THE CANADIAN BOTANICAL ASSOCIATION

BULLETIN

DE L'ASSOCIATION BOTANIQUE DU CANADA

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Patron / Président d'honneur
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

This issue of the bulletin is the last one to be produced by Denis Lauzer. I am sure you will all agree that Denis has done a wonderful job bringing us all up to date on the current happenings in our Association. Thank you, Denis, for all the time you have invested producing such an excellent publication.

The next issue of the Bulletin will be produced in Edmundston, NB, under the direction of our new Editor, Martin Dubé. We look forward to the continued production of an informative and interesting Bulletin under his editorship.

Plans are being finalized for our next Annual Meeting (August 4-7), to be held at the Pyle Conference Center on the campus of the University of Wisconsin in Madison, Wisconsin. The deadline for submission of abstracts is now established (April 1, 2002) and we now have a list of planned Symposia. The subject of the Plenary Symposium is **Evolution: Highlighting Plants**, organized by Patricia Gensel.

Sectional Symposia of the Botanical Society of America (with input from CBA Sections) include the following:

1. **Evolution of mating systems in the genus *Mimulus*** (full-day), organized by Jeffrey Karron and Michelle Dudash.
2. **Tropical intercontinental disjunctions: Gondwana break-up, immigration from the boreotropics, and transoceanic dispersal** (full-day), organized by Suzanne Renner and Tom Givnish.
3. **'Werthwhile' passions: Exploring the plants and research themes that fascinated Dr. Charles R. Werth** (half-day), organized by Christopher Haufler.
4. **Biocomplexity in mycorrhizae** (half-day), organized by Larry Peterson, Jack Fisher and Darlene Southworth.
4. **Conifer reproductive biology: A tribute to John N. Owens** (half-day), organized by Danilo Fernando and David Gifford.
5. **Generating diversity: The link between developmental morphology and phylogeny** (half-day), organized by Denis Barabé, Judy Canne-Hilliker and Nancy Dengler.

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Editors / La rédaction

Editor / rédacteur

Martin Dubé

Campus d'Edmundston
Université de Moncton
165, boul. Hébert
Edmundston NB,
E3V 2S8
Telephone : (506) 737-5154
Fax : (506) 737-5373
E-mail : martin@cuslm.ca

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Information for submitting texts / Soumission des textes

Texts and illustrations for the Bulletin must be sent to the Editor preferably via the electronic mail (attached file) or on a diskette. Texts should be saved under "Word" and illustrations under the "TIFF" format.
If you have any question about text submission please contact the Editor.

Les textes et les illustrations pour le bulletin doivent de préférence être envoyés par courrier électronique (sous forme de fichier attaché) ou encore sur une disquette.
Les textes doivent être enregistrés sous « Word » et les illustrations sous le format « TIFF ».
N'hésitez pas à contacter le rédacteur pour toute information sur l'envoi de documents.

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CBA Bulletin / Bulletin de l'ABC

The CBA Bulletin is issued quarterly (February, May, August, November) and sent to all CBA members.
Le Bulletin de l'ABC paraît quatre fois par année (février, mai, août, novembre) et est envoyé à tous les membres de l'ABC.

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To ensure continuous delivery of the Bulletin please notify the Treasurer promptly of any change of address.
Veuillez communiquer tout changement d'adresse au trésorier afin de recevoir tous les numéros du bulletin.

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If you have any comments or suggetions about the Bulletin, please contact the Editor at the above address.
Si vous avez des commentaires ou suggestions concernant le bulletin, veuillez s'il vous plaît contacter le rédacteur à l'adresse mentionnée plus haut.

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Texts for the May issue must be received before April 15, 2002. Les textes pour le bulletin de mai doivent arriver au plus tard le 15 avril 2002.

CBA Section and Committee Chairs

Section Chairs (2000-2002)

Ecology
Dianne Fahselt
Department of Plant Sciences
University of Western Ontario
London ,ON, N6A 5B7
dfahselt@julian.uwo.ca
Tel. : (519) 679-2111 ext. 6480; fax : (519) 661-3935

Mycology
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
Denis Barabé
IRBV-Jardin botanique de Montréal
4101, rue Sherbrooke Est
Montréal, QC, H1X 2B2
denis.barabe@umontreal.ca
Tel : (514) 872-1436; fax : (514) 872-3765

Systematics & Phytogeography
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

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

Committee Chairs (2000-2002)

Conservation
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
Denis Barabé
IRBV-Jardin botanique de Montréal
4101, rue Sherbrooke Est
Montréal, QC, H1X 2B2
denis.barabe@umontreal.ca
Tel : (514) 872-1436; fax : (514) 872-3765

Development
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
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

President's Message

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6. **Restoration of major plant ecosystems in the USA: Physiological research and teaching opportunities** (half-day), organized by Anitra Thorhaug and Henri Maurice.
7. **Ethnobotany of the Solanaceae** (half-day), organized by David Spooner.

The Phycological Society of America will have the following Symposia:

1. **Green algal conquests of the land: Many conquests, one victory?** (half-day), organized by Russell Chapman, Charles Delwiche and Richard McCourt.
2. **Mycosporines: Detection methodologies and assessment** (half-day), organized by Paul Zimba.

The American Society of Plant Taxonomy will have the following Symposia (duration not known):

1. **Systematics and Evolution of the Caryophyllaceae**, organized by Richard Rabeler and Molly Nepokroeff.
2. **Rosaceae phylogeny : Current knowledge, problems, and prospects**, organized by Christopher Campbell and Tim Dickinson.

The main botanical meeting will be preceded by a Forum on botanical teaching and outreach (Aug. 2-3), which will include workshops and field excursions.

Information on field trips and botanical workshops has not been received yet, but this should be available shortly and will be posted on the Botany 2002 website, which can be accessed through the CBA/ABC website (or directly at: **http://www.botany2002.org**).

Joe Gerrath, President, *jfgerrat@uoguelph.ca*

Macoun Travel Bursary

A John Macoun Travel Bursary will be awarded to a student who participates in the competitions for the Lionel Cinq-Mars Award or the Iain and Sylvia Taylor Award at the Annual Meeting of CBA.

Eligibility:

1. The competition for the Macoun Travel Bursary is open to student members of CBA.
2. Students must have a presentation in the competitions for the Lionel Cinq-Mars Award or the Iain and Sylvia Taylor Award at the Annual Meeting of CBA at Madison, Wisconsin.
3. No student may receive more than one travel bursary while registered for the same degree program.

Procedures:

1. Students applying for the Macoun Travel Bursary must do so no later than April 1, 2002.
2. The application must contain the following documents:
a) A copy of the abstract of the presentation to be given at the Annual Meeting.
b) A supporting letter from the director of the student's research that includes a statement that the student is engaged in a M.Sc. or Ph.D. program.
c) The student's curriculum vitae (one page).
d) A letter of recommendation from a member of the student's research committee (not the supervisor).
3. Send the complete set of application documents to:

Dr. Joe Gerrath
70 Dumbarton St.
Guelph, ON
N1E 3T6
Email: mailto:jfgerrat@uoguelph.ca

4. The CBA President will appoint a committee to examine all applications and to recommend the candidates who will receive bursaries. The sole selection criteria shall be those of academic merit.

Joe Gerrath, President, *jfgerrat@uoguelph.ca*

2002 CBA Annual Meeting / Congrès annuel de l'ABC 2002

For more information about
the Macoun Travel Bursary,
the Lionel Cinq-Mars Award,
the Iain and Sylvia Taylor Award
and the Best Student Paper Awards,
please visit the CBA Website at :

http://www.uoguelph.ca/botany/cba/

Poorly Known Economic Plants of Canada- 32. Buffaloberry, *Shepherdia canadensis* (L.) Nutt. and *S. argentea* (Pursh) Nutt.

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

Like American buffalos, buffaloberries were considered for centuries to be merely a wild food undeserving of much respect, but in more recent times they have attracted attention as a potential gourmet culinary item.

Latin Names

The genus *Shepherdia* was named for British botanist John Shepherd (1764?-1836), a curator of the Liverpool Botanic Garden. The epithets for the two Canadian species, *canadensis* and *argentea*, respectively mean "of Canada" and "silvery."

English Names

S. canadensis: buffaloberry (buffalo berry, buffalo-berry), Canadian buffaloberry, Canada buffaloberry, russet (red) buffaloberry, bitter buffaloberry, soapberry, foamberry, soopolallie, soapolallie ("soap berry" in Chinook jargon, the Northwest trade language). The vernacular name buffaloberry has been attributed to the fondness of the plains bison ("buffalo") for the berries. It is much more likely that the name developed from the practices of the Plains Indians of making a sauce from the berries for bison meat, and also of using the berries in pemmican made with bison meat and the berries. The name "soapberry" alludes to the soapy feel of the berries, and the saponin content.

S. argentea: buffaloberry, thorny buffaloberry, silver buffaloberry, sour buffaloberry, silver berry, silverberry (a name also applied to Elaeagnus commutata Bernh., which is native to Canada, and is best reserved for this species to avoid confusion), silverleaf, bull berry (so-named for the bulls of the buffalo), rabbit berry, Nebraska currant (the flavor has been said to be reminiscent of the currant), beef suet tree, wild oleaster.

French Names

S. canadensis: shepherdie du Canada
S. argentea: grains de boeuf

Morphology

Key to Canadian species of *Shepherdia* (and how to distinguish these from other Eleagnaceae found in Canada)

Leaves alternate ..... *Eleagnus* & *Hippophae*
Leaves opposite ..... *Shepherdia*

Thorny shrub or small tree; leaves oblong, silvery on both surfaces ..... *S. argentea*
Non-thorny shrub; leaves oval, green on upper surface, silvery below ..... *S. canadensis*

Buffaloberry plants are shrubs or small trees (the Canadian species are deciduous), generally dioecious (with separate male and female plants), but occasionally monoecious. The fruits are achenes enclosed in flesh that develops from the hypanthium [the expanded portion of the upper end of the flower stalk (receptacle), this bears the sepals, petals, and sometimes the stamens]. These are "pseudobaccate" (descriptive of berry-like structures that are not true berries in the sense of having a pulpy fruit derived from a single pistil, as in grapes and cranberries); while almost invariably termed berries, strictly the fleshy propagules are not true fruits because the flesh is not derived from the ovary wall. Of course the true fruits are the achenes, which are almost universally called seeds.



Shepherdia argentea

Canadian buffaloberry ranges in height from 0.5-4 m, usually less than 2 m in Canada. Its roots branch considerably, and are often quite deep-penetrating. The upper surface of the leaves is green and white-scurfy. The lower leaf surfaces and the new twigs and buds are covered with reddish-brown ("rusty" or "cinnamon") scurfy peltate scales (hence the name "russet buffaloberry"), while the older bark is dark grey. The fruits turn yellowish-red, reddish-orange, or bright red when ripe, and have a translucent appearance. They are insipid.



Shepherdia canadensis



Shepherdia argentea

Silver buffaloberry is a shrub or small tree 1-6 m high, with stems that may exceed 10 cm in diameter. The branchlets often end in hard spines 4-5 cm long. The thin bark is silvery scruffy when young, becomes greyish-brown in the third or fourth year, and gradually exfoliates. The leaf surfaces are covered with lepidote (scaly) hairs that produce the silvery appearance. A root crown or rootstock is formed, which may produce several shoots about 0.5 m apart, and roots penetrating about a metre into the soil. The fruits are orange-red to red, 5 to 6 mm long. They are very sour but a hard frost improves their taste.

Classification and Geography

The Elaeagnaceae (oleaster family) has only three genera, *Elaeagnus* (about 40 species of Eurasia and North America), *Hippophae* (about eight species native to Eurasia) and three species of *Shepherdia*, all of which are indigenous to North America. *Shepherdia rotundifolia* Parry occurs in southern Utah and northern Arizona. A hybrid of garden origin between *S. canadensis* and *S. argentea*, known as *S.* x *gottingensis* (Rehd.) Rehd., is available in the horticultural trade. *Shepherdia canadensis* f. *xanthocarpa* Rehd. is a form that produces only yellow fruit (sold today as the cultivar 'Xanthocarpa'). Similarly there is also a yellow-fruited cultivar of *S. argentea*, also called 'Xanthocarpa.'

Canadian buffaloberry reaches its northern limits north of the Arctic Circle, and is found in all provinces except Prince Edward Island. It occurs from Newfoundland to Alaska, and follows the Rocky Mountains south to Arizona and New Mexico. It has been reported at elevations up to 1,600 m in Alberta, and 2,500 m in Idaho.

Silver buffaloberry is native in Canada in the Prairie and southern parklands of the Prairie Provinces. In Canada it is most abundant in southwestern Saskatchewan and southeastern Alberta. In the US, it is best developed in the Great Plains, extending east to Minnesota and Iowa, and south to California, Arizona, New Mexico, and Oklahoma. In Canada, silver buffaloberry occurs mostly below altitudes of 1,000 m.

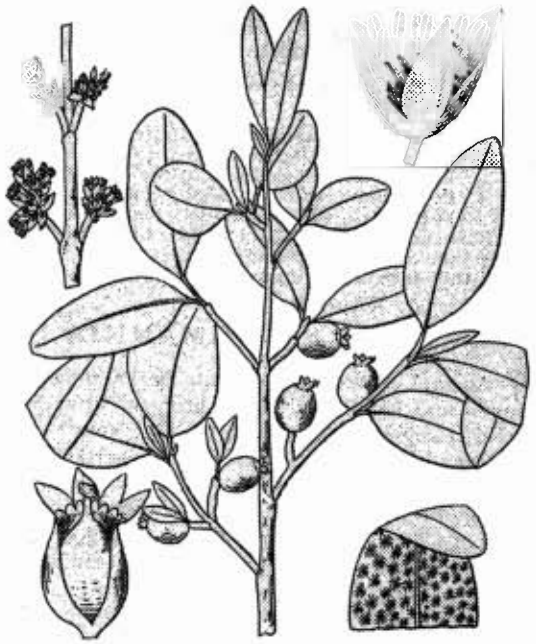
Ecology

The Canadian species of *Shepherdia* flower in early spring, and have mature berries in mid- to late summer. The berries will persist over the winter if not collected. In both species dispersal of the seeds is probably mainly in the droppings of birds and mammals. The nitrogen-fixing ability of buffalober-

ry plants is due to an association with symbionts that occur in "actinorhizal" root nodules. These symbionts are bacteria classified in the genus *Frankia* (discussed at the end of this article).

Canadian buffaloberry is an understory component of conifer and aspen forests, as well as a dominant or subdominant of grasslands and shrub associations. Deer, elk, feral horses, and bighorn sheep browse on the twigs and foliage to a minor extent. Black and grizzly bears and grouse eat large quantities of the berries. The species is generally found on sandy, gravelly, or rocky soils. It grows well on shores, riverbanks, dry slopes, rocky woods, and occasionally in calcareous marshes. Although it can develop well in mesic sites, it often thrives in very xeric sites. The species is considered very desirable for revegetation of disturbed sites, since it is a native plant, provides food and cover for wildlife, and its nitrogen–fixing ability allows it to grow in poor soils while improving them. It is used by wildlife managers for watershed management and habitat improvement.

Canadian buffaloberry fruits are a major late-summer food of bears in parts of the Rocky Mountains. These large omnivores play vital roles in the ecosystem, such as creating special habitats and dispersing seeds. This contributes to the maintenance of rare species and overall biodiversity. Therefore, the seasonal dependence of bears on Canadian buffaloberries is ecologically important. Fruit production by *S. canadensis* is greatest in early successional sites that have recently been produced by fire or where forest cover was removed by an avalanche. As forest cover increases berry production declines. In some situations the decline can be substantial a few decades after the fire, but in xeric sites the effects of fire may be prolonged. Fires, which once occurred naturally due to lightning, are clearly important in the management of wildlife and protection of biodiversity.



Shepherdia canadensis

Silver buffaloberry particularly occupies sandy soils that are often poorly drained, frequently somewhat calcareous, and generally non-saline (although occasionally slightly saline). While it is tolerant of poorly drained soils and some flooding, it is intolerant of prolonged flooding and permanently high water tables. The species is usually on river and creeks banks, low-lying, somewhat marshy areas, wet meadows, floodplains, and along streams, rivers, lakes, springs and ponds. It is usually in open areas, but will tolerate some shading. Silver buffaloberry tends to be a member of more or less dense shrub communities. Vegetative reproduction from the rootstocks and roots is pronounced in silver buffaloberry, and this commonly produces thickets, all of the "plants" representing the same clone. Seedlings are very difficult to find in Canada, although a single female is capable of producing over 10,000 seeds. As with Canadian buffaloberry, silver buffaloberry is browsed by deer and elk, and the berries are consumed by bears, grouse, and other birds, and it is also a useful plant for soil stabilization and erosion control.

Canadian and silver buffaloberries differ dramatically in architecture, apparently in relation to frequency of fire. Silver buffaloberry suckers extensively from its root crown and roots, and this is adaptive to frequent fires, which occurred in the formerly extensive grasslands of central North America. By contrast, Canadian buffaloberry produces some branches that curve downward and root, forming new thickets, but the thickets are much smaller. Canadian buffaloberry occurs in disturbed habitats of largely forested regions where fires are less frequent.

Use as Food

Native Peoples of North America and pioneers of the Central Plains of the United States and the Prairie Provinces of Canada made extensive use of buffaloberries. The berries were often pressed into cakes and cooked. They were also a component of pemmican, a combination of buffalo meat and berries that was a staple food. Today, buffaloberries are harvested from the wild for home use for pies, jams, jellies, and wine, and as a cottage industry for the production of jams and jellies. The fruits contain abundant pectin, and make an excellent jelly. Like most fruits, pectin content decreases somewhat in the later stages of ripening, and slightly immature, sour fruit is best for preparing jelly. The berries also make good pies and conserves. For eating fresh and for pies, it is recommended that picking be delayed until after the first frost, when the flavour of the berries is sweetest. The crop may even be harvested in winter, if spared by birds. The fruits preserve very well when dried. The juice of buffaloberries has a puckering quality not unlike chokecherry (*Prunus virginiana* L.), and has been used to make a cool, sweet, summer drink.



Chemistry

The Vitamin C (ascorbic acid) content of both Canadian buffaloberry and silver buffaloberry has been found to be quite high (over 150 mg/l00 g fresh berries).

Toxicity

One analysis of Canadian buffaloberry indicated a content of 0.74% of saponins in the berries. The bitterness and also the foaming properties of these berries are due to the saponins. Saponins have the undesirable properties of irritating the digestive system, causing nausea, vomiting and diarrhea. It has been recommended that only limited quantities of the berries be consumed to avoid possible toxicity.

Non-Food Uses

Buffaloberries were often used by Indigenous Peoples for medicinal purposes, especially Canadian buffaloberry, which has been used as a cough medicine and a strong laxative. The Salish and Kootenai tribes used Canadian buffaloberry branches to make an eyewash; the Sioux used the boiled roots to treat diarrhea; and the Wet'suwet'en used the berries to induce childbirth. Although much less frequently used medicinally, silver buffaloberry was employed by the blackfoot to treat stomach troubles and as a laxative, and by the Navajo to treat fevers. As noted above, saponins have been considered to be extremely undesirable in food plants. However, recent research suggests that these chemicals bind onto cholesterol, and may be useful for lowering cholesterol levels, and perhaps even for fighting cancer. While saponins are toxic in large quantities to many animals, they are commonly found in small amounts in most of the plants eaten by herbivores and in many plant foods eaten by humans.

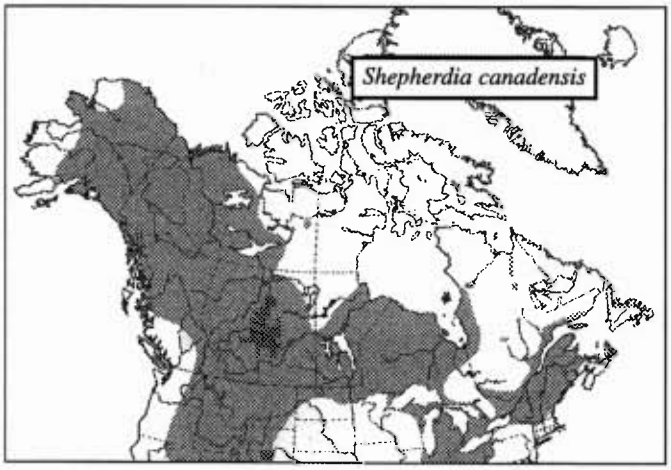
Both Canadian buffaloberry and silver buffaloberry are grown as ornamental shrubs, particularly where climatic hardiness and edaphic tolerance is required. And as reported above, the buffaloberries are used in land reclamation and soil stabilization in northern regions. Although sometimes used to reduce the negative impacts of strong prairie winds, the relatively open and short growth of silver buffaloberry limit its value in shelterbelts.

Agricultural and Commercial Aspects

Buffaloberries are rather sour and small, and collection is tedious. The thorns of silver buffaloberry make picking difficult, although some have described the berries as superior in taste ("a cross between wild grape and currant"). The silver buffaloberry seems to have been first introduced to the horticultural trade as a fruit-bearing plant in 1890, by G.J. and L.E.R. Lambriger of Big Horn City, Wyoming. Since then a number of horticulturists made attempts to improve and popularize it. In the early part of the 20th century, N.E. Hansen of the South Dakota Experiment Station at Brookings had about 7,500 seedlings under observation. However, few other individuals have put much effort into selecting and breeding better buffaloberries. The plants are widely recommended for marginal agricultural areas of the Canadian Prairies, where only the hardiest of fruit plants will survive, especially as a substitute for currants and gooseberries (of the genus *Ribes*). Buffaloberries are also well suited to moderately steep slopes, where most bushes have difficulty in securing a foothold. However, their popularity has not extended to regions where the major domesticated fruits can be grown.

Cultivars & Germplasm

Cultivars of both Canadian and silver buffaloberry, as well as some selections of *S. rotundifolia*, are available in the horticultural trade, but these are intended mainly for ornamental use. Some limited breeding has resulted in improved selections, but true commercial fruit cultivars are not yet available. The two Canadian buffaloberry species have widespread distribution ranges, and the extent of diversity in their natural gene pools requires evaluation. Chromosome counts of $2n$ =22 and 26 have been reported for *S. argentea*, $2n$ =22 for *S. canadensis*., and this cytological variation requires additional study. Both species are widespread, and likely to vary considerably across their broad geographical ranges. Rare populations on the periphery of the range of a species are often significant sources of distinctive variation. Canadian buffaloberry is sufficiently rare that it has "endangered" status in Maine and Illinois.



Prospects

The buffaloberries, particularly the silver buffaloberry, have been considered to be potential new fruits for most of the last century. They have not yet been developed as new crops, although the subject of continuing research in the US and Canada. The desirable characteristics of buffaloberries include high content of Vitamin C, extreme winter hardiness and drought tolerance, and high productivity. Their disadvantages include small size of the berries, sour or bitter taste, and the difficulty of growing a crop that has male and female plants. The names "buffaloberry" and "soapberry" are hardly suitable for marketing, and more attractive names, such as "ice-cream berry" (explained below), would be helpful. *Actinidia deliciosa* (A. Chev.) C.F. Liang & A.R. Ferguson remained an obscure fruit while it was known as "Chinese gooseberry" and "monkey peach," but became a marketing success when it was named after New Zealand's national bird, the flightless kiwi.

It is encouraging that the very close relative of the buffaloberries, the sea buckthorn, *Hippophae rhamnoides* L., has been transformed very recently into an important new berry crop. This native of the colder regions of Eurasia is now grown in plantations in Canada as a new vitamin C - rich fruit for processing into jellies, juices and liqueurs. Many of the problems that buffaloberries present as horticultural subjects have now been solved for the related sea buckthorn, and it is quite possible that application of the same type of research and development could be the basis for turning buffaloberry into a successful crop. With increasing recognition of the value of consuming a variety of fruits to maintain good health, the buffaloberries may become more popular.

Myths, Legends, Tales, Folklore, and Interesting Facts

-The Canadian buffaloberry was called "Ice-cream bush" by some Indigenous Peoples of western North America, particularly the Salishan and Athapaskan. They made a confection called "Indian ice-cream" by mixing Canadian buffaloberries with water and a sweetener (usually sweet berries) and beating them to make a frothy dessert. Specially carved, paddle-like wooden spoons were often used to eat this dish, and in some households each person had his or her own spoon, which was carefully hung up when not in use. Buffaloberry froth is sour and bitter, and is an acquired taste. For those who want to try making ice cream, remember to prevent the berries from contacting oil or grease of any kind, or they will not whip. Also, the "ice cream" should be swished in and out of the mouth to get rid of the air before swallowing (ingestion of the considerable air that can accompany a large amount of Indian ice cream has been observed to cause discomfort).

-The Bella Coola Indians occupy the Queen Charlotte Sound area of British Columbia. In Bella Coola mythology, buffaloberries were once confined to the slopes of a mountain, jealously controlled by a mountain god. On the occasion of a celebration where the mountain god served Indian ice cream to his guests, a raven managed to seize some of it and bring it to the Bella Coola, scattering seeds that were present in the ice cream. The seeds produced shrubs, and ever since everybody has been able to make the confection.

-In British Columbia, Canadian buffaloberries were an important trade item among First Peoples throughout the province, used much like currency. A tradition arose, maintained to the present, of using the berries as gifts during exchanges of presents, especially between coastal and interior tribes.

-Spiritual or magical properties were sometimes attributed to Canadian buffaloberry. The Shuswap used soapberry in death rites. The Northern Okanagan thought that drinking a decoction of the branches, or sometimes using the tea as a bath or hairwash, could confer protection against bad luck. Another Northern Okanagan belief was that if a deer was wounded but managed to escape, the hunter could chew some buffaloberry leaves and spit them out on a drop of the deer's blood, this causing the blood still in the deer to foam up like the berries and stop the animal from running further.

-Silver buffaloberry reproduces clonally so efficiently by its underground rootstock system that offshoot shrubs may still be connected through the root network 6 m away from the original plant.

-The silver buffaloberry produces male and female plants in about equal numbers. Although both kinds are necessary for seed set, more female plants are desirable since these have the berries. Because the plants often don't flower until they are 10 years of age, it is very useful to distinguish the sexes during early growth. The buds of pistillate plants are smaller and more slender than those of staminate plants, and those who are able to recognize the differences need not wait for the plants to come into bloom in order to establish their sex. Ratios of one staminate to 4 to 10 pistillate plants have been recommended for fruit production.

-While the Canadian buffaloberry is known as "soapberry" because of its saponin content, the plants with the most valid claim to this name belong to the genus *Sapindus*, especially the tropical American evergreen soap tree, *S. saponaria* L., which grows as far north as Missouri. The fleshy part of the fruit has a very high content of saponin, and is used instead of detergent for washing clothes (unfortunately some people develop a skin rash). Three classes of nitrogen-fixing bacteria engage in symbiotic associations with plants: rhizobial bacteria, cyanobacteria, and actinomycetes. Rhizobial bacteria have long been considered to belong to the "true" bacteria (Eubacteria). Actinomycetes are a group of morphologically diverse Gram positive bacteria that form long, thread-like branched filaments like fungi, which led to their being considered as related to the fungi in the past (they are now included in the Eubacteria). In contrast to the Eubacteria are the Cyanobacteria, which undergo photosynthesis in very

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much the same way that eukaryotic algae and higher plants, and while these were called blue-green algae by botanists, they are increasingly being recognized as a separate prokaryotic phylum. Most botanists are acquainted with the fact that members of the pea family (Leguminosae or Fabaceae) generally are provided with fixed nitrogen by rhizobia in root nodules. But what other "plants" can fix nitrogen?

Cyanobacteria fix nitrogen for the following: the aquatic fern *Azolla* (the only fern that can fix nitrogen, it does so with the assistance of the cyanobacterium *Anabaena azollae*, and is important in providing nitrogen to rice fields); some bryophytes; some lichens; some cycads (the only gymnosperms that fix nitrogen, and the only vascular plants that form root nodules in which the prokaryotic partner is a cyanobacterium); and some angiosperms, including *Gunnera*, which has the largest leaves in the world (an unusual angiosperm with N-fixing cyanobacteria in pockets at the base of the petioles; often said to be the only angiosperm that forms a N-fixing symbiosis with cyanobacteria, although some tropical angiosperms have cyanobacterial films on their leaf surfaces). About 21 genera of non-legume angiosperms are actinorhizal, as is *Shepherdia* (some other genera: *Hippophae*, *Alnus*, *Ceanothus*, *Myrica*, *Cercocarpus*, *Purshia*, and *Casuarina*).

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



Shepherdia argentea

Book Reviews

Flora of New Brunswick, A manual for identification of the vascular plants of New Brunswick (Second eEition)

by Harold R. Hinds, 2000
Department of Biology, Bag Service # 45111, University of New Brunswick, Fredericton, New Brunswick, Canada E3B 6E1. 695 pp. Price $ 50.00 plus $ 8.00 shipping and handling (softcover only). ISBN 1-55131-015-5

(Introductory contributions by
Stephen R. Clayden and C. Mary Young).

This 700 page manual is a storehouse of essential information on the wild flora of New Brunswick which includes 1644 species of vascular plants as well as 230 infrataxa and 55 natural hybrids. It includes identification keys, distribution maps, illustrations, notes on status, habitat, distribution, and sometimes on other aspects such as taxonomy and toxicity. It provides a reliable foundation of knowledge for teaching, research, agriculture, forestry, conservation, planning and management of natural resources. This manual has been sensibly produced at a relatively low cost but is of appropriate size (6" x 9" and 2 " thick) to be carried on field surveys. It has a strong soft and friendly green cover. The stitch binding in fascicles will go a long way to preventing the pages from falling out.

The first edition of Flora of New Brunswick was published 18 years ago. It included a very brief introduction (8 pages) including notes on botanical exploration by Mary C. Young, followed by keys to plant groups (16 pages), then 424 pages of descriptive flora, then a list of references (1 page) followed by a glossary (8 pages) and 121 pages of illustrations and maps (85 pages). It totalled 692 pages in length. The second edition is only 3 pages longer, but it is much more substantial in content because more is fitted onto the pages.

Among the most important additions and/or improvements are:

(1) A much longer section (38 pages) on history of vegetation change, physical setting and regional variation of the flora contributed by S.R. Clayden.

(2) A number of appendices including various lists that provide information on recent floristic work (additions, exclusions, etc.) and an analysis of the flora in terms of numbers of native, introduced, hybrid taxa, etc. in various families and groups. The list of species to be expected in New Brunswick based on occurrences in neighbouring regions will be particularly helpful to the continuing botanical exploration of the province.

(3) The layout of the descriptive flora section is much more user friendly since the illustrations and maps appear together with the corresponding text (instead of in separate sections).

(4) Text in the descriptive flora section now includes a number of new elements including a translation of the scientific latin name, name used by native people if one was available, chromosome numbers, and rarity rankings. This more informative text is still short. Symbols (stars etc.) indicate toxicity, dermatitis-producing, and rarity status. Distinctive features are often highlighted in a shaded box. Thus a great deal of valuable information, notably appearance, distribution, habitat, and other information can be gleaned in seconds from a relatively small space.

(5) Since the publication of the first (1986) edition 88 new taxa (listed in appendix table 8) have been discovered. Continuing taxonomic research has resulted in the exclusion of many taxa and there have also been name changes and improvements to classification that affect the New Brunswick flora. The inclusion of this new information represents an important update.

Considering the value of these changes, the second edition is a major improvement over the first edition which was already a very valuable contribution (Catling & Day in Canadian Field-Naturalist 103: 312-313. 1989).

No work is without opportunities for improvement. Some of the plants are lacking a distribution map and/or an illustration. This is an inconvenience rather than a serious problem because the numbers of such omissions is less than 5% and most unmapped species are either widespread or very rare and accompanied by a description of the provincial distribution.

Since the work concentrates on floristics and compilation rather than classification, only three new infrataxa are proposed, but the information on these is dispersed and incomplete. Some of the important parts of the taxonomic innovations listed on page 665 occur elsewhere in the text. *Erigeron hyssopifolius* var. *obtusifolius* is listed as a forma on page 454 where the type is alluded to, but not specifically indicated or cited, and the latin diagnosis is on page 665. The type of *Rhus hirta* f. *leucocephala* is apparent on page 667 but not specified. *Mentha canadensis* f. *prostrata* is not specifically indicated as new, nor is a type indicated.

Many copies of the flora have been issued with a downloadable list of addenda and errata,
(http://www.unb.ca/biology/Flora.html).
An earlier list of addenda is also in the volume on pages 665-667 and this is indexed in the main index. The downloadable list is not totally complete. For example the statement regarding Andrew's Rose-purple Orchid (*P.* x *andrewsii*) that "little quantitative information is available to aid in the identification of this hybrid" (p. 648) is incorrect. In fact there is abundant information based on a New Brunswick study that makes its identification relatively simple (see "Identification of *Platanthera lacera* hybrids from New Brunswick and Nova Scotia" in Lindleyana 9(1):19-32. 1994). The hybrid of *P. grandiflora* and *P. lacera* (*P.* x *keenani*), reported from Shediac Cape in the same publication, was left out of the flora. Although not complete, the fact that a good list of corrections is available is a significant achievement.

Harold R. (Hal) Hinds passed away after a lengthy illness on 9 May 2001. His completion of the flora suggests unusual courage and determination. Hal was fortunate in having the help of a very talented and committed group of people who served as the New Brunswick Flora Revision Committee (see acknowledgements). He also sought help from many experts outside of New Brunswick, thus improving the quality of his work in some difficult areas.

Flora of New Brunswick is only one of many significant achievements. Hal's contributions to conservation, biodiversity protection, teaching, and systematic botany and phytogeography research are impressive
(see http://www.web.net/nben/nbenorg/nb_01/hal_hinds.htm).
It is to be noted that Hal not only made significant contributions to science and conservation in producing the flora, but as part of the work he also added 17000 specimens to the University of New Brunswick collection. These are available to researchers worldwide. Hal received the Canadian Park Service Heritage Award, the New Brunswick Conservation Council's Milton F. Gregg Award, the Canadian Nature Federation's Douglas H. Pimlott Award and the Canadian Council of Ecological Areas Award. In September, 2000, the Province of New Brunswick dedicated a unique, remnant, Appalachian hardwood forest in his honour, The Hal Hinds Forest. Flora of New Brunswick was part of a big botanical conservation package from Hal Hinds that significantly benefited Canada. The New Brunswick Environmental Trust provided financial support to make the second edition possible. Well done!

Paul M. Catling, Agriculture and Agri-Food Canada, University of Ottawa, *catlingp@em.agr.ca*

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Cognitive Ecology of Pollination

Lars Chittka and James Thomson (Eds.)
Cambridge Univ. Press, 2001
US $ 90.00.

Pollination biology is the study of flowering plants and their animal pollinators. The dynamic tension created by the interaction between these two distinct groups fuels a fascinating field of research. However, two aspects of the way we conduct research in biology hinders our progress in the field. The first,

and perhaps most obvious, is the traditional taxonomic split between botany and zoology. The second, more subtle, difficulty concerns differences between proximate and ultimate levels of explanation. Physiologists tend to focus on the proximate mechanisms underlying a phenomenon, while evolutionary ecologists focus on the ultimate causes. The split in both taxonomic treatment and level of explanation creates largely autonomous groups of researchers housed in different locations, publishing in different journals, and speaking different technical languages. Nevertheless, these categories of explanation are highly interdependent and each are essential for complete understanding.

The editors of Cognitive Ecology of Pollination, Lars Chittka and James Thomson, hope to bridge these gaps and reintegrate pollination biology. Fortunately their ambition is not to accomplish this with a single book. Their more modest, though certainly not trivial, goals are to synthesise much of the recent work on the cognitive capacities of pollinators and to showcase some of the researchers that are trying to overcome the compartmentalisation of pollination biology. The topics covered in this excellent book are quite varied and fascinating. Unfortunately, any attempt to summarise individual chapters would result in a massive review. I limit comments here to a brief list of the main focus within each chapter followed by an overall evaluation of the book. Hopefully this will provide a sufficient flavour of the book's content to convince you that it is well worth investigating.

The book begins with a focus on pollinator perception and memory and how they influence foraging behaviour. Robert Gegear and Terence Laverty investigate the tendency of pollinators to consistently forage on a particular species while bypassing other, potentially rewarding, species (floral constancy). This is followed with a chapter by Randolf Menzel concerning hymenopteran memory and the construction of mental maps. Keith Waddington then discusses how bees evaluate flowers and make foraging decisions. Taken together, these three chapters represent an excellent overview of the physiological, behavioural, and ecological issues surrounding floral constancy and pollinator choice interpreted in an evolutionary context.

The next section of the book focuses on sensory modalities of pollinators. Martin Giurfa and Miriam Lehrer review honeybee vision and the role of pattern orientation and symmetry in detection and recognition of flowers. Then Robert Raguso describes the role that scent plays in insect pollination, revisiting an ancient medium of communication. Lars Chittka, Johannes Spaether, Annette Schmidt, and Anja Hicklesberger provide an important reminder of non-adaptive influences on the evolution of floral colour and insect vision.

The taxonomic bias towards hymenopteran pollinators inherent in the field is relaxed in the next three chapters. Susan Healy and Andrew Hurly review hummingbird pollination with a focus on optimal foraging theory. Bat pollination is the subject of a chapter from York Winter and Otto von Helversen, which includes an explicit analysis of foraging energetics. Finally, Martha Weiss reviews the little information we have on vision and learning in the poorly studied beetles, flies, moths, and butterflies.

Two chapters then describe typically ignored issues in pollination biology. James Thomson and Lars Chittka discuss the influence of pollinator individuality. Substantial between-individual variation is described for many aspects of pollinator behaviour, including working speed, foraging mode, and learning. Reuven Dukas then follows with a discussion about the role of predation in pollination systems. He shows that predation can have a significant effect on pollinator abundance and discusses the potential effect of predation on pollinator behaviour and, consequently, on plant characters. A strong case is made that failing to consider either factor can lead to serious misinterpretations.

The final section of the book investigates the role of pollinator cognition on floral evolution. Ann Smithson synthesises research on frequency dependence and attempts to reconcile the mixed support found for pollinator preference of common floral morphs in lab and field studies. Kristina Jones returns to issues of floral constancy discussed in the early chapters, this time from the perspective of assortative mating and its influence on floral morphology and plant speciation. The ways in which pollinators respond to variation in floral display size are discussed by Kazuharu Ohashi and Tetsukazu Yahara. In particular they address why individual plants receive disproportionately fewer visits as more flowers become available. In perhaps the most plant-biased chapter, Lawrence Harder, Neal Williams, Crispin Jordan, and William Nelson present an economic analysis of pollination and describe the mechanisms by which plants can manipulate their pollinators. The final chapter in the book, by Nickolas Waser, describes the role of pollinator behaviour in plant speciation. He takes a critical look at the "ethological isolation" view that, through floral constancy, pollinators cause divergent selection in floral morphology leading to rapid reproductive isolation and, consequently, speciation.

Evidently this is an ambitious book in terms of the breadth of coverage attempted. As an evolutionary ecologist interested in floral biology, I appreciated the strong adaptive flavour of the book. I also found a new appreciation for the sophistication of research in pollinator cognition and some of my outdated myths about pollinator behaviour were dispelled. Beyond the reviews and synthesis, many chapters also contained important recommendations on where and how further research should be focused. I highly recommend this book to anyone interested in pollination biology or any of its myriad facets.

Matt Routley, Department of Botany, University of Guelph.

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Kate Frigo, Department of Biology, University of New-Brunswick, St.John, NB, E2L 4L5
Tel. : (506) 648-5811; fax : (506) 648-5650; e-mail : frigo@unbsj.ca

Frédérique Guinel, Dept. of Biology, Wilfrid Laurier University, Waterloo, ON, N2L 3C5
Tel. : (519) 884-0710, ext. 2230; fax : (519) 746-0677; e-mail : fguinel@mach1.wlu.ca

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