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Her Excellency the Right Honourable / Son excellence la très honorable
Adrienne Clarkson, C.C., C.M.M., C.D.
Governor General of Canada / Gouverneure générale du Canada



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President's Message

Dear Members,

As I come to the end of my term as president of the CBA, it is with a great deal of satisfaction that I reflect on the vitality of our Association during the past two years. The contributions that our members make to the vigor and development of plant sciences in Canada is very important to the success of our Association in the future.

Even though the CBA is in good financial shape, I remind you that our finances depend in large part on renewing memberships and recruiting new members. I strongly urge you to encourage students to participate in our activities.

It is now the time to get ready for the Annual Meeting in London that is only a few days away. The meeting, that is being organized jointly with the Canadian Society of Plant Physiologists, promises to be a rewarding one both from a scientific standpoint, and as our social event of the year.

I also remind you that it is already the time to think about proposing candidates for the George Lawson Medal and the Mary E. Elliot Award that will be given at the 2001 Annual Meeting in Kelowna. These awards are important for the development and the visibility of the CBA and reflect the vitality of our association. It is important that members get involved in proposing candidates in order to proclaim the value of scientific research done by Canadian botanists. The George Lawson medal is awarded to a botanist who has made an exceptional lifetime contribution to the development of plant biology in Canada. This recognition may be based on the overall academic career of the nominee or on a particularly outstanding achievement such as the publication of a book. The Mary E. Elliot medal is awarded to an individual CBA member who has given particularly active service to the Association. For more information on these prizes, please contact the new CBA President, Joe Gerrath.

On a final note, I would like to thank the members of the Board of Directors and the Section and Committee Chairs who have devoted time and energy to ensure the smooth functioning of our association and its continued vitality.

I am looking forward to seeing you in London,

Denis Barabé, President

Editors / La rédaction

Editor / rédacteur

Denis Lauzer

Assistant editor / rédacteur adjoint

Stuart Hay

Institut de recherche en biologie végétale
(Université de Montréal / Jardin botanique de Montréal)
4101, rue Sherbrooke Est
Montréal, Québec
H1X 2B2
Téléphone : (514) 872-8494
Télécopieur : (514) 872-9406
Courrier électronique : denis.lauzer@umontreal.ca

Information for submitting texts /

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CBA Bulletin / Bulletin de l'ABC

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Le Bulletin de l'ABC paraît quatre fois par année (février, mai, août, novembre) et est envoyé à tous les membres de l'ABC.

To ensure continuous delivery of the Bulletin please notify the Treasurer promptly of any change of address.

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Si vous avez des commentaires ou suggestions concernant le bulletin, veuillez s'il vous plaît contacter le rédacteur à l'adresse mentionnée plus haut.

Texts for the August issue must be received before July 15, 2000. Les textes pour le bulletin d'août doivent arriver au plus tard le 15 juillet 2000.

CBA Section and Committee Chairs

Section Chairs (1998-2000)

Ecology

Dr. Ed Reekie

Biology Department

Acadia University

Wolfville, NS, B0P 1X0

ereekie@ace.acadiau.ca

Tel. : (902) 585-1162; fax : (902) 542-3466

Mycology

Dr. James Traquair

Agriculture & Agri-Food Canada, Research Centre

1391 Sanford St.

London, ON, N5V 4T3

traquairj@em.agr.ca

Tel. : (519) 457-1470, ext. 224; fax : (519) 457-3997

Structure & Development

Dr. Ron Dengler

Life Sciences Division

University of Toronto at Scarborough

1265 Military Trail

Scarborough, ON, M1C 1A4

dengler@tsunami.scar.utoronto.ca

Tel : (416) 287-7426; fax : (416) 287-7642

Systematics & Phytogeography

Dr. Luc Brouillet

IRBV-Université de Montréal

4101, rue Sherbrooke Est

Montréal, QC, H1X 2B2

luc.brouillet@umontreal.ca

Tel. : (514) 872-8490; fax : (514) 872-9406

Committee Chairs (1998-2000)

Conservation

Dr. Pam Krannitz

Pacific Wildlife Research Centre

5421 Robertson Road, R.R. 1

Delta, BC, V4K 3N2

pamk@interchange.ubc.ca

Tel. : (604) 946-4676; fax : (604) 946-7022

Science Policy

Dr. Joe Gerrath

Department of Botany

University of Guelph

Guelph, ON, N1G 2W1

jfgerrath@uoguelph.ca

Tel. : (519) 824-4120; fax : (519) 767-1991

Development

Dr. Vipen Sawhney

Department of Biology

University of Saskatchewan

Saskatoon, SK, S7N 5E2

sawhney@admin.usask.ca

Tel. : (306) 966-4417; fax : (306) 966-4461

Membership

Dr. Hugues Massicotte

Forestry Program

Faculty of Natural Resources and Environmental Studies

University of Northern British Columbia

Prince George, BC, V2N 4Z9

hugues@unbc.ca

Tel. : (250) 960-5813; fax : (250) 960-5538

Le mot du président

Chers membres,

Durant les deux dernières années, j'ai eu le plaisir de constater le dynamisme scientifique de l'ABC. La contribution des membres au développement de la botanique canadienne est un gage de succès pour l'avenir de notre association.

Bien que l'association jouisse d'une bonne situation financière, il ne faut surtout pas oublier que l'avenir de l'ABC repose en grande partie sur l'adhésion de nouveaux membres. À ce titre, je vous encourage fortement à inciter les étudiants à participer aux activités de l'ABC.

C'est maintenant le temps de penser au congrès annuel qui aura lieu à London dans quelques jours seulement. D'ores et déjà, ce congrès conjoint avec la Société canadienne de physiologie végétale s'annonce fort stimulant, tant d'un point de vue scientifique que social.

Je vous invite aussi à réfléchir dès maintenant aux candidatures pour les prix Georges Lawson et Mary E. Elliot qui seront remis au congrès annuel de 2001 à Kelowna. Ces prix sont deux éléments importants pour le développement et le rayonnement de l'Association botanique du Canada. Ils reflètent le dynamisme de notre association. Il est donc essentiel que les membres présentent des candidatures pour ces prix afin de mettre en valeur les activités scientifiques des botanistes canadiens.

Le prix Georges Lawson est remis à une personne qui a contribué de façon exceptionnelle au développement de la biologie végétale. Le prix peut-être décerné pour l'ensemble d'une carrière ou pour une réalisation particulière de grande envergure, par exemple un livre. Le prix Mary E. Elliot est décerné à un membre qui a participé activement au développement de l'Association botanique du Canada. Pour obtenir de plus amples informations concernant ces prix, veuillez contacter le nouveau président de l'ABC, Joe Gerrath.

En terminant, je voudrais remercier tous les membres du Bureau de direction et les responsables de sections et de comités qui n'ont pas hésité à donner de leur temps pour assurer le rayonnement de l'ABC.

Au plaisir de se rencontrer au congrès de London,

Denis Barabé, président

Protecting the Belanger and Quarry Bay Alvars on Manitoulin Island

In December 1999, seventeen thousand acres of the best alvar ecosystems in the Great Lakes basin were purchased by the Nature Conservancy of Canada from Donohue Inc. Funders of the purchase included the Province of Ontario, The (US) Nature Conservancy (TNC), Garfield Weston Foundation, Federation of Ontario Naturalists (FON), and many, many other supporters. This was the largest purchase of conservation lands in Ontario history and was possible only because of the research that has been invested in alvar ecosystems in the Great Lakes basin over the past decade or so. Most of the site will become an Ontario provincial park, with the remainder an FON nature reserve.

Alvars are hardly a charismatic ecosystem, but they are certainly globally vulnerable. They are found in Europe in the Baltic region and in North America primarily as a scattered rainbow of sites across the central Great Lakes. This distinctive treeless vegetation, with many unusual plants and animals, occurs on flat limestone bedrock where soils are thin or absent. Hence, they are commonly referred to as 'nature's rock gardens' or 'habitats for the hardy'. Alvars are subject to cycles of extreme flooding and drought, which favour the hardiest species, many of which are more often found in the arctic or the prairies. The result is a unique blend of species and landscapes ranging from rock pavements of lichen and moss, to grasslands rich in wildflowers and butterflies, to savannahs and shrublands dominated by oaks, conifers, junipers and many shrubs.

The Great Lakes basin includes the world's largest system of freshwater lakes, and supports more than 130 globally rare plants, animals, and natural communities. Alvars contribute significantly to the biological diversity of the basin. Since 1996, a study of Great Lakes alvars was undertaken by the International Alvar Conservation Initiative (IACI). A team of over 40 co-operating scientists from the U.S. and Canada assessed the locations, species and ecological importance of alvars in the Great Lakes basin, lead by TNC in the US and by FON in Canada. As a result, we know that alvars are clustered just south of the contact line with the granite uplands of the Canadian Shield. About 12,000 hectares of alvar habitat occur across the basin, such as in Michigan on Drummond Island, on the north end of the Bruce Peninsula, and in Lake Erie on Pelee Island. About three-quarters of the total area of alvars in the Great Lakes basin occurs in Ontario, and many of the alvar species found here are of global, national and provincial/state significance; for example, more than 40 plant species regarded as rare in Ontario occur on Ontario alvars.

The IACI completed original botanical studies of 103 alvar sites and reviewed data on many others. The quantitative data were used to generate an alvar community classification that permitted global rarity ranks to be assigned, and the viability of community occurrences to be assessed. New data were

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Poorly Known Economic Plants of Canada - 24. Groundnut, *Apios americana*

P.M. Catling and E. Small, Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Central Experimental Farm, Ottawa ON, K1A 0C6

Common Names: Groundnut, *Apios*, Wild-bean, Indian potato, Potato Bean, Bog Potato. "Apios" is often used as a common name when referring to the plant as a crop. Outside of North America the peanut (*Arachis hypogaea* L.) is often called "Groundnut." The common name "Wild Bean" is frequently applied to *A. americana* when it occurs as a weed in cranberries, but is more often used for wild *Phaseolus vulgaris* L. In North America "Indian Potato" may also refer to the western montane *Orogenia linearifolia* Wats., a member of the Carrot family. Outside of North America "Indian Potato" generally refers to the common potato (*Solanum tuberosum* L.) grown in India. French: *Apios* d'Amérique, pénacs, patates en chapelet, glycine tubéreuse.

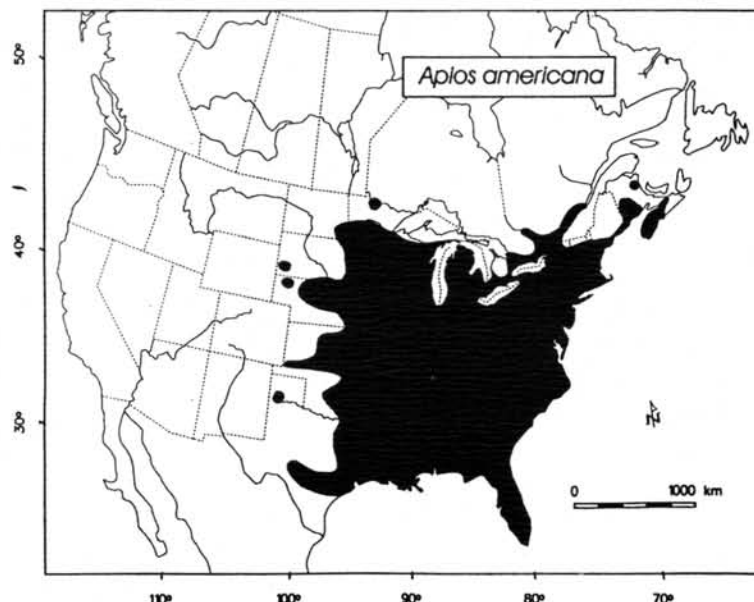
The genus name *Apios* is derived from the Greek word for pear, an allusion to the pear-shaped underground tubers. Synonyms of *A. americana* include *A. tuberosa* Moench. and *Glycine apios* L.

The genus *Apios* contains 5-10 species of perennial, herbaceous vines, two in eastern North America and the rest in China. In North America *A. americana*, with brownish flowers 1-1.5 cm long, is widespread, but generally uncommon, from New Brunswick west to North Dakota and south to Florida and Texas. The closely related Kentucky Groundnut (*A. priceana* Robins.),

with larger, greenish-white, purple-tipped flowers, occurs mostly in Kentucky and Tennessee, and is known only from about 13 locations. *Apios americana* in the southern part of the range with elongated flower clusters (10-20 cm) has been segregated as var. *turrigera* Fern., but elongated inflorescences can be induced to a degree in northern plants by exposure to relatively long daylengths. In *A. americana* f. *pilosa* Steyerf., the stems and leaves have soft hairs. In *A. americana* f. *cleistogama* Fern., the greenish flowers have minute non-expanding corollas. These taxa have not been recognized in most recent floristic studies. Most of the populations north of Connecticut consist almost entirely of sterile triploids, but diploid and triploid clones are nearly indistinguishable morphologically.

A twining or climbing perennial herb, 1-3 m tall, Groundnut produces strings of edible underground tubers. These tubers normally range in size from 2-5 cm in diameter. The odd-pinnate compound leaves have 5-7, ovate-lanceolate leaflets 2-10 cm long. The pea-like flowers are 1-1.5 cm long, deep red-brown, purple-brown, or chocolate-brown, and arranged in heads 5-20 cm long with a single main axis. The straight or slightly curved, many-seeded pods (legumes) are 5-12 cm long and 5-9 mm wide.

Another native wild vine, *Amphicarpa bracteata* (L.) Fern., produces a more nut-like underground part from flowers on the surface or below the ground. This is called "Hog Peanut" or "Ground Bean," but it is often confused with Groundnut. The two often occur together. Hog Peanut leaves have 3 leaflets instead of 5-7. The only other vines with compound leaves and 5-7 leaflets and pea-like flowers in North America are species of *Wisteria* which differ in being woody and having drooping inflorescences, and the introduced (subtropical) Butterfly Pea (*Clitoria ternata* L.) which has much larger flowers.





Groundnut is generally a plant of rich soil (pH 5 - 8) in woodland edges, especially borders of marshes and shorelines. However, it can also occur in much drier and more open sites, and is sometimes a serious weed of cultivated cranberry bogs. In eastern Ontario and southern Quebec Groundnut is confined to the shores of the Ottawa, St. Lawrence and tributary rivers including Barron, Bonnechere and Rideau. It is also associated with a number of well known Indian village sites such as Toniata on the St. Lawrence River near Brockville. This distribution, and probable use of tubers as food suggests introduction by Indian traders and voyageurs for whom these rivers served as highways in presettlement times.

Groundnut belongs to subfamily Papilionoideae, which is mostly bee-pollinated, but its remarkable flowers are apparently myiophilous (pollinated by flies; this is usually spelled myophily, but one meaning of the prefix myo- is mouse, so that there could be confusion with pollination by mice; the prefix myio means fly). This is suggested by the following characteristics: flowers are dark reddish-brown, with a bright green-striped window (clear area) in the back; wing petals function as osmophores (glands, usually floral, that produce fragrances attractive to pollinators); restricted availability of nectar; and flowers hidden instead of well displayed. Interestingly a cavity associated with fly pollination is produced by the large posterior standard (vexillum) petal.

Pollination by explosive tripping of a flower (which rapidly brings the stigma and/or stamens in contact with a pollinator) is quite rare, but is found in several members of the Fabaceae. In most of these cases the explosive mechanism is a consequence of pressure applied to the wing and keel petals. However, in Groundnut a pollinator forces its way into the cav-

ern-like flower toward the rear window of light, and dislocates the pouch, releasing the explosive power contained in the style. The stigma then hits the insect, resulting in pollen transfer.

Low fruit set has been attributed to occurrence of sterile triploids in the northern part of the range, and elsewhere to partial self-incompatibility as well as low rate of floral visits. Dispersal is by tubers carried by birds and/or mammals (including man), as well as by seeds.

One of the worlds greatest botanists, Professor Asa Gray (1810-1888) of Harvard University, claimed that if civilization had started in America, Groundnut would have been the first edible tuber to be developed and cultivated.

Indigenous people and early explorers used the potato-like roots and the pea-like seeds as food. The tubers were eaten raw, boiled or ground and sometimes combined with other foods. Iroquois collected the roots and planted them in suitable places near their villages. Several writers have noted that Groundnut was important when corn crops failed. The Micmac and Malecite tribes of New Brunswick also ate the tubers, and indeed Groundnut appears to have been consumed by native people throughout most of eastern North America. The common potato, although native to the new world (Mexico southward), was only used by northeastern Indians after contact with Europeans.

The availability of Groundnut tubers contributed to the survival of the Pilgrims through their first winter, but the first European to eat the tubers was probably the scientist Thomas Harriot who accompanied Sir Walter Raleigh to Virginia in 1585 and remarked "they are very good meate." Harriot was first to bring the tubers to Europe (England). By the late 1800s Groundnut was well established in European gardens. The first European to eat wild Groundnut from Canada was Samuel de Champlain in 1604 who found it at the mouth of the St. Croix River. He also remarked on their palatability: "very good roasted and boiled."

During the Great Irish Potato Famine of 1845-1848 there was an effort to increase the cultivation of Groundnut in Europe, but it was abandoned when culture of the familiar potato was continued successfully with disease-resistant strains. Groundnut has been cultivated for more than a century in Europe, where it has established as a wild plant. It was introduced to Japan about 100 years ago and was initially used as a medicinal crop for reducing fatigue, and to improve the health of new mothers and children. In Japan it is called "Apios" and is still cultivated.

After scrubbing to remove the soil Groundnut tubers can be either boiled or fried. The tubers can be used in salads, soups, stews and vegetable dishes and in many potato recipes. They have a dry texture and a taste between that of a potato and a boiled peanut. Although they can be eaten raw, cooking substantially improves digestibility. Protease inhibitors in the tubers are destroyed by heat. The tubers do not have to be peeled. They are reported to make good chips and to have good baking qualities when mixed with corn meal or wheat flour.

The tubers are not only palatable but nutritious, providing high quality protein and fat. There is a good amino acid balance, with aspartic and glutamic acids predominating. Crude protein content is 12-13%, three times that of potatoes, and occasionally as high as 18%. The nutritionally important linoleic acid is the major fatty acid in leaves and tubers, although fatty acid profiles vary between locations. Seeds are reported to contain 12-18% lipids, and tubers contain approximately 4% on a dry weight basis.

The isoflavone genistein has recently been discovered in the tubers of Groundnut. Genistein reduces the incidence of various forms of cancer, including breast cancer. Some nutritionists have recommended an increase in consumption of soy foods to obtain the protective effects of genistein. Since it is difficult to persuade North Americans to eat more soybean products, Groundnut has some potential for increasing genistein consumption.

The soybean genus *Glycine* is closely related to *Apios*. Genetic traits of Groundnut such as tolerance of aluminum, acid

European fur traders and native people ate the tubers and carried them on journeys. One of the northernmost populations of Groundnut is near the grave site of a famous French-Canadian coureur de bois named Cadieux. It is said that Cadieux and his family encountered an Iroquois raiding party seeking furs at one of the Ottawa River portages on Calumette Island. Cadieux fired on the raiders enabling his family to escape by shooting the rapids in their birch-bark canoe. Presumably injured during the encounter he dug his own grave and partially buried himself. Before dying, however, he recorded the unfortunate events by writing in his own blood on a piece of birchbark which he affixed to a nearby tree.

soil, and waterlogging, could be used to make soybean hardier. Groundnut produces copious amounts of latex that could have commercial value. The blossoms have a rich fragrance and can be used to make a distinctive perfume. Recent advances in the domestication of Groundnut have occurred at the Louisiana Agricultural Experiment Station. The work has involved controlled crosses and in vitro techniques such as micropropagation and formation of polyploids using colchicine. Selection has been for large closely-spaced tubers, reduced twining, fungal disease resistance, and to some extent non-shattering pods. Most of the germplasm tested to date has come from the lower Mississippi valley with very little from Canada. Some valuable selections have been produced with short rhizomes that can be easily dug and produce a hill of fist-size tubers after 1 year.

Canadian plants are important with respect to the development of a Canadian crop. Most of the northern populations are already adapted to Canadian climates and pests, but unfortunately do not produce seeds. Although sterile triploids predominate in the northern part of the range, a diploid plant has been found at Madoc, Ontario. Canadian clones have been reported to produce more and larger tubers. Aboriginal selection of plants for growth and tuber production in Canada is suggested by the frequent association with Indian sites and trade routes, as well as sterility.

Groundnut is grown as an annual, and has impressive productivity. Up to 3.75 kg of tubers/plant (8 pounds/plant) have been obtained from tuber-started plants, and 2.17 kg of tubers/plant from seed-started plants. Up to 120 tubers have been

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produced from a single cultivated plant, and individual tubers have weighed up to 185 gm. Tuber yield has reached 27 tonnes/ha (12 tons/acre) in the first year.

Groundnut fixes atmospheric nitrogen at a rate of 100 pounds per acre per year, requires much less nitrogen fertilization than other tuber-producing crops, and in this respect is environmentally friendly. Some nitrogen fertilization may still be necessary to maximize tuber yields.

Unlike certain other crops (excepting Sweet Potato) propagated by tubers, the seed tuber of Groundnut does not degenerate. Tubers can remain in soil for extended periods without rotting, even when the soil is waterlogged. Other tuber-producing crops are more or less limited by waterlogging. Although domestication has to a large extent focussed on well-drained sites, Groundnut has the advantage of tolerating dry to very wet sites. However, field studies have shown that Groundnut grows best on well-drained soils. Excess wetness is undesirable since it results in long rhizomes.

Seeds may take 10-30 days to germinate and seedlings are relatively susceptible to insects and diseases. Thus cultivating tubers is advantageous, but improved methods of seed culture in peat pellets have recently been developed. Fungal diseases such

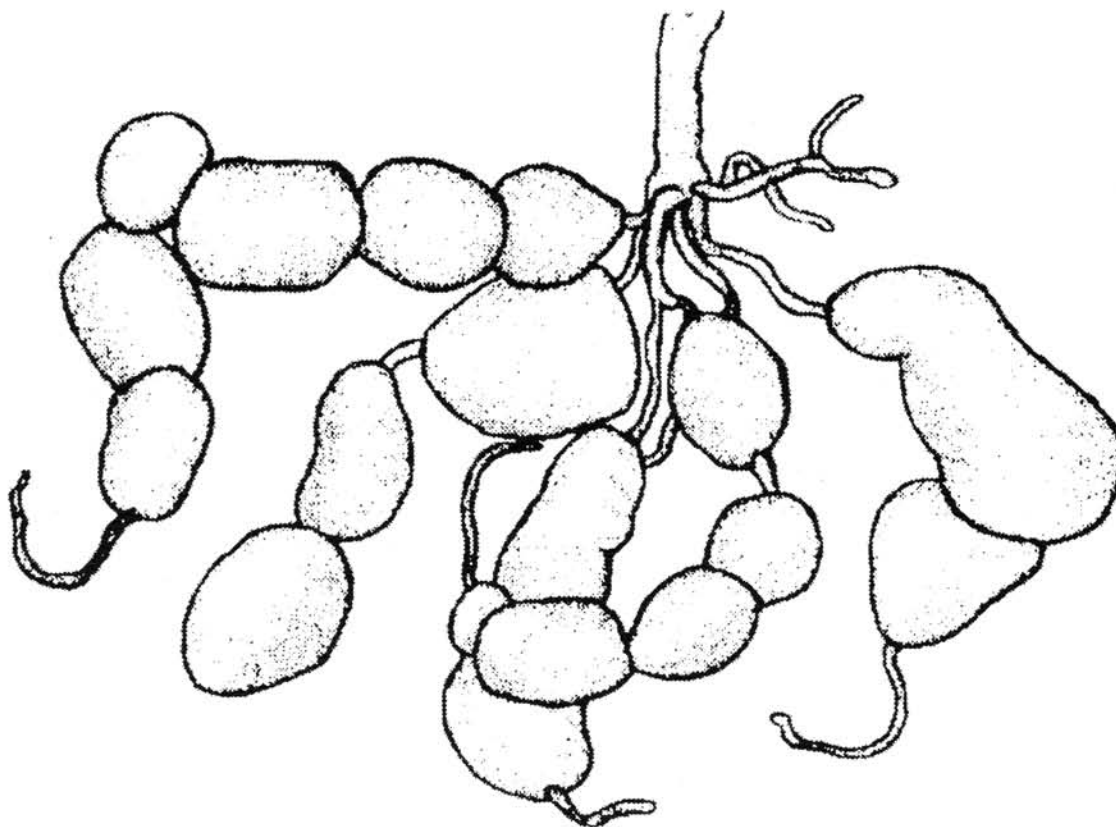
as *Rhizoctonia solani* Kuhn and insect pests such as a stink bug (*Arcrosternum hilare*) have been documented on cultivated plants. Cucumber mosaic virus and Desmodium yellow mottle virus infections have been reported in wild plants. Several pre-emergence herbicides have been identified which reduce the mechanical removal of weeds required to maximize yield. Since it is a robust and aggressive plant, chemical treatments may be less than required by other crops.

Apios americana has promising features as a crop:

- Appealing taste
- Potential health benefits
- Robust and productive
- Desirable agronomic characteristics
- Nitrogen-fixing capability

Groundnut is likely to become a more valuable crop because of the strong current market trend towards the use of novel and gourmet plant foods providing health benefits.

Acknowledgments: W.J. Cody (review), B.D. Reynolds (information), B. Brookes (artwork).



Poorly Known Economic Plants of Canada - 25. American Hazelnut, *Corylus americana*, and Beaked Hazelnut, *C. cornuta*

P.M. Catling and E. Small, Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Saunders Bldg., Central Experimental Farm, Ottawa K1A 0C6

Latin Names

The name *Corylus* is said to have originated from the Greek word *korys*, referring to a helmet or hood.

English Names

- C. americana*: American hazelnut, American filbert.
- C. cornuta*: beaked hazelnut, wild filbert, beaked filbert.
- C. avellana*: European hazelnut, European filbert, Barcelona nut, cobnut.
- C. colurna*: Turkish hazelnut, Turkish tree hazel, Byzantine hazel.

Hazel is derived from *haesel*, the Anglo-Saxon word for hood or bonnet. Hazelnuts are not to be confused with witch hazel (18 in this series). The name filbert is said to have originated from a term meaning full beard, referring to the long husk. It has also been associated with St. Philbert, whose feast date is 22 August when the nuts of European hazelnut are mature. The native plants of North America tend to be called hazelnuts, whereas the European nuts are more often called filberts. Some authors have employed the name filbert for any superior, cultivated plant, but this usage has not been consistent. Hazelnut is currently preferred by the North American marketing industry.

"Trazels" are hybrids of tree hazelnuts with the European hazelnut. The name "filazel" is applied to hybrids of beaked hazelnut and European hazelnut. Hybrids of *C. americana* and *C. avellana* have been referred to as "hazelberts."

French Names

- C. americana*: noisetier d'Amérique, coudrier.
- C. cornuta*: noisetier à long bec, coudrier, noisette à bec, noisette à long bec, petite noisette.
- C. avellana*: noisetier commun, coudrier, avelinier
- C. colurna*: noisetier de Byzance

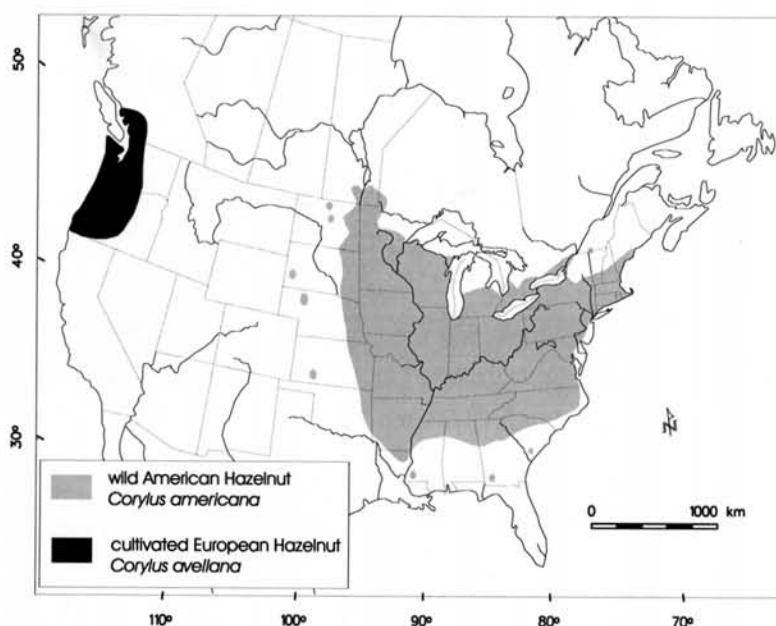
Morphology

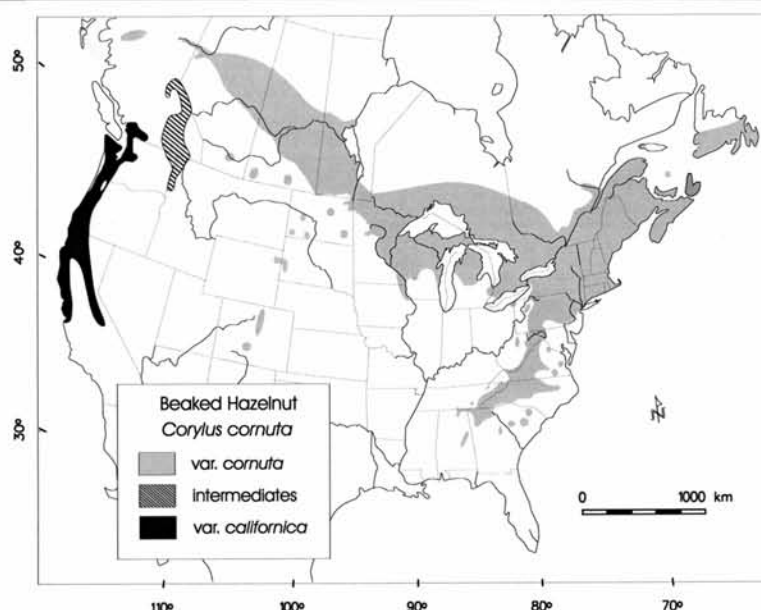
Our two native hazelnuts are thicket-forming shrubs to 3 m tall. The leaves are doubly serrate, alternate, and range up to 15 cm. The male flowers are produced, like many other wind-pollinated woody plants, in elongated caterpillar-like catkins, that release pollen in April, before the leaves expand. The female flowers are inconspicuous, appearing as clusters of red stigmatic branches protruding from a slightly expanded bud. The fruit is a hard-shelled nut, borne singly or in clusters of 2-6, each nut surrounded by a husk of leafy bracts.

Classification and Geography

Corylus includes approximately 13 species of the temperate northern hemisphere. Most of these are shrubs 1-3 m tall that develop suckers abundantly. However, three or four species grow into large trees without suckers. Of these, Turkish Hazelnut (*C. colurna* Marsh), native to eastern Europe and Afghanistan, reaches 26 m in height, and is commonly cultivated in arboreta.

The beaked hazelnut (*C. cornuta* Marsh var. *cornuta* = *C. rostrata* Ait.) is widespread across southern Canada from Newfoundland to B.C. and extends southward in the Appalachians. The leaves have an elongated tip (acuminate) and





the twigs lack glandular hairs. The nuts are 9-17 mm long and are enclosed in a foliaceous involucre 3-6 cm long. *Corylus cornuta* var. *megaphylla* Marie-Victorin & Rousseau, described from Gaspé and New Brunswick, has relatively large leaves 8-13 cm long and 7-9 cm wide and a relatively long beak on the fruit 4-5 cm long. This variety has not recently been recognized as distinct. In *C. cornuta* var. *cornuta* f. *inermis* Fernald, described from East Broughton, Quebec, the involucre is smooth instead of bristly. The lack of distinctive skin-piercing bristles on the fruit of this form makes it easier to handle and thus of horticultural interest.

Variety *californica* (A. DC.) Sharp occurs on the west coast, Coast Ranges and Sierra Nevada from central California north to southwestern B.C. It has acute leaves and glandular hairs on the younger twigs. The involucre is 0.5-4 cm long and the plants have larger nuts 11-20 mm long. Variety *tracyi* Jepson has an extremely short involucre 4-8(16) mm long, but has recently been placed in var. *californica*. Intermediates between var. *californica* and var. *cornuta* occur in southern B.C. and adjacent US. Although the intermediates are predominant in central southern B.C., both varieties also occur there. In southwestern B.C. intermediates and var. *californica* are predominant. Elsewhere in B.C. plants are referable to var. *cornuta*. Beaked hazelnut is closely related to the Asian *C. sieboldiana* Bl.

American hazelnut (*C. americana* Walt.) occurs throughout a large area of eastern and central US from coastal New England south to Georgia and west to the Dakotas and Oklahoma. In Canada it is confined to the southern parts of Ontario, Quebec and Manitoba. American hazelnut appears related to the Asian *C. heterophylla* Fisch., and is another example of the classical Arcto-Tertiary disjunction. Nuts of American hazelnut are 9-15 mm long. The enclosing leaf-like (non-tubular) involucre bracts are 18-30 mm long, sometimes only reaching

the tip of the nut, but usually extending about twice its length. In eastern North America, where they overlap, American hazelnut can readily be distinguished from beaked hazelnut by glandular hairs on the twigs of the former. In addition the staminate catkins of American hazelnut are usually stalked while those of beaked hazelnut are sessile or nearly so. American hazelnuts without stipitate glands (or with few) are referable to f. *missouriensis* (DC.) Fern., which occurs sporadically throughout the range. Variety *altior* Farwell from Michigan also has fewer glandular hairs. Variety *indehiscens* Palm. & Steyerl., reported from North Carolina and Missouri, has fruiting bracts united on one side. Variety *calyculata* Winkl. has an involucre with two very large bracts at the base. While these infraspecific taxa are generally not recognized today, they are pointed out here because they encompass a range of variation of potential agronomic interest, and deserve further study.

The following key serves to distinguish hazelnuts in Canada:

- 1a. Bracts surrounding the nut bristly, $\pm$ prolonged into a slender tube; catkins sessile or with a stalk less than 1 mm
C. cornuta ... 2
- 2a. Tubular portion of bracts twice as long as part enclosing the nut; twigs glabrous or sparsely hairy
C. cornuta var. *cornuta*
- 2b. Tubular portion of bracts shorter than to a little longer than the portion enclosing the nut; twigs hairy
C. cornuta var. *californica* ... 3
- 3a. Twigs and petioles with stalked glands as well as hairs
C. cornuta var. *californica* f. *glandulosa*
- 3b. Twigs and petioles with only hairs
C. cornuta var. *californica* f. *californica*

1b. Bracts surrounding the nut downy and not prolonged into a tube; some catkins with stalks 2-10 mm ... 4

4a. Involucral bracts deeply divided into glandular-pubescent lobes 10-40 mm; medium-sized trees

C. colurna

4b. Involucral bracts shallowly divided into non-glandular lobes 3-8 mm; small trees or shrubs ... 5

5a. Bracts surrounding the nut as long as or more often twice as long as the nut

C. americana

5b. Bracts shorter than to as long as the nut

C. avellana

Ecology

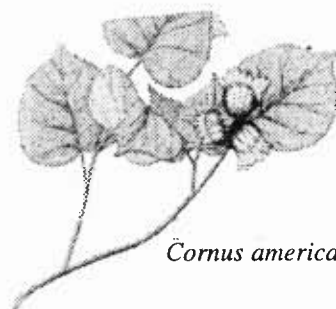
Native Canadian hazelnuts occur in dry to mesic woodlands, woodland edges, prairies, slopes of hills and river banks. They appear to do best on loam and sandy loam soil but beaked hazelnut grows well in coarse, relatively dry sand and on shallow soils over either limestone or granite rocks. The native hazelnuts grow well in the open or in partial shade.

Flowering of native hazelnuts occur in March and April. Pollen is carried by wind from the male catkin to the female flowers. Either hot, dry weather or late spring frosts reduce fertilization and seed development. Self-sterility and differing times of pollen release and receptivity on the same plant (dichogamy) serve to promote cross-pollination. The nuts are disseminated primarily by small rodents such as chipmunks and squirrels. In presettlement times, birds, larger mammals, and humans undoubtedly contributed to dispersal. Much of the increase in density of stems after browsing or fire is probably a result of resprouting.

Stems and twigs are eaten extensively by moose, white-tailed deer and snowshoe hare. Heavy browsing by moose has been shown to favour beaked hazelnut over other shrubs such as mountain maple. This may be related to more rapid and extensive resprouting of hazelnut and may result in rapid changes in dominance. Woodcock, ruffed grouse and sharptail grouse consume buds and catkins. Turkeys, chipmunks and squirrels eat the nuts extensively. Red squirrels can eat 80 hazelnuts per day. The nuts are richer than beechnuts and acorns in protein and fat, and production may reach 32,000 nuts per ha. Hazelnut provides valuable ground cover for wildlife and managers periodically burn or cut woody vegetation to improve stands.

Use as Food

In Europe hazelnuts were eaten by early man during the Mesolithic period of the stone age 10,000 years ago, and were cultivated by the Greeks and Romans 2000-2500 years ago. North American wild hazelnuts were widely used by native people throughout their areas of occurrence. The nuts have been found in many archeological sites. Early North American explorers and settlers also ate the nuts. Today, people find the texture and flavour of hazelnuts highly appealing. The nuts are eaten



Cornus americana



Cornus cornuta

extensively during the Christmas season, but are also used as a substitute for flour, as a spread like butter, in toppings, coatings, cereals, garnishes, soups and in cookies, ice cream and chocolate. The US imports about 50% of the hazelnuts consumed annually, and the percentage in Canada is likely higher.

Chemistry

Hazelnuts have qualities that may be beneficial. They have relatively low carbohydrate and high fibre compared to other nuts. They are a concentrated source of energy and are cholesterol-free. Over half of the weight is unsaturated fat and the fatty acid content is similar to that of olive oil. Oleic and linoleic are the most abundant fatty acids. Hazelnuts are relatively low in sugars and sodium. American hazelnuts contain approximately 5% water, 16% protein, 64% fat, 11-12% carbohydrate and 595 calories/100 gm edible portion. The relatively high levels of vitamins E and B₆ may be useful against coronary heart disease and certain cancers. The nuts are also relatively high in calcium, potassium, magnesium and vitamin B₁. Low moisture and high vitamin E in hazelnuts are reported to resist rancidity (oxidation) which results in off-flavours.

Non-Food Uses

European hazelnut has had numerous medicinal uses dating from the Greek and Roman empires, for example treatment of baldness, the common cold, stomach and sexual problems. American hazelnut was used to treat ulcers and tumours by the Hurons in southern Ontario and has also been used by native people as an analgesic. Decoctions containing hazelnut were employed by the Chippewa to treat convulsions and hemorrhage and to heal wounds. There is little use of hazelnuts in modern medicine.

Ornamental varieties of *C. avellana* include cultivars featuring yellow leaves ('Aurea'), purplish leaves ('Fusco-rubra', 'Purpurea'), dissected leaves ('Heterophylla'),

twisted branches ('Contorta,' 'Harry Lauder's Walking Stick'), and weeping habit ('Pendula'). Shrubs or small trees of *C. avellana* should not be confused with Turkish hazelnut, which is a much larger ornamental tree.

Agricultural and Commercial Aspects

The main source of the hazelnuts (filberts) of commerce is the European hazelnut (*C. avellana*), a shrub or small tree to 6 m tall, native to most of Europe south of 63° N. The Spanish cultivar 'Barcelona' is predominant in North America. It is cultivated in the Pacific Northwest, including the coastal valleys of the Cascade Range of Oregon and Washington, and the Fraser valley between Abbotsford and Agassiz in southern B.C. Turkey leads world production with 77% of the market followed by Italy and the US. Although relatively small, the Canadian crop is stable and worth approximately 1 million dollars annually. Hazelnut is second only to almond in world nut production. Admirable multiple-use of hazelnut plantations occurs in parts of Europe, where the orchards are used not only for nut production, but also provide firewood and foraging space for goats and other livestock. Susceptibility to eastern filbert blight (*Anisogramma anomale* (Peck) E. Muller) and lack of hardiness (flower buds are killed below -9° C) has prevented European hazelnut from being developed as a crop in eastern North America. However, it has become established as a wild plant in mild regions of southwestern B.C. (Saltspring Island and Sumas River).

Hazelnuts have a relatively shallow root system and are easy to transplant. Most American hazelnut is propagated by layering, which involves bending a sucker and securing a part of it beneath the soil; the buried portion then develops roots. Grafting onto Turkish hazelnut roots is also practised. The cost of grafted trees is about \$2,500.00 /ha. Plants are also grown from seed, although this may not result in uniformly productive crops. Seed requires stratification for at least 60 days. Planting is usually done in early spring, the plants generally placed 5-7 m apart. Hazelnuts are cultured either as "trees" trained to only a central stem (the usual method in North America) or as shrubs with several stems.

Although hazelnuts have both male and female flowers, many species have self-incompatible races. As a result plantings must contain two or more genotypes. To achieve maximum yield, one "pollenizer" (pollen-provider, genetically different from the orchard clone) is planted for every 17 crop plants to ensure sufficient fertilization and fruit development. Nuts are harvested when the edges of the husk begin to turn brown, and after they are dried the husk is removed by flailing.

The filbertworm (*Melissopus latiferreanus* Walsingham), a small moth (ca. 1.5 cm long), the larvae of which bore into the nuts and eat the kernel, is a major pest of the North American species. The moth is a generalist, feeding on several other nuts including acorns, and its local abundance may be related to other larval hosts in the area. Pheromone (sex attractant)

traps for adult male moths may be used to predict damage and determine control measures. The filbertworm can be controlled to some extent by early harvest of nuts. Hazelnut weevils (*Curculio obtusus* (Blancard)), also destroy the nuts, and a host of insects eat the leaves. Eastern filbert blight fungus frequently attacks North American species, but does little damage.

Good crops occur every 2 to 3 years in wild American hazelnut, but in cultivation crops the annual yield is often relatively constant. For wild beaked hazelnut the interval between heavy nut crops may be every 5 years. Production under natural circumstances ranges from 7500 to 32,000 nuts/ha. Two to three year old *C. avellana* trees bear a few nuts, but commercial quantities are not reached until 6 years after planting when 1.8-2.3 kg /tree are produced. Mature *C. avellana* furnishes 9-11.5 kg/tree, or even 23 kg/tree. Maximum yield may not be reached for 10 or 12 years and a well managed orchard may last for more than 40 years. Mature orchards average 1.2-2.5 metric tonnes dried nuts/ha. Dried nuts average 1-3 gm.

The Nut Growers Handbook, available at www.teleport.com/~hazelnut/handbook.htm, includes a production calendar with information on pruning, fertilizing, pest control, harvest, management, etc.

Cultivars & Germplasm

The most important cultivars of American hazelnut are 'Rush,' a large variety from southern Pennsylvania, and 'Winkler' a small, but winter-hardy, productive selection. American hazelnut hybridizes readily with European hazelnut when the former is used as the seed parent. Since the American hazelnut is much hardier and resistant to Eastern filbert blight, it is potentially very useful in breeding. Such hybrids were first developed in Pennsylvania by J.F. Jones in 1917, resulting in cultivars 'Bixby' and 'Buchanan.' During the 1930s additional hybrids were made with European Filbert at the New York Experiment Station in Geneva by G.L. Slate and also by C.A. Reed. Two cultivars from this period, 'Reed' and 'Potomac,' resulted in nuts equal to the best commercial filberts. In 1941 in Minnesota C. Weschke used local selections and 'Winkler' to breed 'Carlola,' 'Dolore' and 'Magdalene.'

In the 1950s, a Canadian grower, J.U. Gellatly of Westbank, B.C., made a major contribution to hazelnut breeding when he made hybrids of *C. cornuta* from Peace River with *C. avellana* to create filazels that could survive -45° C. He also hybridized tree hazelnuts with *C. avellana* to produce trazels, some of which were resistant to filbert bud mite and filbert blight. Some of Gellatly's hybrids, with names ending in "oka" for Okanagan, were later found to have commercial possibilities and they were also recognized as having substantial potential for breeding stock to improve hardiness and pest resistance in *C. avellana*. The most recent advancements using North American hazelnuts have been achieved by C.W. Farris in Michigan, who improved kernel size and reduced shell thickness in some of

Gellatly's filazels. The most recent advancements of European hazelnut are blight-immune selections of *C. avellana* produced at Oregon State University to address the spread of Eastern filbert blight in the Willamette Valley since 1970.

Although commercial cultivation in Canada is limited to European filberts and to a relatively small area of southwestern B.C., both winter hardy selections of *C. americana* and a number of *C. avellana* x *C. americana* hybrids have been grown successfully in southern Quebec. Between 1914 and 1950 hazelnuts were evaluated at the Horticultural Experiment Station at Vineland Station, Ontario, and hybrids of *C. americana* cv. Rush with *C. avellana* were reported to be particularly promising. In 1985 under Ontario's crop introduction and expansion program, a number of hazelnuts were tested in a plantation in the Niagara Peninsula to determine whether or not a commercial crop was possible in that area. The yields reached commercial potential, with the best trees producing 9.6 kg. The highest ratings were obtained by NY No. 104, a hybrid of *C. americana* cv. Rush x *C. avellana* cv. DuChilly. Additional highly rated material included other *C. americana* x *C. avellana* hybrids from New York such as NY No. 398, a hybrid of *C. americana* cv. Rush x *C. avellana* cv. Red Lambert, NY No. 616, a hybrid of *C. americana* cv. Rush x *C. avellana* cv. Barcelona, as well as the 'Chinoka Trazel,' a *C. avellana* x *C. chinensis* hybrid, and the 'Manoka' and 'Myoka' filazels, all *C. avellana* x *C. cornuta* var. *cornuta* hybrids. The Gellatly 502 filazel (*C. avellana* x *C. cornuta* var. *cornuta*) and other hybrids have been recommended for Nova Scotia.

The germplasm available has been barely utilized, the world production based almost entirely on *C. avellana*. The Canadian wild species are very important for crop development, especially in Canada, but few selections of American hazelnut are available in germplasm collections. Some Canadian races from northern range limits of the species are significant sources of hardiness and pest resistance. Perhaps the richest sources of variability of North American beaked hazel is in a limited area of central B.C., where the two varieties (*cornuta* and *californica*) overlap. Early maturing, thin-shelled, and cold-resistant races occur here.

Prospects

With both hobbyist growers and research reports suggesting that hazelnuts can be grown commercially much more widely in Canada than is generally thought, the possibilities for increasing domestic hazelnut production are good. Productive cultivars are available. An extensive literature on propagation, culture, management, and pests of the European hazelnut is also available, and can be applied to the hybrids discussed above. The market has been stable, but much of the hazelnut consumed in Canada and the US is imported. Consequently this crop deserves development.

Myths, Legends, Tales, Folklore, and Interesting Facts

- After melting of the continental glaciers 10-7 thousand years ago, *C. avellana* was very abundant in Europe resulting in the "hazel maximum" in pollen diagrams from peat strata.
- !-At the time of the eruption of Mount Vesuvius in 79 A.D., the inhabitants of Pompeii were eating hazelnuts obtained from extensive plantings near the mountain.
- Mercury's winged rod, said to have been made of hazel and entwined with two serpents, became a symbol of communication and commerce.
- The ancient Chinese considered hazel to be one of the five sacred nourishments bestowed upon mankind by God.
- Ancient priests burned hazelnuts to acquire the power of clairvoyance.
- Hazelnut was sacred to the mythological god Thor who, according to the World Wide Web, drove in a chariot drawn by two white goats called Cracker and Gnasher.
- The hazelnut was employed as an emblem of fruitfulness in marriage ceremonies.
- In northern Europe the hazelnut was considered a protection against lightning and a charm against witches.
- Rhabdomancy, the art of finding underground riches with a forked branch, was largely practised with hazelnut twigs. Use of the Y-shaped branch, called dowsing or divining, revealed the location of treasure, minerals, ore and water. The Father of binomial nomenclature, Linnaeus, admitted to being half a convert to the use of divining rods.
- Jaques Cartier discovered the St. Lawrence River in 1535 and found an island where beaked hazelnut was so abundant he named it "l'ysle es couldres," the isle of hazelnuts. When the famous botanist Father Marie-Victorin visited the island in 1920, he could not find any hazelnuts, and this led to a debate about the reliability of Cartier's observation. In 1937 Canadian botanist Bernard Boivin located Cartier's landing place and found beaked hazelnut abundant there. Boivin reported that he filled his pockets with nuts, ate some of them, and noted that the hazelnuts were "as abundant today as four centuries ago." Possibly hazelnuts were very inconspicuous during Marie-Victorin's visit because of the "Herbivore Explosion Effect:" deer and/or rabbits could have suddenly become abundant on the island around 1917 and selectively browsed the hazelnut to the ground. Next the deer and/or rabbit population(s) may have crashed due to starvation or disease, and the hazelnut vigorously resprouted from rootstocks and stolons, again becoming abundant.
- A survey showed that hazelnuts are as popular as almonds in chocolate, but less popular than pecans in ice cream and walnuts in brownies.
- The uninitiated wild nut collector should be warned that the husk of the beaked hazel (*C. cornuta*) is covered with tiny, skin-piercing hairs which can be quite irritating to the hands.
- At the time of pollination the pistillate flower of hazelnut has no ovary, only two elongating stigmatic branches. Pollen remains dormant there for a lengthy period while development of the pistillate flower is completed. The style end of the eventual fruit formed may be a year older than the base of the fruit!

James C. Ritchie honored

Professor James C. Ritchie is the first paleoecologist to receive the prestigious W.A. Johnston medal awarded by the Canadian Quaternary Association (CANQUA), in recognition of his exceptional research career.

Born in Scotland, professor Ritchie received his degree from the University of Sheffield in 1955 for his research on hybridization in *Vaccinium*. He was first employed at the Montreal Botanical Gardens (under the direction of Jacques Rousseau). His career as botanist and ecologist was always been in Canada (University of Manitoba, Dalhousie University, University of Toronto at Erindale College). He was exceptionally active in the Canadian Botanical Association and he served on several different committees of the National Research Council, lending his support to research in this country in the fields of plant ecology and paleoecology. His influence has been enormous as is eloquently shown by his list of 80 scientific publications and two magnificent books, one of which has been awarded the Cooper Prize of American Ecological Society.

Study of the Quaternary Era, or that of the legacy left by the last glaciers, also means the study of the vegetation that evolved at that time. The plant communities and landscapes that we know today are the result of the tremendous subsequent changes that occurred, namely in response to change in the climate. In reconstituting of the postglacial vegetation in Canada, professor Ritchie used palynological data to make the link between paleoecology and present-day ecology. He has developed methods and concepts that will guide the work of generations of researchers. He has succeeded, in a fashion similar to that of Jacques Rousseau, in sharing with us his enthusiasm for the Great North and all its grandeur. He is, justifiably, the greatest and most influential palynologist that we have ever had in Canada.

That CANQUA, whose members are, for the most part, geographers and geologists, should discern its highest distinction on James Ritchie, is added proof of the multidisciplinary nature of research on the Quaternary and of the interest that this association has for holistic studies of the Earth.

For my part, it is with admiration and appreciation that I applaud the gesture of CANQUA. Finally, as a past president of l'Association québécoise pour l'étude du Quaternaire (AQQUA), may I add my appreciation for the high regard in which he has always held the francophone community.

Pierre J.H. Richard, Département de géographie, Université de Montréal

See also the periodical *Géographie physique et Quaternaire* 53 (2) for the presentation addresses of professor Les Cwynar (University of New Brunswick) and professor Ritchie for the CANQUA medal.

James C. Ritchie honoré

Le professeur James C. Ritchie est le premier paléoécologue à recevoir la prestigieuse médaille W.A. Johnston attribuée par l'Association canadienne pour l'étude du Quaternaire (CANQUA), en reconnaissance d'une carrière exceptionnelle en recherche.

Né en Écosse, diplômé de l'Université de Scheffield en 1955 pour des travaux taxonomiques sur l'hybridation chez *Vaccinium*, le professeur Ritchie trouvait un premier emploi au Jardin botanique de Montréal, dirigé alors par Jacques Rousseau. Sa carrière de botaniste et d'écologue fut entièrement canadienne (Université du Manitoba, Université de Dalhousie, Université de Toronto à Erindale College). L'homme fut exceptionnellement actif au sein de l'Association botanique du Canada et dans divers comités au Conseil de recherches en Sciences naturelles et en Génie du Canada, appuyant de la plus heureuse façon les recherches canadiennes en écologie végétale et en paléoécologie. Son influence fut énorme, à la mesure de l'immense talent que traduisent ses quelque 80 publications scientifiques et ses deux livres magnifiques, dont l'un recevait le Prix Cooper de l'*Ecological Society of America*.

L'étude de l'Ère Quaternaire, celle des héritages glaciaires et des processus alors actifs, comprend aussi l'étude de la végétation qui y a évolué, qui s'est adaptée aux changements profonds qui y sont survenus, notamment ceux du climat. Les populations végétales et les paysages actuels sont des héritages du passé. Dans ses reconstitutions de la végétation postglaciaire au Canada, le professeur Ritchie a toujours recherché les informations palynologiques permettant de faire le lien entre la paléoécologie et l'écologie moderne. Il nous a légué des méthodes et des concepts qui éclaireront longtemps encore les travaux de générations de chercheurs. Il nous a fait partager, à l'instar de Jacques Rousseau, sa passion pour les grands espaces nordiques et il nous a laissé un formidable exemple de rigueur dans l'approche pollénanalytique des reconstitutions de la végétation. Il est à juste titre le plus grand et le plus influent palynologue que le Canada ait compté.

Que la CANQUA, dont les membres sont surtout des géographes et des géologues, ait décerné sa plus haute distinction au professeur Ritchie est une autre preuve du caractère fondamentalement multidisciplinaire des études portant sur le Quaternaire, de l'intérêt de cette association pour une approche holistique du système-Terre.

Pour ma part, c'est avec admiration et reconnaissance que je m'associe au geste de la CANQUA, dont je suis membre. C'est aussi en tant que plus jeune collègue ayant largement profité de l'exemple et de l'appui du professeur Ritchie. C'est enfin à titre d'ancien président de l'Association québécoise pour l'étude du Quaternaire (AQQUA), pour l'estime que le professeur Ritchie a toujours eu pour la francophonie.

Pierre J.H. Richard, Département de géographie, Université de Montréal

Voir aussi le numéro 2 du volume 53 de la revue *Géographie physique et Quaternaire* où sont publiés les exposés du professeur Les Cwynar (Université du Nouveau-Brunswick) et du professeur Ritchie lors de l'attribution de la médaille de la CANQUA.

*The following publications have not yet been spoken for.
If you are willing to review one of these books please
contact the editor at the address indicated at the
beginning of the bulletin (page 10).
On request, the book you wish to review will be sent to you.*

*Les publications suivantes n'ont pas encore été réclamées.
Si vous voulez faire la critique d'un de ces ouvrages,
veuillez contacter le rédacteur du bulletin
à l'adresse indiquée à la page 10.*

The Flora of Manitoulan Island

by J.K. Morton and J.M. Venn (Editors)
University of Waterloo Biology Series
Number Forty, 2000

Symmetry in Plants

by R.V. Jean and D. Barabé (Editors)
World Scientific, 1998
(Series in Mathematical Biology and Medicine, Vol. 4)

Cultiver des plantes sauvages... sans leur nuire

par G. Lamoureux et P. Nantel
Fleurbec éditeur, 1999

Molecular Genetics of Plant Development

by S.H. Howell
Cambridge University Press, 1998

SPECIAL PLACES, The Changing Ecosystems of the Toronto Region

B. I. Roots, D.A. Chant &
C.E. Heidenreich (eds.)

UBC Press
Vancouver, 1999
(Cdn \$49.95)

The Toronto region is well known for its many special natural places; this volume is a follow up to *The Natural History of the Toronto Region* (1913), both commissioned by the Royal Canadian Institute. The current work allows one to not only learn about these places, but also in the context of how they have changed since the earlier report. The editors, in addition to their own introductory and concluding contributions, were successful in compiling an impressive array of authorities on various aspects, providing expert reports on the geological record and its

interpretation, climate, local history, watersheds and their development, and each of the major taxonomic groups of plants and animals. Local individuals who have made significant scientific contributions through their studies in the region are featured on special pages. This is followed by reports on the changing attitudes toward the natural environment in the developing metropolis and individual reports on the major areas or land forms.

For those of us who live near Toronto, we sometimes take for granted the special nature of this region and the efforts that have been made to understand and protect individual watersheds, ecosystems or geological features. As a graduate student located outside of southern Ontario, I learned major Pleistocene chronologies and floras from studies that had been conducted at Toronto formations, before I knew much about the city itself. Even though much biodiversity and significant ecosystems have been lost as urbanization occurred, there still is an amazing diversity of organisms and areas to be seen. Much credit can go to early efforts to protect individual sites and the development of a comprehensive park system. More recent efforts to keep ravines and other parks natural, and restore degraded ecosystems provides the promise of the return of some lost species, such as the savannah species of wild flowers and butterflies in High Park.

Local community groups are given credit for watchfully protecting natural areas in their respective areas of the region and pushing for policies to protect major features, such as the Niagara Escarpment and Rouge Valley; they are also recognized for promoting management of parklands to promote or protect natural systems, or restore lost qualities, often backed up with major volunteer work efforts.

The in depth detail of the combination of natural and social history of the region makes this an excellent reference book to better understand the urban landscape and how it developed, or even potentially serve as a text book for the geography of the region. As we become a more urban society, losing our ecological competence and connection to the natural world is a danger we must take seriously, especially among the decision makers of our society. This work provides information to help rectify that trend.

John D. Ambrose, University of Guelph



Protecting the Belanger and Quarry Bay Alvars on Manitoulin Island (continued)

also collected on lichens, mosses, algae, terrestrial molluscs and target insect groups. Sites were ranked using four criteria; sites with the largest diversity of alvar communities, sites that collectively best represent each alvar community type, sites that best represent the diversity of alvar communities within each ecoregion; and sites with globally rare species. Thirty-four 'multiple-value sites' were identified, four of them on Manitoulin Island.

At the same time, the FON supported an Ontario alvar theme study, which will be published in early 2000. Based on IACI data and additional field studies, it assessed alvar conservation needs in the context of Ontario's areas of natural and scientific interest (ANSIs). This study also concluded that the Manitoulin Island sites were among the largest, most pristine and most significant of Ontario alvars.

Manitoulin Island, in Lake Huron, is the largest freshwater island in the world, 80 miles long and 30 miles wide. It shares the warm climate and the limestone and glacial landforms of southern Ontario but it is more remote and supports some of the last extensive wilderness left in southern Ontario and one of the longest undeveloped freshwater shorelines on Lake Huron. Manitoulin is the epicentre of alvars in the Great Lakes region - large, undisturbed examples of rare communities, supporting a wealth of rare species, exist on Manitoulin's south and north shores. Typical of the arctic and prairie species are Arctic Bluegrass and Prairie Smoke, and it is also here that are found a number of Great Lakes endemics, such as Pitcher's Thistle, Hill's Thistle, Dwarf Lake Iris, Houghton's Goldenrod and Lakeside Daisy. Other rare species found on Manitoulin alvars include Prairie Dropseed Grass (*Sporobolus heterolepis*), Ram's-Head Orchid (*Cypripedium arietinum*), Cooper's Milkvech (*Astragalus neglectus*), Yellow Flax (*Linum sulcatum*) and Blazing Star (*Liatris cylindracea*).

The most significant alvars on Manitoulin Island are those along the south coast of the island, from Quarry Bay in the west to Christina Bay in the east, particularly around Belanger Bay. These holdings represent an extraordinary opportunity to preserve an outstanding Great Lakes landscape, and reduce the threat of shoreline and resort development, and roads and quarries, at these sites. Together, Belanger Bay and Quarry Bay contain more than 1200 hectares of treeless alvars, and even more alvar savannahs and shrublands.

The Belanger Bay alvar is an area of rich treeless pavements dominated by populations of Lakeside Daisy and Dwarf Lake Iris. Of the various alvars on Manitoulin, Belanger Bay has the highest diversity of alvar communities (see partial listing below). The alvar communities are in excellent condition with very few non-native species. Belanger Bay likely supports the world's largest population of the endangered endemic Lakeside Daisy (*Hymenoxys herbacea*).

Also on the southwest shore of Manitoulin is the Quarry

Bay site. This alvar is similar to and linked along the shore to the alvar at Belanger Bay. Quarry Bay's alvars are also in excellent condition and, in the final analysis of the IACI, Quarry Bay and Belanger rank as two of the four best sites in the Great Lakes region representing alvar ecosystems and supporting globally rare species.

Summary List of Rare Species and Community Types at the Belanger Bay and Quarry Bay Alvars

<u>Globally Rare Great Lakes Endemic Plants</u>	Ranking
Pitcher's Thistle (<i>Cirsium pitcheri</i>)	G3, S2 Threatened
Lakeside Daisy (<i>Hymenoxys herbacea</i>)	G2, S2
Houghton's Goldenrod (<i>Solidago houghtonii</i>)	G3, S2
Hill's Thistle (<i>Cirsium hillii</i>)	G3, S3
Dwarf Lake Iris (<i>Iris lacustris</i>)	G3, S3
<u>Other Globally Rare Plants</u>	
Ram's-Head Orchid (<i>Cypripedium arietinum</i>)	G3, S3
Prairie Dropseed Grass (<i>Sporobolus heterolepis</i>)	G5, S2
Cooper's Milk Vetch (<i>Astragalus neglectus</i>)	G3G4, S3
<u>Additional Provincially Rare Plants</u>	
Blazing Star (<i>Liatris cylindracea</i>)	G5, S3
Purple Cliffbrake (<i>Pellaea atropurpurea</i>)	G5, S3
Northern Dropseed (<i>Sporobolus heterolepis</i>)	G5, S3
Western Woodsia (<i>Woodsia oregana</i> var. <i>cathcar.</i>)	G5, S3
Lance-Leaved Coreopsis (<i>Coreopsis lanceolata</i>)	G5, S3S4
Great Lakes Wheatgrass (<i>Elymus lanc. ssp. psamm.</i>)	G5T3, S3
<u>Rare Fauna</u>	
Caspian Tern (<i>Sterna caspia</i>)	S3
Chrysis Arctic Butterfly (<i>Oeneis chrysus</i>)	G5, S4
Large Marble Butterfly (<i>Euchloe ausonides</i>)	G5, S3
Mollusc (<i>Catinella exile</i>)	G1, G2, S1
Mollusc (<i>Catinella aprica</i>)	G3, S3
Mollusc (<i>Vertigo morsei</i>)	G1G2, S1
Mollusc (<i>Succinea indiana</i>)	S2
<u>Arctic Plants</u>	
Arctic Bluegrass (<i>Poa arctica</i>)	G5, S2
Drug Eyebright (<i>Euphrasia stricta</i>)	S4
<u>Rare Community Types</u>	
- *Little bluestem grassland	G2, S2S3
- Tufted hairgrass wet grassland	G2, S2S3
- Creeping juniper-shrubby cinquefoil pavement	G2, S2
- Non-vascular pavement	G2
- *Juniper shrubland	G3, S2
- Poverty grass dry alvar grassland	G2
- *Scrub conifer / dwarf lake iris shrubland	G1G2
- *Mixed conifer / common juniper woodland	G2?, S2
(* denotes best representative sites in Great Lakes basin)	

John Riley, Director of Conservation Science, Nature Conservancy of Canada, jriley@natureconservancy.ca

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Paul Cavers, Dept. of Plant Science, University of Western Ontario, London, ON, N6A5B7.
Tel. : (519) 679-2111; fax : (250) 661-3935; e-mail : pcavers@julian.uwo.ca

Directors / directeurs (1999-2001)

Sylvie Laliberté, Dép. des sciences biologiques, Université du Québec à Montréal, C.P. 8888, Succ. Centre-ville, Montréal, QC, H3C 3P8. Tel. : (514) 987-3963; fax : (514) 987-4647; e-mail : laliberte.sylvie@uqam.ca

Ed Reekie, Biology Department, Acadia University, Wolfville, NS, B0P 1X0
Tel. : (902) 585-1162; fax : (902) 542-3466; e-mail : ereekie@ace.acadiau.ca

Ed Yeung, Dept. of Biological Sciences, University of Calgary, Calgary, AB, T2N 1N4
Tel. : (403) 220-7186; fax : (403) 289-9311; e-mail : yeung@acs.ucalgary.ca

Editor / rédacteur

Denis Lauzer, IRBV-Université de Montréal, 4101, rue Sherbrooke Est, Montréal, QC, H1X 2B2.
Tel. : (514) 872-8494; fax : (514) 872-9406; e-mail : denis.lauzer@umontreal.ca

Archivist / archiviste

Joe Gerrath - pro tem. Dept. of Botany, University of Guelph, Guelph, ON N1G 2W1.
Tel. : (519) 824-4120; fax : (519) 767-1991; e-mail : jfgerrat@uoguelph.ca

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