reproductive output. Studies of pod movement revealed that pods produced by beach plants migrate landward each winter, thereby perpetuating the dune population. This has implications for studies of plant ecology in other areas such as lakeshores. (This work was supported by N.S.E.R.C.)

Sexual and Asexual Reproduction in Marramgrass.

Irene KRAJNYK and M. A. MAUN

Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7.

Rhizomes of Marramgrass (Ammophila brevilingulata, Fernald) grew laterally under sand to a distance of 2-4 m from the mother plant. The frequency of occurrences of various groups of consecutive leafy nodes along the phytorhizomers was in a non-random pattern. The plants started to produce panicles in the middle of June and each panicle attained a height of about 60 cm. Anthesis started in the end of June and three peaks in anther extrusion were observed. The time taken for the completion of anthesis by a panicle ranged from 5 to 14 days.

Ecology of Scirpus maritimus var paludosus in Prairie Saline Wetlands.

V.J. Lieffers and J.M. Shay.

Botany Department, University of Manitoba.

The Prairie Provinces have a large number of very shallow saline lakes ranging in size from one to several thousand hectares. In 1978, 24 of these lakes in Saskatchewan, Alberta and Manitoba were monitored for seasonal changes in water levels and water and sediment parameters (specific conductance, Na⁺, Mg⁺⁺, Ca⁺⁺, K⁺, SO₄⁼, Cl⁻ and alkalinity). These data were related to the productivity of Scirpus maritimus the dominant and virtually only emergent species of these wetlands. Discussion will centre on preliminary analysis indicating that increasing water depth caused a reduction in vegetative reproduction but larger culm size and high salinity generally reduced productivity.

Holocene plant succession in the mixed forest region of Ontario
G.C. MANVILLE and J.H. McANDREWS
Department of Botany, Royal Ontario Museum and University of Toronto

Edward Lake sediments record pollen deposition and influx since deglaciation (ca. 14,000 B.P.) that reflect cliseral succession for the region. High *Picea* and herbs and low influx ($125 \text{ gns cm}^{-2} \text{ yr}^{-1}$) in Zone 1 suggests forest-tundra. Boreal forest is inferred for Zone 2 (10,550 to 7670 B.P.) because of high *Pinus* and an average pollen influx of 15,000. With the appearance of mixed forest after 7670 B.P., influx declines to 9000 (Zone 3). Influx declines to 2000 in Zone 4 (after 1850 A.D.) with a decline of trees and increase of herbs reflecting agriculture. Fluctuations within the mixed forest zone (*Tsuga* maximum, decline and recovery followed by a rise in *Pinus*) typify the Holocene south of the Ottawa Valley. The regions of deciduous forest and boreal forest have differing successions.

Reproductive Biology of *Calamovilfa longifolia* L. on Sand Dunes along Lake Huron.
M. A. MAUN
Department of Plant Sciences, University of Western Ontario, London, Ontario N6G 5B7 Canada.

The dominant sand binding grass on Lake Huron sand dunes is *Calamovilfa longifolia*. This species has a high seed output and produces a large number of panicles per unit area. Each panicle has about 550 spikelets, 55% of which contain caryopses. The caryopses disperse by wind over short distances and accumulate in depressions along with leaves and other debris. The seedlings do get established even though the rate of establishment is very low. In a controlled experiment the plants continued to emerge from the weekly sand burial treatments until the total depth of burial was 95.5 cm.

Modern pollen rain of Canada
J.H. McANDREWS and G.C. MANVILLE
Department of Botany, Royal Ontario Museum and University of Toronto

Pollen spectra selected from 1600 analyses form a data base for trend surface analysis of modern pollen rain of 20 taxa north of 40°N latitude. Percentage contours parallel vegetation regions, reflecting taxon distribution and the effects of air mass movement during the pollinating season. Tundra has *Alnus* (10-30%), *Betula* (20%) and herbs (20-30%) with Gramineae and *Artemisia* in western tundra and Cyperaceae in the eastern tundra. *Betula* peaks at 30% in the forest-tundra and eastern boreal forest. The boreal forest has 30-40% of both *Picea* and *Pinus*. Western coastal forests have *Tsuga* (20-40%), *Alnus* (25%) and *Pseudotsuga* (10%); the Cordillera is dominated by *Pinus* (50-70%). *Abies* peaks near the Atlantic coast. The prairie is dominated by herbs (40-80%) and *Pinus* (10-50%).

Ecological Study of Disturbed Shortgrass Prairie Battleranges and Recovery Programs.
J.M. MCKERNAN & J.M. SHAY
Botany Department, University of Manitoba.

The C.F.B Shilo Military Reserve is a 40,000 ha parcel of land 25 km east of Brandon, Manitoba. Annual tank training exercises are conducted by the Federal Republic of Germany on fixed ranges in a shortgrass prairie comprising much of the Base. Impact on the native *Bouteloua-Stipa-Carex* association has resulted in the destruction of the vegetative cover. *B. gracilis* has declined in frequency from 18-24% in undamaged areas to 6-9% on disturbed ranges.

Initial results of an impact assessment and revegetation program will be presented, detailing local frequency in disturbed and damaged areas, productivity of 6 test seed mixtures on soils disturbed by tank traffic, and analyses of soils beneath tank trails and from target and undamaged areas.

The role of dimorphic fruits in the population dynamics of *Cakile edentula* var. *lacustris*
ANITA M. PAYNE and M. A. MAUN
Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7

Cakile edentula var. 'lacustris' grows abundantly along Lake Huron shoreline at Pinery Provincial Park. It is an annual species which produces dimorphic fruits and seeds. Each flower produces a two-segmented fruit. Usually the upper and lower segments each contain one seed. The upper fruits are deciduous, while the lower ones are not and may remain on the parent plant over the winter (non-growing season). This difference in behaviour of the two types of fruit results in different patterns of dispersal which in turn affect the survival and fruit production of the plant. The highest rates of mortality were observed in plants growing on the strand at the high water mark.

Heavy metals in a feather moss, *Pleurozium schreberi*, in northwestern Ontario and in Fennoscandia
R. J. K. RINNE and P. BARCLAY-ESTRUP
Department of Biology, Lakehead University, Thunder Bay, Ontario P7B 5E1

Because feather mosses are dependent on their supply of nutrients from above rather than from the substrate, they are good indicators of heavy metal deposition. The common carpet-forming feather moss *Pleurozium schreberi* (Brid.) Mitt. was sampled from the region of Thunder Bay in northwestern Ontario and from Finland and northern Norway, and analyzed for content of several heavy metals. Concentrations in Fennoscandian and Ontario samples were similar. For most metals, content in the moss was found to decrease with increasing distance from centres of population and with increasing latitude. Some concentration gradients are presented and discussed. (This work was supported by the NRC of Canada and the Finnish Ministry of Education.)

Concentrations of macro-elements (macro-nutrients) in native plants growing on serpentine soils from western Newfoundland.

B.A. Roberts

Nfld. For. Res. Centre, Canadian Forestry Service, P.O. Box 6028, St. John's, A1C 5X8.

The macro-element content (N, P, K, Ca, Mg, Na and Mn) of 29 native plant species representing 13 plant families growing on serpentine soils are summarized in tabular form. The macro-element content of the soils which the native plants grow on are presented and correlated with the concentrations in each plant species. The plant families were rated on the basis of their frequency of occurrence on the serpentine areas, and generally these plants had the highest concentration of Mg and the lowest Ca/Mg ratios (as low as 0.011). The Caryophyllaceae family, well known from other world serpentine areas demonstrated this point well. Two species of this family, *Arenaria humifusa* Wahlenb. and *A. marcescens* Fern. contained 148,500 and 121,500 ppm/dry wt. of Mg and the lowest amounts of almost all the macro-elements listed above.

The effect of fluoride emissions from a phosphorus plant on Lichen communities, Long Harbour, Newfoundland, Canada. B.A. Roberts¹ and L.K. Thompson²

Nfld. For. Res. Centre, Canadian Forestry Service, P.O. Box 6028, St. John's, A1C 5X8 and Dept. of Chemistry, Memorial University, St. John's, A1B 3X7

The fluoride concentration in the terrestrial lichens *Cladonia rangiferina* (L.) Wigg. and *Cladonia alpestris* (L.) Rabenh. was correlated inversely with distance from the emission source in the direction (NE) of the prevailing wind. The minimum observed damage symptoms occurred when these lichens had a fluoride concentration of 25 ppm/dry wt. The fluoride concentrations ranged from 2830 ppm/dry wt. in a severely damaged area close to the emission source to 15.5 ppm/dry wt. 12 km NE of the industrial plant. Control samples from other unpolluted areas had an average fluoride content of 6.4 ppm/dry wt. Fluoride concentrations in these terrestrial lichens are compared with levels in soil humus, several forest tree species and some terrestrial bryophytes in four damage zones. Also the effect of fluoride emissions on epiphytic lichens in this area will be discussed.

Fluctuations in the level of nonstructural carbohydrates in the rhizome of the boreal herb *Clintonia borealis* (Ait.) Raf. (Liliaceae) R.G. SEABROOK and D.R. LINDSAY Department of Biology, Lakehead University, Thunder Bay, Ont.

Rhizomes from three-leaved, non-flowering specimens of *Clintonia borealis* were analysed for total nonstructural carbohydrate (TNC) content to get a picture of the storage and utilization of energy reserves over a one year period. Results indicated a decline in TNC content from late May to early June 1978 that corresponded to spring leaf expansion, followed by the rapid recovery of reserves, which reached a plateau in late June.

Selection of Candidate Cover Crop Species for Ontario. R. Suffling. Faculty of Environmental Studies, University of Waterloo, Waterloo, Ontario N2L 3G1.

A survey was made of potential cover crops for use in Ontario. The initial list of 4034 species was drawn from Gleason and Cronquist's (1965) Flora and a shortlist of 384 species was prepared using criteria of distribution, native status, habit, weed status, habitat, diseases and pests, animal toxicity, allergenic properties and ease of propagation. These candidates were divided into those 48 species already tested as cover crops, and those never tried. Of the tested species, 37 have been recommended in various studies. The tested species are dominated by the Gramineae and Fabaceae whereas, in the untested taxa Gramineae, Cyperaceae and Juncaceae predominate. Present cover crops are selected almost exclusively on the basis of previous agricultural or horticultural use. (This work was supported by the Ontario Hydro-electric power commission).

Patterns and processes of succession of surface mined ecosystems

M. K. Wali¹, R. H. Pemble² and L. R. Iverson¹ Project Reclamation and Department of Biology, University of North Dakota¹ and Department of Biology, Moorhead State University, Minnesota².

Species diversity and cover-abundance, and 42 environmental variables (including 26 for soils) were studied on abandoned coal mine spoils in western North Dakota in an attempt to elucidate species and habitat changes. The study sites represented a time gradient, and were 1, 7, 17, 30 and 45 years old; sites from unmined areas were studied to provide comparisons. In the same geographic area, five more sites which had been recontoured, reshaped, topsoiled, fertilized and seeded, in conformity with the new legal obligations, were examined for similar ecological variables. These areas were from 1 to 4 old years old; an unmined site was also studied for comparison. The processes of community change bore some similarities in the two situations; however, the processes occurred at a much slower rate on the abandoned sites. In contrast, the competitive and allelopathic phenomena were much more pronounced at the amended sites. (Supported by USD-1-Bur. Mines)

Response of *Hieracium floribundum* (Compositae) to the timing of drought in an abandoned pasture WALTER H. WATT and R.J. READER Department of Botany and Genetics, University of Guelph, Guelph, Ont.

A population of *H. floribundum* was studied during two years of very different water budget, using permanent quadrats and repeated harvests. The spring drought of 1977 reduced peak standing crop and reproductive output, and favored recruitment by stolon rosette. In 1978 growth and reproductive rates were normal, but a summer drought caused high stolon mortality and emphasized recruitment of seedlings. The timing of drought may thus influence both the genetic composition and the developmental rate of a hawkweed patch. (This work was supported by NRCC operating grant A9696.)

Grass establishment on barren, stony, metal-contaminated hillsides near Sudbury, Ontario, by broadcast seeding and soil amendment without prior site-preparation.

KEITH WINTERHALDER
Biology Department, Laurentian University,
Sudbury, Ontario.

Early revegetation work on contaminated soils in the Sudbury area was confined to flat or rolling terrain where agricultural machinery could be used. Barren, stony hillsides, which form a large proportion of the 40 square miles of barren land that exist, present a considerable challenge to the reclamationist. Results of small-scale field experiments commenced in 1974 showed that manual broadcasting of lime, fertilizer and seeds could be effective without prior site preparation. Following the successful grassing of two one-acre hillside plots by schoolchildren in 1975 & 1977, a grassing programme involving 82 secondary and post-secondary students was carried out during the summer of 1978, resulting in the grassing of 550 acres of barren land.

General Section

A fossil moss from the Early Tertiary of southcentral British Columbia.

J.F. Basinger, J.A.P. Janssens, and D.G. Horton
Department of Botany, University of Alberta,
Edmonton, Alberta T6G 2E9

A moss gametophyte preserved in fine detail is reported from a Middle Eocene shale near Horsefly, British Columbia. The irregularly branched stems are up to 1.5 cm long with helically arranged, oblong leaves. Leaves are 1.0-2.0 mm long, 0.3-0.5 mm wide, slightly asymmetric, and have a strong costa that ends near the apex. The margins in the upper half are coarsely toothed; teeth are multicellular and multiseriate. Upper and basal laminal cells are isodiametric and 9-13 μ m wide. This combination of character-states clearly suggests a very close relationship to the extant *Aulacomnium heterostichum*, which is disjunct between southeast Asia and southeast North America. The occurrence of this fossil provides evidence that bryophytes currently associated with the deciduous forests of eastern Asia and eastern North America were once a part of the widespread forests of the Early Tertiary.

The plastochron index: its mathematical roots and a new derivation.

KENNETH M. BROWN

School of Forestry, Lakehead University,
Thunder Bay, Ontario. P7B 5E1

The plastochron index is a quantitative measure of morphological development in entire plants or plant organs. Proposed in 1957 by R.O. Erickson and F.J. Michelini, the plastochron index has been used in numerous studies of plant morphology and physiology. Its use permits plants and plant organs to be compared at the same developmental stage regardless of differences in chronological age. This paper reviews the biological assumptions upon which the plastochron index is based and the original mathematical derivation. A new, uncomplicated mathematical derivation is proposed.

Development, ultrastructure, and function in the embryo sac of barley.
D.D. CASS¹, D.J. PETEYA¹, and B.L. ROBERTSON²,
Departments of Botany, University of Alberta,
Edmonton, Alberta T6G 2E9¹ and University of
Port Elizabeth, Port Elizabeth, South Africa².

Barley ovules were fixed at various stages of maturation using glutaraldehyde/osmium tetroxide or freeze-substitution and embedded in low viscosity resin or Epon 812. The mature embryo sac consists of a 3-celled egg apparatus, 2 partly fused polar nuclei in the central cell, and about 100 antipodal cells. Fertilization involves penetration of 1 synergid cell by a pollen tube and discharge of 2 sperms into that synergid. Subsequent passage of sperm nuclei into the egg and central cell may be related to the distribution of wall materials among cells of the egg apparatus. Ultrastructural observation of developing barley embryo sacs indicate that the timing and mechanism of wall formation favor early establishment of wall discontinuities between 1 synergid and between that synergid and both the egg and central cell. Such discontinuities could represent a pathway for sperm transfer.

Breeding systems of northeastern *Spiranthes* spp.
P. M. CATLING, Department of Botany, University
of Toronto, Toronto, M5S 1A1, Ontario.

Pollination experiments with *Spiranthes lacera* var. *lacera*, *S. lacera* var. *gracilis*, *S. vernalis*, *S. tuberosa*, *S. ochroleuca*, *S. romanzoffiana* and *S. lucida* demonstrate that these taxa are sexual and self-compatible. Autogamy and geitonogamy may be prevented by protandry or sequential opening of flowers. *S. casei*, *S. cernua* and *S. magnicamporum* are apomictic. Study of stained serial sections of ovules from these latter species indicates that viable seed develops by adventitious embryony, which leads to polyembryonic seeds and seeds with extruded embryos. Although the diploid *S. magnicamporum* reproduces by adventitious embryony in Ontario, it is exclusively sexual in the vicinity of the type locality in southwestern Illinois. The polyploids, *S. casei* and *S. cernua* appear to be apomictic throughout the northeast. Adventitious embryony may be advantageous in maintaining heterozygosity, fixing adaptive gene combinations, and/or ensuring maximum seed set in environments unfavourable for cross-pollination.

Histological basis of leaf dimorphism in
Selaginella martensii

N. G. DENGLE

Department of Botany, University of Toronto,
Toronto, Ontario, M5S 1A1.

The dorsal and ventral leaves of the plagiotropic shoots of *Selaginella martensii* show a strong dimorphism in morphology and size brought about by differences in the number, sizes and shapes of individual cell types. The difference in area between the dorsal and ventral leaves is correlated with the number of epidermal cells per layer, indicating that cell division is the primary developmental mechanism resulting in anisophylly. Leaf thickness in the ventral leaves is 1.5 x that of the dorsal leaves, reflecting a greater number of mesophyll cells and more intercellular space per unit area. Dimorphism is also expressed in the shape of the major photosynthetic cells which are those of the adaxial epidermis of the ventral leaves and the abaxial epidermis in the dorsal leaves. Stomata do not show the same developmental flexibility and always differentiate on the abaxial leaf surface. This description of mature leaf structure provides the basis for understanding the developmental mechanisms resulting in leaf dimorphism.

Self-incompatibility in *Lotus corniculatus*

SHIRLEY DOBROFSKY and W.F. GRANT

Genetics Laboratory, Macdonald Campus of McGill University, Ste. Anne de Bellevue, Quebec H9X 1C0

A method for electrophoretic examination of *Lotus corniculatus* L. ovary proteins was developed. 24-26h after pollination a difference in the electrophoretograms of selfed- vs. crossed-pollinated florets was observed. In addition, seed position in selfed vs. crossed pods was examined. A lowered seed-set, rather than differences in pollen-tube growth was observed.

Des techniques électrophorétiques furent utilisées pour réaliser l'étude des protéines de l'ovaire chez *Lotus corniculatus* L. Une différence entre les électrophorégrammes des fleurs autofécondées et des fleurs croisées fut observée 24 à 26 heures après la pollinisation. De plus, on a comparé la position des graines à l'intérieur de l'ovaire chez les fleurs autofécondées et les fleurs croisées. Une formation réduite de graines, plutôt que des différences dans la croissance des tubes polliniques, fut notée.

Développement des organes foliacés chez *Nicotiana tabacum* L. et le problème des méristèmes marginaux. M.A. DUBUC-LEBREUX, et R. SATTLER. Biology Department, McGill University, Montreal, P.Q. Deux hypothèses tentent d'expliquer l'ontogénie foliaire: la première fait appel à la notion de méristèmes apical et marginal alors que la deuxième indique une activité méristématique généralisée au début et qui se restreint graduellement à une zone basipète. Espérant trouver un rapprochement entre ces deux interprétations, nous avons étudié le développement du limbe de 4 types d'organes foliacés du tabac (feuilles, bractées, sépales et pétales), après prétraitement à la colchicine, en combinant des méthodes qualitatives et quantitatives. Les courbes de fréquence et d'index mitotiques révèlent une faible activité mitotique dans les régions marginale et médiane et plus élevée dans la région submarginale, ce qui

contredit la présence d'un méristème marginal. Afin de résoudre cette question, nous avons précisé la définition d'un méristème en analysant les principaux critères utilisables à cette fin: critère topographique, critères cyto-histologiques, activité mitotique et critère de fonction.

The intercalary meristem in the fascicle shoot of pine.

J. L. FARRAR and T. BALATINECZ

Faculty of Forestry, University of Toronto.

The fascicle shoot of pine is a few mm long, and the length remains unchanged during its life (2 to 5 years). As the cambium of the major shoot produces new xylem, the fascicle shoot is pushed outward along with the phloem and other bark tissues. Extension growth of the trace takes place by means of an intercalary meristem located at the base of the fascicle shoot. Where the trace passes through the current layer of xylem, it is surrounded by an unlignified tissue which is named sleeve tissue. Sleeve tissue matures in a year or less and provides a connection between the primary tracheids of the trace and the secondary xylem of the major shoot.

Genetic male-sterile mutants of corn: their developmental cytology and potential utility in breeding.

R. I. GREYSON, D. B. WALDEN and P. C. CHENG
Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7

LM, TEM and SEM studies of anther development in normal corn (*Zea mays*) are compared to that of four genic male sterile mutants (ms-2, ms-1, ms-9 and ms-10). Each mutant exhibits unique cytological features associated with anther abortion.

In other species some male sterile conditions can be chemically reverted to form fertile flowers. The practical utility of such a situation were it uncovered in corn is enormous. A report on our attempts to reach this objective is also presented.

The structural relationships between mesophyll and bundle sheath cells in *Atriplex* leaves

A. A. KROUGLICOF and R. E. DENGLE

Department of Botany, Life Sciences Division, Scarborough College, University of Toronto, Toronto, Ontario.

The quantitative leaf anatomy and plasmodesmatal frequencies were compared in one C-4 species, *Atriplex rosea*, and two C-3 species, *A. hortensis* and *A. hastata*. Anatomical parameters such as vein length per leaf surface area, ratio of inner exposed surface area to outer exposed surface area, percentage of bundle sheath-mesophyll cell contact, total cell contact, and volume of bundle sheath cells per volume of leaf were examined. Fine structure analysis of three wall interfaces (bundle sheath-mesophyll, mesophyll-mesophyll, and bundle sheath-bundle sheath) showed no significant differences in the internal structure of the plasmodesmata or in the wall and cytoplasm adjacent to them, but the distribution and frequency of these intercellular connections differed.

The valve-cupule problem in the Fagaceae.
A.D. MACDONALD, Department of Biology, Lakehead University, Thunder Bay, Ontario P7B 5E1.

The female inflorescence of *Fagus grandifolia* is comprised of two flowers; one flower terminates the first-order inflorescence axis, the other flower terminates the second-order inflorescence axis. Each flower is flanked by two cupular valves each of which arise in the axil of a bract. The two valves flanking the flower terminating the first-order inflorescence axis represent second-order inflorescence axes and the two valves flanking the flower terminating the second-order inflorescence axis represent third-order inflorescence axes. The four valves remain discrete. Each female flower of *Quercus macrocarpa* terminates a second-order inflorescence axis and is surrounded by a continuous cupule. The cupule first forms as two primordia in the axils of each of the two transversal second-order bracts. These cupular primordia represent third-order inflorescence branches. The cupule-primordia become continuous about the pedicel by meristem extension. The cupules of *Fagus* and *Quercus* are homologous to the extent that they are modified axes of the inflorescence. This is the model to interpret the fagaceous cupule.

The evolution of form in grasses.
JACK MAZE, Department of Botany, University of British Columbia, Vancouver, B.C. V6T 1W5

The appendages in the spikelets of the grass *Andropogon gerardii* can be described in terms of developmental events that are found in leaves, i.e., apical, marginal and adaxial growth. The ubiquity of such phenomena makes it tempting to speculate that these events, which have been described in anatomical terms, are controlled by a common part of the genome. The presence of an appendage indicates activation, by modifier genes, of that part of the genome which controls these events; differences between appendages is the result of the activity of modifier genes which control the amount and type of expression of the common part of the genome. Developmental differences between *A. gerardii* and the Stipeae can also be described in terms of different amounts of apical, marginal and adaxial growth or the presence or absence of certain appendages. By these interpretations, the evolution of form in grasses would seem to be the result of evolutionary change in modifier genes.

Development and Ultrastructure of root nodules of *Elaeagnus umbellata*

WILLIAM NEWCOMB¹, D. BAKER² and J.G. TORREY²,
Biology Department, Queen's University at Kingston¹. Cabot Foundation, Harvard University, Petersham, Mass. U.S.A.²

Soil actinomycetes form nitrogen fixing root nodules on certain angiosperms including: *Myrica*, *Comptonia*, *Dryas*, *Alnus*, *Sherpherdia* and *Elaeagnus*. The typical nitrogen-fixing endophyte of *E. umbellata* bears spherical vesicles which are considered to be the site of the active nitrogenase enzyme, although direct evidence for this is lacking. Recently, an actinomycete endophyte from *E. umbellata* has been isolated and grown in pure culture. This *Frankia* sp. isolate causes typical early nodule formation. However, the nodules lack the ability to reduce dinitrogen and the plants die from nitrogen starvation. The endophyte in these ineffective nodules lacks vesicles. No

other differences are evident between the ineffective nodules and normal effective nodules. These observations provide further indirect evidence for the hypothesis that the vesicle is the site of active dinitrogen fixation in *Elaeagnus* nodules.

Conifers as subjects of developmental studies and some of the practical implications. J.N. Owens and M. Molder. Biology Department, University of Victoria, Victoria, B.C.

Developmental studies of apices were used to determine the onset and breaking of bud dormancy, relate apical changes with bud and shoot morphogenesis and determine the times and methods of cone initiation. Studies of microsporogenesis and pollen development have been used to determine the causes of pollen abnormalities and inviability. The development of pollination mechanisms shows relationships between species and is a means of determining the optimal time and method of pollination. Embryo development also shows relationships between species and often can be used to determine the causes of seed inviability. (This work was supported by NSERC and British Columbia and Canadian Forest Services).

The histology and histochemistry of sulfur dioxide induced injury in elongating pine needles.

K. E. PERCY and R. T. RIDING
Department of Biology, University of New Brunswick, Fredericton, New Brunswick.

Pinus banksiana and *P. strobus* seedlings were grown from bud break to bud set in air containing 5 ppm sulfur dioxide (SO₂). Histological and histochemical effects on elongating needles were evaluated. White pine was sensitive while jack pine was tolerant to 5 ppm SO₂. In white pine SO₂ caused a delay in the differentiation of tracheids and sieve cells. Mesophyll cell wall plication was altered. An increase in cell metabolism was indicated resulting in an acceleration of needle senescence. No macroscopic foliar symptoms of SO₂ injury were noted. (This work was supported by a contract with NSERC).

Ontogeny of potato tubers grown *in vitro*
R.L. PETERSON, and W.G. BARKER. Department of Botany and Genetics, University of Guelph, Guelph, Ontario.

Excised axillary buds from etiolated stolons of *Solanum tuberosum* L. var. Kennebec were cultured on modified White's medium with 12% sucrose. Tubers were initiated within 72 hrs. Samples of the original explant and tubers at several stages of development were examined by light microscopy, SEM, and TEM. Expansion of cortical and pith cells of several internodes basipetal to the stolon apex accounts for early tuber enlargement. Later, activation of the cambium and phellogen which originates in the epidermis and hypodermis, leads to further radial expansion. Pith and cortical cells store large amounts of starch and some protein. Vascular parenchyma cells have plastids with few internal thylakoids and either no or small deposits of starch. Numerous mitochondria are present in vascular parenchyma cells. Lenticels, which become prominent features of older tubers, form by extensive division of the phellogen below stomata.

Unicarpellate floral development in Potamogeton zosteriformis Fernald
U. POSLUSZNY

Department of Botany and Genetics, University of Guelph, Guelph, Ontario

Two populations of P. zosteriformis were sampled from marshes in Wellington County, Ontario and floral development was examined. As in other species of Potamogeton previously investigated (P. densus and P. richardsonii) a spike inflorescence was found on which from 6 to 20 flowers developed. These flowers developed their appendages acropetally; first 4 tepals followed by 4 stamens opposite the tepals. But, unlike any other Potamogeton species yet investigated (usually 4 carpels alternating with the tepal-stamen pairs) only a single carpel consistently develops on the central portion of the remaining floral meristem. The consequences of this observation for taxonomic, morphological and developmental studies within the Potamogetonaceae will be discussed. (This work was supported by N.S.E.R.C. grant A6260.)

Relationship between Antheridogens and Gibberellins in Fern Development.

ROSS B. PRINGLE. Chemistry and Biology Research Institute, Agriculture Canada, Ottawa.

Ferns provide useful models for studying the biochemistry and physiology of sex organ formation because their development is much simpler than that of higher plants. Gametophytes of ferns live independently of the sporophytic generation and can be grown in axenic culture under rigorously defined conditions of environment and nutrition. Antheridogen-A, isolated from Pteridium aquilinum, is capable of inducing antheridial formation on fern gametophytes from many members of the family Polypodiaceae, as well as members of the family Dicksoniaceae. Antheridogen A_{An}, isolated from the schizaeaceous species, Anemia phyllitidis has been characterized as a kind of gibberellin. These two types of antheridial inducers will be shown to be quite different by considering host range and chemical characteristics.

Xylogenesis and Apical dominance in flax
M.V.S. RAJU, Biology Dept., University of Regina
Regina, Saskatchewan, Canada S4S 0A2

Cotyledonary buds are released from inhibition after the removal of the epicotylary shoot. One of the buds when isolated from the hypocotylary axis remains inhibited. Xylogenesis occurs at the base of both buds. The absence of growth in the partially isolated bud is due to a lack of xylem continuity with the hypocotylary stele. The tracheary elements differentiated at the base of the inhibited bud are morphologically different from those of the bud which is released from inhibition and still attached to the hypocotyl. The buds in nondecapitated plants remain inhibited; occasionally, however, one or both buds grow spontaneously. At the base of the inhibited buds the xylem elements are poorly developed and are different in their morphology from those of the buds showing spontaneous growth. Differentiation of additional xylem elements does not occur in the cotyledonary axils after the buds have been excised in decapitated and nondecapitated plants. It can, however, be induced in decapitated plants by applying IAA and sucrose to the axil immediately after the bud has been removed.

Seasonal changes in long shoot apices of mature Pinus resinosa

R. T. RIDING

Department of Biology, University of New Brunswick, Fredericton, New Brunswick.

Branches were harvested from five trees throughout the growing season and the winter 'dormant' period. Branches were classified as potentially producing microsporangiate strobili or as being vegetative. Primordia formation ceased on both branch types during August. Greater seasonal variability in shape was found in apices from vegetative branches, where diameter increased markedly at the beginning of the growing season. There was also seasonal variation in total carbohydrates, proteins, and nucleic acids. Total carbohydrates were low in June and July peaking in October and November and then decreasing. Total proteins showed a complementary pattern being high in June, decreasing in August and then increasing in November and December. Staining for RNA decreased during the growing season in apices from vegetative branches. Apices from microsporangiate cone bearing branches showed an increase in staining for RNA in August. (This work was supported by an operating grant from NSERC).

The stomatal complex in the Pinaceae

R. T. RIDING, R. W. JOHNSON, G. A. RIMMER and A. RIMMER

Department of Biology, University of New Brunswick, Fredericton, New Brunswick.

The stomatal complex in Pinus strobus and P. banksiana was found to consist of at least 8 cells: 2 guard cells, 2 epidermal subsidiary cells, 2 polar subsidiary cells, and 2 hypodermal subsidiary cells. The subsidiary cells may divide during ontogeny yielding a varying number of subsidiary cells; however, the morphology of the complex is consistent from one stomate to another on the same plant and between plants growing in different habitats. A survey of other members of the Pinaceae found that this general description holds for other Pinus species and Picea species. In both cases there is a distinct hypodermal layer. In Abies and Tsuga it appears that mesophyll cells may occupy the position of the hypodermal subsidiary cells and, therefore, may function as part of the complex. Greater variability was found in these plants than in the pines investigated. (This work was supported by NSERC).

Vegetative bud development in Picea mariana during the growing season

G. A. RIMMER and R. T. RIDING

Department of Biology, University of New Brunswick, Fredericton, New Brunswick.

Apical buds from branches of two age groups of Picea mariana were sampled from June 12 to October 30. The buds were sectioned and examined cytohistologically. The apex progressed from a cone shaped structure to a flattened dome at the end of the growing season. Apical enlargement had commenced by the beginning of the study, however, needle formation did not begin until the first of August. The embryonic shoot elongated until the beginning of September and formation of primordia proceeded until the end of September. Changes in the total carbohydrates, proteins, and nucleic acids were also observed coinciding with changes in bud morphology. (This work was supported by an operating grant from NSERC).

The overwintering vegetative bud of Picea mariana

G. A. RIMMER and R. T. RIDING
Department of Biology, University of New Brunswick, Fredericton, New Brunswick.

Apical buds from first and second order branches of Picea mariana were sampled monthly from September until April. Although these buds showed no demonstrable succinic dehydrogenase activity, there were indications of cellular changes during this period. The buds were stained for total protein, carbohydrates, and nucleic acids. Although it has been reported elsewhere that cytohistological zonation is lost in the overwintering apex of other conifers, zonation was markedly evident throughout the period of study. (This work was supported by an operating grant from NSERCC).

Rhizome anatomy and silicon deposition sites in selected genera of the family Poaceae.

A.G. SANGSTER
Division of Natural Science, Glendon College, York University, Toronto, Ontario.

Deposits of silicon were detected in the rhizomes of genera belonging to the tribe An-dropogoneae by means of electron-probe micro-assay and scanning electron microscopy. These deposits were found to be confined to specific cell layers generally located either immediately outside the stele, or surrounding the larger central vascular bundles. Those Si-accumulating cells located outside the stele formed several layers which were endodermal-like both in their morphology and position in the rhizome. Comparisons among several genera illustrate the existence of a common basic depositional pattern with variations. The fact that these deposits may aid in structural and water retentive capacities would account for this pattern. (This study was supported by the N.R.C.).

Developmental studies on a corollaless mutant of tomato.

V.K. SAWHNEY. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan.

A single gene recessive mutant - corollaless (cs/cs) of tomato (Lycopersicon esculentum Mill.), produces abnormalities in the development of petals and stamens. The petals are sepal-like i.e. they are green and relatively more pubescent than the normal. Stamens appear to be absent but a closer examination reveals that they are infact modified to form carpel-like structures. The carpelloid-stamens possess a distal styler part and a basal swollen part which contains ovules. These structures also adhere closely to the central pistil thus the ovary appears to be multilocular. The ontogeny of petals and stamens in the mutant and normal flowers and the effects of low temperature on the differentiation of mutant flowers will be discussed.

Root-rhizosphere interaction in Rubus chamaemorus L.

D.R. SAVORY and A.K. BAL
Department of Biology, Memorial University of Newfoundland, St. John's, Nfld. A1B 3X9

Rhizoplane-rhizosphere microorganisms have

become increasingly important in studying the growth and development of plants. Rhizoplane microorganisms were found in root apices of Rubus chamaemorus L. (Bakeapple), in both naturally-occurring and greenhouse-cultivated plants. Roots were prepared for transmission electron microscopy, which revealed bacteria at the surface and within cells of the proto-derm and root cap. Septate hyphal structures could be seen within and between cells of the epidermis and the outer cortex. Dense cells have also been described in the root apices of this species. Histochemical tests using light and electron microscopy indicate that the density of these cells is due to the presence of phenolic compounds, which are particularly abundant in cells of the proto-derm, epidermis, and outer cortex. It is probable that these phenolics play a role in controlling the extent of infection by rhizoplane-rhizosphere microorganisms. (Supported by Agriculture Canada Operating Grant.)

Regeneration in Anemone patens L.

T.A. STEEVES and T.D. BETHUNE
Department of Biology, University of Sask. Saskatoon, Saskatchewan, S7N 0W0

Unlike many prairie species, Anemone patens does not propagate vegetatively. It has been observed, however, that regeneration of shoots from roots can occur following extensive injury. The original observation was made at a site at which plants had been excavated for morphological study. Two years later numerous small plants were observed in the still visible holes. These proved to be shoots regenerating from small roots left when the plants were dug. Anatomical study showed proliferation of peripheral stelar tissues. The shoots had arisen from organized centres in the proliferated region. Experiments have shown that if plants are excavated in the spring while actively developing, visible regeneration may occur in two months. If, however, the plants are dug in the late summer there is no visible regeneration until the following spring. Attempts are being made to determine the significance of regeneration of this type to the survival of A. patens in nature. (This work was supported by NSERC.)

Cell wall-bound proteins - vital elements in development, lectins or incidental secretions?
IAIN E. P. TAYLOR, Department of Botany, University of British Columbia, Vancouver, B.C.

Several enzymes have been identified in plant cell walls, but their roles are not understood. The acid-loosening hypothesis for cell wall extension includes a mechanism in which the protons act by activating a cell wall-bound enzyme which cleaves specific bonds to loosen the wall and thereby allow expansion. Other proteins are known to have some chemical similarity to lectins. Some cell wall protein appears to have a structural function.

I argue that the cell wall should be viewed, not as an inert box but, as having analogy with connective tissue matrix in animals. Cell wall proteins (enzyme, lectin or structural) are produced as part of normal developmental sequences and their action may be regulated by control of their binding to wall matrix. (Supported by NSERC of Canada)

Synanthie dans le genre *Syringa* (Oleaceae); contribution au problème des fusions.

J. VIETH, Institut botanique de l'Université de Montréal, Qué.

Plusieurs Lilas du Jardin Botanique de Montréal (certains individus de *S. villosa*, *S. prestoniae*, *S. vulgaris* et *S. amurensis*) produisent régulièrement beaucoup de fleurs pléiomères. Du fait que cette anomalie, par sa fréquence et une certaine régularité, semble morphologiquement significative, un examen a été effectué: tracé du diagramme de panicules entières indiquant à la fois l'emplacement des fleurs aberrantes et le degré de la pléiomérie; évaluation minutieuse des coupes sérieées de fleurs plus ou moins fortement pléiomères. Les données accumulées au cours de ces investigations mènent à la conclusion que la pléiomérie doit résulter ici de vraies synanthies et que ces fusions s'inscrivent dans une évolution visant la simplification des panicules généralement très ramifiées des Lilas.

Modification of Balsam Fir needles by the midge, *Paradiplosis tumifex* (Gagné) (Diptera:Cecidomyiidae).

R.J. West, Laurentian University, Sudbury, Ontario.

P. tumifex oviposits on needles within flushing buds of balsam fir. Changes in the morphology of host needles occur soon after the larvae begin feeding. The mesophyll of galled needles shows hypertrophy and hyperplasy, but in contrast to most galls, the specialized nutritive zone does not appear. Another cecidomyid, *Dasineura balsamicola*, also inhabits maturing *P. tumifex* galls, but has little influence on normal gall morphogenesis.

Aspects of the microfungal flora of heavy metal contaminated soils.

A. CARTER

Department of Botany, University of Toronto, Toronto, Ontario, M5S 1A1.

Employing the soil dilution technique of fungal isolation, the floras of 2 heavy metal contaminated and 2 non-contaminated sites near Sudbury, Ontario were examined. The numbers of propagules per g soil, the numbers of species isolated, as well as species diversity indices were recorded for each site. Edaphic factors such as pH, percent organic matter, percent moisture and heavy metal content were also determined at each site. The results showed that, in comparison with the non-polluted sites, the floras of the heavy metal soils were reduced in all aspects. Also, in the floras of both heavy metal soils, high species importance values were associated with *Penicillium waksmanii*. In contrast, comparable values were not noted in the floras of the non-contaminated soils.

Development, ultrastructure and taxonomy of pycnidial and acervular fungi

G.T. COLE¹ and F. DICOSMO²

Department of Botany, University of Texas, Austin, Texas and Department of Biology, University of Waterloo, Ontario

The pycnidial and acervular fungi (Coelomycetes) are an important group of plant pathogens and saprophytes which have received less than their deserved recognition from biologists, including most mycologists. An extensive investigation of the mechanisms of conidiogenesis and ontogenetic aspects of the asexual fruiting bodies (conidiomata) in these fungi is underway. Many developmental and ultrastructural characters are taxonomically significant and have supported or necessitated revision of earlier generic and species concepts.

Mycology Section

Southern Ontario ferns and fern-allies: their endomycorrhizae and associated Endogonaceae.

S.M. BERCÉ

Department of Biology, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada.

Forty species of ferns and fern-allies were examined for the presence of vesicular-arbuscular mycorrhizae and the surrounding soil sieved for spores and sporocarps of the Endogonaceae. The ferns proved to be extensively endomycorrhizal, although certain exceptions were observed. Ferns from isolated habitats such as rock surfaces (*Polypodium virginianum* L.) and crevices in limestone cliffs (*Asplenium trichomanes* L.) were not mycorrhizal. The fern-allies *Equisetum* spp. and *Lycopodium* spp. had well-developed root-hair systems but no mycorrhizae. A similar negative correlation between extent of root-hair and endomycorrhiza development was noted throughout the range of ferns observed. Variation in the morphology of endomycorrhizae formed may be related to the diversity of Endogonaceae spores extracted from single soil samples. Spores of Endogonaceae were abundant, represented primarily by species of *Glomus* Tul. & Tul. Several undescribed taxa were collected and characterized.

Pycnidial development and ultrastructure in *Chaetomella acuseta* (Coelomycetes)

F. DICOSMO¹ and G.T. COLE²

Department of Biology, University of Waterloo, Ontario¹ and Department of Botany, University of Texas, Austin, Texas²

Development of pycnidia (conidiomata) of *C. acuseta* var. *acuseta* were observed in pure culture and on a natural substrate (*Quercus texensis*) using light and scanning electron microscopy. Examinations of intact and sectioned pycnidia at early stages of ontogeny suggest that setae play a significant role in the initiation of pycnidial morphogenesis. Later, additional setae are formed as hyphae aggregate in a parallel arrangement giving rise to oblong pycnidia on the surface of the substrate. A cavity develops within the pycnidium as the internal hyphae differentiate into conidiophores.

Isoelectric focussing technique for characterization of lichen protein.

D. FAHSELT

Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7.

Until recently the only method used for isolating total protein from lichens necessitated denaturation during the extraction procedure. Since proteins were solubilized using strongly acidic solutions and separated electrophoretically in an acidic medium only the more basic proteins could be observed. By breaking hyphae mechanically instead of chemically and using isoelectric focussing to separate proteins, it has become possible to separate bands of acidic protein which have retained their biological activity. This method may be applied to systematic problems in lichens.

Teratological galls on the mushroom Collybia dryophila.

J. GINNS and S. SUNHEDE

Biosystematics Res. Inst., Canada Agric., Ottawa and Univ. Göteborg, Sweden

Collybia dryophila (Fr.) Kummer has for many years been known to bear galls. The gall formation has been explained as a reaction to excessively wet growing conditions and overmaturity of the mushroom. Our examination of specimens from Canada, Denmark, Sweden and the U.S.A. led to the conclusion that there are three fungi (all species of Christiansenia Hauerslev) parasitizing the mushroom and causing the galls to develop.

Zoospore ultrastructure of Nowakowskiella elegans (Chytridiales)

C.J. LUCAROTTI

Biology Department, McGill University, 1205 Avenue Docteur Penfield, Montreal, Quebec H3A 1B1

The zoospores are spherical, 8µm in diameter, and posteriorly uniflagellate. The lipid body, 3µm diameter, is in a lateral position with a quarter of its surface covered by a rumposome adjacent to the zoospore surface. Towards the centre of the zoospore a microbody lies between the lipid body and the nucleus which contains a dark staining nucleolus. The nucleus is covered on its other side by a cap of ribosomes which has numerous mitochondria closely appressed to its periphery. The zoospore of N. elegans is of the Rhizophydium - Chytridium type (Bio Systems 10:153, 1978). (Research support from, Sigma Xi and McGill University Faculty of Graduate Studies and Research).

Otiorhynchus sulcatus (Fr.), a new host to Beauveria bassiana (Bals.) Vuill.

M. I. TIMONIN

Biology Department, Carleton University, Ottawa, Ontario K1S 5B6.

Among the entomopathogenic fungi, B. bassiana is considered as a wide "spectrum" insect pathogen. It is able to parasitise a number of members of the Curculionidae family. In this investigation it was found that B. bassiana parasitized eggs and larvae, as well as adults of Otio. sulcatus. It was also found that Alternaria sp. was able to kill eggs of the insect, but not the larvae or adults.

Gold mine fungi

JAMES A. TRAQUAIR and JOSEPH F. AMMIRATI

Agriculture Canada Research Station, Lethbridge, Alberta, and Botany Department, The University of Toronto, Erindale College, Mississauga, Ontario.

Despite the use of wood preservatives, decay of timbers is a serious problem in an Ontario gold mine near Kirkland Lake. Constant warm and humid conditions in the mine provide an ideal environment for the growth of wood-inhabiting basidiomycetes. The primary causal agents are identified as Lentinus lepideus Fr. and Poria vaillantii (D.C.) Fr. on the basis of basidiocarps produced in the mine and cultures isolated from the brown, cuboidal rot. Other basidiomycetes collected include Gloeophyllum saepiarium (Wulf.) Karst., Fomitopsis cajanderi (Karst.) Kotl. & Pouz., and Melanotus hartii Ammirati. The latter fungus is a new species occupying a unique habitat. Presumably, untreated material is the source of infection by these fungi whose spores are dispersed throughout the mine by way of the forced-air ventilation.

Art. 59 of the Code of Botanical Nomenclature: new terms and proposals for revision

L.K. WERESUB, Biosystematics Research Institute, Agriculture Canada, Ottawa K1A 0C6

At the International Mycological Congress in Tampa, 1977, the Nomenclatural Secretariat's Subcommittee on Art. 59 reported on proposals for revision of this article, which regulates the naming of non-lichenized Ascomycetes and Basidiomycetes with a pleomorphic life-cycle. These proposals will be submitted to the mycological community for a vote at the next International Botanical Congress. To stimulate discussion, an explanation is presented here of the terms used (HOLOMORPHOSIS: the whole fungus in all its forms; ANAMORPHOSIS: the asexual form; TELEOMORPHOSIS: the sexual form), and of the proposals themselves, with examples to illustrate the effect they will have on the nomenclature of pleomorphic fungi. In addition, a distinction is made between the ANAMORPH-TAXON (in the anatomical system of nomenclature for Fungi Imperfecti) and the FORM-TAXON (best restricted to fossilized material too fragmentary for botanical classification).

Preliminary results of epilithic algal nitrogen fixation in the Muskeg River, Alberta
S.E.D. CHARLTON and M. HICKMAN. Department of Botany, University of Alberta, Edmonton, Alberta T6G 2E9.

Nitrogen fixation by an epilithic algal community in a brown water tributary of the Athabasca River (pH 6.2-8.4) was determined using the acetylene-reduction technique. Mean fixation rates (bacteria plus blue-green algae) were 46.6, 38.0 and 5.58 p moles cm⁻² for mid-stream, shore and artificially shaded sites respectively. Shading reduced the total irradiance by 50 to 80%. Incubations performed in the dark and light indicated the importance of the bacteria. Maximum algal fixation coincided with maximum algal standing crop during spring and autumn. Nitrogen fixation declined to undetectable levels during ice cover. (This work was supported by the NRC and the Alberta Oil Sands Environmental Research Programme).

Distinct strains of the red alga *Chondrus crispus*
L. C-M. CHEN¹ and A.R.A. TAYLOR²
Atlantic Regional Laboratory, N.R.C.C., Halifax N.S.¹ and Department of Biology, University of New Brunswick, Fredericton, N.B.²

Two geographically isolated populations of *Chondrus crispus* Stackh., from Cape d'Or in the Bay of Fundy and Cheticamp Island in the Gulf of St. Lawrence, were shown by field and laboratory studies to be separate strains, isolated also in morphology and habitat. The fronds differ in shape, width, branching pattern, texture, internal structure and arrangement of tetrasporangial sori, and the plants occur in different habitats, littoral and sublittoral respectively.

Culture studies of two distinct strains of the red alga *Chondrus crispus*
L. C-M. CHEN¹ and A.R.A. TAYLOR²
Atlantic Regional Laboratory, N.R.C.C., Halifax N.S.¹ and Department of Biology, University of New Brunswick, Fredericton, N.B.²

A broad-frond strain of *Chondrus crispus* from the Bay of Fundy, and a narrow-frond strain from the Gulf of St. Lawrence were grown simultaneously in controlled culture from both tetraspores and carpospores. Their development and morphology were described. The life history of the 'broad' strain was completed in culture within 18 months. Male and female gametophytes grew from wild plant tetraspores of the 'narrow' strain, carposporophytes developed, and presumed tetrasporophytes arose from carpospores, but tetrasporangial sori could not be induced over a period of 4 years under a considerable variety of conditions. In culture, both strains continued to show the morphology characteristic of their wild parent populations. There was considerable morphological plasticity in response to varying the temperature, photoperiod and aeration. However, when cultured together in the same vessels for 10 months in 2 different sets of conditions, the two strains remained distinct.

Rearing British Columbia Laminariales for kombu
L. DRUEHL, Bamfield Marine Station, Bamfield, B.C., VOR 1B0.

Field and laboratory studies are being conducted to establish the biotechnology necessary to establish an edible kelp industry. Manipulation of gametophyte culture conditions delays gametogenesis and allows for the eventual cloning of gametophytes. Crossing of cloned gametophytes produces a genetically uniform sporophyte generation for rope culture in the sea. Optimal field conditions for sporophyte development are defined by transplanting wild and laboratory reared sporophytes. (This work is supported by the Marine Resources Branch, B.C. Government.)

A revised classification of the Bangiophyceae (Rhodophyta)

D. J. Garbary, G. I. Hansen and R. F. Scagel
Department of Botany, University of British Columbia, Vancouver, B. C., V6T 1W5

A revised classification is presented for the class Bangiophyceae incorporating seven families in four orders: Porphyridiales, Erythropeltidiales, Bangiales and Rhodochaetales. The principal changes include: 1) a new circumscription of the two families in the Porphyridiales based on chloroplast structure and the presence or absence of pyrenoids, 2) the delimitation of the Erythropeltidiales to include the Erythropeltidaceae, Boldiaceae and Compsonemataceae, and 3) the separation of the Bangiaceae as a monotypic order based on life histories and the presence of pit-plugs. Problems in establishing relationships within the Porphyridiales are discussed, and the need for further ultrastructural studies is emphasized.

Systematics & Phytogeography Section

Some problems with oaks in Southern Ontario.
P.W. BALL, Erindale College, University of Toronto, Mississauga, Ontario.

Investigations of variability in *Quercus velutina* (Black Oak) in S. Ontario have revealed that a small disjunct colony of *Q. ellipsoidalis* (Hill's Oak) has been mistaken for this species. This colony of *Q. ellipsoidalis* occurs in southern Waterloo Co. and northern Brant Co. and seems to have been the origin of records of *Q. coccinea* (Scarlet Oak) from this area published by Herriott and Montgomery. *Quercus ellipsoidalis* and *Q. velutina* sometimes occur together in this area and some individuals may be interspecific hybrids.

Quercus prinus (Chestnut Oak) has been reported from several localities in S. Ontario. Investigations in herbaria and in the field have failed to locate a single Canadian specimen. Most specimens so labelled seem to be individuals of *Q. muhlenbergii* with rounded leaf teeth.

Little attention is given to hybridisation in the genus in Canada. Casual field observation suggests that the following may not be uncommon where the parent species occur together: *Q. macrocarpa* x *bicolor*, *Q. rubra* x *velutina* and *Q. ellipsoidalis* x *velutina*.

Evolutionary and taxonomic relationships in North American Stipeae.
M.E. BARKWORTH, Utah State University, Logan, Utah, 84321, U.S.A.

The Stipeae is a small, cosmopolitan tribe of temperate grasses whose affinities are unclear. In North America it is represented by three genera, Stipa, Oryzopsis and Piptochaetium, which, together, comprise about 45 species. Of the three genera, Stipa is by far the largest, both in North America (ca. 30 species) and in the rest of the world. Evidence is accumulating that there are at least two lineages within North American species of Stipa. The large-glumed stipas (Sect. Hesperostipa) appear, on the basis of their morphological, anatomical and cytological characteristics, to be more closely related to species of Piptochaetium, particularly of Sect. Podopogon. The remaining species of Stipa cannot, at this stage, be placed in similar homogeneous groupings but the data suggest that many of them are more closely allied to species of Oryzopsis than they are to the species of Stipa Sect. Hesperostipa.

Patterns of flavonoid evolution in the herbaceous Saxifragaceae.
B.A. BOHM, R.J. GORNALL, J.M. MILLER and E.F. WELLS.

Department of Botany, The University of British Columbia, Vancouver, B.C. V6T 1W5.

Studies of eighteen genera of herbaceous Saxifragaceae have shown flavonols to be the predominant flavonoid type and that they occur in a variety of glycosylated forms. Flavones and dihydroflavonols are of much more restricted occurrence. Several chemical features, e.g. myricetin, 4'-O-glycosylation, 3,7-triglycosylation appear scattered in the family reminiscent of the morphological and cytological parallelisms commonly seen, e.g. smooth vs. echinate seeds, 10 vs. 5 stamens, entire vs. cleft petals. Within more closely allied groups of taxa significant distributions of these compounds may exist: (1) between species pairs in Heuchera; (2) between sections Alternifolia and Oppositifolia (sensu Franchet) of Chrysosplenium; (3) between Boykinia and related genera (Suksdorfia, Telesonix); and between Mitella and related genera (Bensoniella, Conimitella). Support from the NRC, the Killam Foundation and the Research Committee (UBC) is acknowledged.

A solution to the classification problems within the genus Aster.

L. BROUILLET and J.C. SEMPLE. Department of Biology, University of Waterloo, Waterloo, Ont.

The genus Aster (Compositae-Astereae) has always presented major classificatory problems due in part to the use of polyphyletic characters, or the inconsistent application of otherwise good characters in the delimitation of sections. Phyllary characters appear promising in respect to the delimitation of subgeneric groups of Aster. The location and extension of the chlorophyllous zone, the presence or absence of a keeled midrib, the nature of the marginal hairs and the surface texture suggested a division of the species of Aster into seven subgenera. Other morpho-anatomical and karyological traits agree with

this repartition. The effectiveness and significance of this new classification scheme are considerable. Many traditional species relationships have been disrupted, but the homogeneity of each section and subgenus increased.

Taxonomic studies in Agalinis Raf. (Scrophulariaceae).

J.M. CANNE

Department of Botany and Genetics, University of Guelph, Guelph, Ontario.

Agalinis consists of about 30 species of annual, root hemiparasites in eastern Canada and the U.S.A. Sectional and subsectional disposition of species as well as delimitation of species has been aided by light and scanning electron microscope investigations of seeds, corollas, and leaves. Trends in seed shape, size, anatomy and colour are of taxonomic value. Patterns of thickenings on the inner tangential walls of the outer cell layer of seeds are diagnostic for most species. Trends in seed features correlate with variation in leaf morphology and anatomy, and with variation in pubescence of the corolla and corolla shape. The taxonomy of closely related taxa, such as those of the A. purpurea complex of eastern Canada, is made difficult by the intergradation of the morphological features traditionally used to characterize these taxa. Additional features of the capsules, seeds, anthers and seedlings have been employed to delimit Agalinis paupercula, A. neoscotica and A. purpurea.

Morphometrics of autumn-flowering Spiranthes spp. in southern Nova Scotia

P. M. CATLING, Department of Botany, University of Toronto, Toronto, M5S 1A1, Ontario.

Thirty-six morphological features were measured in ca. 200 individual Spiranthes plants selected to include the extremes of variation present at each of 10 localities in southern Nova Scotia. Analysis of variance in clusters existing at low levels of dissimilarity in a distance phenogram (UPGMA) resulted in computation of an "F" statistic for each character. These "F" statistics were used to produce a weighted data matrix from which a matrix of correlations among characters was computed. A principal components analysis (PCA) was performed which clarified the separation of 4 groups vaguely apparent in the PCA derived from correlations based on unweighted data. Discriminant analysis of clusters from the distance phenogram also gave 4 distinct groups. Current treatments recognize 3 autumn-flowering Spiranthes taxa in southern Nova Scotia, corresponding to 3 of the 4 clusters. The 4th taxon, although it is a polyploid apomict, is sufficiently distinct morphologically and ecologically to be worthy of specific rank.

Southern elements of the Vancouver Island flora
A. CESKA and O. CESKA

Ceska Geobotanical Research Co., Victoria, B.C.

Oceanic climate and a rain shadow of the Olympic and Vancouver Island Mountains account for the occurrence of southern elements in the Vancouver Island flora. Many species reach their northern limit of distribution here and some of them have disjunct ranges with the closest localities in Oregon. A small group of species which normally occur east of Cascade Mountains contributes to the phytogeographic

anomaly of the area. The only species endemic to the area, *Limnanthes macounii*, may also belong to the group of southern elements; our knowledge of its distribution is so far very limited. Habitats in which the southern elements occur are disappearing quickly due to the urban development and more attention should be paid to their protection.

Computer editing of identification keys
A. CESKA¹ and A.D. TRUMPOUR²
Ceska Geobotanical Research Cg.¹ and University of Victoria, Computing Centre², Victoria, B.C.

There is a striking similarity between the structure of identification keys and the structure of programs written in APL language. Both schemes also face similar problems in respect to editing. In the APL system the editing problems are solved by the function editor which facilitates deletions, additions, re-ordering, etc. of the APL statements. We found it convenient to use this editing system and to build an identification key in the form of an APL function.

Needle flavonoids of *Abies balsamea*: identification and effects of needle age and crown position.
T.A. CLEVELAND and W.H. PARKER Department of Biology, Lakehead University, Thunder Bay, Ont.

The amount of evolutionary divergence between *Abies balsamea* and *A. lasiocarpa* is uncertain. To provide a supplementary set of characters for taxonomic comparisons, the needle flavonoids of *A. balsamea* were isolated and 19 of these identified as various mono- and diglycosides of 6 flavonol aglycones: syringetin, isorhamnetin, kaempferol, laricytrin, quercetin, and myricetin. Additional needle flavonoids include rhamnosylvitexin, 3 partially identified 7-O-glycosylated flavones and 2 dihydroflavonols. In addition, the effects on flavonoid composition of 1) needle age (year to year, and within season) and 2) position in the crown (upper, middle and lower) were investigated for a pooled sample of 25 trees taken from an even-aged stand of *A. balsamea* located near Thunder Bay. Qualitative variation in flavonoids dependent on either needle age or crown position was minimal. However, some flavonoids tended to disappear from the needles after one growing season.

Analysis of the Plant Remains from the Early Bronze Age Site at Lake Vouliagmeni, Perakhóra, Central Greece.
H.F. COHEN¹, D.W. WOODLAND¹, J.M. FOSSEY²
Department of Plant Science¹ and Department of Classics², McGill University, Macdonald Campus¹, Ste. Anne de Bellevue¹ and Montreal², Quebec.

The Early Bronze Age site at Lake Vouliagmeni, Perakhóra, Central Greece was excavated in 1965 and 1972 under the auspices of the British School of Archaeology at Athens. The 1972 excavations yielded a large number of mud-brick fragments found to contain plant impressions. Seven barley and five wheat floret impressions were identified; one well-preserved stalk fragment was also found. The relationship of these finds to past and present-day vegetation will also be discussed. (Supported by a Canada Council Special M.A. Scholarship.)

A study of 'prey' caught by three native carnivorous plant species

A.A. CROWDER and P.H. LANGLOIS
Queen's University, Kingston, Ontario

The sizes and taxonomy of the animals caught by 3 species of carnivorous plants in a small bog (Hebert Bog, Frontenac Co., Ont.) were analyzed every 2 weeks during May-August 1978. Total catch per plant per season was estimated with marked populations, and expressed as number per leaf and per plant. The arthropods in the bog were also sampled throughout the season using 4 techniques. The catches of the 3 species were compared to this spectrum by size, taxonomy, and the time of capture. Finally, the degree of overlap between the 3 species was examined.

(This work was supported by N.R.C.)

Hybrid origin of Thunder Bay populations of *Bidens connata* (Asteraceae)

D.R. CROWE and W.H. Parker, Department of Botany, University of B.C., Vancouver, B.C. and Department of Biology, Lakehead University, Thunder Bay, Ontario

Four taxa of *Bidens* are common in Thunder Bay: *B. cernua*, *B. frondosa*, *B. vulgata* and *B. connata*. Since *B. connata* is intermediate in gross morphology and ecological preference between *B. cernua* and *B. frondosa*, an investigation was undertaken to determine whether *B. connata* is of hybrid origin. Representative specimens of the 4 taxa were scored for 27 morphological characters, and these data analyzed by Principal Coordinates Analysis. Chromosome counts, seed germination trials, and pollen viability tests also were made. Morphological, distributional and cytological data indicate that *B. connata* (2n=36) is the result of a hybridization event(s) between *B. cernua* (2n=24) and *B. frondosa* (2n=48). Since *B. connata* produces viable seed and stainable pollen that apparently is derived mitotically, Thunder Bay populations of *B. connata* evidently comprise an agamic complex.

Variation in *Caulophyllum* (Berberidaceae).

WILLIAM G. DORE

60 Carlyle Ave., Ottawa, Ontario K1S 4Y4

Two entities differing in size, color and attitude of floral parts are recognized at the species-level in N. Am. *C. thalictroides* also differs in reaching peak bloom about 12 days after *C. giganteum*. No intermediates have been noticed, but one anomalous plant with proliferous stamens, producing seeds but no pollen occurs adjacent to both species at Ottawa and may be of hybrid nature. Interpretation of maps indicate that *C. thalictroides* survived glaciation along a broad front and has the wider distribution today. *C. giganteum* seems to have evolved in post-Wisconsin time at some point in West Virginia, spreading eccentrically and more rapidly northward into Ontario and Quebec. *C. thalictroides* shows close similarity to the eastern Asian variety.

(Study conducted at Bio-systematic Research Institute, Canada Agriculture, Ottawa.)

Biosystematic studies in the Lotus corniculatus group

W.F. GRANT

Genetics Laboratory, Macdonald Campus of McGill University, Ste. Anne de Bellevue, Quebec H9X 1C0

The biosystematic affinities of the diploid species ($2n=12$) closely related to the tetraploid cultivar, Lotus corniculatus L. ($2n=24$) are still very limited. In species hybrids almost normal chromosome pairing occurs, hence as may be judged from pollen fertility cryptic structural differences between chromosomes are not revealed. Two dimensional chromatography of species, hybrids and amphidiploids has helped resolve relationships.

Les affinités biosystématiques des espèces diploïdes ($2n=12$) étroitement apparentées au cultivar tétraploïde Lotus corniculatus L. ($2n=24$) sont encore assez mal définies. Chez les hybrides, l'appariement des chromosomes s'effectue presque normalement, mais si l'on se réfère à la fertilité pollinique, il appert que de fines différences de structure entre les chromosomes ne sont pas révélées. Des études chromatographiques effectuées chez des espèces, des hybrides et des amphidiploïdes ont contribué à la définition de ces rapports.

The vascular hydrophytes of South River, Quebec Canada - A five year study.

C. HAMEL and P. BHEREUR

Département des Sciences biologiques, Université du Québec à Montréal.

A five year study was undertaken concerning the change of vegetation cover in the South River which is an important tributary of the of Richelieu River. The results obtained from quadrats along belt transects, showed that the species of vegetation cover are about the same except for the dominant taxa. In 1974 the dominant species were Eloдея canadensis and Ceratophyllum demersum, which were replaced in 1978 by Vallisneria americana and Heteranthera dubia. (Supported by Environ. Canada and F.C.A.C.)

L'étude porte sur l'évolution de la couverture végétale de la portion terminale de la rivière du Sud, sur une période de cinq ans. Les résultats obtenus à partir de quadrats effectués sur des transects, montrent que les espèces formant le couvert végétal n'ont presque pas changées; cependant, les espèces dominantes en 1974, soit Eloдея canadensis et Ceratophyllum demersum, sont remplacées en 1978 par Vallisneria americana et Heteranthera dubia. (Subventionné par Environ. Canada et F.C.A.C.)

Floristic Studies in Northern Saskatchewan
V.L. HARMS

Fraser Herbarium, Departments of Plant Ecology and Biology, University of Sask., Saskatoon.

Northern Saskatchewan has remained poorly explored botanically. Recent floristic surveys along La Ronge-Southend-Wollaston Lake Roads (Hwys. 102 & 105), the eastern Churchill and Reindeer Rivers, Wollaston Lake, Cluff Lake, etc., have added considerably to the distributional knowledge of vascular plants of northern Saskatchewan, including various significant range extensions and new species records. These inventories establish a better basis for phytogeographical interpretations of the Saskatchewan flora. (Supported by Saskatchewan Dept. of Environment, Gulf

Minerals Canada, Ltd., Institute for Northern Studies and President's Supplementary Research Assistance, University of Saskatchewan.)

Prospects for the cultivation of sweetgrass (Hierochloa odorata).

M.J. HARVEY, F.B. GOLDSMITH and S.L. MURPHY.
Department of Biology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1

Hierochloa odorata is a wetland grass widely distributed across the cooler regions of the northern hemisphere. In the Maritimes it is mostly confined to the upper regions of salt-marshes where it appears to be exploiting the tension zone between the saturated soil of the marsh and the drained edge of dunes or hinterland. It thus escapes competition from both Spartina and Ammophila. Mic-Mac Indians have by long tradition incorporated the leaves into woven baskets and increased sales to tourists have led to local extinctions of the grass. Trials of plants from a number of localities under several cultivation regimes are being carried out to see whether the grass can be successfully cultivated. Preliminary results are that it responds well to nitrogenous fertilizers and spreads readily by rhizomes. (Supported by the Department of Indian and Northern Affairs).

A new set of visual color standards for biologists: the need and the response.

W. I. ILLMAN¹ and KENT H. MCKNIGHT²

ELBA, Carleton University, Ottawa, Ontario¹ and Agricultural Research Center, Beltsville, Maryland².

Inaccessibility, non-reproducibility and perceptible changes in copies of Robert Ridgeway's Color Standards and Color Nomenclature indicate that continued use of this popular work to define the visual colors of biological specimens is ill advised.

Designating related colors, occupying a block of color space, by a meaningful descriptive name which the reader easily visualizes is the basis of the ISCC-NBS Universal Color Language. Standards which represent the central color of each of these blocks are readily available to biologists from the authors — the Centroid Color Charts. How they may be used and how the Color Committees of MSA and ESA plan to incorporate and adapt them in a new versatile set of color charts will be demonstrated.

D. JACQUES and C. HAMEL, Université du Québec à Montréal. Photo-interpretation of aquatic and riparian vegetation.

Aerial photography using color and color infrared film was tested on the Upper-Richelieu for its ability to differentiate between aquatic or riparian plant species. By studying tone and texture combined with stereoscopic observation, vegetative types were easily identified. Density, growth pattern, boundary form, configuration of the stand, as well as species characteristics, all provide important clues for the identification of many species; especially those that tend to form monospecific stands.

Une étude dans le secteur du Haut-Richelieu a été effectuée utilisant les émulsions couleurs et infrarouge couleurs pour déterminer les possibilités offertes par la photographie aérienne dans l'identification de la végétation aquatique. L'analyse des éléments teinte et texture de l'image stéréoscopique nous permet de différencier les formes de vie. Combinée à l'étude des autres caractéristiques des groupements (densité, patron de croissance, formes et contours, biologie de l'espèce, etc.) l'analyse permet d'identifier plusieurs espèces de plantes aquatiques et ripariennes.

The biology of the pollen morphs of Silene alba.

J. McNEILL, Biosystematics Research Institute, Agriculture Canada, Ottawa, Canada, K1A 0C6

Populations of Silene alba have been found to be uniform with respect to pollen type, having pollen with either a reticulate ectexine (type V) or a punctate-tubuliferous one (type II). Hybrids between plants from populations with different pollen types are fully fertile, the reticulate pollen type being dominant. The two pollen types occur widely in North America but plants with type V pollen have not been found in the prairie provinces of Canada or in the midwestern United States. In southern Europe, where the species is native, there appears to be a geographical separation, pollen type II occurring in the east and type V in the west. It appears that the two pollen morphs have been introduced repeatedly into northern Europe and North America, type V from southwestern Europe and type II from further east in Eurasia. The apparent inability of plants of pollen type V to survive in areas with very severe winter temperatures, supports the hypothesis of their introduction from a region such as southwest Europe.

Implications of morphological and anatomical variation in Abies lasiocarpa and A. balsamea from western Canada
W.H. PARKER, J. MAZE, G.E. BRADFIELD, AND S.-C. LIN Dept. of Biology, Lakehead University, Thunder Bay, Ontario and Department of Botany, U.B.C., Vancouver, B.C.

Abies balsamea and A. lasiocarpa are closely related taxa that are generally thought to hybridize and intergrade where their ranges overlap in west-central Alberta. To test this hypothesis, a series of collections was made from 10 populations along an east-west transect between western Saskatchewan and central British Columbia. Each tree was scored for various anatomical, vegetative, and cone characters. The resulting data were analyzed by Principal Components Analysis and Canonical Variates Analysis. The results suggest that variation among the 10 populations of firs is not consistent with the conventional two-species interpretation. Rather, the data seem to reflect population differentiation within a single species in response to local selection pressures, instead of gene flow associated with introgression between two species as formerly assumed.

Association analysis of successional forest in an Eastern Ontario watershed

W.J. ROFF¹, R.N. STARLING² and A.A. CROWDER¹
¹Biology Department, Queen's University, Kingston, Ontario. ²Center for Northern Studies, Wolcott, Vermont 05080 U.S.A.

The arboreal vegetation of the Salmon River watershed in Southeastern Ontario was sampled by means of the random pairs method of Cottam and Curtis. The data was analysed using a polythetic division technique. The resulting groups were mapped and their distribution interpreted on the basis of physiography and land use history. (This work was supported by N.R.C.).

Systematic Studies in Impatiens (Balsaminaceae) in Northeastern North America.

A. RUSSELL and D.W. WOODLAND
Department of Plant Science, McGill University, Macdonald Campus, Ste. Anne de Bellevue, Quebec

Within the region under consideration, the genus Impatiens includes two species and several subspecific taxa. These were evaluated using biosystematic techniques. Most significantly analyses of secondary phenolic compounds indicated the presence of a possible marker compound in I. pallida which was absent in I. capensis. Other biosystematic evidence supporting the separation of the two species will be discussed. (Supported by a Quebec Bursary.)

Dans la région considérée, le genre Impatiens comprend deux espèces et plusieurs taxons sous-spécifiques qui furent évalués selon des méthodes biosystématiques. L'analyse des composés phénoliques secondaires s'est révélée significative pour un composé phénolique présent chez I. pallida, mais absent chez I. capensis. D'autres données biosystématiques nous permettant de séparer les deux espèces seront également discutées. (Subventionné par une bourse du Québec).

The phylogenetic relationships of the X=5 and X=4 asters of North America: a radical view

J.C. SEMPLE and L. BROUILLET
Department of Biology, University of Waterloo
Waterloo, Ontario, Canada N2L 3G1

The cytology, morphology and distribution of ten X=5 and one X=4 species of asters in North America indicate that these eleven species are closely related to each other, but not to the X=9,8 and 7 species of Aster. A new genus is being described to encompass these species, since they have always been previously included in Aster L. and no other generic name exists. Although very different in mid stem leaf morphology and head and phyllary size, the eleven species of the new genus have similar basal rosette leaves, achenes, disc florets and identical karyotypes. Although the rhizome varies between individuals, at least some plants in every species can develop a woody corm-like storage structure. Phyllary variation forms a continuum as well from small, broad and eglandular to long thin and glabrous. Removal of the species from subgenus Aster leaves that taxon considerably more homogeneous morphologically and cytologically. Recognition of the new genus has necessitated a revision of subtribal level classification to a great extent.

The origin of Vaccinium corymbosum L.
(highbush blueberry)
S.P. VANDER KLOET
Department of Biology, Acadia University,
Wolfville, Nova Scotia.

441 highbush blueberry specimens of Vaccinium § Cyanococcus were collected from 48 sites in eastern North America. Numerical, cytological and experimental analyses suggest that the highbush group should be recognized as a single polymorphic species, namely V. corymbosum L. rather than the 12 species which Camp proposed in 1945. Furthermore I postulate that the group originated in northern Florida from a hybrid swarm which resulted when V. tenellum came into contact with V. darrowii during the Pleistocene. (This research was supported by NRC.)

Population differentiation in Plantago major L.
S.I. WARWICK
Biosystematics Research Institute, Agriculture
Canada, C.E.F., Ottawa, Ont.

Patterns of genotypic differentiation were investigated in 14 British populations of Plantago major collected from a) lawns and heavily grazed turf and b) grassy areas which were either not known to be grazed or mown or were infrequently mown as in the case of hay meadows. Standard cultivation trials indicated that individuals with a prostrate growth habit were characteristic of habitats subject to severe defoliation, whereas in areas not known to be regularly defoliated P. major was represented by plants of erect habit. The selective advantage of the prostrate growth form under defoliated conditions was demonstrated in a clipping experiment conducted in pots, a reciprocal transplant experiment of mown and tall grass treatments, and a trampling experiment. Preliminary investigations on Canadian populations of P. major have indicated similar patterns of differentiation.

Preliminary report on the flora of Perth County, Ontario
A. A. WELLWOOD
Department of Biology, Wilfrid Laurier University, Waterloo, Ontario

This survey of the vascular flora of Perth County extended over six summers during which the vascular plants in 230 selected stations were scored at approximately 4-week intervals during the growing season. It is expected that the species count will total approximately 1,000 including a number of carolinian species which extend into the southern portion of the County. Distributions of some species are presented and discussed. (This work was supported by the Canadian National Sportsmen's Show and by Wilfrid Laurier University research funds.)

SOME THOUGHTS ON ENDANGERED AND THREATENED PLANTS

There have been a number of popular books produced lately concerning endangered species. As a botanist, I know enough not to be idealistic, so I open up the book to read on and "species" becomes "wildlife". A few pages further and "wildlife" becomes "animals". Just as I thought! But really, why no plants? After all, it has been estimated by the International Union for Conservation that 20,000 plant species in the world (ca. 10% of earth's flowering plants) are in some form of danger (Hayes, 1977). About 70% of the flora of Hawaii is endangered or threatened with extinction (Fosberg, 1975). Of ca. 20,000 different plant species recorded over the past two hundred years in the continental USA, 100 are believed to be extinct, 750 are endangered and 1,200 are threatened (Elias, 1976). In Canada between 10% and 40% of our flora (consisting of ca. 4,000 species) is rare (Kershaw and Morton, 1976; Kershaw, 1976), and some of these rare plants are very definitely endangered. Recently I had an opportunity to read a very good essay on rare and endangered species. In the introductory paragraphs the botany student explained that there is inadequate literature available to base an essay on endangered plants, so the main body of the essay concerned animals. If one thing is clear from the reference list following these notes, it is that there is now abundant information available upon which to base an essay on various aspects of endangered or threatened plants.

The work of Ayensu and DeFilipps (1978) contains a valuable discussion as well as lists and bibliography relating to endangered plants of the USA. A symposium held at the New York Botanical Garden (ed. by Prance, 1977) contains a survey of the endangered plant problem throughout the Americas. A symposium sponsored by the USDA (USDA Forest Service General Technical Report SE-11, 1977) also represents valuable reference material. Fernald (1940) has provided some useful insights into the early depletion and exploitation of native North American plants.

The Canadian situation is outlined by Kershaw (1976), Kershaw and Morton (1976), Morton (1976) and Argus (1977a, 1977b). On a more local basis, Catling and Whiting (1976), Argus and White (1977) and McKeating and Bowman (1977) have discussed Ontario, while Wagner et al. (1977) and Beaman (1977) have considered the state of Michigan. Shorter popular articles include Elias (1976) and Ehrenfeld (1976).

Why are the popular books available concerned only with animals? It is not simply because most of the technical information on rare plants has been recently assembled. When we first see a photograph of a Giant Panda or a Pygmy Hippo, or realize that whales are intelligent, we suddenly become emotionally involved. A strong emotional feeling can nearly always be applied to the plight of endangered animals, whereas with plants we are forced to rely upon rational appreciation. There are at least four ways of looking at it.

1. Ethical

We regard species as having an unimpeachable right to exist. Extinction forecloses options that might benefit future generations. Extinction is irreversible and should not be a result of our actions.

2. Ecological
The loss of one species may weaken other species since there is often a delicate interdependence in nature.
3. Aesthetic or Recreational
Many of us treasure the variety of life forms around us, just as we treasure great works of art, and it is reassuring to know that they are preserved even if we do not have an opportunity to see them all.
4. Scientific and Practical Aspects
The loss of a species means the loss of material available to biological science. This has both intellectual and practical implications. Biological science has helped us to understand our relationship with the environment and new uses for plants are being discovered all the time.

In a brilliant article Ehrenfeld (1976) has very carefully examined the economic value of "non-resources", elaborating 9 kinds of economic benefit in detail and with examples. He also discusses various exaggerations and distortions applied to endangered species arguments, and examines non-economic values.

Some people have argued that extinction is a natural process, and that we should not interfere. However, mankind has greatly accelerated the rate of extinction. It has been estimated that 3/4 of the extinction of animals since 1600 are directly attributable to man, i.e., would not have occurred without his intervention. It is not a case of one species gradually changing into or being replaced by another. Extinction has become a rapid man-induced depletion of organic diversity.

Some say that rare plants, including those that are endangered and threatened, do not justify attention because they are in the process of dying out anyway. Most rare species that are dying out are clearly doing so because of human intervention. There is a good deal of evidence that many rare plants have been holding their own for a very long time. Stebbins (1942), using rare plants in California as an example, offered evidence that rare species were not declining under natural circumstances. Man has posed a threat to the already rare species by destruction of habitat, introduction of alien species which are more successful in competition, interference with natural processes such as fluctuating water levels and fire, and in some cases, by direct exploitation. In some areas the reasons for increasing rarity of plants have been determined. Beaman (1977) reports that the principal reason for increasing rarity of many plant species in Michigan is industrial development, urban and suburban sprawl, highway construction, agriculture and even recreation and tourism.

It has been suggested that endangered plants could be maintained exclusively in cultivation in botanical gardens. A few gardens have in fact made outstanding contributions to the preservation of endangered plants. However, the increased expense in space, staff, equipment and research that would be necessary for this makes the idea unrealistic as a complete solution. Another important aspect of the problem is that our knowledge of the environmental requirements of many endangered plants is very incomplete. Some plants are very hard to grow. Attempts to cultivate endangered plants (by experts in botanical gardens) are highly desirable in addition to protection of the plants in their natural habitat. Cultivation should not be considered

an acceptable alternative to in situ protection.

In the USA there is federal legislation affording protection to endangered and threatened species. Some states also have such legislation. In Canada, Ontario and New Brunswick have special endangered species legislation. British Columbia protects endangered species within its very impressive reserves system (for details of the Canadian situation see Argus, 1977b). Endangered, threatened and rare plants throughout Canada and the US are afforded some degree of protection by legislation in parks, conservation areas and nature reserves.

Occasionally people decide that we should not be bothering with special legislation for endangered species; that we should be concerned only with habitats and natural areas, or with public education. There are at least several reasons why separate endangered species legislation is highly desirable:

1) Insures adequate protection

It is unlikely that there will ever be a sufficient number of nature reserves, parks, etc. to maintain all endangered, threatened and rare species. There is not enough money available to purchase and manage the necessary land. However, an Endangered Species Act could lead to perpetuation of plants by compromise, agreement, easement etc. In short, an Endangered Species Act can allow for preservation of important natural areas where the creation of a nature reserve is not feasible.

2) Public attention, education and information

An Endangered Species Act draws public attention to the endangered species problem. This in turn attracts the attention of the professional botanists who initiate research programs ultimately leading to increased likelihood of preservation. In addition, the Act results in the compilation of lists of endangered, threatened or rare plants. These are taken into consideration in environmental assessment and land use planning. Beaman (1977) indicated that the US Endangered Species Act encouraged the development of state programs for the conservation of endangered and threatened species. The Ontario legislation has focussed a great deal of attention on the endangered species problem resulting in numerous articles in newspapers and magazines. Legislation promotes both public education and the gathering of information.

3) Management

Establishment of a nature reserve is not a foolproof method of preservation. Endangered species legislation focusses attention on endangered species requiring the monitoring and management programs that ensure perpetuation.

4) Public support

General public support for preservation of natural heritage may be augmented with separate Endangered Species legislation. "We don't always get the same reaction when we talk about the loss of a mosquito-infested swamp as when we talk about the loss of a species".

Unusual and representative communities are another aspect of the natural environment, even though they may contain endangered species. The different justifications for preservation will not be forgotten as long as there is separate legislation.

A recent attack on the US Endangered Species Act charged that it is almost impossible for a farmer to drive his tractor across a field without threatening some "eco-catastrophe".

Not only is this complete nonsense, but it very wrongly implies a conflict between farmers and conservationists. Compromises and agreements are always possible and many farmers are very much concerned with conservation.

Another kind of attack centres on the shortcomings of the classification system. The fact that there are many undescribed insects, that taxonomists disagree over taxonomic status, that there is difficulty in applying the biological species concept, is very much overrated and tends to complicate the issue. The simple fact is that we are eradicating various life forms and many of us are concerned enough to want to do something about it. There will be problems and disagreements, but they will not allow those of us who are concerned to lose sight of our goal.

In the hope that legitimate worries about our impact on the natural environment can be reconciled with a reasonable amount of social and economic progress, one author has suggested protecting plants at the genus level. Losses if this were done would be incredible.

The tropical Eggplant (*Solanum melongena*) belongs to the same genus as the Potato (*Solanum tuberosum*) not to mention a host of other very different species occurring in specific habitats in different regions. The loss of any one of these latter species could place serious restrictions on the future development of improved and disease-resistant strains for potatoes. A great deal of variation is sometimes apparent within species. Kale, Cabbage, Brussels Sprouts, Broccoli, Cauliflower and Kohlrabi, all belong to the same species (*Brassica oleracea*). We should be very much concerned about the preservation of plants below the species level, i.e., varieties, subspecies and locally adapted races. Ideally an attempt should be made to maintain genetic diversity within species by affording them protection in the various parts of their ranges. After all, the extinction of a locally adapted race is not guaranteed to be followed by a successful re-establishment with plants from another area, since these latter plants may be genetically inferior.

Paul M. Catling, Department of Botany,
University of Toronto, Toronto, M5S 1A1

REFERENCES

- Argus, G.W. 1977. The conservation of Canadian rare and endangered plants. Canadian Nature Federation. Special Publication No. 6.
- _____. 1977. Canada, in *Extinction is Forever*. ed. G.T. Prance and T.S. Elias. New York Botanical Garden. pp. 17-27.
- _____. and D.J. White. 1977. The rare vascular plants of Ontario. National Museum of Natural Sciences, Botany Division, Ottawa, Ontario, K1A 0M8. Syllogeus No. 14: 1-63.
- Ayensu, E.S. and R.A. DeFilipps. 1978. Endangered and threatened plants of the United States. Smithsonian Institution and World Wildlife Fund, Inc. Washington, D.C. 403 pp.
- Beaman, J.H. 1977. Commentary on endangered and threatened plants in Michigan. Michigan Botanist, 16: 110-122.
- Brunton, D.F. 1973. Endangered species - so what. Trail and Landscape, 7(3): 72-73.
- Catling, P.M. and R.E. Whiting. 1976. Orchids, fragile and endangered. Ontario Naturalist, 16(3): 20-30.
- Ehrenfeld, D.W. 1976. The conservation of non-resources. American Scientist, 64: 648-656.
- Elias, T.S. 1976. Extinction is forever - what can be done to save endangered species. Garden Journal :53-55.
- Fosberg, F.R. 1975. The deflowering of Hawaii. National Parks and Conservation Magazine 49(10): 4-10.
- Fernald, M.L. 1940. The problem of conserving rare native plants. Smithsonian Institution publication 3573, (report for 1939) pp. 375-391.
- Hayes, S. 1977. Plants are wildlife too! World Wildlife Fund (Canada). Newsletter, Christmas 1977: 1-2.
- Kershaw, L. 1976. A phytogeographical survey of rare, endangered and extinct vascular plants in the Canadian flora. M.Sc. Thesis, Dept. of Biology, University of Waterloo, Waterloo, Ontario.
- Kershaw, L. and J.K. Morton. 1976. Rare and potentially endangered species in the Canadian Flora - A preliminary list of vascular plants. Canadian Botanical Association Bulletin 9(2): 26-30.
- McKeating, G.B. and I. Bowman. 1977. Endangered species. Ontario Fish and Wildlife Review, 16(4): 1-24.
- McLean, A. 1976. Protection of vegetation in ecological reserves in Canada. Canadian Field-Naturalist 90(2): 144-148.
- Morton, J.K. 1976. Recent changes in the Canadian flora, in *Man's impact on the Canadian flora*. ed. J.K. Morton. Supplement Canadian Botanical Association Bulletin 9(1): 13-16.
- Prance, G.T. and T.S. Elias. (eds.)(1977). *Extinction is forever*. New York Botanical Garden. Bronx, New York. 437 pp.
- Stebbins, G.L. 1942. The genetic approach to problems of rare and endemic species. Madrono 6: 241-272.
- United States Department of Agriculture. 1977. Conference on endangered plants in the southeast. USDA Forest Service General Technical Report SE-11. (USDA Southeastern Forest Experimental Station, Asheville, North Carolina). 104 pp.
- Wagner, W.H., E.G. Voss, J.H. Beaman, E.A. Bourdo, F.W. Case, J.A. Churchill and P.W. Thompson. 1977. Endangered threatened and rare vascular plants in Michigan. Michigan Botanist, 16: 99-110.
- World Wildlife Fund. 1972. 20,000 plants in danger. Biological Conservation 4(4): 255.

FLORA OF CANADA - A RESPONSE

I wish to thank Dr. James Pringle for his welcome and most gratifying comments in the January *Bulletin* upon the merits of my flora. They are deeply appreciated, not only by me but also by my sponsors and other persons involved. The Production and Editorial staffs of the National Museums are particularly pleased with the thoughtful remarks concerning the general layout and attractiveness of the set. They gave it their all and I am indebted to them for their diligent work on a long job well done. (On behalf of my supporting staff, I might note that the narrow margins, apparently considered somewhat of a defect by the reviewer, were insisted

upon by the designer of the series as being in line with modern trends. I, personally, find them a refreshing change).

I feel that I should first offer some defense against the "drastic decline" in the updating of nomenclature and classification (and later in other revisionary work). It is important to note that my "References Cited" is largely confined to selected works having a copious and major bearing upon my chief concerns, floristics and phytogeography. The reviewer fails to mention the hundreds of references to numerous publications of more limited application that occur throughout the text in the treatment of individual genera and species. Flipping through Part 3, for example, I located, in a couple of minutes, four 1971 references to different publications, reminding me of the strenuous efforts I had made to update my prime objectives, by no means neglecting nomenclature. This was in the days of "one original and two carbons, please" before the almost universal availability of photocopying, adding greatly to the difficulties of my corrective and revisionary work. In this connection, I made the unfortunate error of absent-mindedly giving June 1972 (my date of retirement) to my editor when she telephoned me for the date of termination of research. I actually submitted the manuscript toward the end of 1971; this was followed by a period of recuperation (no connection implied; Asiatic flu was the culprit) and some accumulated vacation leave. I was not at work in my office during 1972.

The majority of the criticisms being confined to questions of nomenclature and classification, I feel that I should stress the application of these in my manual. It is scarcely necessary to mention that, in a work of this time-consuming nature, it was absolutely essential to establish certain rather strict priorities (in the case of my manual, chiefly floristics and phytogeography) and to aim at some sort of deadline, in the fond hope that the manuscript would reach that state of grace some time before its author. This may somewhat excuse my neglect of the multitude of papers leading to the "respected, standard" European flora, Flora Europea, (of which only the first volume was available during my assembling of the manuscript. In any event, I considered that North American manuals such as Gray's Manual and Vascular Plants of the Pacific Northwest, in conjunction with other manuals and numerous shorter North American publications, were much more in line with my prime objectives and available time. I accepted many nomenclatural changes that appeared to be reasonable but did not consider myself to have either the expertise or the time to make decisions on the merit of all new proposals in this highly subjective field. I proceeded on the assumption that, provided there was strict synonymy, no factual errors were being committed.

The reviewer has very fairly presented both sides of the "lumper-splitter" problem for which I attempted a middle course. As for my accepting "a few discredited segregates in Amelanchier", it is scarcely necessary to note that, in a work of such broad scope, there is bound to be uneven treatment in keying out "easy" and "difficult" taxa. I can only call upon the sympathetic understanding of my botanical colleagues when dealing with the intractable lumps of "species" abounding in such genera as Amelanchier, Crataegus, Rubus, Antennaria, Taraxacum, etc. (Incidentally, I note a bit

of a slip on the part of the reviewer in stating that I maintained both Viola pensylvanica and V. pubescens. I actually relegated the former name to synonymy under the latter).

The reviewer aptly notes that my drawing of attention to as yet unresolved questionable reports may induce further investigation. On the other hand, I am rather taken aback by his attributing manifestations of obsolescence to my manual already on the basis of "the omission of some relatively recently naturalized weedy species reported during the past decade". Most such reports probably occurred during the past seven years of my retirement and might equally well be interpreted as an indication of the usefulness of my manual as a point of reference for new information. This was foremost in my mind in the time-consuming indication of range limits, particularly northwards, of species in the various provinces and territories (also Alaska and Greenland). I consider this of special value to younger botanists and to amateurs wishing to extend Canadian plant ranges. Knowledge of the present distribution of our plants owes much to the work of a multitude of enthusiastic amateurs.

A further concession to youth (for which there are notable precedents and which the majority of more-advanced botanists will probably also appreciate) is my adoption of a strictly alphabetical listing of genera and species. My keys, (largely original, as the reviewer surmises) are also purposely largely "artificial" in nature, for the very practical reason of ease of identification. They are also unusually comprehensive in a manual lacking descriptions of individual species, the time and space thus saved being devoted to data of more immediate concern in an initial flora.

The reviewer notes, in some apparent disapproval of my alphabetical listing, that, "closely related taxa may be widely separated". This is surely abundantly offset by the ease of reference to taxa in the text as they are keyed out. My flora in no way lays any claim to be a treatise on classification. As in most manuals, however, some concept of relationships is revealed or implied in the position of names in the keys. I can see little advantage to their also being neighbours in the text. As far as possible, I tried to use the very important "natural" characters of flower, fruit, seed, sporangium, and spore in my keys as primary sets of leads but any attempt to establish a utopian order indicating natural relationship of equal merit throughout would surely have resulted in a hodge-podge of well-studied groups and a multitude of taxa of uncertain relationships (not to mention unworkable keys). Concerning the remark that, "taxa sought under names rejected by Scoggan are less readily found", this difficulty should surely be resolved by the appearance of my index in Part 4.

The reviewer's comment that, "There are occasional lapses in parallels" in the keys is very probably the result of the admittedly unconventional couplet quoted being taken out of context through insufficient follow-through in the key. Although no page number is given, I believe that it must surely conform to a standard procedure adopted throughout my keys in the endeavour to give as much information as possible in as concise a manner as possible, in the absence of species-descriptions. For example, fruit character in both leads of the couplet provides the necessary parallelism for a start.

The "ovary superior" character applies to all of the taxa under the first lead and the "flowers regular" character to all of those under the second lead. Parallelism would be achieved, as regards the ovary character of the first lead, by a set of subsidiary leads under the second lead of the couplet (these, themselves, of contrasting parallels: e.g., "ovary superior" vs. "ovary inferior"). As regards the flower character of the second lead, parallelism would be achieved under the first lead by a set of subsidiary leads (also of contrasting parallels: e.g., "flowers regular" vs. "flowers irregular"). In addition, if any particular lead terminates with the name of a taxon, further descriptive "non-paralleled" characters may be added to aid in its identification (to be further pursued, in cases of doubt, by recourse to manuals with species-descriptions).

My thanks once more to Dr. Pringle for his heart-warming laudatory remarks and for his high recommendation of my manual to workers in floristics and phytogeography. I was delighted to learn of the reactivation of the colossal Flora North America project and trust that my manual will prove to be a useful Canadian contribution.

Homer Scoggan
#1112 A - 2055 Carling Ave.
Ottawa, Ontario, K2A 1G6

PUBLICATION

IXth International Seaweed Symposium edited by Arne Jensen and Janet R. Stein.

This practical, authoritative volume contains a distinctive collection of valuable new information on seaweed resources presented at the proceedings of the IXth International Seaweed Symposium. Held August 20-27, 1977 at the University of California in Santa Barbara, sponsors included the International and American Phycological Societies and several representatives of the seaweed industry.

Sparked by the growing world-wide interest in the commercial potential of seaweed-derived gelling and emulsifying agents, this unique compilation brings together academic and commercial interests providing a further understanding of seaweed resources and their industrial utilization.

Distinguished international experts from 42 countries presented highly relevant new contributions to the advancement of knowledge and practical applications of seaweed resources focusing on food production, including methods of harvesting and processing, energy resources, and medicine as well as informative discussions on the physical and chemical properties of seaweeds.

This book is an outstanding, indispensable source of reference for Phycologists, Marine Scientists, Marine Ecologists, industry and government as well as other related fields. 1979. 655 pages, \$42. Published by Science Press.

The Bulletin of the Canadian Botanical Assoc.
Editor:- Dr. J.K. Morton
Department of Biology
University of Waterloo
WATERLOO, Ontario N2L 3G1

Issued quarterly in January, April, July and October, and sent to all members of the Association. Non-members can receive it at a price of \$6.00p.a. (\$1.50 per issue) post free, made payable to "The Canadian Botanical Association" and addressed to the editor. Material for inclusion in the Bulletin should reach the editor at least one month prior to the date of publication of that issue.

To ensure prompt delivery of the Bulletin please notify the Editor of any change of address as soon as possible.

Enquiries about membership of the CBA/ABC should be addressed to the Secretary of the Association Dr. D.D. Cass, Department of Botany, University of Alberta, EDMONTON, AB. T6G 2E9.