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The Canadian Botanical Association Bulletin

Bulletin de l'Association Botanique du Canada

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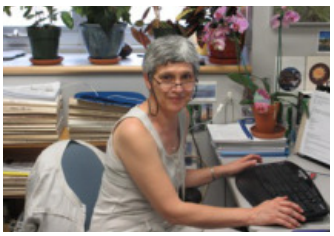

Frédérique Guinel

Chers membres de l'ABC:

Cela a été un long hiver et où que vous soyez au Canada, comme moi, vous devez avoir hâte de voir le printemps. Il me tarde d'écouter le chant des oiseaux ainsi que de voir les premiers perce-neiges dans le jardin. Cependant, nous n'en sommes pas encore là comme indiqué par 1) la «science de la marmotte» et 2) la quantité considérable de neige qui doit encore fondre. Il y a, cependant, des notes de printemps dans l'air: les jours allongent et j'ai senti la première mouffette de l'année! Je n'ai pas beaucoup de choses à signaler dans ce message, à l'exception évidemment des mises à jour sur le processus de prorogation pour notre Association et sur la célébration de son 50ème anniversaire.

Tout d'abord, le processus de prorogation. Un grand merci à tous ceux qui ont participé au vote mi-Décembre sur la modification du statut n° 4. Le vote a été positif et l'amendement a été approuvé à la fin Janvier par Industrie Canada, tel que rapporté par Jennifer Leddy, l'avocat agissant au nom de l'ABC. Il ya maintenant une seule catégorie de membres au lieu de quatre dans notre Association et cette classe est divisée en quatre sous-catégories (réguliers; étudiants / post-doctorants; retraités, et membres à vie). Cela devrait simplifier le vote qui aura lieu en Juin à l'assemblée générale annuelle tenue à Montréal. Maintenant que nous avons passé cet obstacle, le comité de continuation, avec l'aide de Mme Leddy, est en train de mettre les touches finales à l'ensemble des statuts. Ceux-ci seront présentés aux membres avant la réunion afin que chacun d'entre vous puisse les lire avant de voter. Ce calendrier devrait nous permettre de finaliser toutes les mesures nécessaires avant Octobre 2014, date à laquelle toutes les sociétés non-lucratives canadiennes devront être régies par la nouvelle Loi canadienne sur les organisations à but non-lucratif.

Deuxièmement, le 50ème anniversaire de l'ABC. Anne Bruneau et Denis Barabé ont été très occupés à organiser cette réunion, dont le thème sera «50 ans de Botanique au Canada». Dans un long colloque d'une journée, les membres seront en mesure d'entendre des conférenciers éminents présentant la Botanique canadienne d'un point de vue historique. Dans ce colloque, de nombreuses facettes du monde des plantes seront découvertes pour notre plus grande joie et intérêt. J'espère que vous serez en mesure de tous venir pour célébrer cet événement important, qui se déroulera entre le 15 et le 18 juin au Jardin Botanique de Montréal. Ce sera une occasion unique d'apprécier cette

The Canadian Botanical Association Bulletin

The CBA Bulletin is issued three times a year (March, September and December) and is freely availble on the CBA website. Hardcopy subscriptions are available for a fee.

Information for submitting texts

All members are welcome to submit texts in the form of papers, reviews, comments, essays, requests, or anything related to botany or botanists. For detailed directives on text submission please contact the Editor (see below). For general information about the CBA, go to the web site: http://www.cba-abc.ca

Bulletin de l'Association Botanique du Canada

Le Bulletin de l'ABC paraît trois fois par année, normalement en mars, septembre et décembre. Il est envoyé à tous les membres de l'ABC.

Soumission de textes

Tous les membres de l'Association sont invités à envoyer des textes de toute natureconcernant la botanique et les botanistes (articles, revues de publication, commentaires,requêtes, essais, etc.). Tous les supports de texte sont acceptés. Pour des renseignements détaillés sur la soumission de textes, veuillez consulter le rédacteur (voir ci-dessous) . Infos générales sur l'ABCà l'url suivant: http://www.cba-abc.ca

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Next issue / Prochain numéro

Texts for the next issue, 47(2), must be received by September 5, 2014
La date de tombée des textes du prochain numero, le no 47(2), est le 5 septembre 2014

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belle mosaïque qu'est la Botanique au Canada, d'y ajouter de nouvelles couleurs en faisant participer nos étudiants, nouveaux et anciens, et de rencontrer de vieux amis, des collègues et des maîtres / mentors. Comme d'habitude, il y aura une vente aux enchères et de nombreux lieux pour interagir et échanger. Il y aura de nombreuses opportunités de renouveler de vieilles connaissances et de forger des nouvelles avec les étudiants. Pour lancer le deuxième cinquantenaire de notre Association, le Conseil d'administration aimerait que vous écriviez un hommage personnel à un maître ou mentor qui apparaîtrait dans un des Bulletins. Ceci contribuerait aussi au lancement du Prix Magister de l'ABC. Vous, comme moi, devez avoir à l'esprit une personne très spéciale qui vous a appris beaucoup plus que la botanique. Il est peut être temps pour vous de remercier cette personne en nous l'introduisant. Nous sommes ce que nous sommes à cause de ce mentor et je pense qu'en célébrant cette personne, nous célébrons l'enseignement et notre Association.

Enfin, les plans pour Plant Canada 2015 commencent à s'édifier. Nous nous réunirons à Edmonton du 25 au 29 Juillet 2015 au Centre des Congrès Shaw. Marquez votre calendrier car ce sera probablement l'une des plus grands assemblées de botanistes en Amérique du Nord; toutes les sociétés membres de Plant Canada pourront échanger avec leurs collègues américains de la Botanical Society of America et de la Mycological Society of America. Je voudrais ici remercier tout particulièrement John Markham, le président-élu de l'ABC, qui travaille beaucoup pour préparer cette conférence.

Ceci est mon dernier message de président puisque je passerai le sceau de l'ABC à John à Montréal en Juin où j'espère rencontrer personnellement beaucoup d'entre vous, entendre d'étonnantes présentations et voir des affiches surprenantes, admirer de belles plantes dans le Jardin Botanique, et de socialiser avec vous tous. En terminant, je tiens à vous remercier tous pour la confiance que vous avez placée en moi quand vous m'avez élue présidente. Ces quatre dernières années ont été très enrichissantes et ceci principalement grâce à vous. Merci.

Frédérique Guinel
Présidente

Dear CBA Members:

This has been a long winter and wherever you are in Canada I am sure you share some of my eagerness for spring. I long for listening to the birds chirping in the trees as well as seeing the first snow-drops in the garden. However, we are not quite there yet as indicated by 1) "groundhog science" and 2) the considerable snow still to melt. There are, however, sure notes of spring in the air: the days are lengthening and I smelled my first skunk of the year! I do not have a lot to report in this message, except evidently updates on the Continuance Process and the celebration of the 50th anniversary of our Association.

First, the Continuance Process. Many thanks to all of you who participated in the vote mid-December on the amendment of by-law No. 4. The vote passed and the amendment was approved in late January by Industry Canada, as reported by Jennifer Leddy, the lawyer working on the CBA's behalf. There is now a single class of Members instead of four in our Association and this class is divided into four sub-categories (Regular; Student/Post-doctoral; Retired; and Life). This should simplify the vote that will be taking place in June at the Annual General Meeting in Montreal. Now that we have passed that hurdle, the Continuance committee, with the help of Ms. Leddy, is putting the finishing touches to the set of By-laws. These will be presented to the membership ahead of the meeting so each of you will have the chance to read them before voting. This time-line should allow us to finalize all required steps before October 2014, the date at which all federal non-for-profit corporations will transition to the new Canadian

Not-for-Profit Corporation Act.

Second, the 50th Anniversary of the CBA: Anne Bruneau and Denis Barabé have been very busy organizing this meeting, the theme of which will be “50 years of Botany in Canada”. In a one-day symposium, members will hear eminent speakers presenting Canadian Botany from an historical point-of-view. During the symposium, many facets of the plant world will be displayed for our great joy and interest. I hope you will all be able to come to celebrate this important event, which will take place at the Montreal Botanical Garden from June 15th to the 18th. This will be a unique chance to extend the beautiful patchwork that is Botany in Canada, to weave new colours by having our students, old and new, participate, and to meet old friends, colleagues, and mentors. As usual, there will be an auction and many places to interact and exchange. There will be possibilities for old acquaintances to renew their friendship and for students to create new ones. To initiate a new half-century for the CBA, the Executive Board would like to ask you to write personal tributes to our teachers/mentors; these tributes will appear in the Bulletin throughout the year(s). This will also help the Association prepare to launch its Magister Award. You, like me, must have in mind a very special person who taught you much more than just botany. It may be time for you to thank this person by introducing her/him to us. We are what we are because of our mentors and I think that by celebrating these people, we celebrate teaching and our Association.

Finally, plans for the Plant Canada 2015 conference are unfolding. We will be meeting in Edmonton July 25-29, 2015, at the Shaw Convention Centre. Mark your calendar as this will be likely one of the biggest assemblies of botanists in North America; all member Societies of Plant Canada will be able to join with their American colleagues from the Botanical Society of America and the Mycological Society of America. I would like to thank especially John Markham, the CBA President-Elect, who is instrumental in the preparations for this large conference.

This is my last President’s message as I will pass the CBA seal to John at the Montreal meeting in June. I hope then to meet many of you personally, to hear great talks and see stunning posters, to admire beautiful plants in the Botanical Garden, and to socialize with all of you. In closing I would like to thank you for the trust you put in me when you elected me President-Elect. Because of you, these last four years have been very enriching. Thank you.

Frédérique Guinel
President

Announcements

Call for Participants

Interactions between habitat and climate: effects on growth of bryophyte and lichen species across Canada

© Pierre Cartier

Following the symposium on the response of forest bryophytes to forest management held during the 2013 annual meeting of the CBA/ABC, the potential for a continent wide research project was discussed. Since then a few ideas have been tossed around, but we have yet to come up with a definitive project. Here, we present a potential project and look for feedback from interested parties.

Many boreal bryophyte and lichen species grow in a variety of habitats across Canada. However, since the pioneering work of LaRoi and Stringer in 1976, few studies have examined the ecology of bryophytes and lichens across the country. We propose to follow the growth rate and / or changes in cover of common boreal species across the country. A common protocol will be suggested to facilitate continent wide comparisons. Potential species of interest would be Pleurozium schreberi, Hylocomium splendens, and/or members of the Cladina group.

If you would like to take part in this study please contact Nicole Fenton (nicole.fenton@uqat.ca).

Species and methodological suggestions are welcome!

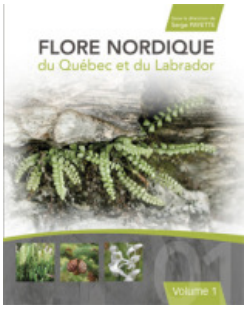
Correction: Winterhalder and Macoun Travel Student Travel Bursary Deadline

The deadline for applications for the Winterhalder and Macoun Student Travel Bursaries was reported as March 1st, 2014 in December's Bulletin. This was incorrect - the actual deadline is April 15th, 2014, so there is still time to submit your applications!

Reviewer Needed: Flore Nordique du Québec et du Labrador

Volume One of Flore Nordique du Québec et du Labrador has been published by Laval University Press. The publisher has provided the CBA Bulletin with a review copy. If you'd like to provide a review for the next issue, please contact the me at cba.abc.bulletin@gmail.com, and I'll have the book sent to you. The press release for the book follows:

Une source d'information essentielle sur le patrimoine végétal du Québec-Labrador nordique.



Cet ouvrage en quatre volumes est consacré à la Flore des plantes vasculaires des régions nordiques du Québec et du Labrador, du 54e parallèle nord jusqu'au détroit d'Hudson, depuis la baie de James et la baie d'Hudson, à l'ouest, jusqu'à la mer du Labrador, à l'est.

L'ouvrage est le fruit d'une collaboration de longue durée entre plusieurs botanistes du Québec. Il rassemble des connaissances et des données inédites sur les plantes nordiques des milieux boréaux, subarctiques et arctiques.

Le premier volume comprend des textes introductifs sur la géographie de la région, l'historique des herborisations et la biogéographie des taxons. On présente également une clé d'identification de toutes les familles de plantes poussant dans cette vaste région nordique. Les caractéristiques morphologiques des taxons appartenant à 32 familles différentes sont décrites, allant des lycopodes aux joncs, en passant par les fougères, les conifères, les potamots et les orchidées.

La description botanique de chaque taxon est accompagnée de photographies des plants et des organes présentant des caractères diagnostiques, d'une carte de répartition et d'un commentaire sur l'écologie et l'habitat de chacun d'eux.

Voici un ouvrage qui servira de référence aux chercheurs et aux étudiants intéressés aux sciences naturelles, aux professionnels de l'environnement et au public averti qui s'intéressent au patrimoine végétal du Québec et du Labrador.

New Review Procedures at Botany

A number of NRC Press journals, including Botany, are participating in a limited trial of a new peer-review service provided by Axios. While the regular manuscript submission procedure remains in place, authors may also submit their papers to Axios instead. Axios describes their service as follows:

Axios Review is an independent peer review service for the fields of evolutionary biology and ecology; their aim is to eliminate rejections on the basis of novelty or scope. Authors submit a paper to Axios along with a ranked list of 4 target journals. Axios puts the manuscript through traditional peer review; external referees comment on both the quality of the paper and how well it fits in each of the 4 target journals. If there is a fit, Axios emails the article, reviews, and reviewer identities to the target journal. If the journal is interested in the paper, the author revises accordingly and submits through the normal channels – and only at that point pays a fee of $250 to Axios.

Full details are available here: http://axiosreview.org/. If you have experience, good or bad, using a peer-review service like Axios, please consider letting us at the Bulletin know.

The CBA Bulletin is Now Open Access

The CBA Bulletin is now freely available on the website, www.cba-abc.ca/bulletin.htm. From issue 46(2) onwards, new issues will be posted online as they are published, and available to the public without a password. This decision was made at the 2013 Annual General Meeting. The main benefit of this change will be increasing the visibility of our activities to non-members. The articles and announcements in the Bulletin provide a strong outreach tool for attracting new members, but only if they can read it!

Prior to this change, we did not have a formal copyright policy for the bulletin. Starting with this issue, we do. The policy is as follows:

1. Authors of articles retain the copyright to their work.
2. Authors must license their work in a way that allows free redistribution:

   • They are encouraged to use the Creative Commons Attribution Share Alike 4.0 International License. This license allows for free redistribution of the work, including adaptation/modification or commercial use, with the requirement that the author is attributed in all derived works, and any derived work must be licensed under the same license.

   • If the author wishes to restrict adaptations of their work, or limit it to non-commercial use, they may elect to use any other Creative Commons license that permits free redistribution.

3. If the article contains photos or other material that the author does not hold the copyright for, the original license for that material will remain unchanged. Such material may only be included in the article if its license allows for redistribution. For example, Ernie Small uses a lot of CC licensed photos. The license on those photos remains unchanged, as Ernie does not have the right to modify them anyways.

This is an exciting change for the Bulletin, as it means we will be able to reach a much broader audience, and provide a truly public face for Canadian Botany.

More information about Creative Commons licenses can be found on their website:
http://creativecommons.org/licenses/

Section News

Systematics and Phytogeography

Dear members of the Systematics and Phytogeography Section,

I would like to take this opportunity to strongly encourage you to attend our annual meeting this summer in Montréal as there could not be a better place to celebrate our 50th year. Highlights that I am sure our sectional members will enjoy include one of the world's largest and most beautiful gardens (the Chinese garden is particularly wonderful), one of Canada's largest and most historically important herbaria (L'herbier Marie-Victorin, MTL), and, of course, the herbarium's new home, a brand-new biodiversity centre to explore (le Centre sur la biodiversité). Just to give you some idea of what wonderful things to expect, I suggest you catch this report on the move of MTL to its new location as seen on one of my favourite Radio-Canada programs, "La Semaine Verte" ("L'herbier Marie-Victorin déménage", Saturday, 5th of May 2012; http://bit.ly/1e6XBbm). You will recognise a certain Luc Brouillet giving us a great interview on the history and importance of the collection and some nice views of its new home. Cheers, to Luc!

That is all for now, except from some interesting news from WIN, MTL and SASK. Remember that if you would like me to include some news on your collection in the next CBA Bulletin, just write (jstarr@uottawa.ca).

Julian Starr
Chair, Systematics and Phytogeography Section

Update from The Vascular Plant Herbarium of the Department of Biological Sciences, University of Manitoba (WIN)

After more than 15 years of dedicated service, Elizabeth Punter has retired from her position as Assistant Curator of WIN. Liz was instrumental in overseeing the dramatic expansion of our collection (now >76,000 specimens) and infrastructure, and for providing expert knowledge on the flora of Manitoba to a number of organizations including Flora of North America, Manitoba Conservation, Agriculture Canada, Nature Conservancy, and COSEWIC. Liz is working on a number of floristics projects and will continue her duties as Regional Reviewer for the Flora of North America Project.

I would also like to take this opportunity to welcome the new Assistant Curator of WIN, Diana Sawatzky. Diana has a strong background in herbarium curation and is spearheading our specimen databasing and imaging initiative. Our objective is to capture the information associated with all of our Manitoban collections and to make this information available to the wider scientific community through the Canadensys web portal.

Finally, it is a pleasure to announce that WIN has just completed a second major upgrade to its infrastructure including new specimen cabinets and benching as well as improved microscopy and specimen digitization facilities. We welcome visitors, and specimen loan and information requests (bruce.ford@umanitoba.ca or diana.swatzky@umanitoba.ca).

Bruce Ford
Curator, WIN

Herbier Marie-Victorin (MTL)

The 2014 Consortium of Northeastern Herbaria meeting, in association with Canadensys, will be held at the Biodiversity Centre of the Université de Montréal just before the Canadian Botanical Association meeting of June 15-18, 2014. There will be a single day of talks on Saturday, June 14. Meeting attendants will be able to attend the CBA excursions (by registering to them on the CBA meeting webpage) on the Sunday. Further details about the meeting dates and agenda will be posted on the CNH website (http://neherbaria.org/).

Luc Brouillet
Curator, MTL

W. P. Fraser Herbarium (SASK)

Things have been slow at the herbarium lately with only a couple projects underway. This semester has seen a focus on the grasses, with the Grasses and Grasslands course using the herbarium's rich collection of prairie grasses to bolster their knowledge and identification skills. Work has also been underway on the latest book by the Flora of Saskatchewan Association (FOSA), which will heavily feature the grasses of our province. We are eagerly anticipating its release. Projects, such as the books by FOSA, help publicize the resources that the herbarium can offer not just to professionals but also to botany and nature enthusiasts. We have had a few members of the public using the herbarium's resources to help identify their own specimens as well as to discover new localities to plan this summer's field trips. Wishing everyone a great field season, that's all from SASK.

Denver Falconer
Assistant to the Curator, SASK

Écologie et Conservation

Malgré un hiver long et garni de tempêtes, la section reste active. Bientôt vous devriez recevoir la nouvelle version de notre document sur la transplantation des espèces en péril, lequel est en existence depuis un bon bout de temps. A la suite des discussions à Ottawa, d'un symposium à Columbus, OH avec notre association sœur des États-Unis, et de plus amples discussions à Kamloops, ainsi que l'aide de certains, à mentionner entre autres, Paul Catling, le document est presque complété.

L'organisation du symposium de la section sur «la recherche écologique à long terme» pour la réunion de Montréal va bon train et devrait être très intéressant. Le symposium examinera la recherche à long terme de divers écosystèmes à travers les yeux de Line Rochefort (Université Laval), André Arsenault (mon co-président, Service canadien des forêts), Roy Turkington (UBC), et un autre chercheur à confirmer plus tard. Cela devrait donner des idées sur les études à long terme au Canada et leur importance. Qu'est-ce que l'Association de botanique du Canada devrait faire à ce niveau?

Pour la désignation des aires de conservation préoccupante, nous avions reçu quelques suggestions, et nous avons reçu un document officiel de nomination que nous partagerons bientôt avec vous! Il serait bien d'avoir une désignation à tous les deux ans.

À bientôt à Montréal!

Liette et André

Ecology and Conservation

Despite this long and stormy winter, the section is still active. Soon you should see the new version of the paper on translocation of species at risk, which has been in existence for a while without changes. Following discussions in Ottawa, a symposium in Columbus OH with our BSA friends and further discussion in Kamloops as well as the help of some, particularly Paul Catling, the paper is nearing completion.

The organization of the symposium of the section on "Long term ecological research" for the Montréal meeting is going very well and should be quite interesting. The symposium will examine long term research of various ecosystems through the eyes of Line Rochefort (Université Laval), André Arsenault (my co-chair, Canadian Forest Service), Roy Turkington (UBC), and one yet to be confirmed speaker. This should give the participants some insights for long term research in Canada and their importance. What can the Canadian Botanical Association do about this?

For the designation of areas of special conservation concerns, there have been a few suggestions and we have received a very good proposal that we will share with you very soon. It would be good to have one every couple of years.

See you soon in Montreal!

Liette and André

Mycology

We are delighted to announce that our Weresub lecturer for 2014 as part of the proceedings of the 50th CBA-ABC meeting will be Dr. Mohamed Hijri, a professor-scientist at the "Institut de recherche en biologie végétale" in Montreal. Dr. Hijri is a specialist of the genetic structure, evolution and reproduction of arbuscular mycorrhizal fungi and we anticipate that this theme will undoubtedly be explored in his lecture, along with historical context of mycology in Quebec. The Weresub Memorial lecture is open to the general public and promises to be fascinating.

We are pleased to announce the participants (official titles have not been provided yet, so these are the themes targeted) to the CBA/ABC Mycology Section Symposium entitled: Fungi and food – the benefits, threats and commerce. We are looking forward to this great meeting of mycological minds!

- Susan Percival (University of Florida) – Mechanisms linking mushrooms and health
- Victor Lemay-Rios (University of Guelph, Ridgetown Campus) – Mycotoxins
- Veronique Cloutier (Laval University) – Animal mycophagy
- Marie-France Gevry (Laval University) – Link between research and the development of mycological resources in Quebec
- Aldéi Darveau (Association pour la commercialisation des produits forestiers non ligneux) – Activities of the ACPFNL
- Shannon Berch (BC Ministry of Environment) – Truffle cultivation and harvesting in Canada

Finally, please note that already some proposals for symposia are being considered for the Plant Canada-Botanical Society of America-Mycological Society of America meeting to be held in Edmonton in July 25-29, 2015. Contact us if you have ideas for symposia or themes that could be explored.

Respectfully submitted,

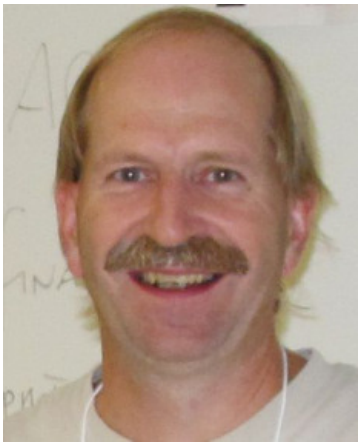
Hugues Massicotte and Shannon Berch
Co-Chairs of the Mycology Section

Membership News

Student Profile: Louis Charon, Memorial University of Newfoundland

I have just started the second year of my Master's degree with Dr. Luise Hermanutz in the *Conservation Ecology of Northern Ecosystems* laboratory at Memorial University of Newfoundland. My research project focuses on the restoration of balsam fir (*Abies balsamea*) forests under heavy browsing by non-native herbivores, specifically moose (*Alces americanus*), in Terra Nova National Park (TNNP). Following the introduction of moose to the Island of Newfoundland in 1878, their population increased drastically, affecting the regeneration of highly preferred palatable species (e.g. balsam fir, birch, maple, etc.). Moose browsing can stunt or damage young seedlings, but more typically browsing impedes the growth of saplings. The consequences of moose over-browsing are seen in TNNP and across the island in the formation of open "moose savannah", which lack fir seedlings and saplings. Moreover, these savannahs are colonized by grasses and non-native plants which are not good seedbeds for fir.

During the summer of 2013, a restoration program was implemented by planting ~10,000 balsam fir seedlings under various ground disturbance treatments and planting densities to determine best planting protocols for forest management within TNNP. Treatments and densities test differences in seedling growth and survival by the manipulation of shading, competition and moose use. Re-establishment of multi-aged balsam fir forests are key to ensure that vital habitat for species at risk, such as the Newfoundland marten (*Martes americana atrata*), the red crossbill (*Loxia curvirostra percna*) and the boreal felt lichen (*Erioderma pedicellatum*) is present on the landscape.



Special Event!

Another famous CBA/ABC Auction!

Once again, our long-term auctioneer, Hugues Massicotte, will be conducting a celebratory auction at our 50th anniversary meeting.

Please bring items, preferably of botanical nature, and witness how Hugues persuades participants to part with their money! Funds collected are directed to a good cause, the Macoun Travel Bursary, which helps us to bring students to our annual meetings.

Canadian Alvars and Limestone Barrens: Areas of "Special Conservation Concern" for plants?

Pauline K. Catling, Paul M. Catling, Jacques Cayouette, Michael Oldham, Bruce Ford, Cary Hamel and Chris Friesen

The process by which CBA/ABC designates areas of "Special Conservation Concern for Plants" is described by Catling and Vasseur (2012) and an example was provided by Catling et al. (2012). The Tusket River Watershed became the first area designated by CBA/ABC (Vasseur 2012). Here we make the second proposal which involves Canadian alvars and limestone barrens.

Alvars are open areas with thin soils over flat limestone, dolostone or marble bedrock where vegetation cover is sparse and tree cover is absent or at least not continuous (Catling and Brownell 1995, Reschke et al. 1999). The coastal limestone barrens of northwestern Newfoundland are similar habitats with some differing ecological processes (pers. obs.). In Canada (Figure 1), alvars occur in Newfoundland (Limestone Barrens Habitat Stewardship Program 2011), Quebec (Cayouette et al. 2010), Ontario (Catling and Brownell 1995, Brownell and Riley 2000), Manitoba (Manitoba Alvar Initiative, 2012) and Northwest Territories (Catling 2009).

All intact alvars in Canada, where one or more of the following criteria apply, are considered at risk: 1) possess one or more of eight typical alvar communities designated by NatureServe (2014) as globally imperiled (G1-G3, meaning that they are at high risk of extirpation due to relatively few occurrences, recent and widespread declines, threats, or other factors); 2) the presence of one or more plant species that have undergone detailed evaluation which demonstrates at risk status either federally or provincially (Table 1); 3) are subject to one or more threats including quarrying, urban and industrial development, overgrazing, dominance of invasive alien plants, unrestricted off-road vehicle use, fire suppression in the absence of alternative biomass removal processes and waste dumping.

In addition to the 20 species of alvar and limestone barren habitats that are federally or provincially listed at risk (Table 1) there are at least 100 species with S1-S3 rankings indicating susceptibility to extirpation. Recognizing the significance of alvars in the protection of biodiversity, the United States Nature Conservancy initiated an international project to locate and preserve alvar habitats (Reschke et al. 1999). While progress has been made over the past decade there are still alvar landscapes where very little alvar habitat is protected. Alvar and limestone barren habitats vary greatly on a regional basis and examples from across the geographic range need to be protected (Catling and Brownell 1995). Alvars of the Northwest Territories (Catling 2009) and Manitoba (Manitoba Alvar Initiative 2012) have no current protection. Various alvar species are still at risk even in protected sites (Table 1).

Although not an important consideration for the proposed designation, the protection of Canadian alvars has a number of additional benefits. As well as supporting many plants that are at risk, alvars and limestone barrens also contain animals in "at risk" categories. Some of the alvar communities are believed to be the only existing analogs of the *Picea* parkland that existed in front of the Wisconsin glacier for hundreds of thousands of years. They are important in the study of vegetation response to climate change. Not only are alvars important from the perspectives of conservation and research, but they have become increasingly significant in recreation and education. The coastal barrens of Newfoundland have interpretive museums and trails that attract thousands of people every year and have economic value for the local population. The Carden alvar has thousands of birders visit every year in search of alvar restricted bird species. Other locations support spectacular wildflower displays that attract photographers. Finally, alvars are important for *in situ* protection of germplasm for stress tolerance in crop relatives including strawberries, Saskatoon berries, currents, gooseberries, cherries, wild onions and plums.

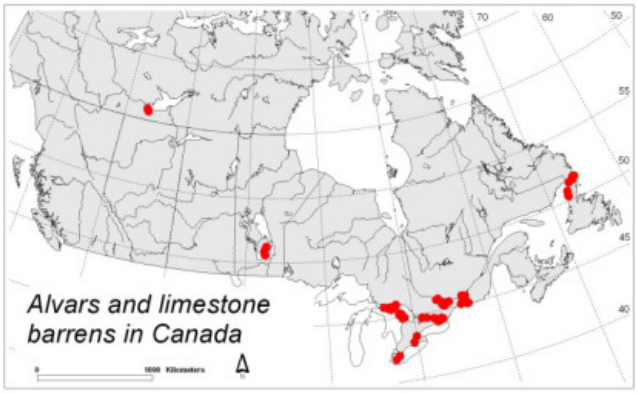


Figure 1. Locations of alvars and limestone barrens in Canada

The need to protect alvar habitats is clear and the risk and threat is substantial. The information available, including international discussions, is a sufficient and reliable basis for designation as a CBA/ABC "Area of Special Conservation Concern". Alvars will greatly benefit from this designation through providing high profile support for local groups to preserve these habitats. A number of local groups exist with this purpose.

Common Name	Latin Name	Conservation Status
Agalinis, Gattinger's	*Agalinis gattingeri*	E (Can, ON)
Butterflyweed	*Asclepias tuberosa*	E (QU)
Milk-Vetch, Fernald's	*Astragalus robbinsii* var. *fernaldii*	E (QU), SC (Can, NL)
Braya, Fernald's	*Braya fernaldii*	E (Can), T (NL)
Braya, Long's	*Braya longii*	E (Can, NL)
Sedge, Juniper	*Carex juniperorum*	E (Can, ON)
Hackberry, Dwarf	*Celtis tenuifolia*	T (Can, ON)
Thistle, Hill's	*Cirsium hillii*	T (Can, ON)
Lady's-slipper, Ram's Head	*Cypripedium arietinum*	T (QU)
Ash, Blue	*Fraxinus quadrangulata*	SC (Can, ON)
Iris, Dwarf Lake	*Iris lacustris*	SC (Can, ON)
Forget-me-not, Spring	*Myosotis verna*	E (QU)
Knotweed, Douglas'	*Polygonum douglasii*	T (QU)
Pinedrops, Woodland	*Pterospora andromedea*	E (QU)
Sumac, Fragrant	*Rhus aromatica* var. *aromatica*	T (QU)
Willow, Barrens	*Salix jejuna*	E (Can, NL)
Goldenrod, Houghton's	*Solidago houghtonii*	SC (Can), T (ON)
Daisy, Lakeside	*Tetraneuris herbacea*	T (Can, ON)
Elm, rock	*Ulmus thomasii*	E (QU)
Vervain, Narrowleaf	*Verbena simplex*	E (QU)

Table 1. Vascular plants of alvars listed as “at risk” in Canadian legislation (based on COSEWIC 2013, OMNR 2013, GNLDEC 2013, Centre de données sur le patrimoine naturel du Québec 2012). E=Endangered; T=Threatened; SC=Special Concern. The Québec equivalents menacées (endangered) and vulnérables (threatened) that have been officially recognized were included, however there is no provincial version of special concern.

Figure 2. Alvar near Belleville on the Napanee Plain in early May. This site has four imperiled or vulnerable species. The Napanee Plain alvars are some of the most significant in Canada and contain plants found nowhere else in the country. No alvar sites are currently protected within this extensive area.

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On student involvement in the Canadian Botanical Association

James Jones[1]

The purpose of this article is to answer a seemingly simple question: Why should we, as students, be involved in the CBA?

After all, students are not yet specialised in their field, and may not have published before. What can they gain from their investment of time and money towards this association? More than anything, I think membership in the CBA provides opportunity. Where else can students share and exchange knowledge with the national experts in their field, or forge long-lasting bonds between colleagues and friends? The above are only a few examples, and nowhere are these opportunities exemplified more than at CBA annual meetings.

It is here, amongst poster sessions, symposia, and a bewildering variety of talks that the most fertile ground for student growth can be found. While both presenting and posing questions to presenters can be nerve-wracking, they provide the best chance to showcase your skills and knowledge. Only in a few other instances can you communicate face-to-face with the people benefitting most from your work, or speak directly to those on whom your work is based. Though the exchange of scientific knowledge typically takes place through publications, at CBA meetings a unique atmosphere is created in which ideas are easily exchanged. However, it is not only ideas that come together during annual meetings, but the people behind those ideas as well. One should take advantage of this to meet and pose questions to those who previously might have just been names under an article title. Don't rely on your supervisor to introduce you; introduce yourself! The more interaction that occurs, the more potential we have to advance botanical research in Canada. Nothing in this world acts in isolation, so why should we? The friendships and connections that are established here can last a lifetime.

Annual meetings are also full of people involved in your field to various degrees, and the potential for networking and collaboration is enormous. Even if you have a good idea of what you want to do for your career, if you take the time to explore the breadth of botanical research available, you may uncover the perfect area to work in. Conversely, if you are unsure of "what you want to do when you grow up", the poster presentation you gave might have peaked the interest of a future potential supervisor/employer, who might then offer you the job of your dreams! Like plants, careers have to start from somewhere, and annual meetings are the optimal conditions in which a career can begin.

I'd like to finish on what is perhaps a more serious note by talking about the future of the Canadian Botanical Association, namely us. We, the students of today, are going to be the leaders of this society tomorrow. Societies like ours are not maintained by some external force, it is through hard work that this society continues to exist. Without students like us, our supervisors, and those interested in botany, there would be no CBA. The direction the society takes, the values it upholds, and the opportunities it provides are the direct result of our actions. Take the time to attend general meetings, and voice concerns if you have any. The more often we participate, the stronger the society as a whole becomes. If we fail to do so, the hard work of all those that came before us will be for nothing, and all those opportunities will be lost to those who come after us.

This year marks the 50th annual meeting of the CBA! Join us for a look back on June 15-18th in Montreal, Quebec. Activities include a student mixer, as well as several exciting field-trip opportunities!

Visit http://www.irbv.umontreal.ca/cba-meeting to learn more and register!

[1]CBA Student Representative (East)

Remembering W. Alan Charlton

A great friend and supporter of Canadian Botany

Compiled by Usher Pozluszny and Anne Charlton

Born in Prestwich, Manchester, England, on December 27th 1938, W. Alan Charlton died in the South Lake District town of Ulverston, England, July 8th 2013.

Although Alan Charlton was born, lived and worked in and around Manchester, England for most of his life, he was to some extent a Canadian at heart. During his long and distinguished career as an outstanding botanical researcher Alan seemed to have one foot firmly planted in Canada. He received a Masters degree at the University of Saskatchewan under Taylor Steeves, published 28 articles in the Canadian Journal of Botany (now Botany) and collaborated with and mentored many members of CBA/ABC. In fact, Alan was a member of CBA/ABC for many years, attending and contributing to numerous meetings.

Alan's parents came from the North East of England, the area around Newcastle-upon-Tyne whose residents are colloquially referred to as Geordies. His father was a research chemist with Imperial Chemical Industries and his mother was trained in domestic science at a well-established regional college. Alan received a scholarship to attend Bury Grammar School and then spent a year at Salford Technical College. He was a keen long-distance cyclist and very involved in building and flying model aircraft and keeping tropical fish.

In 1957 Alan entered the University of Manchester to study Botany. He graduated in 1960 with a First Class degree in Botany and then moved on to the University of Saskatchewan at Saskatoon to work on his MSc with Taylor Steeves. At this stage Alan's tremendous interest in plant morphogenesis developed and various aspects of it formed the basis of his research for the rest of his career. In Saskatoon his focus was on the roots of the weedy species Linaria vulgaris. Alan's respect and affection for Taylor were very deep and he kept in close touch with him for the rest of his life. In 1962 Alan returned to Manchester. The work from his masters was published in 1966 in the Canadian Journal of Botany in a series of two articles: The root system of *Linaria vulgaris* Mill.: I. Morphology and anatomy and II. Differentiation of root types. At the University of Manchester he began his PhD studies with Professor Claud Wardlaw, probably the foremost plant morphogeneticist at that time. In 1964 Alan was awarded a PhD degree. His thesis was entitled, "Anatomical and experimental investigations of roots of the *Linaria vulgaris* Mill."

After obtaining his PhD Alan was appointed as lecturer at the University of Manchester and continued his research. He also met a young graduate student, Anne Turner, who was completing her PhD with Wardlaw. They married on the 22nd September, 1965. After graduating Anne also took up a position at the University of

Manchester but she moved away from the study of plants and established an internationally renowned research group focusing on cancer education, which was closely associated with Cancer Research UK. Anne's work with children and smoking became world famous and was duly recognized with a professorship becoming Professor of Cancer Health Education in the Medical School.

As can be seen from Alan's MSc and PhD, his first interests were dicot roots but he soon moved on to water plants, specifically at that stage in the 1960s to *Echinodorus tenellus*. This was the first of a series of papers on the Alismataceae in which he at first described the development of the shoots of *Echinodorus* and the developmental stages leading to the reproductive phase. There would be a remarkable twelve papers in the Alismataceae series all published in the Canadian Journal of Botany and ending in 2004 with the paper, "Alismataceae. XII. Floral organogenesis in *Damasonium alisma* and *Baldellia ranunculoides*, and comparison with *Butomus umbellatus*".

Always interested in the mathematics of plants and their development, several of Alan's research studies had a mathematical basis. Because he considered that studies on stomatal development in monocot leaves were lagging behind those of dicots, Alan studied stomatal patterns in *Chlorophytum comosum*, *Galanthus nivalis*, *Schizostylis coccinea* and *Scilla lanicifolia* in the mid 1980s, publishing the work in Annals of Botany.

Mathematics also played an important role in the investigation of primary vascular patterns in root meristems in *Pontederia cordata* and their relevance to studies in root development. Alan found that there are several lines of metaxylem cells in root apices of *Pontederia*. As roots grow, successive prospective vessels are added to some, but not all, of these files. Addition of the prospective vessels appeared to take place in the "quiescent centre" of the root apical

meristem. Not leaving mathematics but at least temporarily leaving roots, Alan investigated differentiation of the leaf epidermis in *Chlorophytum comosum*, finding that guard mother cells which failed to undergo mitosis may be those which are most distant from the guard cell zone. The study on *Pontederia* root apices was published in the Canadian Journal of Botany, while the work on the leaf epidermis in *Chlorophytum comosum* was published in Annals of Botany.

During the late 1980s and into the 1990s Alan continued his research on aquatic monocots, a group known as the Helobiae but now referred to as the Alismatidae, collaborating with Usher Posluszny at the University of Guelph. During the fall semester of 1992 Alan came to Guelph on a three-month short-term visiting professorship to work on *Hydrocharis morsus-ranae*, a member of the Hydrocharitaceae and an invasive weed in south-central Ontario. This work was eventually published as a chapter in "The Evolution of Plant Architecture", edited by M.H. Kurmann and A.R. Hemsley.

In spite of his many interests, skills and collaborations, Alan was, at heart, an independent researcher who liked to focus on what might be termed "odd ball" and somewhat ignored morphological questions. In the early 1990's he began an iconic series of studies into the developmental importance of the rotated lamina in leaf development. He produced a seminal series of eight papers from 1993–2008, all of them published in the Canadian Journal of Botany (later Botany). This series of papers included genera like *Ulmus*, *Begonia*, *Corylus*, *Magnolia*, *Pellionia*, *Prunus*, *Tilia* and *Elatostema*. There were some brilliant papers in this series, a showcase of his great skill at dissecting apical meristems and documenting them with his updated version of epi-illumination light microscopy. All of which clarified the complex orientation of leaves during development in plagiotropic branches and also added considerable insight into one of Alan's other pet projects: figuring out what makes pendulum symmetry tick.

The University of Manchester had a giant purge in 1989, when the size and status of one of the world's great Botany Departments was merged into oblivion. Many of us are all too familiar with this sort of development in Botany Departments over the past few years. Alan took voluntary retirement on the grounds that he would be provided with space to continue with his research. He certainly did. Not only did he continue with his morphological research, but he also researched and wrote a history of the University of Manchester Botany Department, entitled "135 Years of Botany in Manchester". In his usual thorough way, he searched archives, visited other Universities, took photographs, interviewed and wrote to many former students, staff and faculty and in the end produced a fascinating and very readable account of a Department that no longer existed but had, in its time, been the lynch pin of plant research not only in Great Britain but in the world. Alan loved to brag about all of the famous botanists who at one time or another had passed through Manchester. It was really an amazing group of scientists including Elizabeth Cutter, W.C. Wardlaw, Marie Stopes (paleobotanist and pioneer in family planning), Alan Turing (father of the modern-day computer who was also involved in plant morphology and morphogenesis) and, of course, our very own Taylor Steeves who spent a year working with Wardlaw in 1950.

After suffering a massive stroke in 2009, Alan was virtually paralyzed on his right side, but with great determination he managed to walk and he regained limited use of his right hand. Even with this modest recovery he remained deeply frustrated at being unable to do any more of his much-loved microscopy work. He did not give up writing, however, thanks to his computer. In the four years after his stroke he wrote articles on tropical fish (fancy guppies) and the history of British-made fountain pens that he keenly collected and, like everything that interested him, he soon became a respected and universally recognized authority. He did not want to do any further botanical research, saying that his last two papers were his best and he wanted to go out with a bang not a whimper! These two papers, published in Botany [86: 1474-1487 (2008); 87:136-144 (2009)], were most certainly landmark publications, notable for both their technical brilliance and conceptual breadth. They were a fitting conclusion to Alan's remarkable series on leaf development and rotated-lamina syndrome.

In a way Alan's many talents were not well recognized or celebrated during his lifetime. He took quiet satisfaction in doing something well and getting it as close to perfect as possible. He was a genius at tinkering and inventing scientific techniques, instruments and gadgets. For example, the perfect stain for epi-illumination light microscopy, a specially designed Petri dish to hold dissected apical meristems and the refinement of the digital stacking of images for greater depth of field are just some of his brilliant innovations. Alan's other unheralded contribution was his generous and unselfish mentoring of students. Although he did not have many graduate students of his own there were quite a number of young botanists in the UK and Canada who benefited from his encyclopedic knowledge and advice. Quite a few members of CBA/ABC owe much to Alan's mentorship.

Alan's research in developmental morphology and morphogenesis has most certainly advanced and greatly added to botanical knowledge. Yet, there is a feeling that his potential wasn't fully realized. At one time plans were being made to have Alan collaborate with Elizabeth Cutter at revising and updating her seminal two-volume work on Plant Anatomy. Unfortunately, those plans fell through and a wealth of knowledge that Alan had to contribute was never published. One can't but feel that there was a lost opportunity to have had a much-needed updated botanical text on plant anatomy, morphology and morphogenesis.

In spite of his great knowledge and genius-like skills, Alan had total respect for others, no matter their level of

education. He was not a snob and he appreciated everyone for their own values. His favourite book was *Moby Dick* by Herman Melville. He particularly liked the quote, “A whale ship was my Yale College and my Harvard”. Alan recognized that everyone’s education and background, no matter how basic or unorthodox, was still valuable and he respected them for it. In a way that sums up Alan: complex, brilliant and yet unassuming, the kind of guy you could just go out to a pub for a beer and talk about anything and everything. It just wasn’t a good idea to challenge him to a trivia quiz — he usually would know all the answers.

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Top Canadian Ornamental Plants. 7. Geraniums

Ernest Small[1,2]

Geraniums (*Pelargonium* species) are one of the world's leading ornamentals grown as annual garden and container plants. Indeed, they are Canada's most commonly purchased flowering potted plant for outdoor use. Their popularity is due to production of spectacular masses of blooms which look good from summer to a killing frost, ease of cultivation, and the availability of thousands of cultivars providing a dazzling kaleidoscope of colours and forms.

Well, I love geraniums, and anybody who does not love geraniums must obviously be a depraved and loathsome person

—Beverley Nichols (John Beverley Nichols, 1898 –1983, prolific English author, in Merry Hall, 1951)

Names

Scientific names: The genus name *Pelargonium* is derived from the Greek *pelargos*, a stork; the long slender fruit is reminiscent of a stork's bill. As discussed in this review, the two most important classes of geranium cultivars are the "zonals" and the "regals." The name *P.* ×*hortorum* L.H. Bailey has been applied to the zonals, and the name *P.* ×*domesticum* L.H. Bailey to the regals.

English names: The species of the genus *Pelargonium* have the common name "geranium." However, there is also a related genus, *Geranium*, many of which are also garden ornamentals. This regularly results in confusion, which could be avoided by using the vernacular name "pelargonium" for species of the genus *Pelargonium*. Unfortunately the common name geranium is now rather entrenched in North America for species of *Pelargonium*. In England, New Zealand, Australia and South Africa, geraniums are often referred to as pelargoniums. "Hardy geraniums" generally refers to *Geranium* species. Species of *Pelargonium* are frequently called storkbill or stork's bill, while species of *Geranium* are often called cranesbill. "East Indian geranium" and "Turkish geranium" are names for the grass *Cymbopogon martinii* and its essential oil, used as a flavorant.

French names: Géranium (also applied to *Geranium*); also bec-de-cigogne (also applied to other genera), pélargon, pelargonie, pélargonium.

Geography and ecology

The genus *Pelargonium* is native mainly to the Southern Hemisphere, mostly in South Africa where the majority of cultivated forms originated. A few species are also indigenous to Australia, eastern Africa, New Zealand, Madagascar, Yemen, Asia Minor, and the Atlantic Ocean islands of Saint Helena and Tristan de Cunha. In some areas of the world, notably Australia and California, domesticated geraniums have escaped to the wild and grow as weeds. Geraniums grow in quite varied habitats, but are characteristically found in low-humidity, cool areas with limited seasonal rainfall.

Figure 1. Common cultivated geranium (*Pelargonium* ×*hortorum*). ©Forest & Kim Starr (http://www.hear.org/starr/) (CC BY 3.0)

Appearance

Pelargonium includes annual and perennial herbs and shrubs. Some species develop underground tubers. The foliage may be evergreen or deciduous, lobed or dissected, the margins entire, curly or crisped, and the leaves may have a rough, sticky or velvety texture. Some cultivars have variegated leaves or foliage with distinct colour along the veins. Stems may be erect or trailing, succulent, spiny, or initially herbaceous but later woody. The flowers are arranged in an umbel-like cluster (because the oldest ones are at the centre, unlike a true umbel, the inflorescence has been termed a "pseudo-umbel"). The flowers may be shaped like butterflies, funnels, saucers, stars, or trumpets, and may resemble cactus flowers, carnations, tulips, or pansies. The posterior one of the five sepals is basally modified into a nectary, which is fused to the pedicel. The fused structure is (correctly) termed a "hypanthium" (more typically in angiosperms, a hypanthium is a fusion of a calyx, corolla, and androecium). The five free petals are often clawed (with a narrowed, stalk-like base) and arranged into two upper ones and three lower ones. The

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Character	*Pelargonium*	*Geranium*
Corolla	Irregular[1], the upper two petals different in shape and size to the lower three	Regular, all petals more or less the same in shape and size
Hypanthium, with a nectar spur (see text)	Present	Absent
Number of fertile stamens	Less than 10 (7 or fewer bear fertile pollen, the remainder are staminodes)	Ten
Habit	Various	Mostly herbaceous
Frost hardiness	Mostly tender	Mostly hardy
Native hemisphere distribution	Mostly Southern Hemisphere	Mostly Northern Hemisphere
Number of species	280	423[2]

Table 1. Differences between Pelargonium and Geranium (after Miller 2002)
[1]Less obvious in some zonal and regal cultivars bred to bear regular flowers with rounded petals.
[2]Aedo, C., Muñoz Garmendia, F., and Pando, F. 1998. World checklist of *Geranium* L. (Geraniaceae). Anales Jard. Bot. Madrid 56: 211–252.

style opens into five stigmas, after the anthers have dehisced, to avoid self-pollination. At maturity, the five fruit segments (each with a single seed) split apart, dispersing their plumed seeds (Figure 2).

Distinguishing *Pelargonium* and *Geranium*

The two so-called geranium genera both provide many cultivars, and are widely confused. The easiest way to differentiate *Pelargonium* species from *Geranium* species is by floral shape. *Pelargonium* flowers are bilaterally zygomorphic (the corolla has a single plane of symmetry, with two mirror-image halves), while *Geranium* flowers are actinomorphic (the corolla is radially symmetric, the five petals arranged in star-like fashion). *Geranium* species frequently fling their seeds away by an explosive mechanism, while *Pelargonium* seeds float away on the breeze with the aid of a feathered end (lacking in *Geranium*). The foliage of cultivated *Geranium* species is often more divided than in commonly cultivated *Pelargonium* species. *Pelargonium* tends to have rather thick, succulent stems, unlike cultivated *Geranium* species. Table 1 contrasts the two commonly confused genera.

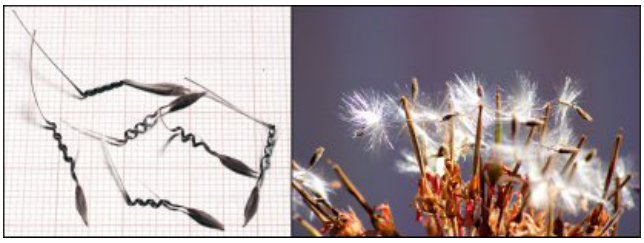

Figure 2. Left: Seeds of *Pelargonium aestivale*. The spirally twisted awn of geranium seeds is a burial mechanism; it is hygroscopic, winding and unwinding in response to moisture, drilling the seed into the ground. ©Michael Wolf CC BY 3.0. Right: *Geranium* seeds being dispersed by the wind pushing against the hairs on the awn. ©P. Jeremy (CC BY 2.0)

History and modern status

The first *Pelargonium* species exported to Europe was *P. triste*, transported from Cape Province to the Netherlands and England at least by the early 16th century. Subsequently, European gardeners created many strains by hybridization. Much of this development occurred during Victorian times, as rich landowners included *Pelargonium* species in their conservatories and glasshouses. Geraniums are now widely sold in the nursery trade, principally in temperate climates. They have become very popular bedding plants, used as staples in public and residential gardens, and in indoor and outdoor containers. Geraniums are the leading outdoor potted plant sold in Canada, with about 20 million pots produced annually. They are second in this category in the U.S., outsold only by *Impatiens* (patience). There are numerous societies devoted to *Pelargonium* (usually to *Geranium* as well).

Classification of geranium cultivars

Although some modern cultivars of *Pelargonium* are derived from one species, most have originated by hybridization from two or frequently several species. Two dozen or so wild species have contributed the parentage of most cultivated geraniums. There are hthousands of cultivars, in a very wide range of shapes, sizes, floral colours and scents. Most of the common cultivars produce excellent, long-lasting floral displays, many have decorative foliage, and some are trailing, suitable for hanging baskets and window boxes. *Pelargonium* cultivars are widely classified into the following informal groups, which only partly reflect the taxonomic divisions recognized in the genus.

Zonal

These are mainly hybrids derived from *P. zonale*, *P. inquinans*, and a few other species in section *Ciconium*. Zonals are the most common kind of geranium, with over 2000 recognized cultivars, including the ill-defined *P. ×hortorum*. They are upright, bushy, succulent-stemmed perennials grown for their single or double flowers

Figure 3. Attractive foliage of a variegated zonal cultivar ©Jeray Opioła (CC BY 3.0)

Figure 4. 'Angeleyes Randy', an angel geranium. ©Gothika (CC BY 3.0)

(Figures 3, 11). The group includes large plants as well as "dwarfs" (13–20 cm or 5–8 inches tall) and "miniatures" (not exceeding 13 cm or 5 inches in height). As the name zonal suggests, there is a dark (pigmented), crescent or horseshoe-shaped zone on the leaf (although not in all selections), and various cultivars are noted for their attractive, rounded foliage. This class is mostly used for bedding displays and containers.

Angel

Mostly derived from *P. crispum* with input also by *P. grossulariodes*, these are similar to regals, but are more compact and bushy, rarely taller than 30 cm (1 foot). They are said to have a distinctive "pansy-face" (Figure 4).

Regal

This group of hybrids is derived from *P. cucullatum* and perhaps a few other species, including *P. graveolens*, *P. angulosum*, *P. fulgidum* and *P. grandiflorum*. They are also known as Martha Washington, Lady Washington, and show pelargoniums. The plants are bushy evergreen perennials and shrubs, with rounded, sometimes lobed or deeply dissected leaves, producing single or rarely double flowers in shades of mauve, pink, purple or white, and grown both for outdoor and indoor display (Figure 5). The flowers are much larger than in the zonals, and individual potted plants can be rather spectacular. Regal geraniums have beautifully coloured petals in a wide range of hues, but tend to have a restricted flowering period, do not do well in wet summers, attract whiteflies, and tend to be less successful outdoors than the zonals.

Unique

This is a class of shrubby plants, woody at the base, mostly cultivated in the early 19th century, probably from crosses with *P. fulgidum* (Figure 6).

Ivy-leaved

Derived from *P. peltatum*, this class consists of trailing evergreen perennials with stiff, fleshy, shiny, five-angular-lobed leaves (reminiscent of ivy, *Hedera helix*), and single or double flowers like zonal geraniums (Figures 7). Ivy-leaved geraniums are frequently grown in hanging baskets.

Figure 5. Regal geranium cultivars. Left: 'Regal' ©Habib M'henni. Right: 'Tornado' ©Andy Mabbett (both CC BY 3.0)

Figure 6. 'Crimson Unique', a geranium cultivar of the unique class. ©Paolo Harlock (CC BY 2.0)

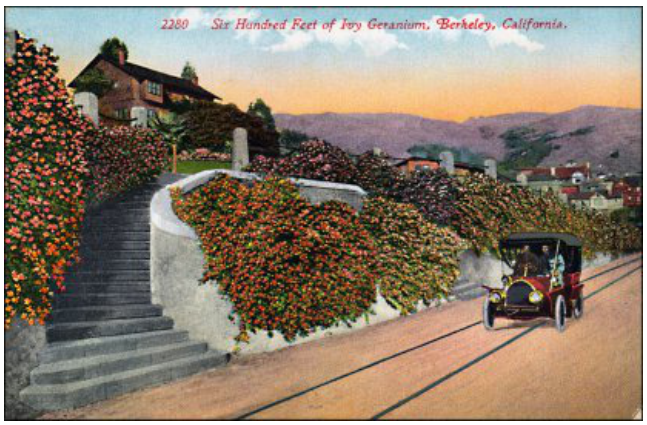

Figure 7. 1917 postcard featuring displays of ivy geranium in Berkeley, California. Published by Edw. H. Mitchell (public domain)

SCENTED-LEAVED

These are shrubby evergreen perennials and shrubs, which are mainly cultivated for their scented and often distinctly lobed, toothed or incised or variegated leaves (Figure 8). These plants have a wide range of kinds of foliage and habits. These are excellent houseplants, although the flowers are usually not showy. This is a very heterogenous group, described additionally in the next section, "Non-ornamental uses."

Figure 8. Rose geranium (hybrids of *Pelargonium graveolens*), the most popular scented-leaved geranium, and the source of rose geranium oil. Step, E., and Bois, D. 1896. Favourite flowers of garden and greenhouse. Vol. 1. Frederick Warne, London, U.K. Plate 56. (public domain)

Non-ornamental Uses

CULINARY USES

All Pelargonium species have glandular hairs producing essential oils, some much more than others. The "scented-leaved" or "fragrant-leaved" geraniums are a mixed group of odoriferous species, including several dozen used for culinary purposes. The species smell like fruits (apricot, apple, peach, strawberry), citrus (lemon, lime, orange), "nuts" (coconut, filbert), spices (allspice, cinnamon, ginger, nutmeg), mint, pine, camphor, and especially roses. It should be noted that the perception of smell is at least somewhat unique to individuals, and one person's apricot-scented plant may be another's sour milk.

The taste does not necessarily reflect the smell. So-called chocolate geraniums have a brownish spot on the leaves, but imagination is required to perceive a chocolate taste. Plants that lack an appetizing aroma should not be used as culinary herbs, but an attractive odour does not guarantee an attractive taste.

The wide range of geranium tastes and scents allows for an extensive range of culinary applications. For edible purposes, fresh or dried leaves are used to flavour gelatins, puddings, preserves and the like. The leaves can be infused in liquid, and the filtered liquid employed to impart aroma to sauces, custards, jellies, buns, water ices, butters, jams, sugar, syrups, vinegars, meats and soups. Cakes can be flavoured simply by putting a leaf in the bottom of a cake pan. The flowers can be tossed in salads. Geranium ice cubes can be prepared by freezing sprigs (especially of lemon or mint-flavoured forms) in an ice cube tray. Geranium oil is used in baked goods and fruit desserts. Except for some utilization of geranium oil as a flavouring in commercial food preparations, the culinary use of geranium is insignificant, and is essentially confined to occasional home use.

While consumption of Pelargonium species is not thought to be a hazard for humans, it is quite dangerous for dogs and cats (Figure 9). Geraniol and linalool are responsible for this toxicity, and can also cause skin irritation and skin allergies in susceptible people.

Science, or para-science, tells us that geraniums bloom better if they are spoken to. But a kind word every now and then is really quite enough. Too much attention, like too much feeding, and weeding and hoeing, inhibits and embarrasses them.

—Victoria Glendinning (in Green Words, the Sunday Times Book of Garden Quotations, 1986)

Figure 9. "Cat in a Cottage Window" (1881), a very popular art print by British painter Ralph Hedley (1848–1913). The geranium could kill the cat. (public domain)

Scented-leaved geraniums are widely grown in flower gardens and as potted plants, although their flowers are often small and not as attractive as species grown mainly for floral display.

PERFUMERY

Geranium oil is extensively used in manufacturing perfumes and for providing scent for cosmetics, soap and other toilet products. Hybrids of *Pelargonium* species with rose geranium (*P. graveolens*) as one of the parents are employed as a source of geranium oil. These hybrids are especially a source of "rose geranium oil," which is almost indistinguishable from the more expensive oil of roses. Geraniums are grown commercially as a source of geranium oil in many countries, especially China, Egypt, Morocco, and the South African island of Réunion, but also in Algeria, El Salvador, France, India, Madagascar and Spain. The annual world production of geranium essential oil is about 250 tonnes, with a value exceeding $10 million.

MEDICINE

Extracts from *Pelargonium* species are occasionally employed in modern Western medicine. There have been many folk uses, some persisting to the present. (*Geranium* species are much more commonly used in herbal medicine than are *Pelargonium* species, and accounts of "geraniums" employed medicinally often confuse the two genera.) Geranium oil from *Pelargonium* is used in aromatherapy. In their native area of Africa, the main region where *Pelargonium* species were used medicinally, the plants have been regarded as beneficial for treating diarrhea and dysentery, with the root of several species employed to treat syphilis. In Middle America, geranium decoctions (teas) are added to baths to relieve skin problems. Rose geranium leaves mashed in vinegar and salt were once applied in New Mexico to the forehead for headache, and warmed leaves were stuffed into the ear for earache. In the West, geranium has been used as a folk remedy in the treatment of ulcers. In Chinese medicine, the essential oil of geranium has been applied locally to treat cervical cancer.

Cultivation

SOILS

In nature, all species of *Pelargonium* grow well on nutrient-poor sand, but geraniums also thrive in well-rotted, well-drained compost and fertile soils. A pH of 6.0–6.8 is recommended. In their native habits geraniums generally grow on dryish, well-drained loamy soils, and the key to successful cultivation is a very well-drained soil. For pot culture, three parts loam, one part coarse sand, and one part leaf mould (or one-half part leaf mould and one-half part peat moss) has been recommended. A commercial grower's mix prepared specifically for geranium can often be purchased.

CLIMATE

Almost all *Pelargonium* species grow and flower best under cool conditions. Curiously, they are poor ornamentals in their native South Africa because the spring, although ideal, is only a few weeks long, and is followed by a summer which is far too hot. By contrast, the whole summer is ideal in Europe, where one sees splendid displays in flower beds. Areas of the tropics and subtropics where geranium oil is produced are all at high altitudes with a temperate climate all year round. A high light level is very important, and in nature practically all species occur in direct sunlight (some also grow well in semi-shade). Although many geraniums are evergreen perennials, almost all of the species are tender. *Pelargonium* does not tolerate frost, and must be wintered indoors in Canada. Many of the species endure some drought, and indeed are damaged by heavy rains. In general, plants should be watered sparingly, the soil allowed to become barely dry before watering. If the soil becomes too dry, the lower leaves tend to turn yellow and fall off. Pots of geraniums should be allowed to dry out a little, between thorough soakings, but water should never be allowed to collect in pots or saucers under pots,

and the foliage should not be misted. Geraniums can be brought indoors during the winter as potted house plants, preferably in a cool location, and lightly watered.

Propagation

Potted plants that have been sunken in the garden during the summer can simply be brought indoors before threat of frost. However, it is difficult to maintain garden-grown plants disease- and insect-free indoors overwinter, and reproducing plants by cuttings tends to result in healthier stock. Most geraniums can be reproduced by root cuttings, but stem cuttings are universally employed. Many geranium plants are of hybrid origin and need to be propagated vegetatively. However, some cultivated geraniums can be grown from seed (which can be obtained commercially, or from the capsules). Seeds are sown shallowly, and preferably kept at no lower than 13°C. Germination usually occurs in several weeks, or in some cases, in several months. The best time to take stem cuttings is soon after the flowering season. Typically, cuttings are made in early fall before frost. Unlike some other house plants, cuttings of geraniums tend to rot if the attempt is made to root them in water. Cuttings (7–13 cm long) from young, short-jointed shoots can be placed in a sand and peat mixture to root. Using a sharp knife, cleanly cut a stem just below a node. Large varieties require longer cuttings 10–13 cm long, while cuttings of smaller varieties can be about 7 cm long. Remove all but three leaves. Cut ends may be dipped in root-stimulating hormone. The cuttings should be inserted sufficiently deep in sand that they will stay erect. These are watered and kept shaded for a few days, then gradually exposed to sunlight. Subsequently the cuttings should be kept on the dry side, and not overwatered. Cuttings are potted when the roots are 1.5–2 cm long.

Maintenance of indoor plants

Keeping the root systems of potted specimens slightly pot-bound usually prevents the plants from growing large and taking excessive room. Regular pruning of some species encourages branching, but many cultivars do not respond well to pruning. Indoor plants should be kept fairly cool if possible (12°C at night and 18°C during the day are desirable), best achieved in a house by placing the plants close to a sunny but cool window. When overwintered indoors, geraniums should be given at least 4 hours of direct sunlight daily, or 14 to 18 hours of artificial light. A half-strength house-plant fertilizer can be used every 2 weeks during the flowering season, and monthly during the remainder of the year. Spent flower heads should be removed. Whiteflies, aphids, and other insects may weaken indoor plants considerably, but once taken outside again in the spring they recover.

Symbolism

- In Poland, pelargoniums are considered to be symbols of hope and protectors of the home.
- In traditional Bulgarian weddings, every bouquet and wreath should have a red carnation – symbol of manliness, and a geranium – symbol of health ("geranium" in Bulgarian is "zdravetz" and the word health is the very similar "zdrave").
- In 1964 in Chicago, a geranium on a white person's windowsill signified that they opposed racism.

Curiosities of Science and Technology

- According to a Muslim legend, the first geranium was created when the prophet Mohammed washed his shirt and hung it over a mallow plant to dry. The humble mallow was transformed into a magnificent geranium.

Figure 10. Geranium fairy, from the children's book: Flower children – the little cousins of the field and garden, by Elizabeth Gordon, drawings by M.T. Ross, published by P.F. Volland & Company in 1910. (public domain)

It's no go the picture palace, it's no go the stadium,
It's no go the country cot with a pot of pink geraniums.
It's no go the Government grants, it's no go the elections,
Sit on your ass for fifty years and hang your hat on a pension.
—Louis MacNeice (1907–1963, Anglo-Irish poet)

• English chemist and physicist John Dalton (1766–1844), who pioneered modern atomic theory, first realized he was colour blind when he heard others describe some geraniums as red, while he perceived them as blue. He went on to conduct research on colour blindness, which is sometimes called Daltonism in his honour.
• A mixture of the fat of a hippopotamus or a python, and the powdered root of *Pelargonium luridum* which has flowers that release their scent at night, has been rubbed on the faces of young men during Zulu courtship rituals in South Africa, attempting to charm the opposite sex.
• South African Xhosa warriors fighting European settlers in the 1850s thought that the roots of *P. pulverulentum* warded off the bullets of their enemies.
• In South Africa, the foliage of *P. papilionaceum* has been smoked and employed as a tobacco substitute.
• In the Victorian era (1837–1901), "floriography" or "the language of flowers" was a coded system of communicating private emotions by mentioning plants or flowers in letters, or placing them in small bouquets called tussie-mussies which were very fashionable at the time. "Geranium" unqualified meant gentility. Some more specific geranium meanings were: lemon geranium: unexpected meeting; nutmeg geranium: expected meeting; oak-leaf geranium: true friendship; rose-scented geranium: preference; fish (zonal) geranium (which can be unpleasantly scented): disappointed expectation.
• In Victorian England, pots of scented geraniums were strategically positioned indoors so that the long skirts of ladies would brush against them and spread the scent throughout the room.
• Scented geraniums are very popular as houseplants, but generally do not thrive in the low light levels of many interiors. With the invention of Edison's electric light in the late 1800s, one of the first houseplants suggested as benefitting from the extra illumination was the scented geranium.
• The Guinness Book of World Records reports a record length of 3.4 m (11 feet, 3 inches) for a geranium plant grown from November 12, 1996 to October 30, 1997.
• The Japanese beetle (*Popillia japonica*), an alien invader that arrived in North America about a century ago, is one of the most destructive pests of ornamental and turf plants, feeding on hundreds of different species. There are established populations in the eastern U.S. and adjacent Canada. Within half an hour of eating the petals (but not the foliage) of zonal or some other geraniums, the insect becomes paralyzed for several hours, but will usually recover (unless discovered by a predator) within 24 hours, and may resume feeding on geraniums. The amino acid quisqualic acid is responsible for the paralysis, thought to affect neuromuscular transmission in the insect.
• Methylhexanamine (also known as 1,3-dimethylamylamine and DMAA) has been extensively marketed as a dietary supplement, employed by athletes and body builders. It has also been called "Geranamine," and according to an early report (which has been discounted) it is present in "geranium oil." The chemical has become widely known as "geranium." Deaths have been reported from its use, which was restricted (essentially banned as a supplement) in Canada in 2011, and in the U.S. in 2013. It has been forbidden by numerous sports organizations.
• "Geranium" (the plant) is often confused with "germanium," a chemical element with the symbol Ge. This is a lustrous, hard, grayish-white metalloid in the carbon group, chemically similar to tin and silicon. Purified germanium is a semiconductor. John Bardeen and Walter Brattain invented the transistor in 1947 by inserting two electrodes into a sliver of germanium. Consequently, they and their colleague William B. Shockley received the Nobel Prize for Physics in 1956. The transistor effectively initiated the Information Age, and has been characterized as the most important invention of the 20th century. There are many accounts on the web that mistakenly claim the invention of the transistor was based on "geranium."
• Because of its citronellol content, geraniums have been reported to have some value in repelling insects, and indeed some scented geraniums are actually used as intercrops to repel insects. However, a hoax involved the marketing of a scented geranium called 'Mosquito Fighter' (Figure 12; see Tucker and Maciarello 1993 for a detailed discussion). It was claimed to be the

Figure 11. Cultivars of zonal geranium. Source: Step, E., and Bois, D. 1896. Favourite flowers of garden and greenhouse. Vol. 1. Frederick Warne, London, U.K. Plate 54.

Figure 12. *Pelargonium* 'Mosquito Fighter'. Photo by Chhe (public domain)

result of genetic engineering that transferred to it a gene from citronella grass (*Cymbopogon nardus*) producing citronella oil, a common ingredient in insect repellents. Said to keep mosquitoes, black flies and other insects away (tests have shown that these claims are untrue), the plants are still widely sold today. 'Mosquito Fighter' has produced allergic reactions.

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Geraniums online – http://www.geraniumsonline.com/index.htm (has numerous links to extensive information)
Pelargonium page – http://www2.arnes.si/~mstrli/pp.html
Pelargonium & Geranium Society (U.K.) – http://networkedblogs.com/JNGpP (publisher of "The international register and checklist of pelargonium cultivars")
Pelargoniums: an Herb Society of America guide – www.herbsociety.org/factsheets/Pelargonium%20Guide.pdfj

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Figure 13. "Still life with geraniums in a bronze bowl," painted in 1880 by impressionist French artist Pierre-Auguste Renoir (1841–1919). (public domain)

Major Invasive Alien Plants of Natural Habitats in Canada. 8. Reed Canarygrass, Phalaris roseau: *Phalaris arundinacea* L.

Paul M. Catling[12], Gisèle Mitrow[1] and Liette Vasseur

Reed Canarygrass was listed as number 9 in the priorized list of 81 invasive aliens of natural habitats across Canada. Its major impact on biodiversity reduction in Canadian ecosystems may have begun soon after introduction of European races prior to 1900, but was not understood or documented because introduced and native races were not distinguished. Unlike the massive concern over invasive Purple Loosestrife in Canada, Reed Canarygrass, at least an equal threat, has been largely overlooked. This is because grasses are less well known, Reed Canarygrass is partly native, and it has a reputation as a useful plant for erosion control, bioremediation and forage. Only recently has it become a much more serious concern as European races have been documented in North America with genetic evidence. Now its high abundance on the landscape provides a huge source of seed and readily available stolon and stem fragments for dispersal and colonization. It is present as a dominant in many wetlands and a potential problem in many others.

Identification

Key to *Phalaris* and similar species

Reed Canarygrass occurs across Canada as a native plant, as putative hybrids, and introduced races from Europe that can be differentiated (at least to a degree) using DNA but not using morphological characters. In many parts of southern Canada the plants behave like an introduced race by dominating wetlands to the exclusion of other species. Plants that are far less dense and occur sporadically along beaches and shorelines, especially in the north, are thought to be the native race. Although the races cannot be distinguished in a key, the species is distinctive. The inflorescence is branched and the spikelets have a single shiny fertile floret with two sterile florets reduced to hairy appendages attached at its base. It is most often confused with Northern Reedgrass (*Calamagrostis stricta*), but also with Orchard Grass (*Dactylis glomerata*), Velvet Grass (*Holcus lanatus*) and European Common Reed (*Phragmites australis* subsp. *australis*, no. 1 in this series). The following key will distinguish these species.

1a. Plants tall; ligule with a fringe of hair; spikelet with 2-8 florets; rachilla hairs exceeding the glumes
… ***Phragmites australis*** [both subsp.]

1b. Plants medium height; ligule without a fringe of hair; spikelet with 1-6 florets; rachilla hairs shorter than the glumes or absent
…. **2**

2a. Plants softly hairy; spikelets with 2 florets; upper lemma with a twisted awn arising from below the apex
… ***Holcus lanatus***

2b. Plants more or less smooth or scabrous; spikelets with 1-6 florets; awns present or not
… **3**

3a. Spikelets with 2-6 florets; glumes and lemmas with strong hairs on the keels and tipped with a short straight awn
… ***Dactylis glomerata***

3b. Spikelets with one obvious floret; glumes and lemma with soft hair or none on the keels and awn present or absent
… **4**

4a. An indistinct awn present about as long as the lemma; lemmas dull; fertile floret 1 or rarely 2 and without a pair of basal infertile florets
… ***Calamagrostis* spp.** (most often confused with *C. stricta* that also has a tight elongate inflorescence)

4b. Awnless; lemmas glossy; base of lemma with one or more often two scale-like and hairy infertile florets;
… ***Phalaris arundinacea***

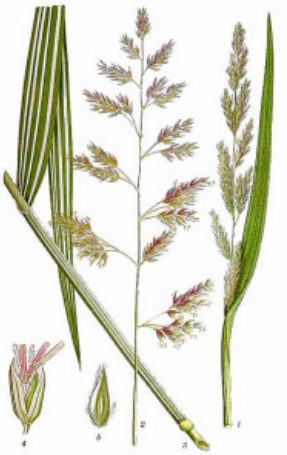

Figure 1. *Phalaris arundinacea*, by Swedish botanist Carl Axel Magnus Lindman (1856-1928) from his book "Bilder ur Nordens Flora." 1, top of culm with inflorescence of post-flowering plant; 2, flowering inflorescence with briefly spreading panicle branches; 3, portion of a culm of var. *picta*; 4, spikelet with floret in peak flower; 5, fertile floret with sterile florets at base.

[1]Science and Technology Branch, Agriculture and Agri-Food Canada, Saunders Bldg., Central Experimental Farm, Ottawa ON, K1A 0C6

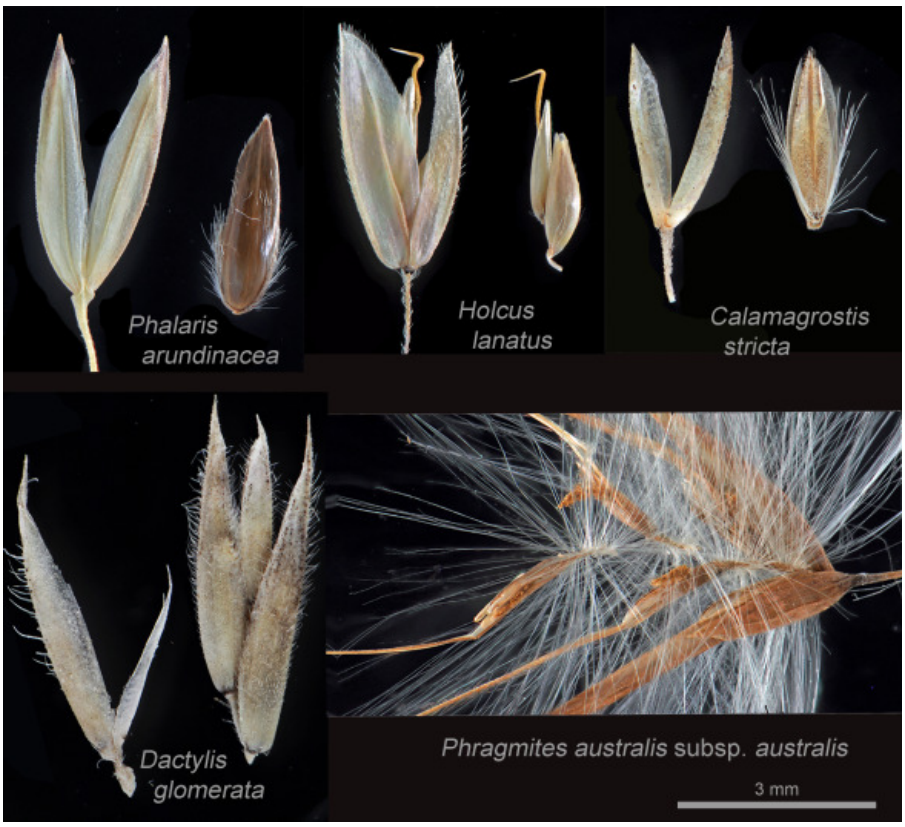

Figure 2. *Phalaris arundinacea* and other grasses that are sometimes confused with it including:
Holcus lanatus (DAO 99503)
Dactylis glomerata (DAO 22766)
Calamagrostis stricta (DAO 604360)
Phragmites australis (DAO 792221)
©P.M. Catling

KEY TO THE SPECIES OF *PHALARIS* IN CANADA

Phalaris has 22 species, most of which grow in the temperate regions of the world. Evolution in the group is associated with a decrease in the size of the of the sterile lemmas. Four species are currently known in Canada and two others occur near the Canadian border.

1a. Spikelets in clusters and disarticulating at the base of the cluster (falling as a group)
… ***Phalaris paradoxa* L.**, Hooded Canarygrass [only in SW British Columbia]

1b. Spikelets borne singly with disarticulation at first above and later at the base of the glumes (falling individually)
… **2**

2a. Glume keels not or only slightly winged toward the apex
… **3**

2b. Glume keels prominently winged and expanded toward the apex
… **5**

3a. Plants annual; fertile florets with acuminate apices
… ***Phalaris caroliniana* Walter**, Carolina Canarygrass

3b. Plants perennial; fertile florets with acute apices
… **4**

4a. Leaves green
… ***Phalaris arundinacea* L. var. *arundinacea***, Reed Canarygrass

4b. Leaves green with white stripes
… ***Phalaris arundinacea* L. var. *picta*** L., Ornamental Reed Canarygrass

5a. Sterile florets two, equal or subequal [exposed ends of glumes almost semi-circular and inflorescence thick and oval]
… ***Phalaris canariensis* L.**, Annual Canarygrass

5b. Sterile floret only one, or the upper three times longer
… **6**

6a. Plants annual; sterile florets smooth; glume keels more or less dentate
… ***Phalaris minor* Retz.**, Lesser Canarygrass

6b. Plants perennial; sterile florets hairy; glume keels entire
… ***Phalaris aquatica* L.**, Bulbous Canarygrass

Description

Tall, erect, rhizomatous and stoloniferous perennial 4-25 dm tall; leaves pale to dark bluish-green, 10-30 cm long, 5-20 mm wide, scabrous, margins serrate; ligules membranous, 4-10(11) mm, truncate, lacerate, pubescent on the outer base; panicles 5-40 cm long, 1-2 cm wide (except when in flower and spreading), elongate, usually dense, branched at least near the base with branches to 9 cm long; spikelets with a bisexual floret that disarticulates above the glumes and beneath the two sterile florets; glumes subequal, 4-8.1 mm long, 0.8-1 mm wide, with keels smoothly curved, scabrous, not or narrowly winged distally, the wings to 0.2 mm wide, apices acute; sterile florets (1)2, subequal to equal, 1.5-2 mm, less than 1/2 as long as the bisexual florets (including the hairs), pubescent; lemmas (bisexual florets) 2.5-4.2 mm long; sparingly pubescent with long

Native and Exotic Races of Reed Canarygrass

It has only recently been recognized that European races of Holarctic plant species (plant species living in Asia and North America) have been introduced to North America and become serious invasive aliens. As well as Reed Canarygrass, the Common Reed (*Phragmites australis* ssp. *australis* is an example, recently elevated to the rank of subspecies, but prior to that it was concealed within the native population. The European race of Reed Canarygrass and hybrids of native and European races, are concealed within a single North American population. Only through the use of molecular techniques can they be elucidated with certainty, although aggressive subpopulations in man-made habitats are believed to be of European origin.

soft hairs over the very glossy surface, green to dull yellow when immature, becoming shiny gray-brown to brown often with pale longitudinal stripes at maturity, apices acute; anthers 2.5-3 mm: grains about 2 mm.

Classification and Distribution

Reed Canarygrass belongs to the Grass Family, Poacae. It is widely distributed in temperate parts of the Northern Hemisphere and is native to north temperate regions, but has been introduced in all continents. The invasive race is believed to have originated from Europe and was repeatedly introduced to North America as forage. Attempts to morphologically discriminate early collections and remote collections which should be the native race, from later collections from anthropogenic (man-made) habitats which should be the introduced race, have failed.

Plants with white- or cream-striped leaves, *Phalaris arundinacea* var. *picta* L. (lectotypified by Baldini & Jarvis 1991), also referred to as *P. arundinacea* forma *variegata*

Figure 3. Post-flowering culms of Reed Canarygrass photographed at Rush Lake, Winnebago Co., Wisconsin. ©J. Mayer (CC-BY-SA 2.0)

(Parnell) Druce, is known as 'Ribbon Grass' or 'Gardener's Gaiters' and is sometimes grown as an ornamental. This variety differs not only in foliage colour but also in spikelet size, possibly associated with frequent abnormal meiosis. As well as being invasive, it is cultivated and has a different distribution in Canada from that of var. *arundincea*. Contrary to many reports it is not entirely sterile. Viviparous plants of var. *arundinacea* are known from two locations in Ontario and one in Quebec. Reed Canarygrass hybridizes with some other species of *Phalaris*. The hybrid *P.* × *monspeliensis* Daveau (= *P. arundinacea* × *P. aquatica*) is sometimes grown as forage and is known outside of cultivation in the southern United States.

Phalaris arundinacea is a tetraploid (2n=28, reported as 27, 28, 29, 30, 31, 35). The closely related hexaploid (2n=42), *P. caesia* Nees (subsp. *oehleri* Pilger), has longer glumes 6-7 mm, and the related diploid (2n=14), *P. rotgesii* (Husn.) Baldini has fertile lemmas less than 3 mm long. Neither of these taxa have been reported in North America.

The maps illustrate where *Phalaris arundinacea* var.

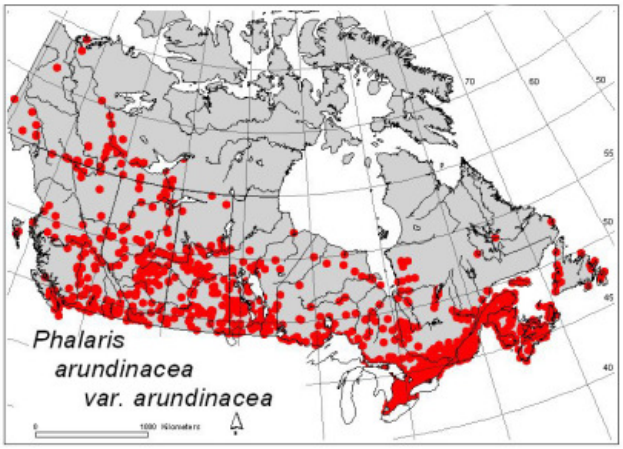

Figure 4. Distribution of *Phalaris arundinacea* var. *arundinacea* in Canada.

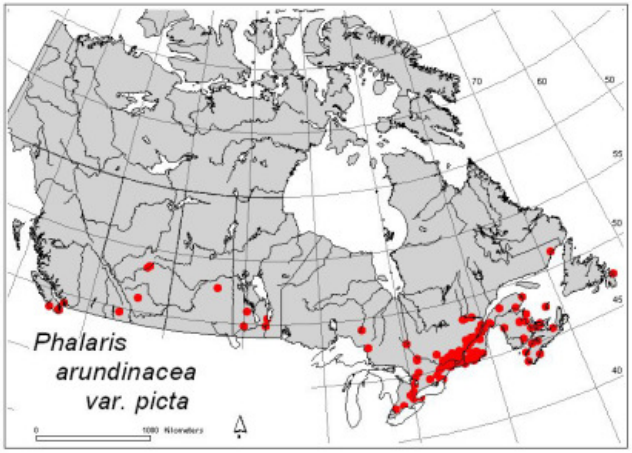

Figure 5. Distribution of *Phalaris arundinacea* var. *picta* in Canada.

arundinacea and *P. arundinacea* var. *picta* have been recorded outside of cultivation in Canada. The map is based on 2971 collections (herbarium sheets) from ACAD, ALTA, CAN, DAO, LKHD, MMMN, MT, MTMG, NFLD, NSPM, OAC, QFA, QK, QUE, ROM, SASK, TRT, TRTE, UBC, UNB, UWO, V, WAT and WIN.

Variety *arundinacea*, including both native and introduced (and undoubtedly hybrid) races, occurs across Canada north to the MacKenzie Delta. The overall range of both native an introduced races is likely much the same but the native race may be relatively more frequent in parts of the north and extend further north. Variety *picta* has a more restricted distribution, there being only 227 collections, and it is more frequently encountered in the east.

History

It has been suggested that the European race of Reed Canarygrass was introduced to North America with the very early European explorers and settlers such as Columbus and the Pilgrims. Waterfowl then spread it throughout much of the east. Seed was commercially available in Europe by 1850, and it was a popular livestock feed in New England by this time. In 1749 there were large stands in Quebec, which because of their size, may have been the European race. In the early 1900s seed was extensively imported to North America from Europe.

Figure 6. Reed Canarygrass, *Phalararis arundinacea*. AAFC drawing by K.F. Best in 1967.

How can a native plant be invasive?

A good definition of invasive is found in the United States Presidential Executive Order 13112 where an "invasive species" is defined as "a non-native species whose introduction does, or is likely to cause economic or environmental harm or harm to human health" (http://www.invasivespecies.gov). "It now appears likely that most Reed Canarygrass found in the wild is of Eurasian origin" (Casler et al. 2014). So it is partly or predominantly non-native, and environmental harm in North America is widely documented. North American Reed Canarygrass is thus both native and introduced, and is also harmful and therefore an invasive species.

As far as European origin is concerned, there are four possibilities. Invasive North American plants are: (1) Eurasian genotypes; (2) hybrids of native and Eurasian genotypes; (3) cultivars (that are at least partly European in origin); and (4) cultivars introgressed with native genotypes.

Agronomic varieties (cultivars) were produced in North America starting with "Ioreed" developed in Iowa in 1946 and based on 86% North American germplasm and 14% German germplasm. At least four varieties have been produced in Canada, "Castor", "Grove", "Rival", and "Bellevue". Also produced in Iowa were "Palaton", "R.P. 200", "Vantage", and "Venture." These cultivars were created for increased palatability through low alkaloid content (Palaton, Rival, Venture, Bellevue) or slow shattering for seed production. Recent studies have provided evidence that native North American Reed Canarygrass germplasm is preserved within cultivars of the species.

The earliest collection of the European race in North America based on genetic data was in 1891.

The oldest Canadian specimen of var. *arundinacea* (at MT) was collected in Montreal in 1820. A specimen at QK was collected at Kingston in 1844. The oldest Canadian specimen of var. *picta* (at MTMG) was collected in 1864 at Ottawa.

Ecology

Reed Canarygrass is found in open or semi-shaded habitats including mesic and marshy meadows, edges of rivers, lakes and ponds, in ditches and creeks, and in water as an aquatic. It colonizes easily after disturbances such as road construction and benefits from run-off of agricultural fertilizers.

Flowering occurs in late May and June to early July northward. The plant blooms and sets seed from the top down. The ascending panicle branches spread during flowering but after flowering is over they again become

erect.The pollen is transported by wind.

Dispersal may be by seed or root fragments in water or by waterfowl and mammals by adhesion of seeds to feathers and fur. Seeds and plant parts may also be distributed by people (on boots) and on vehicles. Reed Canarygrass can establish from rooting nodes of culms as well as by laterally elongating stolons. Variety *picta* is sometimes spread by transplanting from the wild. Seeds are sometimes available commercially providing yet another means of spread.

Detrimental Aspects

Significance is suggested by the number of asterisks (0-5), 5 being most significant. Control methods have proven costly.

(1) Negative effects on biodiversity *****

There are many reports of Reed Canarygrass colonizing native habitats in North America and then forming monocultures and dominating wetlands resulting in exclusion of native flora and fauna and reduced biodiversity. These examples include river and lake shores, prairie potholes, wet or mesic prairie, natural meadows, marshes, swamps and fens. There are also numerous articles describing failed attempts to control it. It overwhelms native marsh dominants such as Lakebank Sedge (*Carex lacustris*), and it has a deleterious effect on rare and endangered native wetland plants such as *Spiranthes lucida*, *Sidalcea nelsoniana* and *Howellia aquaticus*. One extensive and comprehensive study concluded that: “These results support the hypothesis that there are negative effects for multiple taxa from Reed Canarygrass invasion. Because negative effects observed in the local study either corroborated, or were neutral with respect to results from statewide surveys, they suggest that native biodiversity and biological integrity are being dampened across wide areas of this invader’s range.”

(2) Toxicity **

Reed Canarygrass may have negative impacts on livestock due to high concentrations of indole alkaloids. Some of these reports have involved sheep in Australia and New Zealand, but cases of toxicity have also been reported in cows and horses. Recently one situation was reported in the United States where the death of 18 cows was attributed to Reed Canarygrass. Avoidance of the grass resulting in poor weight gain is well known in parts of Canada, but researchers at the University of Manitoba discovered that most alkaloids could be eliminated by selective breeding and several low-alkaloid lines were produced for forage in the 1970s.

(3) Impeding water flow **

The extensive growth and dead material can slow flow, cause flooding and change movement of irrigation canals, ditches, rivers and streams.

Biological Advantages of Invasive Species

All invasives have advantages that have contributed to their success. Many share the same advantages. Those of Reed Canarygrass are:

1. genetic variability due to native and introduced races and multiple introductions from varying sources.
2. tall and dense growth
3. rapid vegetative spread by stolons and rooting of nodes of the culm.
4. high phenotypic plasticity
5. efficient long distance dispersal by water, waterfowl, people and vehicles
6. high physiological tolerance
7. early season growth
8. establishes a thick layer of litter (thatch) that reduces germination and growth of other species
9. is relatively unpalatable to a number of herbivores.
10. high ratio of total shoot length to biomass

Beneficial Aspects

Soil and Water decontamination ****

Reed Canarygrass can purify water by absorbing nutrients. It produces more biomass in beds receiving polluted leachate from landfill than it does in non-polluted beds. The plants are able to extract nitrogen, other nutrients and metals in industrial and municipal waste effluents and have proven effective in the bioremediation of contaminated soils. Regardless of specific applications, the value of this plant in providing improved water quality over the landscape may be substantial. Reed Canarygrass has been used in irrigation with wastewater from municipal and industrial sources as a pollution control measure. However, it may block water flow in shallower canals to which it spreads.

Forage ****

Reed Canarygrass has been highly recommended and widely used as forage. It is among the highest yielding of perennial grasses that are used for grazing in moist habitats for which it is adapted. It regrows well for the entire pasture season. Even after the seed shatters, the leaves remain green and succulent which may allow them to provide green fodder in July and August when other plant material becomes scarce. Reed Canarygrass is less palatable than other cool season grasses such as Timothy and Brome, but it can be grown in wet and periodically flooded soils. For hay production, native marsh hay may serve as well under some circumstances but in central British Columbia Reed Canarygrass has been promoted for replacement of sedges and rushes in “unproductive” native meadows. See also under “Toxicity” above. There is some evidence that the low alkaloid cultivars grown by farmers are not escaping to natural situations based on their high susceptibility to preferential grazing by meadow voles.

What is a cool season grass?

Reed Canarygrass is one. They are grasses that start their growth early in spring and continue that growth as long as it is cool and damp. They often become dormant or die back in summer. They establish quickly. Warm season grasses are slower to establish, and put on most growth during warmer weather. Invasive cool–season grasses such as Kentucky bluegrass (*Poa pratensis*), Smooth Brome (*Bromus inermis*), Quack-grass (*Elytrigia* [*Agropyron*] *repens*), Red-top, Bent-grass (*Agrostis* spp.), Reed Canarygrass (*Phalaris arundinacea*), and Timothy (*Phleum pratense*), can displace native warm season grasses in the absence of fire, by creating an increasingly cool-season environment, and in other ways. Natural area managers use fire, formerly a widespread natural process, to protect native warm season grasses and their associated biodiversity. Fires not only kill tissue but also remove litter increasing ground temperature and reducing soil moisture, reducing the length of the cool season and, over time, reducing available N.

Energy Production ***

Reed Canarygrass is a source of material for energy production in wet soils, and possibly with improvement on drier soils. Over 10,000 acres are in production for biofuel in Scandinavia. High ash content may be a limiting factor in use as biofuel.

Soil stabilization **

This plant has proven useful for erosion control because of its stoloniferous and patch-forming growth. It has been planted along waterways, gullies, ditches, ponds, lakes and reservoirs to stabilize sediments. The rapid development from seed or existing plants is an advantage for this use. In some cases it is the commercial availability of seed that results in the use of Reed Canarygrass instead of native stabilizing flora such as Cordgrass (*Spartina pectinata*). Use of Reed Canarygrass in stabilization may be effective but may also lead to new local infestations.

Garden ornamental *

The ornamental form of this species with green and cream striped leaf blades, *Phalaris arundinacea* var. *picta* L., also known as *Phalaris arundinaceae* var. *variegata* L., and commonly known as “Ribbon Grass or Gardner’s Gaiters,” is fairly popular in cultivation.

Food and cover for wildlife

Plants have been used to provide wildlife habitat because the seeds have been available on the market. Since a monoculture with limited wildlife value is likely to be produced, this is not a benefit.

Regulation

Canada

Because Reed Canarygrass is both native and introduced, and only one taxon was recognized until recently, the spread of alien stock has aroused little concern. It is listed under the Canada Seeds Act which allows the use of the species, but only under specific conditions. See the Justice Law website:
http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1400/page-46.html#sched1.
According to the Canadian Food Inspection Agency, the seeds are allowed to be used but under specific conditions:
http://www.inspection.gc.ca/plants/seeds/imports/abcs-of-importation/eng/1347740952226/1347741389113.

United States

The USDA lists this plant as an invasive species and has management plans to control it: http://www.invasivespeciesinfo.gov/plants/controlplans.shtml. It is also found on the Weed US - Database of Plants Invading Natural Areas in the United States http://www.invasive.org/species/list.cfm?id=76.

The “State Noxious-Weed Seed Requirements Recognized in the Administration of the Federal Seed Act” website has the different seed mixture groups which includes seeds of *Phalaris arundinacea* and the

Figure 7. Reed Canarygrass. ©M. Becker (GNU Free Documentation License)

requirements are listed by state laws http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5090172.

Reed Canarygrass is on many state invasive lists, and is a class C noxious weed in Washington. Seed is banned, prohibited, or illegal to possess in some states.

Management

Reed Canarygrass has been much more extensively controlled in the United States than in Canada and most of the detailed literature on the subject originates there. This may be partly due to the United States Environmental policy of "no net loss" of natural wetlands. Difficulty of control has led to an emphasis on specific small goals and slowing establishment by preventing both eutrophication of substrate and the introduction of new strains. Chemical methods and burning may require licenses and strict procedures. Combining various treatments listed below has proven most effective because the effects are often cumulative. Some studies have indicated that continued management is needed to maintain native wetland flora. A useful management document is that produced following a Nature Conservancy Symposium (Tu 2004).

Chemical Methods:

A variety of herbicide sprays have been employed, but those that are safer for use near waterways are preferred. Some studies have shown that Dichloropropionic Acid (Dalapon) and 3-amino-1,2,4-triazole ammonium thyocyanate (amitrole-T) are the most effective chemicals for control. Others are Roundup, Paraquat, and Rodeo. The latter is the only one approved in adjacent states of the Pacific Northwest. Chemical controls may be effective for up to two years after which regrowth and germination result in re-establishment. The use of graminicides has been accompanied by setbacks and re-establishment of dominance of Reed Canarygrass over the longer term.

Manual and Mechanical Methods

These include tilling, hand-pulling, digging, flooding, mowing, shading, scalping and cutting. Manpower required is variable. For hand-pulling and cutting to be effective, many treatments are required. These techniques can be useful in smaller areas to protect high priority native species from being overwhelmed. Shading using plastic or landscape fabric may also be used to reduce competition around native plants. Burning is limited in effectiveness due to moist soils and buried perennial roots, and is not generally helpful in reducing monocultures but it can promote native species, especially where fire-adapted native species and a native seedbank are present. A two to three-year burning rotation in Illinois prairie preserves was effective in maintaining native biodiversity. Scalping involves the removal of 12" of soil including the seeds, culms, major roots and rhizomes.

Biological Methods

The fungus *Heminthasporium* can cause severe damage but is not specific. At least 65 other fungal species have been reported on Reed Canarygrass. Gall Midge larvae feeding beneath the leaf sheaths have damaged Reed Canarygrass crops in Sweden. Three Palaearctic noctuid moths, which feed on riparian grasses including *Phalaris*, have recently been reported in North America, but their impact is not clear. The likelihood of developing a specific control agent is thought to be low. Biocontrol usually cannot always be restricted so would be counterproductive in using the plant for benefical purposes. Planting of shrubs such as willow in Reed Canarygrass monocultures can reduce the grass and improve biodiversity and some, at least temporary, control may be possible through grazing.

Prospects

Reed Canarygrass has not reached its limits of distribution and colonization in Canada. Wherever native plants of wet areas are affected by substrate disturbances, water fluctuations and/or by nutrient imputs, it is likely to take over and reduce native biodiversity. It is also likely to be increasingly problematic in landscapes where it is already abundant due to mass effect. There is still much to be gained by controlling it in key areas. It should not be used to create wildlife habitat.

A passenger or driver of ecological change?

A scientific paper with this interesting phrase in the title won the CBA/ABC Rowe Award in 2006 (Best Student Paper in Ecology: MacDougall, A.S. and R. Turkington. 2005. Are invasive species the drivers or passengers of change in degraded ecosystems? Ecology 86(1): 42-55.).

Many invasives may initiate colonization through non-interactive factors such as dispersal capability and environmental change, possibly due to human activity. In the case of Reed Canarygrass, this could be nutrient addition and/or a change in water level. The driver is ecological change, not the invasive plant. However, after a time interactions may begin to play a role. The characteristics of invasives (see text box) may give them an edge. In addition their sheer abundance, and their dominance on the landscape can result in them becoming quite independent of human activity and they can assume the role of drivers that are able to take over by mass effect. Imagine the propagules of Reed Canarygrass as rain droplets in a heavy thundershower where only a few droplets are native species. The chances of colonization of any half appropriate habitat by Reed Canarygrass are hundreds of thousands to one. So invasives may start as passengers, become more frequent passengers through fortunate adaptation then become untouchable drivers as a result of abundance.

Figure 8. *Phalaris arundinacea* var. *picta* ©Andrey Korzun (CC-BY-SA 3.0)

Its values in decontamination should not be overlooked. Development of palatable, high biomass and non-aggressive Reed Canarygrass may improve its use without increasing environmental damage.

Believe It or Not

- Carolina Canarygrass (*Phalaris caroliniana*), a related native annual of the southern US was one of the earliest cultivated plants in North America. It preceded Maize (corn) which reversed dependence on wild resources in the US and parts of southern Canada beginning about 1000 years ago.
- In a 1749 report to Linnaeus, it is indicated that Reed Canarygrass was the most palatable of grasses for Swedish cattle horses and goats.
- Energy crop cultivations of Reed Canarygrass in Sweden are an inferior breeding habitat for Skylarks compared to cereal-dominated conventionally cultivated fields.
- Tweetie Bird (Grandma's Canary properly known as *Serinus canaria domestica*) knew far more about seeds (and most things) than Sylvester (her wired cat) … and 99.999 % of people. He (Tweetie was an Alpha male) could differentiate Canarygrass seed and Reed Canarygrass seed, and he was not impressed with the latter. The florets of Canarygrass have large foliaceous sterile florets at the base, and the grains, approx. 4 mm long, are twice as large as those of Reed Canarygrass.
- Although it has little documented negative impact on agriculture in Canada, elsewhere Reed Canarygrass is a weed of rice fields and is also an alternate host of fungi that attack rice.
- Reed Canarygrass has been referred to as "one of the most dominant wetland invaders in North America over the past century."

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Collecting Blackberries for Herbarium Study

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Blackberries (*Rubus* spp.) present a long-standing source of vexation for taxonomists. One of the many challenges in this group is obtaining adequate herbarium material for study. Collecting a flowering shoot, adequate in most groups, is not enough for this challenging genus. In this short article I describe the protocol I have been using over the past two seasons of field work.

Figure 1. A single *Rubus allegheniensis* specimen, with the first-year primocane on the right, the second-year floricane on the left, and my expert *Rubus* presser Charlotte in the middle. Note that the primocane is unbranched, while the floricane has many flowering branches.

Collecting blackberries and their relatives (*Rubus* spp.) for herbarium study is particularly challenging, and even experienced field-botanists may not appreciate everything that is involved. More than in other vascular plant groups, to make a good *Rubus* specimens, you need to understand a bit about the their life-cycle.

Blackberries, and most other *Rubus*, are perennial shrubs. However, their stems, called canes, are biennial. In the first year of growth a cane remains in a vegetative state, and does not flower. Usually, it doesn't even form any side branches. These canes are referred to as primocanes. At the end of the season, buds form in the leaf axils and at the shoot tip.

In the second year of growth, flowering shoots will emerge from these buds. At this stage, the cane is called a floricane. Growth stops after the fruits are formed; the floricane doesn't produce any over-wintering buds.

A mature blackberry plant produces both primocanes and floricanes at the same time (Figure 1). The floricanes start earlier in the season, since they get a head-start building from last year's primocanes. By the time the flowers appear in June or early July, the next batch of primocanes are only just beginning to emerge from the underground rhizome.

Unlike other angiosperms, blackberry flowers haven't attracted much taxonomic interest. The really interesting characters are the primocane leaves, the stem armature (prickles, bristles, hairs and glands) and the mature inflorescences of the floricane. This means the best time to collect specimens is later in the season, when the fruits are forming or ripe and the primocanes are well developed.

With this in mind, based on two years' intensive collecting, we currently use the following protocol for preparing specimens.

First, confirm that you are collecting both a floricane and a primocane, and they both come from the same rootstock (Figure 2). This is important, as we've seen a lot of mixed populations!

Make at least two separate sheets for each plant. For the first, select a representative section of the cane from the central part of the primocane, with a few well-formed mature leaves attached (Figure 3). The cane tips are easily damaged, and don't generally press well. Similarly, the leaves at the base of the cane are often damaged or misshapen.

Pressing the leaves is tricky, particularly on prickly specimens. Keep in mind that on the mounted sheet you will want to see the intact outline of a complete leaf, as well as examples of the upper and lower surface of the leaves.

Make sure the specimen includes a nice segment of the most heavily-armed section of the stem (Figure 4). Sometimes the best leaves and the nastiest prickles are on different sections of the stem. If this is the case, include a section of the prickliest part of the stem, with the leaves removed, in your sample.

Figure 2. *Rubus* rhizome, confirming the primocane and floricane are part of the same plant. The upper cane is the primocane, and the lower one is the floricane. Primocanes are usually green, and floricanes usually red. This can vary though!

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Figure 3. Preparing a herbarium sheet from a Rubus primocane. Note there are two well-formed leaves, and we're pressing them so that both upper and lower surfaces will be visible.

Figure 4. Include a section of the prickliest portion of the stem in your collection.

Figure 5. Preparing a floricane for pressing.

Figure 6. Preparing a sample of *Rubus* leaf tissue for drying in silica.

Use a second sheet, with a separate newsprint folder, for the floricane (Figure 5). Get a section of the stem with two or three well-formed inflorescence branches. Again, the little shoots at the very top or bottom of the cane are often misshapen, so use the center of the cane. As for the primocane, make sure you've got a section of the prickliest cane.

Floricane leaves are incredibly variable. If you can include a few well-formed leaves in the folder, great. They don't get much attention taxonomically, though, due in large part to their inconsistency.

If you're collecting tissue for DNA work, the freshly-formed leaves at the end of the primocane are the best source. I collect enough for at least four extractions, and four flow cytometry analyses. Typically 50-100 cm^2, double-bagged, with labels inside and out in case of catastrophe (Figure 6).

Finally, make sure you note the habit of the plant for the label. The major growth forms include:

- highbush blackberries, with upright, ascending, or somewhat arching stems that don't reach the ground and don't root at the tip
- doming forms, that start out upright, but arch and may or may not root at the tips, possibly trailing along the ground as well
- trailing forms, which may either grow prostrate on the ground, or trail and scramble over other low vegetation

Do your best to describe what you see. It can be challenging to determine if you're looking at a trailing form, or a highbush form that is now growing on the ground after having been weighed down by snow or fallen branches. And some highbush species will look strange and stunted when growing in poor conditions.

The shape of the inflorescence should be visible on the sheet. The fruits, however, will either rot or dry down to a pile of seeds. So definitely include a note on their size (length and width). Also flavour, if you get some ripe ones. Better in your belly, with a good description on the label, than pressed into mash untasted!

Note that this protocol reflects the minimum necessary material for a useful herbarium collection. If you have time and space for more than two sheets, and you see interesting bits you'd like to include, you can always collect more. Some of our collections include five or six sheets for a single plant.