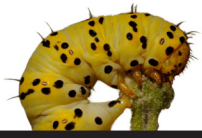


Bulletin

Entomological Society of Canada
Société d'entomologie du Canada

Volume 46
Number / numéro 1

March / mars 2014

Published quarterly by the
Entomological Society of Canada

Publication trimestrielle par la
Société d'entomologie du Canada

List of contents / Table des matières

Volume 46(1), March / mars 2014

Images

Sous le titre: *Cucullia lychnitis* sur une tige de Verbascum (Escalona, Aragon, Espagne) 1 juillet 2011. Photo: Francois Lieutier

1 La jeune entomologiste Aya Hoover inspectant un cadre d'abeilles (*Apis mellifera*) (ferme de recherche Beaverlodge, Alberta, Canada). Photo: Shelley Hoover

2 Un des rares Lucanidés du Canada, *Sinodendron rugosum*, marche dans la mousse (Burnaby Mountain, Colombie-Britannique, Canada), 31 juillet 2013. Photo: Sean McCann

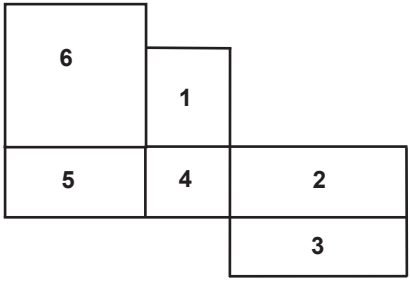
3 Femelle *Phiddipus regius* (Lake Placid, Floride, États-Unis d'Amérique). Photo: Guillame Dury

4 Charançon de la graine du chou (*Ceutorhynchus obstrictus*), un ravageur envahissant du canola (Delémont, Suisse). Photo: Tim Haye

5 Ces Membracidés ont été trouvés le long d'un petit arbre en Guyane sous la garde de fourmis (pas montrées). Photo: Steven Paiero

6 *Platypedia areolata*, émergée de sa chrysalide (Idaho, Etats-Unis d'Amérique). Photo: Malcolm Furniss

Couverture arrière: Un orthoptère indéterminé (trop de segments tarsaux pour un criquet) déplaçant sa biomasse vers le haut de la chaîne alimentaire. L'honneur est au moucherolle à ventre roux... Photo: Bob Lalonde



Up front / Avant-propos

Rebecca Hallett, President of ESC / Présidente de la SEC

Expectation, Operation, Destination

Believe it or not, this column was inspired by Maestro Fresh Wes (Godfather of Canadian Hip Hop, rapper, actor, record producer, and writer). I encountered the Maestro last night at the Fab5 Cabaret – an evening to celebrate the five festivals that make Guelph such a fabulous place to live – where he shared passages from his book "*Stick to Your Vision*" and his three steps to creating history: Expectation, Operation, Destination.

Expectation – set your goal, decide what it is you want to achieve. *Operation* – do all the work needed for getting there. *Destination* – achieve that goal, celebrate getting there, and then start the cycle again.

I think most of us in some way or other undergo a similar process when we establish goals and then set out to achieve them, but it struck me that this is particularly true of the ESC these days. We as a society are not content to stick to the status quo, but are always looking for ways to improve the way our Society functions and the services we provide to our members. And so, over the past few years, we have undertaken visioning exercises

Attentes, opérations, destination

Croyez-le ou non, cet article a été inspiré par Maestro Fresh Wes (le parrain du Hip Hop canadien, rappeur, acteur, producteur d'albums et écrivain). J'ai rencontré le Maestro hier soir, au Cabaret Fab5 – une soirée pour célébrer les cinq festivals qui font de Guelph un endroit fabuleux à vivre – où il a partagé des passages de son livre « *Stick to Your Vision* » et ses trois étapes pour créer l'histoire : Attentes, opérations, destination[i].

Attentes – Fixez votre but, décidez de ce que vous voulez accomplir. *Opération* – Faites tout le travail requis pour vous y rendre. *Destination* – Accomplissez ce but, célébrez d'y être parvenu, et recommencez le cycle à nouveau.

Je pense que la plupart d'entre nous, d'une façon ou d'une autre, passent par un processus similaire lorsque nous établissons nos buts et nous enlignons pour les accomplir, mais ce qui m'a frappé, c'est que c'est particulièrement vrai pour la SEC ces temps-ci. Nous, en tant que société, ne voulons pas nous contenter du statu quo, mais nous cherchons toujours des façons d'améliorer la façon dont notre Société fonctionne et les services que nous fournissons à nos membres. Nous avons donc, durant les dernières années, entrepris des exercices sur la vision de la Société en lien avec différents aspects des affaires de la SEC. Plusieurs de ces initiatives porteront fruit dans la prochaine année.

Loi sur les organisations à but non lucratif
Attentes – En 2013, nous avons dû faire la transition vers la nouvelle loi afin de continuer à opérer en tant que société à but non lucratif. Nos nouveaux statuts de prorogation et notre

[i]Traduction de « *Expectation, Operation, Destination* »

related to several aspects of ESC business. Many of these initiatives will be coming to fruition over the coming year.

Not-for-Profit Corporations Act

Expectation – In 2013, we were required to transition to the new Act in order to continue operating as a non-profit society. Our new Articles of Continuance and new By-Laws were filed with Industry Canada in November 2013. The final step in this process is for all of our Standing Rules and Committee Guidelines to be brought into line with the new Bylaws and requirements of the Act. *Operation* – The Bylaws, Rules & Regulations Committee and the Ad hoc Committee on the Transition have now started a review of all our Standing Rules and Committee Guidelines to ensure that they are in compliance with the Act, as well as accurately reflecting the way in which committees need to function. Over the course of the year, we will be providing information to the membership about how these changes will impact the operational processes of the Society – such as appears in Gary Gibson's article on p. 54 of this issue. In the future we will provide updates on the nominations/elections process and other issues of key interest to the membership. *Destination* – The revised Standing Rules and Committee Guidelines will be submitted for approval at the 2014 AGM and Board of Directors meetings.

Financial Future

Expectation – I think we all expect the ESC to be financially stable and secure, and in order to ensure that it is, it is important to undertake a periodic review our financial status. *Operation* – In response to recent unexpected changes in anticipated revenues, the ESC Executive and Finance Committee will be meeting with a financial advisor (pro bono!) to review our financial situation and investments. We will use this information to guide decisions about whether and when to sell the ESC Headquarters building, and how to structure our budget and investments in order to ensure that we are well positioned to

nouveau règlement intérieur ont été déposés à Industrie Canada en novembre 2013. L'étape finale dans ce processus est d'enligner nos règles permanentes et lignes directrices aux comités avec le nouveau règlement intérieur et les dispositions de la loi. *Opérations* – Le comité des règlements et le comité Ad hoc sur la transition ont maintenant débuté une révision de nos règles permanentes et des lignes directrices aux comités afin de s'assurer qu'ils sont conformes avec la loi, et qu'ils reflètent adéquatement la façon dont chaque comité doit fonctionner. Durant l'année, nous fournirons de l'information aux membres sur l'impact de ces changements sur les processus opérationnels de la Société – tel que mentionné dans l'article de Gary Gibson en p. 54 de ce numéro. Dans le futur, nous fournirons des mises à jour sur les processus de nominations/élections et d'autres sujets d'intérêt pour les membres. *Destination* – Les règles permanentes et les lignes directrices des comités révisés seront soumis pour approbation à l'AGA et aux réunions du CA 2014.

Futur financier

Attentes – Je pense que nous nous attendons tous à ce que la SEC soit financièrement stable et en sécurité, et afin de s'en assurer, il est important d'entreprendre une révision périodique de nos états financiers. *Opérations* – En réponse à de récents changements inattendus dans les revenus anticipés, le conseil exécutif de la SEC et le comité des finances rencontreront un conseiller financier (pro bono!) afin de réviser notre situation financière et nos investissements. Nous utiliserons ces informations pour guider nos décisions de vendre ou ne pas vendre, et quand, le bâtiment du siège social de la SEC, et comment structurer notre budget et nos investissements afin de s'assurer que nous sommes bien positionnés pour soutenir nos opérations en cours et les nouvelles initiatives stratégiques. *Destination* – Un nouveau plan financier sera développé au cours de la prochaine année.

support our ongoing operations and new strategic initiatives. *Destination* – A new financial plan will be developed over the coming year.

Running of Society Business

Expectation – We want to serve our members well, enhance their professional lives and development through our core activities, and to do so efficiently, conveniently and in a cost-effective manner. Over the coming year, we have established goals to improve our membership renewal and conference registration systems, and to review our Headquarter *Operations*, in light of budgetary constraints and the potential sale of our HQ building. Operation - The Web Content Committee and our Webmaster are working to improve the functionality of our membership database and online membership renewal system; the Annual Meeting and Web Content Committees are together exploring ways to improve the JAM registration system; and the Ad hoc Committee on Headquarter Operations is determining the best way in which to manage and modernize our Society operations. *Destination* – Membership renewal will be a fully online process for 2015. We hope to have a plan in place for improved conference registration prior to the 2014 JAM, and to have decided on what our operational structure will be before then.

New Treasurer and Scientific Editor

Expectation – As noted in my December 2013 Up front column, we will have both a new Treasurer and a new Editor-in-Chief of *The Canadian Entomologist* in 2014. *Operation* – A search for replacements for Scott Brooks and Chris Buddle was initiated during JAM 2013. I am very pleased to announce that Christopher Dufault will step into the role of Treasurer at JAM 2014. Christopher is already becoming familiar with the Treasurer's responsibilities and will be participating in the examination of the financial status and future of the ESC over this coming year. I am also thrilled to announce that Kevin Floate, former chair of the Publications Committee,

Roulement des affaires de la Société

Attentes – Nous voulons bien servir nos membres, améliorer leurs vies professionnelles et leur développement par le biais nos activités principales, et nous voulons le faire de façon efficace et rentable. Pour la prochaine année, nous avons établi des objectifs afin d'améliorer le système de renouvellement des adhésions et d'inscription à la conférence, et afin de réviser nos opérations du siège social, à la lumière des contraintes budgétaires et de la vente potentielle du bâtiment de notre siège social. *Opérations* – Le comité du contenu Internet et notre webmestre travaillent ensemble afin d'améliorer les fonctionnalités de notre base de données des membres et du système de renouvellement de l'adhésion en ligne; les comités de la réunion annuelle et du contenu Internet explorent des façons d'améliorer le système d'inscription à la réunion annuelle; et le comité Ad hoc sur les opérations du siège social détermine la meilleure façon de gérer et de moderniser les opérations de notre Société. *Destination* – Le renouvellement de l'adhésion sera un processus entièrement en ligne pour 2015. Nous espérons avoir un plan en place afin d'améliorer l'inscription à la conférence avant la réunion annuelle de 2014, et d'avoir décidé ce que notre structure opérationnelle sera d'ici là.

Nouveau trésorier et nouvel éditeur scientifique

Attentes – Tel que mentionné dans mon Avant-propos de décembre 2013, nous aurons un nouveau trésorier et un nouvel éditeur pour *The Canadian Entomologist* en 2014. *Opérations* – Une recherche de remplaçants pour Scott Brooks et Chris Buddle a débuté à la réunion annuelle 2013. Je suis très heureuse d'annoncer que Christopher Dufault débutera comme trésorier à la réunion annuelle 2014. Christopher se familiarise déjà avec les responsabilités du trésorier et participera à l'examen des états financiers et le futur de la SEC durant la prochaine année. Je suis également ravie d'annoncer que Kevin Floate, ancien président du comité des publications, a accepté de pren-

has agreed to assume the role of Editor-in-Chief of TCE. Chris and Kevin are working as co-editors on the current volume so that the transition will be as seamless as possible. *Destination* – Reached!

In addition to the usual society business, it is clear that there are many activities underway this year that will affect the structure and operations of the ESC. It is my very sincere hope that whatever changes we undertake will lead to a stronger ESC, changes that will allow us to serve our members well, to meet our Mission Statement, and to pursue our societal Vision. Borrowing again from the words of Maestro Fresh Wes, over this coming year, a year full of transition and change, let's

Reach for the Sky, Stick to Our Vision, and Let Our Backbones Slide!

dre le rôle d'éditeur scientifique du TCE. Chris et Kevin travaillent comme coéditeurs pour le numéro actuel afin que la transition soit aussi continue que possible. *Destination* – Atteinte!

En plus des affaires courantes de la société, il est clair que beaucoup d'activités en cours cette année affecteront la structure et les opérations de la SEC. J'espère sincèrement que les changements, quels qu'ils soient, que nous entreprendrons mèneront à une SEC plus forte, que ces changements nous permettront de mieux servir nos membres, de rencontrer notre mission et de poursuivre notre vision sociétale. Pour emprunter une fois de plus les mots de Maestro Fresh Wes, dans la prochaine année, une année pleine de transition et de changement,

Reach for the Sky, Stick to Our Vision, and Let Our Backbones Slide!

Stephen Marshall

So many species, so little time: taxonomic impediments versus taxonomic challenges and taxonomic opportunities.

It is a tremendous honor to be awarded the Gold Medal, and a special pleasure to receive it here on the campus where I have spent so much of my life. I was born in Guelph while my father was still a student, and I grew up chasing bugs in campus woodlots when he was an economics professor in the Ontario Agricultural College (OAC). Dad, by the way, will turn 92 during this meeting and he is here in the room today. Being part of the small, tightly knit OAC community of the early 1960s allowed me the opportunity to meet several professors, of whom the most important was entomologist Dave ("D.H.") Pengelly ... the first adult I had ever met who actually shared my interest in collecting insects. Professor Pengelly later became a major influence, but at that time my biggest entomological influence was probably a little field guide written by Ralph Swain and beautifully illustrated by his wife SuZan. When I was given the book I was too young to understand that Swain was a tragic figure who had been fatally shot by robbers while driving through Mexico with his family, but I did recognize his book as a sort of treasure map that sent me on a quest to find, collect and understand the irresistibly interesting organisms illustrated and named therein.

Many years and many countries later that quest took me back to the University of Guelph, where I was a student in three of Professor Pengelly's undergraduate entomology courses. His courses, which were packed with nascent ESC members, all emphasized the links between identification and understanding and thus all had a significant taxonomic component, but his fourth year systematics class was an especially influential immersion into the "so many species, so little time" zone. That course, officially titled "Insect Biosystematics", was widely known as the infamous "collection course" because one of the requirements was to collect 500 insects and identify them to the family level. The "collection course" allowed lots of time for interaction with a remarkable group of students of whom many, if not most, went on to careers in entomology and several became accomplished insect systematists. As I recall, we spent almost all our time in the lab, spending hours and hours trying to identify our collections, and many of us got hooked on the sense of discovery. Every time we ran specimens through a key we felt that we were opening doorways to all sorts of remarkable information, and in some cases we really were making new discoveries about insect life cycles and distribution. But, retrospectively, my most indelible impression of that course was how such a keen group of students was challenged to use available tools just to identify insects to the family level. For many insect groups, identifications below the family level were impractical without specialist expertise and access to a reference collection; species identifications were simply impossible for some groups. These sorts of barriers to specimen identification are now widely referred to as the "taxonomic impediment", but a main point I want to make today is that the problems currently blocking identification of some insects should be seen less as impediments and more as fascinating challenges and endless sources of new and interesting hypotheses.

My first real collision with the so-called taxonomic impediment came shortly after I went to Carleton University to do graduate work with the great beetle systematist Henry Howden. Although I had enrolled at Carleton with the intent of working on aquatic beetles, Professor Howden

Stephen Marshall (samarsha@uoguelph.ca) is Professor of Entomology in the School of Environmental Sciences and the Collection Director of the Insect Collection at the University of Guelph.

instead sent me out to New Brunswick to undertake a study of the insect community that lives in the massive piles of seaweed found along Canada's Atlantic coast. Similar piles of kelp, known as wrack, occur on rocky temperate shorelines the world over, where they are usually washed up as huge windrows at the monthly high tide to swiftly decompose before washing back into the ocean as soluble nutrients about a month later. The insects that catalyze this critical cycle are almost all in fly taxa entirely restricted to wrack at the generic or even the family level, and the dipteran density in wrack piles is astonishing. The clouds of flies that envelop your lower legs if you walk on washed up seaweed, for example, belong to the wrack-restricted sphaerocerid genus *Thoracochaeta*; the bigger flies scrambling down into the seaweed when disturbed are species in other wrack-only genera in other families such as the entirely wrack-restricted family Coelopidae. On arrival on the East Coast with a mandate to study this specialized insect community, I found that the habitat I was supposed to study literally swarmed with apparently unidentifiable little flies that had to be named before they could be understood in the context of their history, distribution and relationships. This is a good example of the classic "taxonomic impediment", but of course it was not really an impediment, it was a grand opportunity. Overcoming the identification problem required a thorough revision of at least the Nearctic *Thoracochaeata* in order to name the undescribed species, to correctly identify others that had been previously unrecognized from Canada, and to work out the relationships and history of the species. When I started the project, the genus *Thoracochaeta* included 8 species worldwide of which 3 were known from North America; it now includes 34 species worldwide and 9 species in North America (Fig. 1). I continued to study this genus for years after finishing my MSc, but my first stab at turning a taxonomic impediment into a taxonomic opportunity was to revise the North American species of *Thoracochaeta*. This proved more satisfying to me than the ecological project for which the names and context were needed, convincing me that what I wanted to do was solve taxonomic problems … to render species identifiable and to play with some phylogenetic and zoogeographic puzzles along the way. At that time, in the 1970s, the phylogenetic or cladistic approach to taxonomy was relatively new and exciting, and enough of an "antiestablishment" approach to be particularly attractive to a young student. And so I returned to Guelph to do a doctorate in insect phylogenetic systematics and ended up staying here, replacing Pengelly as the insect taxonomist in the Department of Environmental Biology in 1982.


Stephen Marshall

Figure 1. A seaweed fly, *Thoracochaeta johnsoni* (Spuler)

The University of Guelph's Department of Environmental Biology, now part of the School of Environmental Sciences, has a special responsibility to the Canadian entomological community as the home of the University of Guelph Insect Collection. The Collection, Canada's oldest since it includes the original pre-Confederation Entomological Society of Canada insect collection, had been in the care of the Ontario Agricultural College since 1906, and was part of the OAC Department of Entomology and Zoology until the formation of the Department of

Environmental Biology as part of the newly established University of Guelph in 1964.

When it became my responsibility, the Collection was made up of about half a million pinned specimens housed in wooden cabinets and loosely fitting drawers that required the annual application of frightening amounts of naphthalene to stave off invading dermestid beetles. Although the Collection was, and is, rich in authoritatively identified specimens, unique data, significant unstudied material, and heritage material of species now rare or extirpated in the province, I think it is fair to say that in 1982 few people recognized what a treasure it was. In fact, the general opinion in the Department at that time was that the Collection was an anachronistic white elephant to be plundered for teaching material, and there was no support of any sort for its maintenance and development. Fortunately, a group of keen students associated with the Collection helped to keep it alive and growing through volunteer efforts and stopgaps, such as homemade drawers and unit trays, until things changed for the Collection when our Department moved into the brand new Bovey building at the end of the 1980s. There our new insect collection facility included tight-fitting Cornell drawers in new metal cabinets mounted on a motor-driven compactor (mobile shelving unit), finally giving us world-class housing for a world-class insect collection. The space occupied by the collection increased again about 10 years ago when we expanded the mobile shelving system and added another 30 cabinets and 750 drawers. That same period saw the Collection grow rapidly in both quantity and quality thanks to a period of support for an extraordinary professional curator, Matthias Buck. We now have no regular curator and instead rely on dedicated graduate students, but the Insect Collection remains a dynamic resource of over two million specimens including over a million flies from around the world (Fig. 2) and a goldmine of data on the identity, distribution, and taxonomy of all orders of insects in southern Ontario. Like all major collections, the University of Guelph Insect Collection includes vast numbers of incompletely identified specimens as well as a solid core of authoritatively named specimens, and it is thus both a repository for countless taxonomic impediments and the source of material needed to overcome the impediments.

Stephen Marshall

Figure 2. This unusual pollen-splattered African tabanid (*Rhigioglossa nitens*) is just one of the over two million specimens in the University of Guelph Insect Collection

The so-called taxonomic impediment can be broken down into two distinct components representing two distinct problems. The first arises when taxa cannot be identified because they have no meaningful names. This would indeed be an impediment to identification in the absence of taxonomists able to correct the situation, but for taxonomists each such impediment really is an exciting discovery, opening the door first to formal recognition of new species, and then to the documentation of their distribution, morphology and relationships in order to name them in proper context. One component of the taxonomic impediment can therefore be viewed as a "taxonomic opportunity". Like most systematists, I spend most of my time on that first component, pursuing taxonomic opportunities that ultimately turn into revisions of entire monophyletic groups such the whole family Syringogastridae or the genus of seaweed flies I mentioned earlier. I see such revisions, with their aggregated and verified distributional and biological data, descriptions, keys and phylogenetic information, as the foundation of all bio-

diversity work, and the task of contributing to that foundation is an immensely satisfying one. But there is a second component to the so-called taxonomic impediment.

The second component of the taxonomic impediment is the challenge of identifying taxa that have already been revised, or at least have available names. The Sciomyzidae of Ontario, for example, are relatively well known and probably all named, but matching a name to a specimen is currently very difficult for a non-specialist. This component of the taxonomic impediment is really an interpretive challenge rather than a gap in the taxonomic infrastructure, but it is no less important.

In a sense I started my career as a taxonomist in an undergraduate course that focused on the interpretive component of the taxonomic impediment, an experience that persuaded me that the task of improving the tools used for insect identification is a meaningful and important one. So, from my perspective, some of the most exciting developments in Canadian entomology during the course of my career have been those that contributed to the interpretation of our existing taxonomic infrastructure, thus facilitating access to existing names and associated information. The Manual of Nearctic Diptera (MND), a collaborative effort spearheaded by Agriculture Canada dipterists, was a milestone in this regard, in one stroke rendering almost all North American Diptera identifiable to the generic level. The MND is over 30 years old now and although it is time for a new collaborative effort refreshing and extending the Manual using new tools and technologies, the MND remains the gold standard for comprehensive generic keys. Although I only worked on one chapter of the original Manual, I learned a great deal from more senior contributors, especially Dick Vockeroth, Herb Teskey, Frank McAlpine, and Monty Wood. Many of the same scientists who produced MND also worked on the more recent Manual of Central American Diptera (MCAD), which did for Neotropical flies what MND did for Nearctic flies. The MCAD was an important experience for me partly because of the pleasure of working with a team of the world's best dipterists but also because the head editor, previous Guelph graduate student Brian Brown (a plenary speaker at this meeting) persuaded me to work on several different chapters including generic keys to different families. In many cases this meant writing keys to unnamed genus A, unnamed genus B, and so on, because the taxonomic infrastructure in the tropics is so incomplete, and so many tropical flies remain to be formally described even at the generic level. But ... and this is an important point ... such is not the case for Canadian flies, nor is it the case for most other Canadian insects. The Canadian arthropod fauna is relatively small, with only tens of thousands of species of which most are formally named and recognizable at least to specialists. The taxonomic impediment in the neotropics represents a huge opportunity for taxonomic discovery because the task of formally describing even the genera remains so incomplete. This is not so in Canada, especially in eastern Canada where relatively few species remain to be described, although many are essentially unrecognizable to non-specialists and a significant proportion remain to be formally recorded from Canada. Here in Canada the taxonomic impediment is primarily an interpretive challenge.

Online insect identification tools should be sufficiently complete and clear to enable any biologist to identify any Canadian insect to a meaningful level. Generic identifications should be easily accessible and species identifications routinely accessible. But that is not yet true for most groups, and projects requiring species identifications still routinely rely on help from specialists. I, for example, am very much in debt to my colleagues in the taxonomic community for help with my book projects, which are essentially attempts at empowering naturalists to identify, understand and appreciate insects. Those book projects could not have succeeded without assistance from a whole community of specialists who generously ensured that the images used in those books had the right names on them. More recently, however, I've been shamelessly pressuring the same colleagues to encapsulate their expertise into online reviews and photographic keys

that will expedite identifications by others. Most taxonomists would be happy seeing others enabled to do routine identifications, and many are now publishing identification guides and associated data in the Canadian Journal of Arthropod Identification (CJAI). CJAI is an important and rapidly expanding source of free, easily used and comprehensive keys to Canadian insect species. Originally launched as a product of the Biological Survey of Canada, it is now a core journal of our Society, so I am sure everyone here is familiar with the CJAI website. I look forward to the day when most of our arthropods can be quickly identified using the digital keys in CJAI, and I would urge those of you with special expertise on an arthropod taxon to package it for publication in CJAI. Everyone now has access to the necessary tools to put together a useful digital key, and each additional taxon reviewed and keyed in CJAI represents a solid step along the way to making CJAI a complete guide to the arthropods of Canada and beyond.

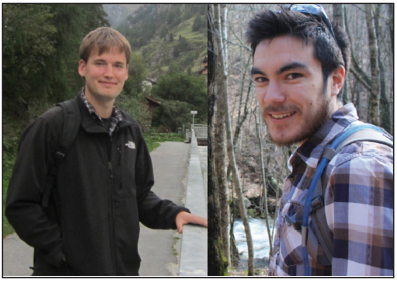
Just as a sound taxonomic foundation allows the development of identification tools such as CJAI, those identification tools allow the efficient use of existing or new collections of insects to answer a variety of questions about biodiversity, such as where and when species occur or occurred. My lab has been involved with regional or site inventories and surveys for decades, initially leaning heavily on primary literature, specialist assistance, and identified reference specimens to generate species lists for numerous regions, habitats and protected areas in Ontario and beyond. Some of these projects were long-term and opportunistic, such as the 25 years of periodic collecting and curating specimens from Point Pelee National Park, and others were focused and funded survey projects such as our projects in Rondeau Provincial Park, Bruce Peninsula National Park, and Ojibway Prairie, which documented thousands of species. Doing such inventories is becoming easier and easier as new identification tools like CJAI become available, and of course the development of those very identification tools is greatly expedited by the accumulation of identified specimens, images and distributional data resulting from our survey work. We could legitimately take the view that each successful survey … indeed, every successful identification … is a victory over the taxonomic impediment. But I really prefer to view the taxonomic impediment less as a foe to defeat than as an ally bearing a Pandora's box of wonderful interpretive challenges and taxonomic opportunities. I hope that you, and many more generations of insect enthusiasts, have as much fun chasing such challenges and opportunities as I have had (Fig. 3)!

Stephen Marshall

Figure 3. Have fun chasing entomological challenges and opportunities, even if at first they don't seem to fit in your net!

The student wing / L'aile étudiante

Paul Abram and Boyd Mori



The winter is nearly over, and entomology students across the country are breaking their winter writing diapause. Whether you'll be spending long days driving around in the field this spring/summer or doing experiments in the lab, and whether your specimens are living or dead, we hope they are cooperating.

We would like to take this opportunity to introduce this year's ESC Student Affairs Committee (SAC). The committee is composed of entomology students from across the country with diverse backgrounds and research interests, including several new additions. We are hoping to continue working on existing initiatives (the Graduate Student Showcase at the JAM, the Directory of Entomological Research in Canada), while developing some ideas for exciting new ones. As always, if you are a student and have ideas for how your Society could better serve you, please don't hesitate to contact us!

The 2014 ESC Student Affairs Committee:

Paul Abram (ESC Student Representative, SAC Co-Chair, Montreal)

Paul has been a member of the SAC since 2010, and is excited to serve as student representative for the ESC in 2014. In 2012, he completed his Master's work at Carleton University (Ottawa) and CABI (Switzerland), conducting a survey of Europe for potential biological control agents of the swede midge, *Contarinia nasturtii*, an invasive pest of *Brassica* crops in Canada. He is currently working on his PhD at the Université de Montréal under the supervision of Jacques Brodeur and Guy Boivin, studying the fascinating behavioural ecology of egg parasitoids of stink bugs.

L'hiver est presque terminé, et les étudiants en entomologie de tout le pays sortent de leur diapause hivernale d'écriture. Que vous passiez de longues journées à conduire sur le terrain ce printemps/été ou à faire des expériences au labo, et que vos spécimens soient vivants ou morts, nous espérons qu'ils coopèrent.

Nous voulons saisir cette opportunité pour vous présenter le comité des affaires étudiantes de la SEC cette année. Le comité est composé d'étudiants en entomologie de tout le pays possédant des expériences et des intérêts en recherche divers, et nous avons plusieurs nouveaux membres. Nous souhaitons continuer à travailler sur des initiatives existantes (la vitrine aux étudiants gradués à la réunion conjointe annuelle, le répertoire des formations en recherche entomologique au Canada) tout en développant de nouvelles idées pour de nouvelles initiatives. Comme toujours, si vous êtes étudiant et que vous avez des idées sur la façon dont votre Société peut mieux vous servir, n'hésitez pas à nous contacter!

Le comité des affaires étudiantes de la SEC 2014 :

Paul Abram (représentant étudiant de la ESC, co-président du comité des affaires étudiantes, Montréal)

Paul est membre du comité depuis 2010, et il est ravi de servir comme représentant étudiant de la SEC en 2014. En 2012, il a terminé son travail de maîtrise à l'Université Carleton (Ottawa) avec CABI (Suisse), menant un inventaire en Europe pour des agents potentiels de lutte biologique contre la cécidomyie du chou-fleur, Contarinia nasturtii, un ravageur envahissant des cultures de Brassica au Canada. Il travaille actuellement sur son doctorat à l'Université de Montréal sous la direction de Jacques Brodeur et Guy Boivin, étudiant l'écologie comportementale fascinante des parasitoïdes des œufs de punaises.

Boyd Mori (co-président du comité des affaires étudiantes, Edmonton)

Boyd a commencé ses études post-secondaires à l'Université de la vallée Fraser à Abbotsford, Colombie-Britannique, avant d'aller à l'Université de l'Alberta pour finir son bac.

Boyd Mori (SAC Co-Chair, Edmonton)

Boyd started his post-secondary education at the University of the Fraser Valley in Abbotsford, British Columbia, before transferring to the University of Alberta to finish his Bachelor's degree. During his time at the U of A, he was inspired by some fantastic faculty members to continue on in entomology. He is currently completing his PhD under the supervision of Maya Evenden, exploring the use of pheromones to monitor and manage *Coleophora deauratella*, a significant pest of red clover in north-western Alberta. He also hopes to track the invasion of *C. deauratella* in Alberta, and possibly Canada, using molecular phylogenetic analyses.

Chandra Moffat (Fredericton)

Chandra is a PhD student at the University New Brunswick, where she studies the evolution of host-race formation and speciation in herbivorous insects. She has been involved with the ESC Student Affairs Committee since 2010, and served as the Student Representative from 2010-2012. She is currently Co-Chair of the International Congress of Entomology Student Affairs Committee, representing the ESC SAC. She completed a BSc at the University of Victoria where, through the co-op program, she gained experience in agricultural entomology, invasive plant ecology and biological control. After her BSc, she worked for both the CFIA and CABI Europe-Switzerland, and then completed an MSc investigating the host-associations of a candidate weed biological control agent in its native range.

Léna Durocher-Granger (Saint-Jean-sur-Richelieu/Honduras)

Léna completed her Master's degree in 2011 on reproductive strategies of parasitoids at McGill University and Agriculture and Agri-Food Canada. She is now working in Central America to support IPM projects with small producers, but still helping in the SAC.

Guillaume Dury (Montréal)

With the help of his parents, Guillaume started collecting insects before he was 5 years old. The passion has only grown; during his undergraduate degree at the University of Québec at Montréal, Guillaume studied the feeding behavior of forest tent caterpillars. He is currently studying circular group defense in the larvae of neotropical leaf beetles (Chrysomelidae: Chrysomelinae). Using molecular phylogeny he hopes to uncover the evolutionary history of this behaviour. He is

Durant son temps à l'U de A, il a été inspiré par certains professeurs fantastiques pour continuer en entomologie. Il termine actuellement son doctorat sous la direction de Maya Evenden, explorant l'utilisation des phéromones afin de surveiller et contrôler *Coleophora deauratella,* un ravageur important du trèfle des prés dans le nord-ouest de l'Alberta. Il espère également suivre l'invasion de *C. deauratella* en Alberta, et possiblement au Canada, en utilisant des analyses phylogénétiques moléculaires.

Chandra Moffat (Fredericton)

Chandra est étudiante au doctorat à l'Université du Nouveau-Brunswick, où elle étudie l'évolution de la formation de races d'hôtes et de la spéciation chez les insectes herbivores. Elle est impliquée dans le comité des affaires étudiantes de la SEC depuis 2010, et a été représentante étudiante de 2010 à 2012. Elle est actuellement co-présidente du comité des affaires étudiantes du International Congress of Entomology, représentant le comité des affaires étudiantes de la SEC. Elle a fait son bac à l'Université de Victoria où, via le programme coop, elle a acquis de l'expérience en entomologie agricole, en écologie des plantes envahissantes et en lutte biologique. Après son bac, elle a travaillé pour l'ACIA et CABI Europe-Suisse, et a ensuite fait une maîtrise sur les associations d'hôtes d'un candidat comme agent de lutte biologique des mauvaises herbes dans son aire de distribution native.

Léna Durocher-Granger (Saint-Jean-sur-Richelieu/Honduras)

Léna a terminé sa maîtrise en 2011 sur les stratégies de reproduction des parasitoïdes à l'Université McGill avec Agriculture et agroalimentaire Canada. Elle travaille maintenant en Amérique centrale afin de soutenir des projets de lutte intégrée avec de petits producteurs, mais aide toujours le comité.

Guillaume Dury (Montréal)

Avec l'aide de ses parents, Guillaume a commencé une collection d'insectes avant même d'avoir 5 ans. Sa passion n'a fait que grandir : durant ses études de premier cycle à l'Université du Québec à Montréal, Guillaume a étudié le comportement de nutrition de la livrée des forêts. Il étudie actuellement la défense de groupe circulaire des larves de chrysomèles néo-tropicales (Chrysomelidae : Chrysomelinae). En utilisant la phylogé-

completing this Master's project at McGill's Macdonald Campus and the Smithsonian Tropical Research Institute in Panama.

Ikkei Shikano (Vancouver)

Ikkei completed his Master's degree at the University of British Columbia where he ignited a passion for insects while researching their ability to retain long-term memory. He is currently working on a PhD at Simon Fraser University studying self-medication behaviour associated with tritrophic interactions between cabbage loopers, their host plants, and entomopathogens.

Joanna Konopka (London)

Joanna's main research interest is applied entomology, especially integrated pest management and medical entomology. Joanna has recently completed her MSc (Western University), where she established the pre- and post- mating behaviour of western bean cutworm females in terms of sexual maturity, courtship, and sexual receptivity. With her background in ecology and evolution, she is now starting her doctoral research on a biocontrol project incorporating molecular and imaging techniques (Western University; Agriculture and Agri-Food Canada; in collaboration with CABI Europe-Switzerland).

Tyler Wist (Edmonton/Saskatoon)

Tyler received his Bachelor's degree from the University of Saskatchewan where his passion for economic entomology was ignited. Along the way he killed many mosquitoes, monitored West Nile Virus in *Culex tarsalis* (Diptera: Culicidae) populations and tracked urban forest insects with the Pest Management department of the City of Saskatoon. He worked on insect pollination of *Echinacea* at the University of Saskatchewan for his MSc until the ash leaf coneroller, *Caloptilia fraxinella* (Lepidoptera: Gracillariidae) invaded the ash trees of the urban forests of the Western Canadian prairies. Tyler has nearly completed his PhD studies on the chemical ecology of the ash leaf coneroller and its dominant parasitoid, *Apanteles polychrosidis* (Hymenoptera: Braconidae) at the University of Alberta. The SAC welcomes him back to help organize the 2014 ESC JAM in Saskatoon.

Justin Gaudon (Toronto)

Justin completed his Bachelor's degree (BES) at the University of Waterloo, where he gained a broad yet deep ecological skill set. Shortly after, he became fascinated by the great diversity of

nie moléculaire, il espère élucider l'histoire évolutive de ce comportement. Il termine son projet de maîtrise au campus Macdonald de l'Université McGill et le Smithsonian Tropical Research Institute au Panama.

Ikkei Shikano (Vancouver)

Ikkei a terminé sa maîtrise à l'Université de Colombie-Britannique où sa passion pour les insectes a débuté en travaillant sur leur habilité de mémoire à long-terme. Il travaille actuellement sur son doctorat à l'Université Simon Fraser, étudiant le comportement d'automédication associé avec les interactions tri-trophiques entre la fausse-arpenteuse du chou, ses plantes-hôtes et ses entomopathogènes.

Joanna Konopka (London)

L'intérêt principal de recherche de Joanna est l'entomologie appliquée, plus particulièrement la lutte intégrée et l'entomologie médicale. Joanna a récemment terminé sa maîtrise (Université Western) où elle a étudié le comportement pré- et post-copulatoire des femelles du ver-gris occidental du haricot en termes de maturité sexuelle, parade et réceptivité sexuelle. Avec son expérience en écologie et évolution, elle débute maintenant ses recherches doctorales sur un projet de lutte biologique incorporant des techniques moléculaire et d'imagerie (Université Western, Agriculture et agroalimentaire Canada, en collaboration avec CABI Europe-Suisse).

Tyler Wist (Edmonton/Saskatoon)

Tyler a reçu son bac de l'Université de Saskatchewan où sa passion pour l'entomologie économique a débuté. Il a tué de nombreux moustiques, a contrôlé le virus du Nil occidental dans les populations de *Culex tarsalis* (Diptera: Culicidae) et a suivi les insectes des forêts urbaines avec le département de gestion des ravageurs de la ville de Saskatoon. Il a travaillé sur la pollinisation par les insectes de *Echinacea* à l'Université de Saskatchewan pour sa maîtrise jusqu'à ce que *Caloptilia fraxinella* (Lepidoptera: Gracillariidae) envahisse les frênes des forêts urbaines des prairies canadiennes. Tyler a presque terminé son doctorat sur l'écologie chimique de C. fraxinella et de son parasitoïde dominant, *Apanteles polychrosidis* (Hymenoptera: Braconidae) à l'Université de l'Alberta. Le comité des affaires étudiantes lui souhaite un

insects, how many are poorly known, and their importance. Justin is now a PhD student at the University of Toronto's Faculty of Forestry and is specializing in forest entomology. His research is concerned with augmenting native parasitoids - primarily *Phasgonophora sulcata* - to slow the spread of the highly invasive emerald ash borer (*Agrilus planipennis*) in North America.

Other student related news

The SAC is your student voice to the Entomological Society of Canada. If you have any questions, comments, or suggestions about student concerns feel free to email us at students@esc-sec.ca. We have a lot of exciting things happening over the course of the year and are looking forward to serving you.

Until next time,

Paul & Boyd

bon retour pour aider à l'organisation de la réunion conjointe annuelle 2014 à Saskatoon.

Justin Gaudon (Toronto)

Justin a terminé son bac (BES) à l'Université de Waterloo, où il a acquis un ensemble d'habiletés diverses et approfondies en écologie. Peu de temps après, il a développé une fascination pour la grande diversité d'insectes, le nombre qui sont encore peu connus et leur importance. Justin est maintenant un étudiant au doctorat à la faculté de foresterie de l'Université de Toronto et se spécialise en entomologie forestière. Sa recherche s'intéresse à l'augmentation des parasitoïdes indigènes – principalement *Phasgonophora sulcata* – pour ralentir la dispersion de l'agrile du frêne (*Agrilus planipennis*), hautement envahissant en Amérique du Nord.

Autres nouvelles concernant les étudiants

Le comité des affaires étudiantes est votre voix à la Société d'entomologie du Canada. Si vous avez des questions, des commentaires ou des suggestions concernant des questions étudiantes, n'hésitez pas à nous écrire à students@esc-sec.ca. Nous avons une foule de choses excitantes qui auront lieu durant la prochaine année, et nous avons hâte de vous servir.

À la prochaine,

Paul & Boyd

Thesis Roundup / Foisonnement de thèses

If you or a student you know has recently defended an entomology-related thesis at a Canadian University, and would like notice of this accomplishment published here and on the ESC website, please email

students@esc-sec.ca

with the relevant information following the format below

Si vous, ou un étudiant que vous connaissez, a récemment soutenu sa thèse dans un domaine lié à l'entomologie dans une université canadienne, et que vous voulez publier l'avis de cette réalisation ici et sur le site web de la SEC, merci d'envoyer les informations pertinentes selon le format ci-dessous à

students@esc-sec.ca.

Paulson, Amber. MSc, 2013. The microbial associates and putative venoms of seed-chalcid wasps (Hymenoptera: Torymidae: *Megastigmus*). Supervisors: Steve Perlman and Patrick von Aderkas, University of Victoria.

Wong, Alpha. MSc, 2013. Effects of poplar phenolics on the fitness and behaviour of *Chaitophorus* aphids. Supervisors: Peter Constabel and Steve Perlman, University of Victoria.

Joint Annual Meeting of the Entomological Societies of Canada and Saskatchewan

"Entomology in a Changing World"

Saskatoon, Saskatchewan

Sunday 28 September –Wednesday 1 October, 2014

Radisson Hotel

405-20th Street E, Saskatoon, Saskatchewan

Room rates: $172 for single or double occupancy "Queen" rooms and $182 single or double occupancy "King" rooms (+$12/day parking)
(http://www.radisson.com/reservation/itineraryEntrance.dopacLink=Y&promoCode=ENTOM&hotelCode=SKSASKAT)
(Promo code ENTOM)
Call for reservations using group code "Entomological Society of Canada": 1-800-665-3322.
Room rate valid until 27 August, 2014. Please book early because Saskatoon hotels often reach 100% capacity weeks in advance.

Program Highlights

Plenary Symposium: Entomology in a Changing World
Heritage Lecture
Gold Medal Address
Graduate Student Showcase
Student Paper and Poster Competitions
Regular Oral and Poster Presentation Sessions

Symposia:
- Biological Control in a Changing World
- Insect "omics"-Impact on Insect Management
- 21st Century Aquatic Entomology - from Theory to Application
- The Changing Face of Urban Entomology

Registration Details

Early Bird Deadline: 1 July 2014
Member - $350
Non Member - $450
Student - $150
Accompanying Person - $50
Late registration add - $100

Réunion annuelle conjointe des Sociétés d'entomologie du Canada et de la Saskatchewan

"L'entomologie dans un monde en changement"

Saskatoon, Saskatchewan

Dimanche 28 septembre – mercredi 1 octobre 2014

Hôtel Radisson

405-20th Street E, Saskatoon, Saskatchewan

Tarif des chambres: 172$ en occupation simple ou double en chambre « Queen » et 182$ en occupation simple ou double en chambre « King » (+12$/jour de stationnement) (http://www.radisson.com/reservation/itineraryEntrance.dopacLink=Y&promoCode=ENTOM&hotelCode=SKSASKAT)
(Code promotionnel ENTOM)
Appelez pour réserver en utilisant le code de groupe « Entomological Society of Canada »: 1-800-665-3322.
Tarif en vigueur jusqu'au 27 août 2014. Veuillez réserver tôt car les hôtels de Saskatoon se remplissent souvent des semaines à l'avance.

Points saillants du programme

Session plénière: L'entomologie dans un monde en changement
Allocution du patrimoine
Allocution du médaillé d'or
Vitrine aux étudiants gradués
Compétition des présentations et affiches étudiantes
Présentations et affiches régulières

Symposiums:
La lutte biologique dans un monde en changement
Les « Omiques » des insectes - Impact sur la gestion des insectes
Entomologie aquatique au 21e siècle - de la théorie à l'application
Le nouveau visage de l'entomologie urbaine

Détails pour l'inscription

Date limite hâtive: 1 juillet 2014
Membre - 350$
Non Membre - 450$
Étudiant - 150$
Accompagnateur - 50$
Pour les inscriptions tardives, ajouter - 100$

I'm almost done my PhD and so have started following the job boards in hopes of landing my first academic post. I'm having second thoughts about a career in academia though: it seems like there are a lot of us here at grad school, and not enough jobs out there for everyone. I'm thinking maybe it's time to look at leaving the research track, but I'm not sure how to go about it. Any advice?

Signed 'Thinking twice in Thunder Bay'

Despite being gainfully employed, at least for the time being, Buggy still pays attention to the job market. Things out there are tough for a PhD. One recent estimate is that just 0.45% of all doctoral students will attain a professorship position, while 17% will obtain positions in non-university research (i.e., government, industry) (The Royal Society 2010). Entomologists are lucky as our job prospects are a bit better than those of other disciplines in the biological sciences. With a PhD in entomology, you are qualified for a number of very different and potentially rewarding careers in industry, government and universities. Still, these fields will only employ 17.45 % of all graduates! Clearly, today's PhD student needs to be better aware of their career options, as most likely won't end up in these 'traditional' fields.

The argument has been made in recent years that graduate students need to become better aware of the job market, specifically the market that exists outside universities, earlier in their career. Those who write about the science job market have coined the term 'alternative academic' careers to describe jobs outside academia. You'll find much available on the internet under this heading (or sometimes 'post-academic' careers) in discussion boards and blogs dedicated to this topic.

A brief digression, I think the term 'alternative academic' is misleading. That's because in reality most PhDs won't get a job at a university, or even a 'traditional' research job in government or industry. Therefore, to classify every other possible career as 'alternative' implies that securing a research position is the convention or the norm for anyone with a PhD. That may have been true at one point but it is not so now, and has not been so for some time. Today, the conventional career for someone with a PhD will not be at a university; the alternative career will be as a university or college faculty member. That's not to say that you shouldn't set your sights high; just have your feet firmly planted on the ground.

So what should today's graduate students be doing to prepare themselves for life after grad school, if they aren't likely to find a job as a professor? As is my habit, I have a few suggestions.

Chris MacQuarrie is a research scientist with Natural Resources Canada, Canadian Forest Service, in Sault Ste. Marie where he studies the management of native and invasive insects. Currently, he's hoping he never hears the term 'polar vortex' again. Have an idea for a column? Send it to cjkmacquarrie@gmail.com, ping me on Twitter @cmacquar, or post in the Facebook student group.

1. Seek alternative advisors. You have a say in how your graduate advisory committee is comprised. Consider asking for a member from government or industry to help guide you through your program. These advisors will have a different take on what skills you should be developing during your graduate program to help you find a job outside academia. These advisors will also be able to help you frame your research in other ways. For instance, if your program is heavy on theory, a non-academic advisor might be able to help you apply your findings to influence government policy, or bring your research to market.

2. Try alternative lifestyles. Design your program so that you can spend part of your program working outside the university environment. You might be able to do a rotation through an industry or government lab as a visiting scholar; you could do a co-op placement, or even design a whole study that you do at another lab. This is where having an outside advisor can come in handy. Even if you must do all your work at a specific location, sometimes just taking a desk somewhere else for a few months can be eye opening. The idea is to experience a work place outside a university. You will be exposed to people that work in different ways, have different careers, and work in different disciplines. You may find a career that you hadn't considered before (or, on the flip-side, rule out one you thought you wanted!).

3. Have alternative activities. Broaden your horizons outside the academic sphere, but do it so as to build a skill set and a resumé that you can use if you leave research. This can take many forms: you can get involved in politics; volunteer with an NGO; hang out your shingle as an editor or statistical consultant; teach; start a blog. Doctoral candidates develop a wide variety of skills during their training that are difficult to quantify. Usually, the only tangible asset we have is a thesis and a few papers. To move out of a university and into the mainstream workforce, these 'soft skills' are not only desirable but you'll need to be able to demonstrate them with concrete examples. There's a fine balancing act here though, as you've made a commitment to do research and produce results. These activities will take time. Your goal would be to balance the development of your professional portfolio with the development of your thesis.

4. Make alternative plans. A professorship is likely Plan 'A' for most doctoral students; many though do not have a Plan 'B' or 'C'. An alternative plan can be anything really, but you need to think broadly about what you would want to do if your Plan 'A' doesn't work out. This includes taking steps to broaden your employment prospects outside a research or university career. A good plan should also include an exit strategy: you should know how long are you willing to commit to the academic treadmill before you step off.

5. Explore alternative expectations. Most people who try the PhD want to be academics, but why do they all have to be? The life of an academic has some serious benefits, but also some rather significant downsides. While in grad school make a conscious effort to observe the lives of those who have the position you want. Then, ask yourself if you aspire to that same lifestyle. Do you want to spend 10 years as a post-doc before getting your first position? Do you want to work 60 hour weeks? Do you want (or even like) to teach? If you don't, then you need to figure out what you do enjoy, then go out and find the career that lets you do that.

6. Have an optimistic outlook. I'll break my alliterative string of headings here to end this list on a positive note. I assume you attempted a PhD because you love insects and wanted to spend part of your life learning about them. If you get a job with that PhD, this will not change how you feel about insects, or even your ability to keep learning. Some very successful entomologists

don't have PhD's; others have 'normal' jobs and do entomology on the side. A doctoral diploma is a piece of paper that says you're obstinate enough to put up with the difficulties of science, the vagaries of peer review, the politics of academia and the antipathy of Society to produce a thesis that doesn't embarrass your committee. What you do with that piece of paper is up to you. Moving off the academic track isn't a failure; it's a divergence. You'll still get to where you're going in the end. You'll just take a different path.

Buggy

Reference

The Royal Society. 2010. The Scientific Society: securing our future prosperity. RS Policy document 02/10. London, UK. 73 pp.

DNA barcoding makes an impact on the other side of the globe

Muhammad Ashfaq

Morphological identifications of organisms have always been a challenge (Hey 2001). Use of DNA sequences for identification and determination of phylogenetic relationships of species was embraced soon after publication of the first DNA sequences and continues today with a much broader scope (Bellis et al. 2003). DNA identification is based on the assumption that individuals from the same species carry specific DNA sequences that are different from those found in individuals from other species (Pereira et al. 2008). A wide range of molecular techniques have been used for the recognition of taxonomic units including (but not limited to) DNA hybridization, Random Fragment Length Polymorphisms (RFLP), Amplified Fragment Length Polymorphism (AFLP), Random Amplified Polymorphic DNA (RAPD), conventional Polymerase Chain Reaction (PCR), real-time PCR, sequencing and microarrays. Sequences from different loci from coding or non-coding DNA have been used for diverse animal groups with different preferences, and in most cases use of these loci across taxa has not been standardized (Avise and Liu 2011). Based on a comparison of sequences from divergent loci it is difficult to reach a conclusion on species identities and their relationships (Knowles and Carstens 2007). If a new genetic marker is used for the first time, the genetic composition of all species of that taxon should be resolved. This has made the application of DNA in resolving species conflicts not only difficult and non-productive, but in some cases counterproductive (Shaw 2002). The existence of some 5±3 million species of organisms on earth, of which only 1.5 million are named (Costello et al. 2012), with many more that are either morphological synonyms or cryptic complexes, warrants standardization of loci to be used for species identities.

In 2003 it was proposed that a single gene fragment of approximately 650 base pairs from the 5′ end of the mitochondrial cytochrome oxidase I (COI) could be used as a marker to identify an organism to its species (Hebert 2003). This gene region was termed a "DNA barcode" providing the foundation for DNA barcoding and predicting its utility in taxonomy (Hebert and Gregory 2005). Later, sections of two chloroplast genes, matK and rbcL, were selected as the DNA barcodes for plants (CBOL 2009). Soon DNA barcoding turned into an international initiative with an objective to barcode all species on earth with the International Barcode of Life Project (iBOL) centred at the University of Guelph. According to information on the iBOL website (ibol.org), "iBOL's main mission is extending the geographic and taxonomic coverage of the barcode reference library -- Barcode of Life Data Systems (BOLD) -- storing the resulting barcode records, providing community access to the knowledge they represent and creating new devices to ensure global access to this information". With these objectives in mind, iBOL has engaged nations across the globe to barcode all biodiversity. Nations have responded to the challenge and since the launch of iBOL in 2010, barcoding has progressed at a steady speed and currently barcode records are available for more than 2.8 million specimens representing roughly 350,000 species. Previous researchers have often assigned specimens to operational taxonomic units (OTUs) in cases where morphological identifications are difficult (Stackebrandt and Goebel 1994; Kauserud et al. 2008). Ratnasingham and Hebert (2013) recently developed the Barcode Index

Muhammad Ashfaq (mashfaq@uoguelph.ca) is a Research Associate in the Biodiversity Institute of Ontario, University of Guelph. He is the focal person for iBOL's Pakistan National Node and for the last 4 years has been engaged in DNA barcoding of biodiversity of Pakistan. His main focus has been pest and beneficial insects.

Number (BIN) system which provides a species-level taxonomic registry for animal groups (Hausmann et al. 2013) and has aided the discovery of new species (Landry and Hebert 2013). Consequently animal barcode data on BOLD has been organized by BINs.

Pakistan barcode project

DNA barcoding in Pakistan was initiated in 2010 under the project "DNA barcoding economically important insect species of Pakistan". This collaborative project between the National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, and the Biodiversity Institute of Ontario (BIO), University of Guelph, aimed at sequencing important pest and beneficial insect species and constructing a regional barcode reference library for species identification. The project barcoded more than 10,000 insect specimens during the first 18 months. In 2012, the project was expanded with a grant from the International Development Research Centre (IDRC) through the University of Guelph/iBOL with an added objective of barcode applications in studying special interest pest insects and disease vectors impacting with socio-economic impacts on the country. The IDRC grant was additionally supported by sequencing and data management support provided at BIO through the Canadian Centre for DNA Barcoding (CCDB) and BOLD. This support enabled collection of fresh specimens from remote geographical areas in Pakistan and enhanced the capacity for front end specimen processing and data basing. Arthropod collections for barcoding included agricultural and forest pests, human/animal disease vectors and beneficial predators and parasitoids. Collected specimens were identified at least to order and labeled appropriately, and the data were submitted to BOLD. Barcodes were sequenced following standard barcoding protocols and the sequences obtained were assigned BINs.

Revealing biodiversity

The Pakistan project generated barcode data for 31,333 arthropod and 1,259 plant specimens representing roughly 4,510 insect and 365 plant species. The arthropod specimens represented 12 orders of Insecta and 2 of Arachnida. Thirty seven percent of the BINs were represented by single records (singletons) (Table 1). A significant number of Hymenoptera were barcoded, but almost half of their BINs were singletons. Only 22% of the Pakistan BINs were shared with other countries. A relatively large number of BINs were Coleoptera (668) but just 9% were shared with other countries. Similarly, out of 937 hymenopteran BINs, only 15% found a match with other countries. The highest number of BINs on BOLD came from Lepidoptera (>96,000), but just 29% of Pakistan Lepidoptera found a match on BOLD. A significant number of invasive pest species are Hemiptera, which makes it a particularly important order. Out of 418 BINs from this order, only 20% were common with other countries. Mantodea, which represent important insect predators (beneficial insects), shared only 8% of the BINs with other geographic regions. Spiders (Araneae) are also important predators, and sequences from 1,228 specimens were assigned to 183 BINs, though only 20 (11%) BINs were found in other nations (6,500). The Pakistan data shows the localization of biodiversity, but to reach to a final conclusion on biodiversity overlap between Pakistan and other countries, much more coverage of the regional arthropod fauna is required. A recent publication on the butterflies of Pakistan (Ashfaq et al. 2013) points to the presence of regional endemism in this group of insects. Barcode libraries of butterflies of Pakistan, and cotton species are public and are accessible through the web at dx.doi.org/10.5883/DS-MABUTPUB and dx.doi.org/10.5883/DS-MAPLTPUB, respectively.

Table 1. Number of specimens with a barcode sequence and number of BINs represented in 12 insect orders and spiders from Pakistan

Order	Number of barcodes	BINs recovered	Singleton BINs (%)	BINs shared with other countries (%)
Lepidoptera	4589	1030	284 (28)	397 (29)
Coleoptera	2912	668	305 (46)	59 (9)
Diptera	11677	876	340 (39)	186 (21)
Hemiptera	2900	418	150 (36)	85 (20)
Orthoptera	1256	158	38 (24)	33 (21)
Thysanoptera	471	52	15 (29)	18 (35)
Isoptera	98	9	3 (33)	1 (11)
Phthiraptera	706	7	0	3 (43)
Hymenoptera	4554	937	418 (45)	136 (15)
Neuroptera	499	84	29 (35)	5 (6)
Mantodea	103	37	19 (51)	3 (8)
Odonata	340	51	8 (16)	24 (47)
Araneae	1228	183	78 (43)	20 (11)
Total	31333	4510	1683 (37)	970 (22)

Examples of barcode applications: Revealing cryptic species complexes and discovering new species

Whiteflies:

Whiteflies (*Bemisia tabaci*) are important pests not only due to their direct damage to host plants but also due to their role as virus vectors. This taxon is known to be a complex of at least 35 cryptic species (De Barro and Boykin 2013). Barcode data for 593 *B. tabaci* specimens from Pakistan revealed the presence of 9 BINs in this complex from 2 cotton-growing provinces (Punjab and Sindh). Previously, three *B. tabaci* lineages were documented from the country (Ahmed et al. 2011). The barcode-based species distribution analysis showed that Asia II 1, vector of leaf curl virus on cotton, has expanded its range in other areas. Barcoding has helped our understanding of the expansion of cotton leaf curl disease southward.

Mosquitoes:

Recent outbreaks of dengue fever caused by mosquito-vectored dengue virus have underscored the need to identify and analyze mosquito species from the region. Barcode analysis of 1684 mosquitoes from dengue-affected areas of Pakistan revealed 32 species. The genus *Aedes* was represented by six taxa with the two dengue vector species, *Aedes albopictus* and *Aedes aegypti*, dominant and broadly distributed. The BIN system revealed the presence of four cryptic lineages of *Aedes* which have not been previously reported from the country. The barcode-based distribution analysis when compared with prior studies showed a shift in *Ae. albopictus* habitat from rural (forested areas) to urban areas. Barcodes also discovered the presence of *Anopheles culicifacies-A* and *Anopheles annularis-B*, which are the first reports from Pakistan.

Noctuid species in/ around cotton fields:

Cotton contributes significantly to Pakistan's economy. Although the crop is attacked by a number of insect pests, larvae of Noctuidae are the major concern. Barcode data revealed the

presence of 25 noctuid species in and around cotton fields in Punjab. Barcodes identified four species of *Spodoptera*, of which three, *S. littoralis*, *S. cilium* and *S. exigua*, were the first reports from agricultural areas of Pakistan.

Mango mealybug complex:

The species status of the mango mealybug, *Drosicha mangiferae*/*Drosicha stebbingi*, in Pakistan has been debated for decades (Latif 1949). This species attacks a wide range of host plants and gains its name from its host. The mealybug from mango is called *D. mangiferae* while similar-looking specimens from other trees are called *D. stebbingi*. Barcode data was used to analyze the genetic differences among mealybug species from different host plants from three regions of the country. As nucleotide sequences failed to differentiate specimens from different hosts, it was concluded that the same mealybug species is found on both mango and citrus trees.

In summary, results from the Pakistan barcode project suggest that DNA barcoding provides an efficient tool for assessing and documenting regional biodiversity and comparing and connecting them with global databases. Results support the value of developing regional biodiversity reference libraries through the involvement of all nations across the globe.

Acknowledgements

I thank colleagues at the CCDB for aid with sequence analysis, and staff employed with the DNA barcoding project at NIBGE, Faisalabad, for their diligence in collecting specimens. Financial support from the Higher Education Commission Pakistan and IDRC Canada is acknowledged.

References

Ahmed, M.Z., De Barro, P.J., Greeff, J.M., Ren, S.-X., Naveed, M., and Qiu, B.-L. 2011. Genetic identity of the *Bemisia tabaci* species complex and association with high cotton leaf curl disease (CLCuD) incidence in Pakistan. Pest Management Science, **67**: 307-317.

Ashfaq, M., Akhtar, S., Khan, A.M., Adamowicz, S.J., and Hebert, P.D.N. 2013. DNA barcode analysis of butterfly species from Pakistan points towards regional endemism. Molecular Ecology Resources, **13**: 832-843.

Avise, J.C., and Liu, J.-X. 2011. On the temporal inconsistencies of Linnean taxonomic ranks. Biological Journal of the Linnean Society, **102**: 707-714.

Bellis, C., Ashton, K.J., Freney, L., Blair, B., and Griffiths, L.R. 2003. A molecular genetic approach for forensic animal species identification. Forensic Science International, **134**: 99-108.

CBOL Plant Working Group et al. 2009. A DNA barcode for land plants. Proceedings of the National Academy of Sciences USA, **106**: 12794–12797.

Costello, M.J., Wilson, S., and Houlding, B. 2012. Predicting total global species richness using rates of species description and estimates of taxonomic effort. Systematic Biology, **61**: 871-883.

De Barro, P., and Boykin, L.M. 2013. Global *Bemisia* dataset release version 31 December 2012. v1. CSIRO. Data Collection. 10.4225/08/50EB54B6F1042.

Hausmann, A., Godfray, H.C.J., Huemer, P., Mutanen, M., Rougerie, R., van Nieukerken, E.J., Ratnasingham, S., and Hebert, P.D.N. 2013. Genetic patterns in European Geometrid moths revealed by the Barcode Index Number (BIN) system. PLoS ONE, **8**: e84518.

Hebert, P.D.N., Cywinska, A., Ball, S., and deWaard, J. 2003. Biological identifications through DNA barcodes. Proceedings of the Royal Society London B, **270**: 313–321.

Hebert, P.D.N., and Gregory, T.R. 2005. The promise of DNA barcoding for taxonomy. Systematic Biology, **54**: 852-859.

Hey, J. 2001. The mind of the species problem. Trends in Ecology and Evolution, **16**: 326-329.

Kauserud, H., Mathiesen, C., and Ohlson, M. 2008. High diversity of fungi associated with living parts of boreal forest bryophytes. Botany, **86**: 1326-1333.

Knowles, L.L., and Carstens, B.C. 2007. Delimiting species without monophyletic gene trees. Systematic Biology, **56**: 887-895.

Landry, J.-F., and Hebert, P.D.N. 2013. *Plutella australiana* (Lepidoptera, Plutellidae), an overlooked diamondback moth revealed by DNA barcodes. ZooKeys, **327**: 43-63.

Latif, A. 1949. The taxonomic status of *Drosicha stebbingi* (Green) and *Droshicha mangiferae* (Green) (Hem., Coccid.). Bulletin of Entomological Research, **40**: 351-354.
Pereira, F., Carneiro, J., and Amorim, A. 2008. Identification of species with DNA based technology: current progress and challenges. Recent Patents on DNA & Gene Sequencing, **2**: 187-199.
Ratnasingham, S., and Hebert, P.D.N. 2013. A DNA-based registry for all animal species: the Barcode Index Number (BIN) System. PLoS ONE, **8**: e66213.
Shaw, K.L. 2002. Conflict between nuclear and mitochondrial DNA phylogenies of a recent species radiation what mitochondrial DNA reveals and conceals about modes of speciation in Hawaiian crickets. Proceedings of the National Academy of Sciences USA, **99**: 16122-7.
Stackebrandt, E., and Goebel, B. 1994. Taxonomic note: A place for DNA-DNA reassociation and 16S rDNA sequence analysis in the present species definition in bacteriology. International Journal of Systematic Bacteriology, **44**: 846-849.

Entomological insights from studying a bird

Sean McCann

When I started my doctoral research, I had never considered working with birds. I was an entomologist! I had finished a Master's degree studying reproductive ecology of mosquitoes, and wanted to branch out into insects with a bigger brain…maybe Hymenoptera. Over the last several years, I have indeed studied several hymenopterans, but mainly through the eyes of a specialist vertebrate predator.

Red-throated Caracaras (*Ibycter americanus*) are members of the Falconidae found in forested areas from Central America to southern Brazil. Until recently, the behaviour and life history of this strikingly-marked raptor (Fig. 1) was little known to scientists. For my doctoral research, I have been lucky enough to lead some fascinating fieldwork on these birds in the pristine rainforests of French Guiana.


Sean McCann

Figure 1. The Red-throated Caracara (*Ibycter americanus*) is an unusual member of the Falconidae that preys primarily on social wasps.

From observations and examination of gut-contents, Red-throated Caracaras had been reported to be specialist predators of social wasps (Thiollay 1991), but there was little in the way of quantitative data. Our 2010 nest camera study (McCann et al. 2010) was the first to provide a close glimpse at the nesting biology and diet of these birds. Confirming some previous reports, we found that the caracaras are highly cooperative, with up to seven adults providing care to a single chick. Surprisingly, we found the caracaras nested in large

Sean McCann (smmccann@sfu.ca), a PhD student at Simon Fraser University, has been a member of the ESC since 2003, when he was an undergraduate student of Richard Ring at the University of Victoria. He has studied Medical Entomology at the University of Florida and is currently engaged in conservation research in Honduras. You can follow his research and photography at www.ibycter.com.

bromeliads, rather than constructing a nest of their own (Fig. 2). They modify these spiky epiphytes by tearing the leaves to form a clear area on top, which they use for egg laying and brooding their chicks. As anticipated, the main food of the caracaras was the brood of social wasps, comprising 60-80% of items brought to the nest (Fig. 3). Other food items included large spirostreptid millipedes and fruits of various kinds.

Because the helpless young of social wasps are a concentrated form of protein that is attractive to predators, they must be defended by the adult workers of the nest. Wasps achieve


Sean McCann

Figure 2. We observed nesting Red-throated Caracaras at the Nouragues Station in French Guiana in 2008 and 2009. They did not make nests of sticks, but rather used large epiphytic bromeliads as platforms.


Sean McCann

Figure 3. Most of the social wasps the caracaras preyed on were from the tribe Epiponini, which are swarm founders. Here is a nest of a nocturnal epiponine (genus *Apoica*).

this with a devastating array of stinging, biting and venom-spraying behaviours that dissuade most potential predators from attacking a second time.

For a bird like the Red-throated Caracara, however, raiding nests is a daily activity, and obviously they must be able to overcome these defensive tactics. The main question we wanted to answer was how they preyed on such formidable insects without being harmed. One hypothesis is that the birds had some kind of repelling chemical that kept worker wasps from approaching and attacking the birds (Thiollay 1991). We set out to investigate this hypothesis using chemical analyses, behavioural observations, and manipulations of social wasp nests (McCann et al. 2013).

To sample the chemicals on the caracaras, we first needed to capture them. Because caracaras are highly territorial, they readily respond to call playbacks, and attack conspecific decoys, so both of these were used to lure the birds into our mist nets. We took qualitative samples from various areas of the birds using solvent-soaked cotton swabs (Fig. 4). Reasoning that any potential chemical repellent on the birds should

Figure 4. Sampling chemicals from a Red-throated Caracara in Central French Guiana. Photo by Patrick Chatelet (CNRS), used with permission.

be perceptible to sympatric wasps, we brought two species of *Polybia* back to the lab so we could perform coupled gas chromatography/electroantennography. This procedure allowed us to reduce the large number of compounds found in the natural extracts to only those that were relevant to the question at hand.

We quickly discovered several interesting compounds this way, including a few iridodial isomers and two ketones. These compounds were only present on the foot samples of the birds, and intriguingly, they seemed to be similar to compounds reported from the defensive secretions of *Azteca* ants (Formicidae, Dolichoderiniae) (do Nascimento et al. 1998). We managed to collect some of these ants' defensive secretions, and lined up the ant and bird chromatograms. Sure enough, several iridodial isomers, as well as the two ketones were present in roughly similar proportions (Fig. 5).

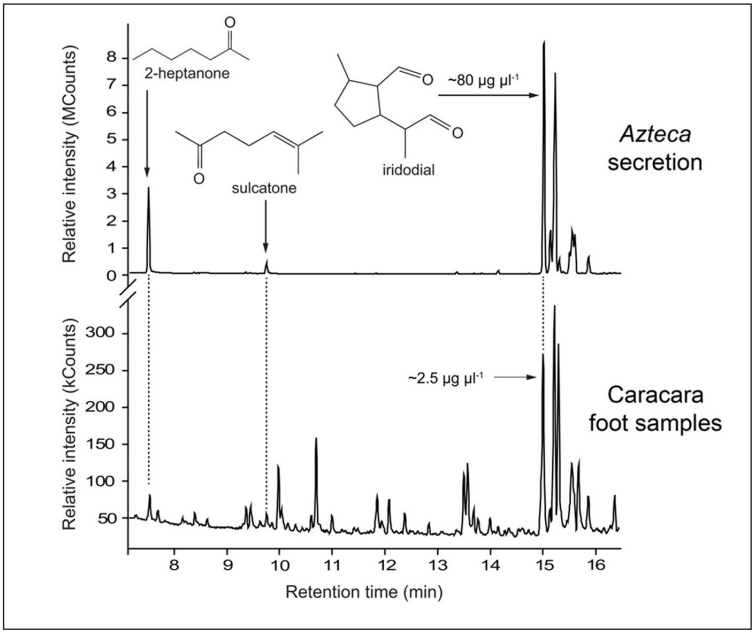


Figure 5. GC/MS traces of *Azteca* nr. *chartifex* defensive secretion (top) and Red-throated Caracara foot samples (bottom). Note the shared ketones and iridodial isomers.

Because these compounds were only present on the caracaras' feet, and seemed to be derived from ants, the question was, how did they come to be there? Was this an example of caracaras anting (using ant compounds as an anti-parasite defense), or was it just happenstance? Our best guess is that caracaras are attacked by *Azteca* while perching near or preying on the nests of a wasp called *Polybia rejecta* (Fig. 6). These large wasps nest almost exclusively in association with *Azteca* ants (which provide defense against army ants) (Servigne 2003; Corbara et al. 2009), and it seems likely that *Azteca* might attack the caracaras coming to prey on the wasps.

So if the only interesting chemicals on the caracaras are some casually-acquired ant defensive compounds, it would seem that the caracaras don't have a wasp repellent after all. So how do they manage to subdue their well-defended prey? We had to make our own predation observations to figure it out.

From experience in the rainforest, we discovered how difficult it is to observe these birds closely. For one thing, much of their activity is in the canopy, which can be almost 40 m above the forest floor, and full of tangled vegetation. The chances of us coming upon a wasp nest at the right moment to observe a caracara attack was vanishingly small (not to mention that just finding wasp nests is pretty difficult as well!).

Figure 6. Nesting association between *Polybia rejecta* (right) and *Azteca chartifex* (left). The wasps gain protection from predatory army ants by nesting in close proximity to the fierce and abundant *Azteca*. Photo by Pablo Servigne, used with permission.

We decided to set up a video arena/feeding station to film the birds doing their thing in more controlled conditions. Because Neotropical wasps are easily transplanted by night, we moved nests, with their entire worker force, to our arena. The arena was outfitted with four video cameras, and had room for two wasp nests, so that if caracaras attacked, we would get two predation observations for the price of one (Fig. 7). The video cameras fed into a motion-triggered digital video recorder.

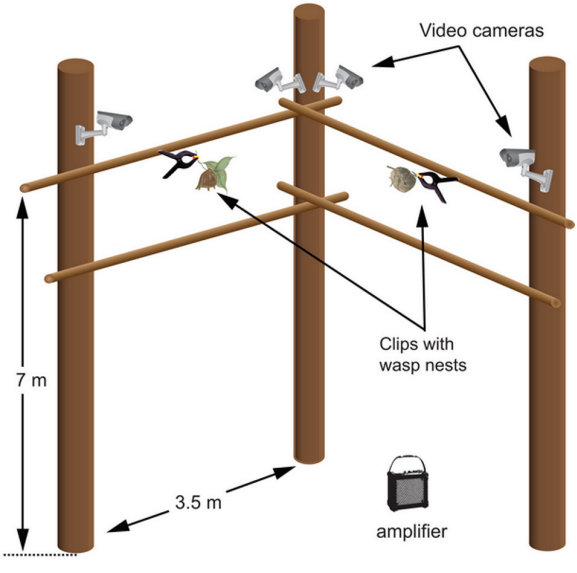


Figure 7. The video arena used for capturing video of Red-throated Caracara predation behaviour. From McCann et al. 2013.

We hoped to have caracaras stumble upon this "wasp buffet" spontaneously, but after a month with no luck, we switched gears and used call playback to get the birds in the vicinity of the arena. This approach quickly yielded results, and we managed to record our first predation event, where a female caracara (which we had banded in 2009) swooped in and plucked a *Polybia bistriata* nest from the branch it was attached to. This and other attacks on *P. bistriata*, *P. scrobalis* and *P. belemensis* all took place without any evidence of defensive stinging on the part of the wasps. The caracaras just came in, and as soon as they tore into a nest, the wasps departed.

This was not the case, however, when larger species such as *P. jurinei* or P. affinis were attacked. In every instance of an attack on these wasps, at least some wasps flew out to sting the caracaras, resulting in the caracaras flying away, or at least scratching wasps from their face or plucking them from their feathers.

The caracaras were not beaten by any means and in three instances, flew in and struck at these more fiercely-defended nests with their talons. In two cases, the nests were knocked to the ground and once the nest was struck hard five times. After this, the wasps abandoned their nests and the caracaras were free to eat the brood at their leisure.

Sean McCann

Figure 8. Some wasps, such as these *Polybia singularis*, have armoured nests. This species uses a heavy and tough mud layer as an envelope, while other species use a tough woven felt of plant fibres. They are well anchored to sturdy branches, and would presumably be difficult for a caracara to break or dislodge.

By striking the nest to the ground, or ramming into it repeatedly, the caracaras exploit the absconding response of their swarm founding wasp prey. Just like honey bees, swarm founding wasps can fly off to start a new nest if their nest is compromised. In doing this, they sacrifice their brood and their nest materials, but save their worker force for rapid re-establishment of brood rearing in a safer location. The caracaras seem to have hit upon a technique that minimizes their exposure to stings when preying on well-defended wasps.

This research is only the beginning of what could turn out to be a fascinating field of study. Different wasp species have different defensive behaviours, and some may have evolved specific anti-caracara defenses. Some that come to mind are wasps such as *P. singularis* (Fig. 8) and members of the genus *Epipona*, which build large fortified nests, with extremely tough envelopes. These are so tough that they would probably resist the blows of striking caracaras. Also, the habit of nesting in dense tangles of branches and vines could protect against caracaras by limiting their access.

I feel very fortunate to have had the opportunity to study such a remarkable animal. Examining a vertebrate predator of insects has broadened my appreciation for entomology, and introduced me to a fascinating world of symbioses and trophic relationships I had barely considered.

References

Corbara, B., Carpenter, J.M., Céréghino, R., Leponce, M., Gibernau, M., and Dejean, A. 2009. Diversity and nest site selection of social wasps along Guianese forest edges: assessing the influence of arboreal ants. Comptes Rendus Biologies, **332**:470–479.

do Nascimento, R.R., Billen, J., Sant'ana, A.E.G., Morgan, E.D., and Harada, A.Y. 1998. Pygidial gland of *Azteca* nr. *bicolor* and *Azteca chartifex*: Morphology and chemical identification of volatile components. Journal of Chemical Ecology, **24**:1629–1637.

McCann, S., Moeri, O., Jones, T., Donnell, S.O., Gries, G. and O'Donnell, S. 2010. Nesting and Nest-Provisioning of the Red-throated Caracara (*Ibycter americanus*) in Central French Guiana. Journal of Raptor Research, **44**:236–240.

McCann, S., Moeri, O., Jones, T., Scott, C., Khaskin, G., Gries, R., O'Donnell, S., and Gries, G. 2013. Strike Fast, Strike Hard: The Red-throated Caracara exploits absconding behavior of social wasps during nest predation. PLOS ONE, **8**:e84114.

Servigne, P. 2003. L'association entre la fourmi *Azteca chartifex* Forel (Formicidae, Dolichoderinae) et la guêpe *Polybia rejecta* (Fab.) (Vespidae, Polistinae) en Guyane Française. Universite Paris-Nord.

Thiollay, J.M. 1991. Foraging , home range use and social behaviour of a group-living rainforest raptor, the Red-throated Caracara Daptrius americanus. Ibis, **133**:382–393.

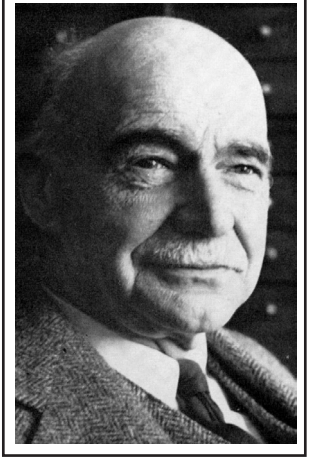


Fig. 1: Portrait of E. H. Strickland. (Courtesy of Strickland Museum, University of Alberta)

Edgard Harold Strickland – 100 years of professional entomology in Alberta

Héctor Cárcamo, Bob Byers and Donna Giberson

Alberta entomologists will remember a special presentation (by John Acorn) devoted to Edgar Harold Strickland at the Annual Meeting of the Entomological Society of Alberta in 2013, but other Entomological Society of Canada members may not be as familiar with him. The year 2013 marked the centenary of professional entomology in Alberta, as it was 100 years since Edgar Harold Strickland (Fig. 1) arrived in Lethbridge (in January of that year), and became the "Grandfather" of professional entomology in Alberta. The anniversary is also remembered in the dedication to E.H. Strickland in the 3rd Volume in the series, *Arthropods of Canadian Grasslands, Biodiversity and Systematics, Part 1* (Edited by H. Cárcamo and D. Giberson, 2014, Fig. 2). Here, we provide a short overview of E. H. Strickland, to recognise his legacy to Alberta and Canadian entomology.

Héctor Cárcamo (hector.carcamo@agr.gc.ca) is a research scientist with AAFC at the Lethbridge Research Centre. His research focuses on Integrated Pest Management strategies such as cultural, host plant resistance and biological control approaches to reduce dependency on insecticides. Other interests include the biodiversity of carabid beetles and spiders in agroecosystems. Bob Byers is a retired AAFC scientist who joined the Entomology Research Institute, Ottawa, in 1968 and transferred to the Lethbridge Research Centre in 1981. At Lethbridge he mainly studied the biology of cutworms and the application of sex-attraction pheromones to monitor population levels before retiring in 1997. Donna Giberson is a Professor of Biology at the University of Prince Edward Island, and is interested in biodiversity and ecology of aquatic insects in the Arctic and Maritimes in Canada.

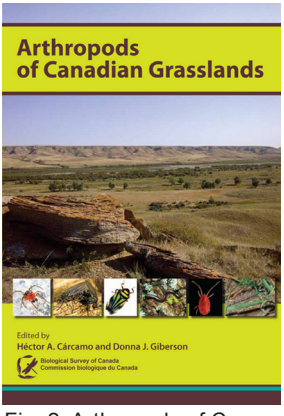


Fig. 2: Arthropods of Canadian Grasslands, Volume 3, dedicated to Strickland's memory.

E. H. Strickland (29 May 1889 – 31 May 1962) was charged by the Dominion Department of Agriculture to establish a field laboratory at Lethbridge, Alberta, in 1913. His initial focus was to control severe outbreaks of cutworms and wireworms that were occurring on the Prairies. He was fresh from a Master's degree at Harvard and was appointed "Officer-in-Charge" of the new Dominion Entomological Laboratory – a laboratory that wasn't actually built yet! He "set up shop" in the attic of a sheep barn until the first dedicated lab was built in 1915 (Fig. 3). Using a motorcycle for field work, he covered thousands of miles helping farmers do battle against cutworms, wireworms and wheat stem sawfly. In 1916, he took a 3-year break from crop entomology to serve in the First World War and became a well-decorated soldier. He returned to his entomological duties in 1919 after he was wounded in the war. In 1922, he was offered a position with the Faculty of Agriculture at the University of Alberta, based on his outstanding entomological record with the Department of Agriculture. He founded the Department of Entomology at the University, and remained its only faculty member until 1946. He retired in 1952, and moved to Victoria with his wife Alice Fairfield, where he died in 1962 at the age of 73. They had two daughters and four grandchildren.

Strickland's entomological legacy is vast. He published more than 60 scientific articles (see Hocking 1963, for a complete list of Strickland's contributions) on a wide array of topics: cultural methods to manage crop and household pests, the distribution of black widow spiders, improved methods to store insects in vials, and the role of parasitoids and birds in natural control. In 1945, he published a visionary article questioning the environmental impacts of the widespread use of DDT. As an avid collector, he caught insects during and after work and identified them as well as he could, also depositing the specimens in the collections where he worked. He founded the insect collection at the University of Alberta that was later named in his honour; it now includes over a million specimens and features a "virtual museum" (http://www.biology.ualberta.ca/facilities/strickland/)which allows electronic access to prairie insect information. One of Strickland's greatest legacies was a series of seminal checklists on several important prairie groups (see list below). Their continuing importance is acknowledged in the references of several chapters in the two systematic entomology volumes of the Arthropods of Canadian Grasslands (Fig. 2): Coleoptera (Elateridae), Biting Flies (Diptera), Hymenoptera (Ichneumonoidea and Braconidae), and Hemiptera. Another chapter, the Odonata, acknowledges the Strickland Virtual Museum.

Fig. 3: The first dedicated Dominion Entomological Laboratory at Lethbridge, circa 1915. (Lethbridge Research Centre Archives)

His work was also recognized by his peers. In 1952, he was the first president of the Entomological Society of Alberta; he became an honorary member of the Entomological Society

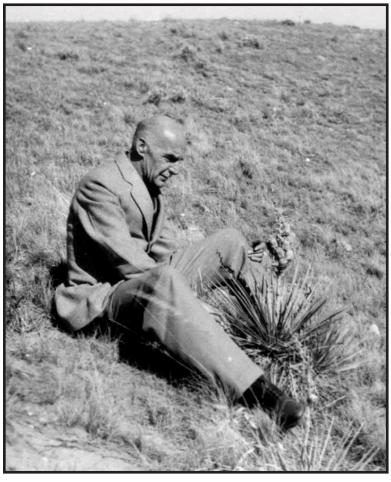


Fig. 4: Strickland examining a yucca plant in southern Alberta. (Courtesy of Strickland Museum, University of Alberta)

of Canada; and he was elected a fellow of the Entomological Society of America. In 1954, he was honoured by the University of Alberta with a Doctor of Science degree. Strickland's legacy extends beyond science and he is remembered both as an outstanding teacher and as an accomplished soldier. As Hocking (1963) noted, Strickland's first-year entomology courses were the highlight in many students' careers because he mixed insect biology teachings with his philosophy of life. He also continued his work with the Canadian military: Colonel Strickland, as he was known later, became a caring advocate for war veterans, a mentor to young faculty, and an anonymous philanthropist.

Strickland's Checklists

Strickland, E.H. 1927. Wireworms of Alberta: A Preliminary Report. University of Alberta, Bulletin 2, Edmonton, Alberta.

Strickland, E.H. 1938. An annotated list of the Diptera (flies) of Alberta. Canadian Journal of Research, Section D, **16**: 175–219.

Strickland, E.H. 1946. An annotated list of the Ichneumonoidea of Alberta. The Canadian Entomologist, **78**: 36–46.

Strickland, E.H. 1952. Additions to the list of Ichneumonoidea from Alberta. The Canadian Entomologist, **84**: 118–122.

Strickland, E.H. 1953. An annotated list of the Hemiptera (s.l.) of Alberta. The Canadian Entomologist, **85**: 193–214.

Further Reading on E.H. Strickland

Byers, B., and Cárcamo, H. 2013. E.H. Strickland - Alberta's first professional entomologist - one hundred years ago. Newsletter of the Biological Survey of Canada, **32**(1): 8–9.

Hocking, B. 1963. Edgar Harold Strickland, M.Sc., D.Sc., F.E.S.A., F.R.S.C., died at Victoria, British Columbia, on May 31, 1962. The Canadian Entomologist, **95**: 292–296.

Shpeley, D. 2010. Insect Collections in Canada Series: E.H. Strickland Entomological Museum, University of Alberta. Newsletter of the Biological Survey of Canada, **29**(1): 14–19.

Scientific Animations Without Borders: How the need to spread entomological solutions has given rise to a new approach for international educational strategies for low-literate learners

Julia Bello-Bravo and Barry Robert Pittendrigh

Introduction

In 2011, the program, Scientific Animations Without Borders (SAWBO), was officially launched (www.sawbo.illinois.edu; http://goo.gl/I3y82j). Over the past 3 years, the program has grown rapidly in terms of content, international partnerships and impact. The idea for SAWBO emerged out of the challenge of providing knowledge to the approximately one billion low-literate learners on the planet, considering that this diverse group lives across numerous countries, speaks a great diversity of languages and often lives in rural areas. These factors combined have presented government and non-government, as well as inter-governmental, organizations with incredible challenges when they have attempted to deliver life-altering knowledge into these communities. Interestingly, many of these organizations have neither the access nor the resources to develop appropriate educational content. In some organizations, they do have such educational materials, but they are only for use within their organizations, something that is especially true for many NGOs.

In the SAWBO program, the critical question we raised was as follows – "How can we systematically, and in a highly cost-effective manner, develop educational content in a large diversity of global and local languages that can be deployed into communities in developing countries through existing educational networks or through the development of new networks?" The emerging answers to this question may lie in a set of concurrent technological changes that have occurred and are still occurring. In the past decade we have seen (1) a dramatic rise in the use of cell phones in developing countries (including phones with video capacity and Bluetooth® technology that allow videos to be freely transferred between phones), (2) increased capacity to develop high quality animations, and (3) the explosion of the Internet, which now allows people around the world to collaborate in a virtual manner – both for the development of educational content and for the deployment of such content. It was within this context that the idea for the SAWBO program was born.

SAWBO focuses on taking scientifically validated techniques that can help people to improve the quality of their lives, mainly in the areas of health and agriculture (Bello-Bravo et al. 2011; Bello-Bravo and Baoua 2012; Bello-Bravo and Pittendrigh 2012; Bello-Bravo et al. 2013a; Bello-Bravo et al. 2013b), and then turns this information into high quality two (2D) or three (3D) dimensional animations that typically last no longer than 3 minutes (Fig. 1). These animations are first developed with a team of content experts on the given topic. SAWBO relies on the great, but relatively untapped, resources of experts around the world who might have the time to help create or validate (or at

Dr Julia Bello-Bravo (juliabb@illinois.edu) and Dr Barry Robert Pittendrigh (pittendr@illinois.edu) both work at the University of Illinois Urbana Champaign and are both co-founders and co-directors of Scientific Animations Without Borders. Dr Bello-Bravo is the Assistant Director for the Center for African Studies and Dr Pittendrigh holds an endowed chair professor position in the Department of Entomology. Dr Bello is originally from Spain and holds a PhD from Purdue University. Dr Pittendrigh is originally from Regina, Sask., holds a BSc Honours from University of Regina and previously worked at Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada as well as at the National Research Council Canada – Plant Biotechnology Institute in Saskatoon, Sask.

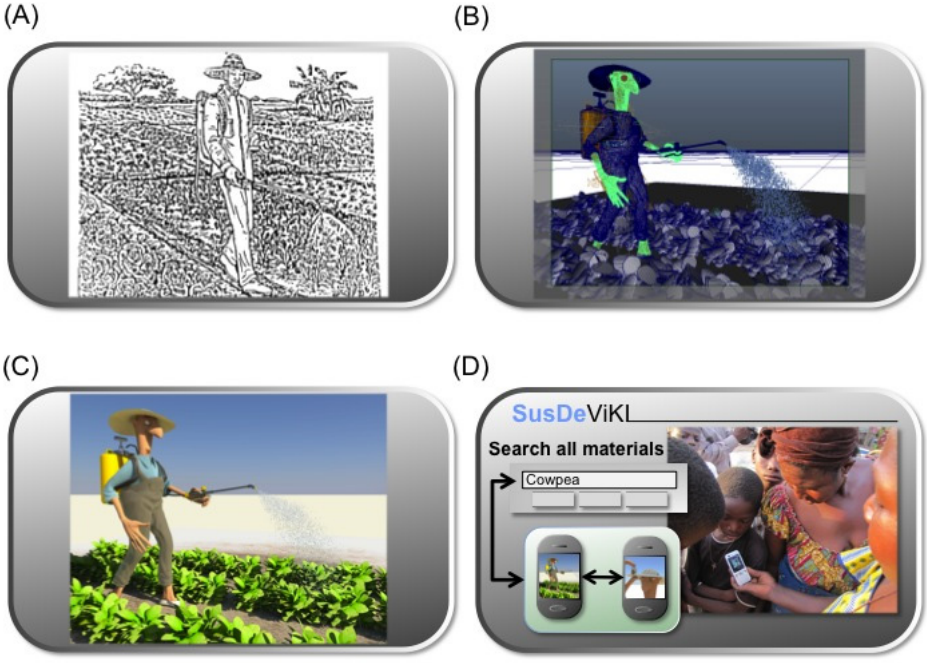


Figure 1. The following are the steps that the Scientific Animations Without Borders (SAWBO) team takes in the process of creating an animation. The given example is from an animation explaining the use of neem seed extracts for the creation of sprays useful in the control of pest insects that attack cowpea crops. (A) The SAWBO team worked with a research group in Mali to determine extension materials that they used in their educational programs – materials that the group from Mali wished to use in larger-scale educational efforts. These materials were available in a printed format and were the basis of the development of the script and the needed visuals. (B) The SAWBO team created draft animated content that was approved by the content experts at the research institution in Mali. (C) A finalized animation was created and placed into a diversity of languages both appropriate in Africa and for other regions around the world. (D) The animations are available on a variety of file sharing systems, including the Sustainable Development Virtual Knowledge Interfaces (SusDeViKI), which is an online journal style system to share extension materials appropriate for low literate learners. An English version of this animation can be found at http://susdeviki.illinois.edu/SearchResultView.aspx?id=36&vid=1 and a 3gp version appropriate for cell phone use can be downloaded from this site. Animations can also be downloaded from the SAWBO websites (http://sawbo-illinois.org/main.htm and http://sawbo-illinois.org/mobile/).

times, both) a succinct script and storyboard that contain key concepts that need to be conveyed to the target audience. From their office desks, and without the need to travel, these experts can check the visuals and instantly respond to the SAWBO team. We also rely on the great creative talent pool of students at the University of Illinois at Urbana Champaign (UIUC), where SAWBO is based, and sometimes animators from around the world, for the creation of our animations. The development of an animation is a reiterative process between the experts and the animators with the SAWBO team both managing the process and often creating the animations. Once an animation is approved by the SAWBO team, it is released to the world using online sharing systems including YouTube®

(www.youtube.com/user/SAWBOsm) and various social media systems [e.g., Facebook® (www.facebook.com/SAWBOsm), Twitter® (https://twitter.com/SAWBOsm), and Google Plus® (http://goo.gl/780vkQ)] to seek crowd-sourced feedback from people around the world. Based on crowd-sourced or peer-to-peer feedback, we sometimes release variant versions that take into consideration cultural adaptations that would only be apparent to someone from a particular area or cultural group, and this variant may ultimately only be useful for a localized region or group, of which such variants can typically be created at a very low cost.

In order to make the content available to people, in a great diversity of languages, SAWBO again turns to volunteers, to the local and world communities to help us to translate and record into these languages and accent variants. Each person who translates and volunteers to perform voice-overs is acknowledged in the credits section of that particular animation. The talent pool for these language variants comes from a variety of sources. First, the University of Illinois has a sizable international community in terms of students, faculty and staff, as well as individuals living in the local community. We often work directly with this international group and they come to the SAWBO laboratory space to record the audio necessary for the voice-overs. Second, we have had many collaborators at other academic institutions around North America, indeed the world, which do the translations and voice-overs from the comfort of their homes or offices; they perform the recordings on everything from their laptops, hand-held recorders or even their cell phones. The recordings are often e-mailed to the SAWBO team who in turn voice overlays them onto the animations, and the language speaker checks the final animation before it is released. On numerous occasions, we have developed multiple versions of the same language variant – in order to have accent variants of the same language from different countries or in some cases different social-economic groups within the same community, region or country.

Animations - An Adaptable System

With the emergence of seemingly ever-improving animation techniques and technologies, compounded with the decreasing costs of creating animations, the long-term expansion of animations, in entertainment and educational realms, is almost a foregone conclusion. One obvious question is – "Why use animations and not live-action filming?" Simply put, high to medium quality live-action filming is more expensive than the creation of animations. Additionally, animations can be adapted and altered to fit with new circumstances, the need for new or altered characters, objects, and landscapes or in fact updates in innovations associated with the techniques being conveyed. The SAWBO team has already experienced these aforementioned issues and the potential for altering animations that makes it a very logical long-term strategy. For example, existing animations may have slight variations that need to be created due to local cultural issues. These adaptations can be made rapidly and in a cost-effective manner. Additionally, in the case of 3-D animations, as objects, characters and landscapes are created, they become tangible items that can be used in future animations, ergo reducing the cost of future productions. Therefore, when more animations are made for a given region, topic or given characters appropriate for developing countries, and these "animation assets" become available for our team, it makes the process cheaper and more efficient.

There currently exists a debate of whether live action filming or animations represent a better approach for delivering knowledge, which both exist in the realm of "edutainment" – i.e., educating people in an entertaining manner. The simple reality is that the needs are great for a billion people speaking many languages, and few resources exist or have been developed to meet these needs. Like other forms of entertainment, there is a considerable amount of market space for live action materials and animations. Other programs are currently developing approaches where local groups do their own local filming in their own local language and these can be shared with others in the community. This is an excellent approach for many localized concepts and ideas. However, our

decision to go down the path of animations came out of pragmatic concerns. High quality, live action filming is expensive (more so than high quality 3-D animation) and has not been amenable to online collaborative approaches. The latter often requires a specific grant, in a specific region, and when a new and improved process emerges out of a research for development community, it may be highly difficult to go back and alter the video to adapt to this/these new innovation(s). Finally, the animated approach is highly amenable for the involvement and the building of volunteer networks of people who are interested, and have important expertise for the creation of educational content. Normally, these volunteers do not have the time, lifestyle, career path or resource that would allow them to be actively involved in international development. Thus, competition between live-action versus animated approaches is non-existent as they are simply two different paths, which involve somewhat different resources to create educational content.

SAWBO's Entomological Origins

Although SAWBO now has educational content on a great diversity of important topics and languages from around the world, its origins are based on the need to deliver insect pest control solutions to West African cowpea farmers. For almost a decade, both of the co-authors have been involved with a USAID funded program, to deliver pest management solutions to cowpea crops in West Africa. The cowpea is an important protein source for tens of millions of people in West Africa, many whom live on less than $2 a day. When insect pests attack this crop, it can result in reduced access to protein for the farmers or their families during that year. Additionally, significant postharvest losses of cowpea seeds can also occur due to the cowpea bruchid (*Callosobruchus maculatus*). Over the past two decades, several simple albeit highly effective cultural practices have been developed to deal with some of these pests. However, many of these solutions have not made their way out of academic literature and into the hands of farmers. Our initial animation, illustrating how to hermetically seal cowpea seeds to prevent cowpea bruchid damage, was an exploration of how to create such animations and how to get these animations into numerous different languages. Thus, the first series of animations that we created were centered on the control of cowpea pests in the field and in storage (http://goo.gl/DC4A7H). However, with the development of these animations, plus the strategies that emerged from their creation, it became apparent to our team that this approach could be used in a reproducible manner for other topics.

From Insects to Healthcare – SAWBO Grows into a System

Over the past several years, SAWBO has developed over 50 animations on a wide diversity of topics. It has worked with partner groups on subjects ranging from reducing postharvest loss, to prevention or treatment (or both) of diseases such as malaria (http://goo.gl/L1MjMn), dengue (http://goo.gl/3IUhV8), yellow fever (http://goo.gl/PzQjt0), Chagas disease (http://goo.gl/83PXTr), and tuberculosis (http://goo.gl/lrTVvO), as well as topics associated with microfinance to empower women. SAWBO has evolved from a few animations dealing with insect problems, into a system where research for development (R4D) innovations, on a great diversity of topics, can be and are being turned into educational animations. We work with those that have expertise on a given topic and we interact with global content experts to develop animations that are scientifically accurate and with local experts to make sure the animations will be understood locally and will be culturally sensitive. In fact, some of our more recent work has also included the development of educational animations for problems associated with health issues in Chicago – a collaboration we have with the University of Illinois at Chicago Medical School (http://goo.gl/tjOFAC). Thus, we are developing content for both global and local use.

How do we make it all happen? – From *Silent Spring* to SAWBO – The Power of Giving

The billion low-literate learners on the planet are often the same people that live on less than $2 a day. As well, many small-scale NGOs cannot afford to pay for such educational content. It is the stated goal of SAWBO to freely give all educational animations to anyone that can use these in their programs for educational purposes only. We have been fortunate enough to receive funding from the Dry Grains Pulses CRSP and the Legume Innovations Lab (both supported by USAID) for our work on the pests of cowpea. This funding has been specifically focused on an important crop and SAWBO has rapidly expanded well beyond this initial concentration. This expanded focus has represented a challenge for SAWBO, as funding agencies tend to fund groups that are experts in given topic areas, not a generalizable system for creating content. However, there are real costs in the creation and management of such content and creation of content in a timely manner for existing needs on a diversity of topics!

What has made SAWBO possible, along with animations on a diversity of topics, is a story that reaches back in time to a connection with influential figures in entomology and their impact, which has been felt across generations in both the environmental movement and through SAWBO. The key connecting person in all of this was the late Dr Roy Barker who was a graduate of the UIUC Department of Entomology. He performed seminal work, now considered a textbook case, explaining the impact of DDT on American robin populations via their food source - earthworms. There were three entomology professors at UIUC that influenced Dr Barker's career and instilled in him a life-long passion for insect toxicology: C.W. Kearns, C.L. Metcalf and W.P. Flint. Additionally, Dr Barker was a personal friend of Rachel Carson and his work on DDT was a critical piece of evidence in *Silent Spring*; the book that has been highly regarded as a flashpoint for the modern environmental movement (Carson 1962). Dr Barker and his spouse, Mary Lou Barker, provided the funding for the establishment of the C.W. Kearns, C.L. Metcalf and W.P. Flint Endowed Chair in Insect Toxicology, a position held by Dr Barry Pittendrigh. This endowment keeps the core of SAWBO sustainable. Other private donations, ranging from individuals to the UIUC Chancellor's Fund and the ADM Institute for the Prevention of Postharvest Loss, have allowed SAWBO to grow and create educational content that is both timely and needed by communities - these are animations that could likely never have been created through traditional funding mechanisms.

Private donations have gone a long way! One of SAWBO's animations illustrates how to prevent Konzo - a disease that is caused by cyanide, which occurs in bitter cassava (http://goo.gl/62F3NP). Bitter cassava is resistant to many forms of insect attack, but it comes at the cost of the fact that it can also have negative health effects on humans if the flour is not properly processed. When people consume food that contains flour made from bitter cassava which has not been properly treated, they can become permanently paralyzed from the waist down. A simple process can be used to remove the cyanide from the flour – an easy technique that can be taught. SAWBO was able to create content, through a donation from a private individual, for an educational animation focused on demonstrating the technique to remove the cyanide from bitter cassava flour. Funding from the ADM Institute for the Prevention of Postharvest Loss has also allowed SAWBO to create educational content, dealing with reducing postharvest loss, that has been placed on 700 tablet computers distributed to extension agents across Ethiopia, with each extension agent having the capacity to use these in educational programs that impact thousands of individuals. Many other examples exist; however, with all of them a common theme has emerged – private funding has allowed SAWBO to move rapidly to respond to real world needs and to provide educational tools for groups working with some of the most disadvantaged people in the world.

Moving Forward

SAWBO is continuing to produce and release new animations, with new language variants; however, we are also exploring creative and low-cost ways to place this content into the hands of educators who can take them out to the target audiences (Fig. 2). For example, we are currently developing a cell phone and tablet application ("App") that will allow users to access our complete and growing database of animations in all languages and country accents through a search engine that allows them to search for content by topic, language and country. Once they find the animation of interest and appropriate for the target community, they can download it onto a cell phone or tablet and the animation can be shared to other devices (e.g., cell phones) using Bluetooth®. As we move forward, we expect that as new technologies emerge, we will be able to develop new deployment approaches for the global sharing of SAWBO's growing content that we have been able to develop both through the SAWBO staff team and our local, national and international volunteers.

Figure 2. The picture is of two women in Nigeria watching a Scientific Animations Without Borders (SAWBO) animation on a cell phone; the animation was in a local language (Yoruba) and the topic describes how to treat water to prevent cholera. Picture courtesy of Tolulope Agunbiade.

References

Bello-Bravo, J., Agunbiade, T., Dannon, E., Tamo, M. and Pittendrigh, B.R. 2013. The prospect of animated videos in agriculture and health: A case study in Benin. International Journal of Education and Development using ICT, **9**: 4-16.

Bello-Bravo, J. and Baoua, I. 2012. Animated videos as a learning tool in developing nations: A pilot study of three animations in Maradi and surrounding areas in Niger. The Electronic Journal of Information Systems in Developing Countries, **55**: 1-12.

Bello-Bravo, J., Nwakwasi, R., Agunbiade, T.A. and Pittendrigh, B.R. 2013a. Effectiveness of cell phones as an educational tool: A case study in southeastern Nigeria. International Journal of Information and Communication Technology Research, **3**: 308-315.

Bello-Bravo, J., Olana, G.W., Enyadne, L.G. and Pittendrigh, B.R. 2013b. Scientific Animations Without Borders and communities of practice: Promotion and pilot deployment of educational materials for low-literate learners around Adama (Ethiopia) by Adama Science and Technology University. The Electronic Journal of Information Systems in Developing Countries, **56**: 1-11.

Bello-Bravo, J. and Pittendrigh, B. 2012. Scientific Animations Without Borders: A new approach to capture, preserve and share indigenous knowledge. The Journal of World Universities Forum, **5**: 11-20.

Bello-Bravo, J., Seufferheld, F., Steele, L.D., Agunbiade, T., Guillot, D., Cutz, G. and Pittendrigh, B.R. 2011. Scientific Animations Without Borders: An international online approach for building applicable scientific educational materials for use on cell phones and the Internet in developing nations. The International Journal of Science in Society, **2**: 49-62.

Carson, R. 1962. Silent Spring. Houghton Mifflin, Boston.

Seventh International Symposium on Molecular Insect Science
Amsterdam, The Netherlands, 13-16 July 2014
http://www.molecularinsectscience.com/

XVII Congress for the International Union for the Study of Social Insects
Cairns, Australia, 13-18 July 2014
http://www.iussi2014.com/

ECE X (Tenth European Congress of Entomology)
York, UK, 3-8 August 2014
www.ece2014.com

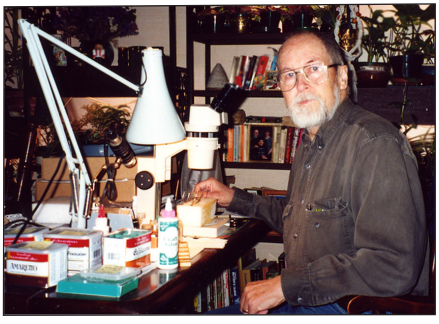
7th International Conference on the Biology of Butterflies
Turku, Finland, 11-14 August 2014
http://nymphalidae.utu.fi/icbb2014/

XXV International Congress of Entomology (Entomology without Borders)
Orlando, Florida, 25-30 September 2016
http://ice2016orlando.org/

Readers are invited to send the Editor notices of entomological meetings of international, national or Canadian regional interest for inclusion in this list.
Les lecteurs sont invités à envoyer au rédacteur en chef des annonces de réunions entomologiques internationales, nationales ou régionales intéressantes afin de les inclure dans cette liste.

Donna Giberson

Cicendela hirticola on Blooming Point Beach, PEI



Willetta Preston

William Burton Preston (1937-2013) One of a kind

The Entomology Society of Manitoba has lost a longtime member with the passing of Bill Preston at St. Boniface Hospital on 11 October 2013; he was 76. Bill grew up happily exploring the desert, grassland and forests of the Okanagan Valley, where he developed his love of nature and of rattlesnakes in particular. After graduating from the University of British Columbia with BSc and MSc degrees in wildlife management, Bill married Willetta, and the couple moved to Norman, Oklahoma, where he completed his PhD in Zoology, studying water snakes. He also spent many pleasurable days collecting and studying the rich insect fauna of the region. While living there, they were able to explore many parts of the southern United States, Mexico and St. Lucia.

Returning to Canada in 1969, he accepted the position of Curator of Reptiles, Amphibians and Fishes at the newly opened Manitoba Museum of Man and Nature in Winnipeg. During his 28 years with the Museum, he enjoyed numerous opportunities to explore the province and to travel to other countries. He was a man with a wide range of interests about the natural world, and became a passionate entomologist, amassing an extensive insect collection for the Museum and his own personal collection. The study of butterflies, tiger beetles, spiders and ants drew his attention, and he had plans to publish a number of papers on these subjects. Bill was always generous with his time and expertise, and often helped friends and students with troublesome identifications for the species he knew best. He will likely be notably remembered for his book on "*The Reptiles and Amphibians of Manitoba*" - part of the provincial fauna that had received little previous attention. He also co-authored "*The Butterflies of Manitoba*" and contributed articles to "*The Encyclopedia of Manitoba*."

Bill loved field work and was elated to discover the first Manitoba records of the Great Plains Toad and a species of ant. He walked frequently down to the Red River behind the Museum during his lunch hours, and faithfully recorded notes on the appearance and habits of butterflies. He never lost his "little boy" excitement about learning new things regarding the natural world, and he just had to discuss these observations with his Museum colleagues. In fact, it was impossible to walk past the open door of his office without being invited in for a lengthy conversation. Bill was also notorious for his quirky sense of humour, and often he could barely complete a joke without losing his voice as he broke out in laughter. He loved showing youngsters the many critters in his laboratory, ranging from a Hognose Snake to a giant, one-eyed Snapping Turtle that he rescued from the Assiniboine River. Bill was an active participant in the ESM Youth Encouragement and Public Education Committee, when it was revamped under the presidency of Ron Sinha in 1973. The group organized numerous field trips and workshops in the ensuing years, to LaBarrière Park, Sandilands Provincial Forest, and to the newly developing outdoor education facility at Fort Whyte. Bill was always keen to go out on these adventures, and he loved to share his knowledge and experience with all the keen young entomologists. For a number of consecutive years, the Youth Encouragement Committee conducted a week-long display on insects at Polo Park Shopping Mall, and later at the newly opened St. Vital Mall. There were all

This obituary is reprinted, with permission, from the Entomological Society of Manitoba Newsletter **39***(2&3) (Fall/Winter 2013).*

manners of insects, alive and dead on offer to the public. Bill was the only person who always attended all day every day of the exhibit. He loved to talk about insects, and there was hardly a better opportunity for non-stop conversation than at the entomology display. He could never understand the concern of the Polo Park manager when someone had laid a drinking straw to breach the petroleum jelly barrier that was meant to contain the thatching ant colony. Many of the ants had gone walkabout in the night and were found by disgruntled shop keepers the next morning. Bill just couldn't see the problem; to him they were harmless ants.

Bill was also interested in photography, astronomy, geology, theatre and electronics, and recently built himself a computer. He belonged to a number of associations including the Entomological Society of Canada, Entomological Society of Manitoba, Manitoba Naturalists Society, Winnipeg Amateur Movie Makers, and the Manitoba Rock and Mineral Society. He served in various capacities within these groups for which he received several awards. He was a member of several government committees such as the Endangered Species Advisory Committee, and attended meetings regarding the snake pits at Narcisse. Bill had the well-earned respect from his many friends and colleagues, due to his broad knowledge, developed over his long career at the Museum.

In later years, Bill's health deteriorated to the point where he could no longer participate in field activities, but with the loving support of Willetta, he maintained a positive attitude about life and his passion for nature to the end of his days. Bill cared deeply about educating the public about the need to conserve biodiversity. He will be missed by many people, and his legacy lives on through his books, exhibits, and collections.

Robert Wrigley and Terry Galloway
Winnipeg

Michael Locke, who died on 20 October 2013 in London, Ontario, was among the most influential insect scientists of his generation whose work illuminated insect development and cell biology. Gifted with extraordinary intelligence, restless curiosity, and quiet determination, he was able to spot crucial lacunae in our knowledge of how insects function, to identify with great precision the appropriate questions, and, using a variety of tools, provide answers that were unfailingly provocative.

Ken MacDonald

Michael Locke (1929-2013)

Born in 1929, Locke attended Drayton Manor Grammar School in Ealing, London, England, and, after obligatory National Service in the RAF, took up a state scholarship to Cambridge, obtaining a double first in the Natural Sciences Tripos, an early recognition of his talent. He joined the growing group of students of V.B. Wigglesworth on the top floor of the Zoology Department, obtaining his PhD in 1956. He later earned a DSc for his additional work.

The three papers from his doctoral work, published in the *Quarterly Journal of Microscopical Science* in 1958, had a fresh look at the structure and development of insect tracheae. He used electron microscopy (EM) to demonstrate that tracheoles exhibit the same taenidial structure as the rest of the tracheal system and demonstrated convincingly that the taenidia

arose simply as a result of physical forces generated during development. More importantly, he identified and explored an apparent paradox: although the normal developmental pattern resulted in a series of branching tubes in each segment in which the total cross sectional area after each branching remained approximately constant (an observation first made by the Danish physiologist Krogh), the system was also capable of considerable plasticity. A series of simple surgical approaches outlined the dimensions of this plasticity and hinted at the existence of both tissue gradients and blood-borne factors. These papers are still attracting citations more than half a century after publication, a clear indication of their influence.

Michael, perhaps surprisingly, took up a position at the University of the West Indies in Jamaica. Among the consequences was his adoption of the skipper butterfly *Calpodes ethlius* as an experimental model. Easily reared, the larvae are transparent, permitting the observation of events in living specimens. He used this model to explore a paradox in the secretion of the wax layer of the cuticle. The current dogma held that this layer reached the cuticle via pore canals, but often the melting point exceeded 60°C. A paper in *Nature* showed that final synthesis of the wax occurred after secretion. Note that while the solution to the paradox was important, so also was the identification, and clear statement, of the problem.

While in the West Indies, he also took up the question of segmental developmental gradients that had been raised by his analysis of tracheal growth. In two extraordinary papers, completed while on leave in Cambridge, he used clever transplantation of *Rhodnius* cuticle and underlying epidermis, to explore the effect on cuticular pattern of rotating the transplants. While the concept of developmental gradients had been in the air for many years, these papers were the first to provide an unequivocal demonstration of their existence, and launched a renewal of interest. The papers continue to attract citations.

These early papers exemplify Locke's approach that characterized all of his work. First, identify the paradox or problem, and provide a clear analysis leading to an experimental approach to solve or at least further clarify the problem. All of this is written in unfailingly clear, simple, easily comprehended prose. Indeed, these papers could easily be used in teaching about how to write in science.

During a 6 month leave in Cambridge, Locke used the EM to explore the question of wax secretion in *Calpodes*. This marked the beginning of his use of the EM as the primary (although not exclusive) tool for his research. He was still to some degree a novice, however, and he spent the summer of 1960 in the Rockefeller Institute (now University) with Keith Porter exploring the ultrastructure of insect cuticles, particularly pore canals. By the time that the paper (which still attracts citations) appeared in 1961, Michael had been recruited by Howard Schneiderman to the faculty of the Department of Biology to join a large group of developmental biologists at Western Reserve University (later Case Western) in Cleveland. Others in the group were also former students of VBW: Tony Watson, John Edwards, Peter Lawrence, Michael Berridge. This period was enormously productive and a flood of papers appeared, mostly concerned with the tracheal system or the epidermis and cuticle. It would be a mistake, however, to regard these as simply descriptive biology. In each case, the observations were directed toward a specific problem in the cellular dynamics of the insect system. At least one of these publications, on cuticulin, was designated as a "citation classic".

During this period, a new interest in the movement of protein within and between tissues developed, exemplified by a series of five papers using the fat body of *Calpodes* (including one in Science and another in Nature) with his student, Janet Collins.

In 1971, Michael was attracted to the University of Western Ontario to be chair of the Department of Zoology. It was perhaps an odd appointment, given his commitment to research, but he remained as chair for 14 years with external reviews every 5 years. During all of this

time, he continued his personal research program, working personally at the bench, providing leadership by example. Given a granting system that rewards professors as managers, directing the research of others, it is a remarkable achievement. His interests in the cell biology of epidermal cells and fat body were undiminished, and papers on a wide variety of problems emerged. Of particular note are those on the beads of the Golgi complex, and the exploration of ferritin. The Golgi beads were at first challenged, informally and amusingly, by those who regarded insects as "lower" organisms and hence not particularly relevant to "real" (mammalian) cells. Michael extended the reach of his research and showed that they were observable in mouse testes.

As always, however, he remained close to the organism. An example is the remarkable discovery of the tracheal lung in *Calpodes*, stemming from his recognition that, although every cell in an insect received a direct supply of oxygen via the tracheal system, there was one exception: the blood cells. Generations of insect scientists had failed to recognise this problem. Michael did, and the transparent *Calpodes* was the ideal organism to answer the question. I suspect that I was not the only scientist to feel a little foolish for having missed that anomaly. Curiously, others have not taken up this interesting and important question. Although *Calpodes* has a specialised tracheal structure, that is not the case in all insects. The fundamental question, identified by Michael, remains: how do blood cells get their oxygen?

Michael was frequently at his best as a synthesizer of a field. Those papers, often invited, are not simply the recitation of his research, but develop new insights. The paper "What every epidermal cell knows" in the Festschrift for Wigglesworth marking his formal "retirement" in 1967 is still relevant, as is his contribution to the remarkable volume he developed with David Smith to celebrate Wigglesworth's 80th birthday 13 years later. For several years in the 60s, he served as editor of the annual Symposium of the Society of Developmental Biology and Growth (now the Society of Developmental Biology).

Like most academic scientists, he leaves the legacy not only of a body of papers (about 200 in all) and several books, as author or editor, but also a legacy of students. Among his doctoral students from the time in Cleveland were Joan Lai Fook (faculty at University of Toronto), Susan Bonner-Weir (faculty at Harvard), Joseph Kunkel (faculty at the University of Massachusetts), and Eugenia Wang (faculty at the University of Louisville). At Western, his doctoral students included Reddy Palli (faculty at the University of Kentucky), Jan Ryerse (faculty at St Louis University), Helen Nichol (faculty at the University of Saskatchewan), David Brodie (pharmaceutical industry), Tim Brac (Brac Scientific Consulting), Oana Marcu (SETI Institute), and Alan Tuck (faculty in Medicine, Western). Among the post docs at Cleveland were Michael (now Sir Michael) Berridge and Peter Lawrence, both of whom returned to Cambridge, and at Western, David Carter (UC Riverside), Cheryl Ketola (Fanshawe College) and Rob Dean (faculty, Western).

Various honours recognized his achievements: Fellow of the Royal Society of Canada, Fellow of the Entomological Society of Canada and of the Entomological Society of America, Honorary Fellow of the Royal Entomological Society, Killam Fellowship. The award by the RES of the Wigglesworth Medal and Lectureship at the International Congress of Entomology in Brazil gave him great pleasure, since Wigglesworth was his inspiration.

I think it is important that I should say something about Michael, Cambridge and Wigglesworth. Being a student in that environment was clearly a defining experience in Michael's life, as it was in mine. Certainly it changed my life. VBW was required to take on students as a condition of the Quick Professorship that he occupied. Once he was satisfied that you had selected and defined a worthwhile problem, you were left to get on with it, leaving Wigglesworth free to get on with his research, his consuming interest. This single-minded commitment to,

and personal involvement in, research at the bench impressed Michael and he tried, successfully in my view, to emulate that behaviour within the constraints of a very different academic environment in North America. For students of Wigglesworth, the dissertation was YOURS, the papers were YOURS. There were no committees to satisfy, no course work required, and Wigglesworth refused to read the dissertation or drafts of the papers. But that did not imply indifference. Because I had the privilege of returning to the group as a Fellow, and because I visited VBW at least once per year until the late 80s, I was able to observe him more closely. He was certainly aware of what the students were doing, and while he would never intervene directly, he might ask about progress, implying perhaps that you had better get on with it. He also followed the progress of former students. VBW had a strong preference for students from Canada, a strategic move designed to strengthen insect science in Canada, and he took a great interest in what he referred to as his Canadian mafia. He was thus pleased that Michael had taken on the job at Western and often asked about his progress. Incidentally, Michael was the second Wigglesworthian to serve as chair of Zoology at Western. A.W.A. Brown, who was chair during my time at Western, had worked his way across the Atlantic in a cattle boat to work with VBW in the late 30s while he was still at the London School of Hygiene and Tropical Medicine.

And that brings me to Michael the man. He was, as already noted, blindingly bright, unswervingly principled and above all, rational. He set very high standards for himself (and others!): good enough was not in his vocabulary. At the same time, he was also entirely self-contained: extrovert is not a characteristic that leaps to mind. All of that sounds cold and humourless, and first encounters could be daunting or even terrifying.

He was in fact a man capable of great generosity and kindness, particularly for the young. Evidence of that can be found in the acknowledgments of his help by many authors from what might be regarded as competing labs. He was generous about recognising the contributions of others to his thinking and about authorship: his long-time assistant at Western was a co-author on many of his papers.

Although he served as chair for 14 years, he regarded most "administrators" in universities as superfluous, and he frequently turned his devastating sense of humour in their direction, often in the form of a carefully crafted bit of writing. I wish that I had retained one piece, written when he was dealing with bowel cancer. He compared the administrative process in universities to the fascination of the aged with their own digestive process: "a far too careful inspection of the product combined with an excessive use of paper". He even managed to insert a bit of invective in his address for the Wigglesworth Medal, published in the *Journal of Insect Physiology.*

Michael married Audrey in 1953, before beginning his doctoral work. They had four children. In 1980, Michael married his former student, the formidable Janet Collins, who left a position in Biology at Dalhousie to join him in London. She entered law school at Western, qualified as a lawyer, and served on the Board of Governors at Western.

He was, for a supposedly entirely logical predictable man, capable of great surprises. On one occasion, he took me after dinner to the basement where he revealed the equipment he used in lapidary. He explained that since he no longer had the time to cut sections, he found that he needed something to do with his hands. (I note that VBW produced soapstone carvings, often of *Rhodnius*). As in his science, lapidary was done at a level of perfection matched only by the best professionals. Michael was incapable of superficiality. The lapidary led him to an interest in objects fashioned from bone, and eventually ivory and horn. He developed so much expertise that he was consulted about antiquities made from these materials. Typically, his examination of bone identified some questions about the details of the accepted structure, and a paper in the *Journal of Morphology* resulted. Similarly, he investigated the structure of ivory from a

wide variety of animals. That study also resulted in a paper in the *Journal of Morphology* that included characteristic sketches that clarified the apparent complexity. A book on bone, ivory and horn appeared at the end of 2013, after his death.

He and Janet shared an interest in gardening, and the garden at the back of their home in London was a perfection, whether it was dominated by flowers or, as happened suddenly, converted to a vegetable garden, including a miniature swamp, fed by run-off from the roof.

It has been, by any measure, an extraordinary life that has enriched our science, and the lives of many students. For me personally, I have often remarked that I have led a life full of good fortune and great privilege. That life has been enhanced by the privilege of having Michael Locke as a friend.

Ken Davey
Toronto

People in the news / Gens qui font les manchettes

Gold Harvest Award made to Charles Vincent / Le prix Moissons d'or remis à Charles Vincent

It was recently announced that Charles Vincent had received a 2013 Gold Harvest Award in the Innovation, Collaboration and Service Excellence category.

The Gold Harvest Award honours exceptional and significant contributions made by AAFC employees and partners through the excellence of the work they perform, the exemplary behaviour they demonstrate, and the positive results they achieve.

Il a récemment été annoncé que Charles Vincent a reçu le prix Moisson d'or 2013 dans la catégorie Innovation, collaboration et excellence.

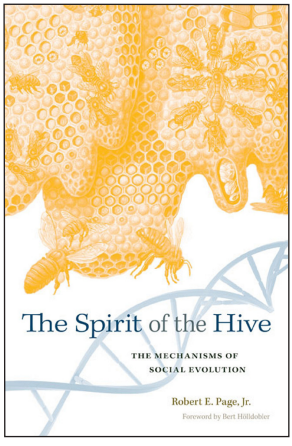
Le prix Moisson d'or récompense les employés d'AAC et leurs partenaires qui ont apporté une contribution exceptionnelle et significative en faisant preuve d'excellence dans le travail qu'ils accomplissent, en affichant un comportement exemplaire et en obtenant des résultats positifs.

Julien Saguez

On behalf of Agriculture and Agri-Food Canada, Roger Chagnon (Director of Operations, HDRC/Saint-Jean-sur-Richelieu-left) presenting a plaque to Charles Vincent (right).

Au nom d'Agriculture et agro-alimentaire Canada, Roger Chagnon (Directeur des opérations, CRDH/Saint-Jean-sur-Richelieu-gauche) présentant une plaque à Charles Vincent (droite).

The Spirit of the Hive. Page, R.E. 2013. Harvard University Press, Cambridge, MA. 240 pages. Hardcover. ISBN 9780674073029. $39.95.



Scientific research is often communicated through an impersonal report of data. In his book, *The Spirit of the Hive*, Robert Page breaks with tradition and weaves a narrative of his research career detailing his investigation into the mechanisms behind sociality while maintaining a casual, friendly tone. This book is very much a scientific autobiography of Page's career efforts and the detective-style story of how simple processes lead to complex social organizations, such as division of labour within the honey bee. Early career researchers take note: Page offers a unique perspective on how research questions adapt and evolve over a career in response to novel information drawn from collaborators. Warning, if you are looking for a detailed explanation of 'why' traits facilitating the development of social systems evolve, this book is not for you. Refreshingly, Page instead carves out his own niche by focusing on the 'how' questions in a very mechanistic manner. Over the course of the book, he develops an explanation on how complex social behaviour in honey bees arises through genetic and phenotypic mechanisms. As a whole, one gains a valuable glimpse into the inner workings of both the hive and the academic journey of the man behind the research.

Predominately, *The Spirit of the Hive* was written for those with a genuine interest in social systems, specifically honey bees, while still including content encouraging accessibility to a general audience. To maintain this more general audience, Page uses a casual tone and includes some introductory biology. With this concession, one aspect of the book that may lead to dissatisfaction is the lack of in-text citation. Instead, Page refers to post-docs and graduate students by name and provides a list of suggested readings at the end of each chapter. This approach makes the text very readable, but also makes it difficult to link facts to specific papers. Moreover, the targeted audience seemed unclear until the end since the book ramps up in intensity as it progresses. The initial four chapters present basic pieces of the puzzle: a brief overview of the hive, questions that arise, and simple models explaining division of labour. The next few chapters are presented as complex, independent cogs of the machine in a seemingly unrelated manner. Only in the last four chapters do all the pieces fall into place in a satisfying revelation. This style of writing runs the risk of losing the interest of less invested readers during the mid-portion of the book. However, for those who read till the end, the reward is deeper knowledge of the concepts achieved through a path of self-discovery mirroring Page's own journey to his current understanding. As a result, this book would function well as reading material for an upper level undergraduate or graduate level course highlighting honey bee social behaviour.

As mentioned, the first four chapters outline Page's interest in mechanistic questions and how simple rules of assembly lead to complex social systems. Here, Page breaks complex thoughts and theories into easily understandable concepts. Page introduces the notion of how theory is built in the field of ecology and how theory and data inform each other using the 'stone soup model' from which the rest of the book develops. In addition, Page explains the rules of the social hive while avoiding the role of the environment in their formation which may lead to some wanting more. However, one quickly comes to understand that environment is not what this book is about. Overall, the reader is eased into a complex and mechanistic way of thinking. Page's warm and conversational writing style works very well for this section, providing

an easy and appealing read.

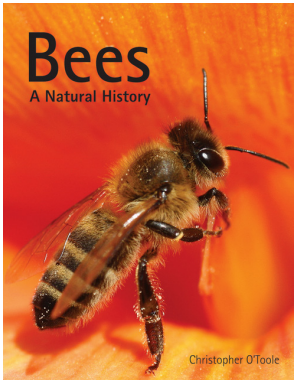
Page moves on to the evolution of polyandry, and pollen hoarding where he focuses on specific experiments regarding how genotypic and phenotypic characteristics lead to pollen hoarding. These chapters walk a fine line between fleshing out advanced abstract ideas and providing the base underlying knowledge necessary to understand them. This trade-off works for the evolution of polyandry, but the pollen hoarding chapters lag behind. This is unfortunate, since pollen hoarding is the core of the book, and Page's writing style only reveals the importance of these chapters upon further retrospection. Although interesting to read as an overview of multiple experiments, the content becomes difficult to synthesize, and the lack of in-text citations becomes frustrating when trying to access the primary literature. Nevertheless, Page assembles a diverse array of literature in order to show how genes and the environment work to explain pollen hoarding. Page uses the lessons he learned on pollen hoarding as a model for understanding the evolution of the sociality for the rest of the book.

In the final chapters, Page's investment into pollen hoarding becomes clear and he uses the model of pollen hoarding as an analog for sociality and the role the ovary plays. He presents a complex but easily understood positive feedback network between genes and the behaviour structuring the hive. Even though he has focused on his own story, Page remains excited about further developments in the field. He specifically addresses the major criticisms of his work in a very transparent way. This presents a different side of science to the uninitiated reader, presenting a behind-the-scenes view of the research process. Page brings his many ideas together and makes it ultimately satisfying to cross the finish line, after achieving a more nuanced understanding of the mechanisms behind division of labour and sociality.

True to his word, Page delivers a book focusing specifically on the mechanisms structuring the honey bee hive. He accomplishes a very thorough, interesting read and distinguishes himself by not touching on ultimate mechanisms of evolution which are normally discussed. Besides being an informative book, *The Spirit of the Hive* is very much a reflection on Robert Page's academic journey through a discipline that he helped define. The structure of each chapter mimics the path from a basic understanding of the subject to a multi-faceted interdisciplinary synthesis. Page impressively brings together research sprinkled across disparate journals into one comprehensive source. Ultimately, this book would be an enjoyable addition to any biologist's collection and is an excellent glance into the spirit of the machine.

Devin de Zwaan, Franz W. Simon, Alysha Martins, Tina Dancau, Dennis Quach, Selina Dhanani, & Bernard Roitberg
Evolutionary and Behavioural Ecology Research Group (eBERG)
Department of BioSciences
Simon Fraser University, Burnaby

Bees: A Natural History. O'Toole, C. 2013, Firefly Books Ltd., Richmond Hill, Ontario. 240 pp. ISBN 1-77085-208-5, Can$40.00 (hardcover).



As described in the final chapters of this book, humans have a long history of exploiting bees. Due to numerous reports on bee declines over the past 7 years, people are now more than ever aware of the importance of bees for crop pollination and sustaining natural environments. Until very recently, most of the attention has focussed on the honey bee, but as the role played by several of the other ~20,000 species of bees has become evident, we are seeing an increase in the public's awareness of bees beyond the honey bee. In his latest book, *Bees: A Natural History*, Christopher O'Toole provides a great general primer to bees and their impressive diversity for the non-bee specialist that will also be of interest to the melittologist.

O'Toole, author of 20 books on insects for the general reader, is also co-author of *Bees of the World* (O'Toole and Raw 1991), famously known to have a fly on the cover of one of its reprints. I consider this to be an updated version of that book, though several topics could have been further updated to reflect more recent research. The book is 8 ½ x 11" and its 240 pages contain an introduction, 14 chapters, 2 appendices, an index, and 125 colour photographs. Many of the photographs are striking, but most have been enlarged to occupy entire pages which leads some to appear pixelated and blurry. It is unfortunate that a book emphasizing the diversity of bees, and whose self-stated aim is to introduce solitary bees to a wider audience, features a honey bee on the cover.

Overall, the book is an easy enjoyable read, written in an informal tone with the author making numerous references to his own personal experiences and observations. In an effort to make the book as accessible as possible, he includes common names when appropriate and employs numerous analogies such as comparing pollen-grooming while hovering to a man running on the spot and rolling a cigarette in each hand. Despite this book being targeted to non-bee specialists, as a bee specialist, I still greatly appreciated reading the book, learned a few new things, and was especially intrigued by the last few chapters focussing on the historical relationship between bees and people. Let's face it, how can it not be fun to read about bees? The over-simplifications and generalizations leading to inaccuracies which are often made in these types of books, are kept to a respectable minimum. For the most part, it is clearly written, though a few passages are confusing, and the book would have benefited from more careful editing as typographical and grammatical errors can be found throughout.

In the Introduction, O'Toole introduces the themes and topics of the book while emphasizing the diversity of bees, human dependence on bees, and the importance of bees in maintaining various ecosystems through pollination services. Chapter 1 (The Wasp Inheritance) covers basic morphology, metamorphosis, and characteristics that are shared and not shared between bees and wasps. Chapter 2 (The Business of Being a Bee) covers how bees collect and transport pollen, as well as bee taxonomy. Here, he takes the time to explain the importance of the binomial system for clarity and stability which I appreciate, but the taxonomy used throughout the book is inconsistent and at times outdated. Furthermore, his cladogram of the seven bee families has been inappropriately modified from its original source to now contain a polytomy between Crabronidae, Melittidae, and all other bees. Though there is uncertainty about the monophyly of Melittidae and whether bees are sister to or evolved within crabronids, there is no uncertainty about the monophyly of bees. The remainder of the chapter briefly introduces the seven families of bees, listing common genera found within each. I disagree with his dividing the apids into two major groups: those which have scopae on the hind legs for the transport of pollen, and the corbiculate bees. This division is not natural and ignores a large proportion of

apids which are parasitic bees with no structures for carrying pollen.

Chapter 3 (Solitary Bees) relates several interesting stories about solitary bees and describes the various nesting behaviours and life-cycles found. Chapter 4 (Social Bees) describes the various forms of sociality found within bees from communal nesting to eusociality. There is some inconsistency in the terms employed to describe the various forms of sociality. Also unclear is the basis for his claim that social behavior evolved 12 times in insects and 11 in Hymenoptera. There are alternative hypotheses for the number of origins within Hymenoptera and regardless of which number is used, there is more than one other non-hymenopteran lineage of eusocial insects. Also, his repeated claim throughout the book, first made in this chapter, that honey bees are not native to North America, ignores the honey bee fossil found in Nevada which extended the native range of honey bees (referring to Apini and not just Apis mellifera) to North America (Engel et al. 2009).

Chapter 5 (The Male of the Species) is interesting for its description of the unusual roles of males in some social species. Chapter 6 (The Pollination Market) considers the mutual dependency of bees and flowering plants as a complex marketplace with flowering plants as the retailers and bees as consumers. I find the behavioural-ecological guilds presented here to be an oversimplification leading to confusion and inaccuracies.

Chapter 7 (Squash Bees and Other Pollen Specialists) describes polylectic and oligolectic bees and emphasizes the asymmetrical relationship between plants and bee specialists. Chapter 8 (Bees and Orchids) describes numerous fascinating bee - orchid relationships. It unfortunately states that bumble bees are the closest relatives of orchid bees, a statement not supported by either morphological or molecular data. Chapter 9 (The Enemies of Bees) includes a confusing description of the strepsipteran life cycle where it is not always clear if he is referring to the bee host or the parasite. Chapter 10 (The Conservation and Management of Bees) gives examples of native bee declines due to loss of bee-friendly habitat in intensive agricultural landscapes. It also touches upon recent problems with honey bees and the use and need to further develop alternative managed pollinators. Chapter 11 (Bees and People), reviews the historical evidence of the exploitation of bees by people dating back to Paleolithic cave paintings. It includes several interesting stories such as how wild honey harvests declined by 50% in an area in India after 29 honey collectors were eaten by tigers. Chapter 12 (Bees in Folklore) recounts fascinating tales of bee genesis, the need to inform bees of their master's death, using bees to test the character of a suitor, written contracts with bees, and bee accomplices in burglaries. Chapter 13 (Bees in Folk and Modern Medicine) is true to its title and Chapter 14 (Bee Projects: Becoming a Backyard Bee Scientist) gives a few basic pointers on how to encourage bees to forage and nest in your garden.

If you are interested in learning more about bees in general, or if you are looking for a book to give someone with a general interest in natural history, this is a great option. My PhD advisor used to make every new student working in the lab read *Bees of the World* (O'Toole and Raw 1991) when they first started, and I think this will now be his go to book for new students needing a broad general and accessible introduction to bees.

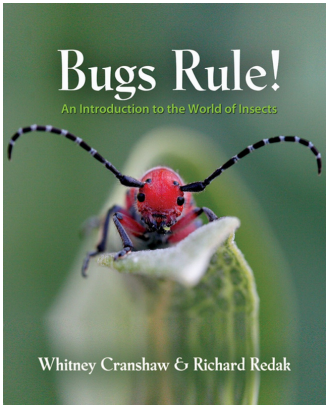
Literature Cited

Engel, M.S., Hinojosa-Diaz, I.A., and Rasnitsyn, A.P. 2009. A honey bee from the Miocene of Nevada and the biogeography of *Apis* (Hymenoptera: Apidae: Apini). Proceedings of the California Academy of Sciences, Series 4, **60**: 23-38.

O'Toole, C., and Raw, A. 1991. Bees of the World. Facts on File, New York. 192pp.

Sophie Cardinal
Agriculture and Agri-Food Canada
Canadian National Collection of Insects
Ottawa

Bugs Rule! An Introduction to the World of Insects. Cranshaw, W. & Redak, R. 2013. Princeton University Press, 830+ color photos, 496 pp. ISBN: 978-0-691-12495-7. $55.00 (hardcover).



As a field ecologist I always feel uneasy when it comes the turn of the "what's this bug?" question. An awkward silence and a deep embarrassment inevitably follow the inability to tell apart a sawfly larva from a caterpillar. It is true that I took an introductory entomology course during my degree and that I should know my bugs better, but most of the things I learnt are long gone. Therefore, I was particularly keen on finding a general entomology book that would go through all the basics in a readable manner. What attracted my attention to *Bugs rule!* was that it promised a visually attractive approach to insects (and non-insect relatives), with a bit of scientific rigour, that could help me refresh some of the concepts I had forgotten. And I must say I was not disappointed. This book was designed for a non-majors general education entomology course and, through the extensive use of fantastic photographs and an elegant style, provides an attractive alternative to the dull textbooks I had to use for that entomology course back in the day. The text is an enjoyable read and provides a lot of fun-facts about bugs and their natural history, making the read more lively (which indeed is to say a lot about a textbook). Fun-facts are provided in boxes throughout the book and cover a wide variety of topics. For example, there are maps depicting the Great Silk Road, a brief history on the origins of the traditional dance *tarantella*, and even a recipe for Maeng Da that uses giant water bugs as the main part of the dish (with even a recommendation to eat only the abdomen of these belostomatids, because "*the rest is too crunchy*"!).

The book is structured in a rather classical way. A few chapters in the beginning (Chapters 1 to 4) cover general issues of arthropod biology, from basic body organization to metamorphosis and physiology. They offer a broad introduction to basic concepts, and present interesting discussions, for example, arguing why insects cannot be too big nowadays but they were in geological time, or if insects sleep. In my opinion, it covers well, and at a good pace, most of the relevant points for students with little previous exposure to the subject (and as I said, it served as a good refresher for me too). The rest of the book (Chapters 5 to 18) is devoted to describing major insect and non-insect orders, with special emphasis on those that are most relevant to humans, like disease vectors or economically important pollinators and pests. The book also gives coverage to non-insect arthropods (Chapters 5-7), which, despite being acknowledged in the preface of the book, is rather surprising given the subtitle of the book: "*An Introduction to the World of Insects*". Chapters 8-18 deal with the main insect orders. Although some information is presented here and there in boxes throughout the book, I missed some specific chapters on the ecology of insects, their importance to humans and the potential responses of insects to global change.

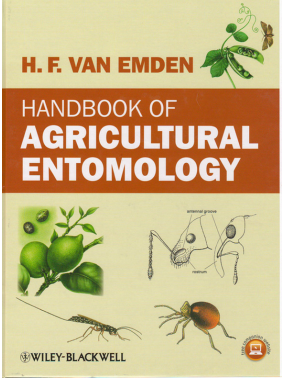
Making the world of insects more accessible to a broad audience is definitely one of the main strengths of *Bugs rule!* but, for my liking, this goal is sometimes taken too far. Chapters of the book generally cover one or several orders, but they are given far too "sexy" titles, and it is sometimes difficult to realize that "Insects fly!" will talk about Ephemeroptera and Odonata, or that the order Hymenoptera will be covered in a chapter entitled "City Builders That Rule". To add to this confusion, there are no taxonomic lists within each chapter to serve as a roadmap and give the reader some more rigorous orientation. Major taxonomic divisions are thus treated sequentially in each chapter, and information is not consistently presented for each group - for example, on more than one occasion I was left wondering about the type of metamorphosis

for some of the major orders. However, to compensate for this, there is an extremely useful appendix that presents systematically and concisely the main features of the hexapod orders (Appendix 3). Unfortunately, this appendix is buried among other less informative ones, such as the state insects for the USA and a list of the largest arthropods, and it is not referenced anywhere in the text. And this takes me to my other main criticism of this book: the lack of in-text citations. This was particularly frustrating, probably because as a scientist I am used to being able to check the citations for assessing the sources of information, or just for following up on a particularly surprising fact. Not even the beautiful photographs that illustrate the book are referenced in the text, which sometimes makes these visual aids miss their point entirely. Nor is there a recommended 'further reading' section to look for more details on specific subjects.

That said, I still believe that *Bugs rule!* is definitely a good introduction to the world of insects, and I would not hesitate to recommend it for its intended purpose: a general entomology course for non-science majors. As well, those of us who desperately want a reminder on the basics of entomology will greatly enjoy (and learn much from) reading this book.

Isabel C Barrio
Department of Biological Sciences
University of Alberta, Edmonton

Handbook of Agricultural Entomology. van Emden, H.F. 2013. Wiley-Blackwell, Oxford, UK. 312 pp. ISBN 978-0-470-65913-7. CAN$142.95, hardcover.



This is Helmut van Emden's twelfth book. An emeritus professor of horticulture at the University of Reading in the UK, Dr van Emden has distilled the essence of what he taught for over 30 years to students from all over the world. Written with a worldwide focus on 'insects that matter' this book is primarily about insects of importance to agriculture, especially horticulture, and a few forest pests, but also includes those that are household pests, attack humans and animals, transmit disease, or produce valuable or marketable substances. Consequently, the book title is somewhat misleading, but would need to be much longer to encompass all of this!

The book begins with a table of contents, preface and acknowledgements, and three chapters that introduce the reader to the world of insects, the external features of insects, and the major divisions of the Insecta. This is followed by nine chapters covering the important subclasses or orders of insects, one chapter on the Arachnida, a bibliography and an index. In his description of individual species, the author focuses on information such as damage symptoms, life histories and spot characters for recognition. He gives sufficient information on how to distinguish insects down to the family level. Included are over 400 figures to illustrate many of the described species and the damage they cause; particular morphological characters are indicated by arrows. The figures and some tables are also available online at a student companion website http://www.wiley.com/go/vanemden/agriculturalentomology. The book does not include information on how to control any particular pest problem.

A number of features of the book are most useful to the student entomologist. For example, new terms are in bold when first defined and the descriptions certainly help to develop identification skills. The number of all currently described species in each order is included, thus giving the reader a sense of their relative importance. Descriptions of damage, including explanations as to how insects can transmit a variety of plant and animal diseases, help the student to understand why the insects in this book are pests and need to be controlled. For example, the author provides a superb discussion regarding the

transmission of aphid-borne viruses. For those taxa having the most important pests, much information is included on their life history and behaviour that applied entomologists should know. Again, the information provided on aphids is particularly outstanding; this is not surprising as the author has published extensively on the subject of aphids and their control. Inclusion in the book of what the author considers currently to be some of the most significant insect pests worldwide, is also a useful ranking.

A few aspects of the book could stand improvement. Although most illustrations are excellent (and presented close to the accompanying text rather than on distant colour plates), some lack sharpness (e.g., the Essex skipper, *Thymelicus lineola* [Fig. 9.23, p. 145]) or some of the life stages are too small to distinguish their features (e.g., the pupal stage of the onion maggot, *Delia antiqua* [Fig. 10.46, p. 186]). Page numbers are not listed in the index next to common names that refer the reader only to the associated scientific name; one must look up a separate entry for the scientific name in order to find the page number. Perhaps this extra step is intended to aid the student in learning scientific names but otherwise it slows down looking up information.

There is considerable variation in the level of detail of crop type, geographical range and life history information for each species; although I assume this is generally related to the author's view of the importance of each pest, and space limitations, it left me wanting more in some instances. For example, although *Phyllotreta* species are referred to as being serious pests of brassica seedlings, only *P. cruciferae* and *P. nemorum* are specified (p. 257-258). The reader would have no sense that the crucifer flea beetle, *P. cruciferae,* and the striped flea beetle, *P. striolata,* are very destructive pests on the Canadian Prairies (in fact, they necessitate the application of insecticides to virtually all of the canola seed planted annually to millions of hectares). As another example, the San José scale, *Diaspidiotus perniciosus*, is reported as being "widely distributed" and a "major pest of yam, orchard fruits and currants in the subtropics" (p. 105-106). From this, the reader would not be informed of its presence in temperate regions such as Canada and Northern USA where it can be a serious pest on apples. Similarly, other important but largely episodic pests of the Prairies such as grasshoppers are not included, the text for the Acrididae focussing largely on the important locust grasshoppers (p. 49). Occasionally, pest species are mentioned as being found in the USA with no mention of Canada where they are also found (e.g., the Hessian fly, *Mayetiola destructor* [p. 164], or the peach twig borer, *Anarsia lineatella* [p. 132]) or it is not apparent they are found in North America (e.g., the western corn rootworm, *Diabrotica virgifera*, or the northern corn rootworm, *D. barberi* [p. 260]).

Overall, it seems that the book puts somewhat greater emphasis on pests of the tropics, subtropics, and of Europe (especially the UK) than of other temperate regions. More emphasis is placed on pests of crops such as citrus, coffee, cocoa, sugar cane and rice than on field crops such as corn, soybeans, cereals, oilseeds and pulses. The author states ". . . I have had to use my experience to select those [species] that seem to me to 'matter' most. A different author might well make a partially different selection." Indeed, if the book included everything various readers could want in it, it would be several times longer. But this book is not intended to be an update of Hill (1983; 1987) or a duplicate of CABI (2014); rather, it is intended as an affordable stand-alone text for the budding entomologist in need of a basic understanding of insect taxonomy and a world view of applied entomology. With this in mind, this very well written and delightfully engaging book certainly succeeds.

Literature cited

CABI. 2014. Crop Protection Compendium. www.cabi.org/cpc/ CABI, Wallingford, UK.

Hill, D.S. 1983. Agricultural insect pests of the tropics and their control, second edition. Cambridge University Press, Cambridge, UK.

Hill, D.S. 1987. Agricultural insect pests of temperate regions and their control. Cambridge University Press, Cambridge, UK.

C.P. Dufault
Christopher P. Dufault & Associates Inc.
Ottawa

Books available for review / Livres disponible pour critique

The ESC frequently receives unsolicited books for review. A list of these books is available online (http://www.esc-sec.ca/bulletinbooks.html) and is updated as new books are received.

If you wish to review one of these books, please send an email to the Chair of the Publications Committee (Tom Lowery, Tom.Lowery@agr.gc.ca).

You should briefly indicate your qualifications to review the topic of the book, and be able to complete your review within 8 weeks.

Preference will be given to ESC members.

La SEC reçoit fréquemment des livres non demandés pour des critiques. Une liste de ces livres est disponible en ligne (http://www.esc-sec.ca/fr/f-bulletinbooks.html) et est mise à jour lorsque de nouveaux livres sont reçus.

Si vous souhaitez critiquer un de ces livres, veuillez envoyer un message au président du comité des publications (Tom Lowery, Tom.Lowery@agr.gc.ca).

Vous devez brièvement indiquer vos qualifications pour critiquer le sujet du livre, et être en mesure de terminer votre critique en 8 semaines.

La préférence est donnée aux membres de la SEC.

Guidelines

Book reviews should be approximately 800-1200 words in length. They should clearly identify the topic of the book and how well the book meets its stated objective. Weaknesses and strengths of the book should be described.

Formatting of the review should follow that of reviews in recent issues of the Bulletin. A scan of the book cover (jpeg or tiff format, about 500 kb) should be submitted with the review.

Lignes directrices

Les critiques de livre doivent compter entre 800 et 1200 mots. Elles doivent clairement identifier le sujet du livre et si le livre rencontre bien les objectifs énoncés. Les forces et faiblesses du livre devraient être décrites.

Le format des textes doit suivre celui des critiques des récents numéros du Bulletin. Une version numérisée de la couverture du livre (en format jpeg ou tiff, environ 500 kb) devra être soumise avec la critique.

Currently available for review / Disponibles pour critique

Lemelin, R.H. (Ed.) 2013. Management of Insects in Recreation and Tourism. 365 pp. Cambridge University Press. ISBN: 9781107012882 [hardcover]

Morales-Ramos, J., Rojas, G. and D.I. Shapiro-Ilan. 2013. Mass Production of Beneficial Organisms, 1st Edition, Invertebrates and Entomopathogens. 764 pp. Academic Press. ISBN: 9780123914538 [hardcover or ebook]

Abrol, D.P. (Ed.) 2013. Integrated Pest Management, 1st Edition, Current Concepts and Ecological Perspective. 584 pp. Academic Press. ISBN: 9780123985293 [hardcover or ebook]

Onstad , D.W. (Ed.) 2013. Insect Resistance Management, 2nd Edition, Biology, Economics, and Prediction. 560 pp. Academic Press. ISBN: 9780123969552 [hardcover or ebook]

Sanborn, A.F. 2013. Catalogue of the Cicadoidea (Hemiptera: Auchenorrhyncha), 1st Edition. 1002 pp. Academic Press. ISBN: 9780124166479 [hardcover]

Lonsdale, O. 2013. Review of the Families Tanypezidae and Strongylophthalmyiidae, with a Revision of *Neotanypeza* Hendel (Diptera: Schizophora). Smithsonian Contributions to Zoology, Number 641. vi + 60 pages, 92 figures, 5 tables. (http://si-pddr.si.edu/dspace/handle/10088/21132)

Hoy, M. 2013. Insect Molecular Genetics, 3rd Edition, An Introduction to Principles and Applications. 840 pp. Academic Press. (hardcover, ebook). ISBN: 9780124158740

Chyb, S. and N. Gompel. 2013. Atlas of *Drosophila* Morphology, 1st Edition, Wild-type and Classical Mutants. 248 pp. Academic Press. (hardcover, ebook). ISBN: 9780123846884

Wajnberg E. and S. Colazza (Eds.) 2012. Chemical Ecology of Insect Parasitoids. 328 pp. Wiley-Blackwell, Hoboken, NJ. (hardcover). ISBN: 978-1-118-40952.

Paiero, S.M, Jackson, M., Jewiss-Gaines, A., Kimoto, T., Gill, B.D. and S.A. Marshall. 2012. Field Guide to Jewel Beetles (Coleoptera: Buprestidae) of Northeastern North America. Canadian Food Inspection Agency. 164 maps. 411p

Pfau, H.K. 2011. Functional Morphology and Evolution of the Male Secondary Copulatory Apparatus of the Anisoptera (Insecta: Odonata). 103 p., 65 figures (Zoologica, Volume 156). ISBN: 978-3-510-55043-2 (paperback) (http://www.schweizerbart.de/publications/detail/isbn/9783510550432)

Announcements / Annonces

Biological Survey of Canada Winter 2013 Newsletter / Bulletin de l'hiver 2013 de la Commission biologique du Canada

The winter 2013 BSC Newsletter is posted on the BSC website (http://www.biology.ualberta.ca/bsc/news32_2/bscwinter2013.pdf)
This issue contains three great articles related to the Biota of Canada Project (one on mites, one on tardigrades and one on the general status of species in Canada), a sneak peak at the Tables of Contents for Volumes 3 and 4 of the Arthropods of Canadian Grasslands series, as well as the report of the Annual General Meeting.

Le bulletin de l'hiver 2013 de la CBC est disponible sur le site Internet (http://www.biology.ualberta.ca/bsc/news32_2/bscwinter2013.pdf).
Ce numéro contient trois excellents articles reliés au projet « Biota of Canada » (un sur les acariens, un sur les tardigrades et un sur le statut général des espèces au Canada), un aperçu de la table des matières pour les volumes 3 et 4 de la série *Arthropods of Canadian Grasslands*, ainsi qu'un rapport de l'Assemblée générale annuelle.

2013 Pest Management Research Report / L'édition 2013 de la Rapport de recherches sur la lutte dirigée

The 2013 Pest Management Research Report is now available at / L'édition 2013 de la Rapport de recherches sur la lutte dirigée est maintenant disponible à :
http://www.cps-scp.ca/pest_management-reports.shtml

Just out – of special interest to soldier beetle lovers! / Fraîchement sorti – particulièrement intéressant pour les amateurs de cantharides!

The Cantharidae of Eastern Canada and Northeastern United States
Georges Pelletier & Christian Hébert
CJAI 25 February 28, 2014
http://dx.doi.org/10.3752/cjai.2014.25
urn:lsid:zoobank.org:pub:0D1AF9FE-8898-48CF-B031-4A3783079C69

Canadian Journal of ARTHROPOD IDENTIFICATION
A product of the Biological Survey of Canada

64th Annual Meeting of Members and Board of Directors Meetings

The Annual Meeting of Members of the Entomological Society of Canada will be held at the Radisson Hotel, Saskatoon, Saskatchewan, on Tuesday, 30 September 2014. The Board of Directors Meeting will be held at the same location on Saturday, 27 September 2014, from 8:30 to 17:00. The incoming Board of Directors will also meet immediately following the Annual General Meeting. Matters for consideration at any of the above meetings should be sent to Alec McClay, Secretary of the ESC (see inside back cover for contact details).

64e assemblée annuelle et réunions du conseil d'administration

L'assemblée annuelle de la société d'entomologie du Canada se tiendra à l'hôtel Radisson de Saskatoon, en Saskatchewan, le mardi 30 septembre 2014. La réunion du conseil d'administration se tiendra au même endroit, le samedi 27septembre 2013 de 8:30 à 17:00. Le nouveau conseil d'administration se réunira également immédiatement après l'assemblée annuelle. Les sujets à aborder pour n'importe laquelle de ces réunions doivent être envoyés à Alec McClay, secrétaire de la SEC (voir le troisième de couverture pour les coordonnées détaillées).

Changes to ESC Election Procedures

Under the new By-laws approved by ESC members under the Canada Not-for-profit Corporations Act, some changes were needed to the Society's election procedures. The Act requires (1) that Directors be elected at the Annual Members' Meeting, rather than through the postal or on-line election that has been conducted in the past, and (2) that Societal Officers also be Directors in order to have a vote at Board meetings. We will therefore still hold a ballot to select candidates for a slate of Directors prior to the Annual Meeting as in the past, but the name of the selected individuals will then be presented for formal election at the Annual Meeting in Saskatoon in September. This ballot will select candidates for a Director at Large and a Societal Director; the Societal Director will then be appointed as Second Vice-President by the Board, and will succeed to the positions of First Vice-President, President and Past-President in the following years. We are therefore putting out the following **Call for Nominations** under this revised procedure, and an online ballot will be held with voting closing on 15 July 2014. As last year, paper ballots will be

Changements aux procédures d'élection de la SEC

En vertu du nouveau règlement intérieur approuvé par les membres de la SEC selon la loi canadienne sur les organisations à but non lucratif, quelques modifications aux procédures d'élection de la Société étaient nécessaires. La nouvelle loi requiert (1) que les directeurs soient élus à l'assemblée générale annuelle plutôt que par des élections par la poste ou en ligne tel que mené par le passé, et (2) que les dirigeants de la Société soient également directeurs afin de pouvoir voter aux réunions du CA. Nous allons donc désormais tenir un vote pour sélectionner les candidats pour une liste de directeurs avant la réunion annuelle, comme par le passé, mais le nom des individus sélectionnés sera ensuite présenté à des élections formelles à la réunion annuelle à Saskatoon en septembre. Ce vote sélectionnera les candidats pour un conseiller et un directeur sociétal; le directeur sociétal sera ensuite nommé comme second vice-président par le CA, et occupera ensuite les postes de premier vice-président, président et président-sortant lors des années suivantes. Nous annonçons donc un **appel à nomination** selon cette procédure révisée, et un vote en ligne sera tenu, avec fermeture des

provided to members who have not provided email addresses.

Call for nominations: Societal Director (Second Vice-President), Director at Large

Nominations for the Societal Director and Director at Large must be signed by three active members of the Society and be received by the Secretary of the Entomological Society of Canada, Alec McClay, by 30 April 2014 (see inside back cover for contact details).

votes le 15 juillet 2014. Comme l'an dernier, des bulletins de vote papier seront fournis aux membres qui n'ont pas fourni d'adresse courriel.

Appel à nomination : directeur sociétal (second vice-président), conseiller

Les nominations pour directeur sociétal et conseiller doivent être signées par trois membres actifs de la Société et être reçues par le secrétaire de la Société d'entomologie du Canada (Alec McClay) au plus tard le 30 avril 2014 (voir le troisième de couverture pour les coordonnées détaillées).

The ESC and the new Canada Not-for-profit Corporations Act

Gary Gibson

In 2009, a new Canada Not-for-profit Corporations Act was passed. This requires all federally incorporated not-for-profit corporations, such as the Entomological Society of Canada, to "transition" into the new Act by 17 October 2014 or be dissolved and have all assets dispersed to some other not-for-profit corporation. Transitioning required that ESC members approve *Articles of Continuance* to replace its original Letters Patent of incorporation granted under the old Act, and new *By-laws* that are compliant with provisions of the new Act. Members of the ESC accepted Board-proposed *Articles of Continuance* and revised *By-laws* at the 63rd Annual General Meeting in Guelph, 22 October 2013, and the ESC successfully transitioned under the new Act as of 30 October 2013, when Corporations Canada granted it a Certificate of Continuance. The *Scholarship Fund of the Entomological Society of Canada* was originally established as a Charitable Trust within the ESC under Canada Revenue Agency provisions. It therefore did not need to transition, though provisions of the new Act will affect its governance within the Society.

One consequence of transitioning is that some aspects of how the ESC governed itself under

La SEC et la nouvelle Loi canadienne sur les organisations à but non lucratif

Gary Gibson

En 2009, une nouvelle loi canadienne sur les organisations à but non lucratif est passée. Celle-ci requiert que toutes les organisations à but non lucratif enregistrées au fédéral, telle que la Société d'entomologie du Canada, fassent la transition vers la nouvelle loi au plus tard le 17 octobre 2014, ou seront dissoutes et verront leurs biens dispersés parmi d'autres organisations à but non lucratif. Le processus de transition demande que les membres de la SEC approuvent le *statut de prorogation* afin de remplacer les lettres patentes originales en vertu de l'ancienne loi, et que le nouveau règlement intérieur soit conforme avec les dispositions de la nouvelle loi. Les membres de la SEC ont accepté le *statut de prorogation* et le règlement intérieur proposés par le CA lors de la 63e assemblée générale annuelle à Guelph le 22 octobre 2013, et la SEC a effectué la transition avec succès en vertu de la nouvelle loi en date du 30 octobre 2013, lorsqu'Industrie Canada lui a remis un certificat de prorogation. Le *Fonds de bourses d'études de la Société d'entomologie du Canada* a été originalement établi en tant que fiducie caritative au sein de la SEC en vertu des dispositions de l'Agence du revenu du Canada. Il n'avait donc pas à faire la transition, bien que les dispositions de la

the old Act conflict with some provisions and definitions in the new Act. The most significant aspects of the new Act that affect how the ESC governs itself include:

- only members of a corporation can elect Directors (therefore Regional Affiliates can no longer appoint Regional Directors),
- only Directors of a corporation may vote at Board meetings and the Chair of the Board must be a Director (therefore ESC Societal Officers, who were not Directors, no longer have voting privileges and the President cannot Chair the Board or the annual member meeting),
- all Directors must be elected by members at the annual meeting of the corporation (therefore Directors-at-Large can no longer be elected prior to the AGM),
- Directors can no longer vote by proxy at Board meetings, though they may participate by electronic means,
- by definition of the Act, current ESC trustees such as the Secretary and Treasurer are officers of the corporation, the same as the President and Vice-Presidents of the Society,
- the Board of a corporation appoints officers of the corporation (currently the 2nd Vice-President is elected by members and all other officers are appointed by the Board),
- the necessity of an annual public accountant audit of finances depends on whether a corporation is a soliciting or non-soliciting corporation, which is defined by the amount and origin of income derived annually.

These and other conflicts necessitated that the ESC modify its existing *By-laws* to comply with provisions of the new Act prior to transitioning. The revised, member accepted *By-laws* can be viewed in the Member's Section of the ESC web site (http://www.esc-sec.ca/index.php), and enable the Board to:

- establish a new category of Director, the Societal Director, who would also be appointed by the Board to the offices of 2nd Vice-President, 1st Vice-President, President and Past-President in successive years,
- submit to members at each annual meeting

nouvelle loi affectent sa gouvernance au sein de la Société. Une conséquence de la transition est que certains aspects de la façon dont la SEC se gouverne en vertu de l'ancienne loi sont en conflit avec certaines dispositions et définitions de la nouvelle loi. Les aspects les plus importants de la nouvelle loi qui affectent comment la SEC se gouverne incluent :

- Seuls les membres d'une organisation peuvent élire les administrateurs (et donc les représentants régionaux ne peuvent plus être nommé directeurs régionaux),
- Seuls les administrateurs de l'organisation peuvent voter aux réunions du CA et le président du CA doit être un administrateur (les dirigeants sociétaux de la SEC, qui n'étaient pas administrateurs, n'ont donc plus le privilège de voter, et le Président ne peut pas présider les réunions du CA ou les AGA),
- Tous les administrateurs doivent être élus par les membres à la réunion annuelle de l'organisation (les conseillers ne peuvent donc plus être élus avant l'AGA),
- Les administrateurs ne peuvent plus voter par mandataire aux réunions du CA, bien qu'ils puissent participer de façon électronique,
- Par définition de la loi, les fiduciaires actuels de la SEC tels que le secrétaire et le trésorier sont des dirigeants de l'organisation, tout comme le président et les vice-présidents de la Société,
- Le CA d'une organisation nomme les dirigeants de l'organisation (présentement, le 2e vice-président est élu par les membres et tous les autres dirigeants sont nommés par le CA),
- La nécessité d'une vérification annuelle des finances par un expert-comptable dépend du fait que l'organisation ait recours ou non à la sollicitation, qui est défini par le montant et l'origine des revenus annuels.

Ces aspects et d'autres conflits nécessitaient que la SEC modifie son règlement intérieur existant afin de se conformer aux dispositions de la nouvelle loi avant la transition. Le règlement intérieur révisé et accepté par les membres peut être consulté dans la section des membres du site Internet de la SEC (http://esc-sec.ca/f-index.php) et permet au CA de :

- Établir une nouvelle catégorie d'administrateurs, le directeur sociétal, qui sera également nommé par le CA pour le

a slate of names for election as a Societal Director, Director-at-Large and one or more Regional Directors, as necessary, each for a three year term on a rotational basis,

- seek from an Affiliate Society, as necessary, the name of an individual to be presented to ESC members for election as a Regional Director to represent that Affiliate,
- poll members prior to the annual meeting for the name of an individual to be presented to members for election as Societal Director and subsequent appointment by the Board as 2nd Vice-President,
- poll members prior to the annual meeting for the name of an individual to be presented to members for election as Director-at-Large and,
- appoint the Past-President of the ESC as a Director for a one year term as provisioned by the *Articles of Continuance*.

In addition to conflicts in how the ESC governed itself, several other conflicts existed between provisions of the Act and provisions of its old *By-laws* and *Standing Rules*. Consequently, the ESC *Standing Rules* are now being revised to ensure that they are compliant with the new Act and its revised *By-laws*, to reflect governance and other operational changes made necessary by the new Act, and to incorporate parts of its old *By-laws* that the ESC wishes to retain as part of its accepted operating procedures. The revised *Standing Rules* will incorporate numerous changes and must be approved by members before they become valid. They will be submitted to members for discussion and comment prior to the next Joint Annual Meeting and members are urged to study them carefully prior to the 64th annual meeting in Saskatoon.

rôle de second vice-président, premier vice-président, président et président-sortant dans les années successives,

- Soumettre aux membres à chaque réunion annuelle une liste de noms pour l'élection du directeur sociétal, conseiller et un ou plusieurs directeurs régionaux, si nécessaire, chacun pour un mandat de trois ans sur une base de rotation,
- Chercher auprès d'une société affiliée, si nécessaire, le nom d'un individu à être présenté aux membres de la SEC pour l'élection d'un directeur régional afin de représenter cette société affiliée,
- Sonder les membres avant la réunion annuelle pour obtenir le nom d'un individu à être présenté aux membres pour l'élection du directeur sociétal et de la nomination subséquente par le CA comme second vice-président,
- Sonder les membres avant la réunion annuelle pour obtenir le nom d'un individu à être présenté aux membres pour l'élection du conseiller, et,
- Nommer le président-sortant de la SEC comme administrateur pour un mandat d'un an tel que stipulé par le *statut de prorogation*.

En plus des conflits concernant la façon dont la SEC se gouverne, plusieurs autres conflits existent entre les dispositions de la loi et les dispositions de ses anciens *règlement intérieur* et *règles permanentes*. Par conséquent, les *règles permanentes* de la SEC sont actuellement révisées afin de s'assurer qu'elles sont conformes avec la nouvelle loi et le nouveau *règlement intérieur*, afin de refléter les changements de gouvernance et opérationnels effectués en vertu de la nouvelle loi, et d'incorporer les parties de son ancien *règlement intérieur* que la SEC souhaite maintenir parmi ses procédures opérationnelles acceptées. Le *règlement intérieur* révisé incorporera plusieurs changements et doit être approuvé par les membres avant d'être valide. Les changements seront soumis aux membres pour discussion et commentaires avant la prochaine réunion conjointe annuelle et les membres sont priés de les étudier attentivement avant la 64e réunion annuelle à Saskatoon.

Tenth Annual Photo Contest

The Tenth Annual Photo Contest to select images for the 2015 covers of *The Canadian Entomologist* and the *Bulletin of the Entomological Society of Canada* is underway. The cover images are intended to represent the breadth of entomology covered by the Society's publications. Insects and non-insects in forestry, urban or agriculture; landscapes, field, laboratory or close-ups; or activities associated with physiology, behaviour, taxonomy or IPM are all desirable. A couple of 'Featured Insects' (for the spine and under the title) are also needed. If selected, your photo will grace the cover of both publications for the entire year. In addition, winning photos and a selection of all submitted photos will be shown on the ESC website.

Contest rules:

Photos of insects and other arthropods in all stages, activities, and habitats are accepted. To represent the scope of entomological research, we also encourage photos of field plots, labora¬tory experiments, insect impacts, research activities, sampling equipment, etc. Photos should, however, have a clear entomological focus.

Digital images must be submitted in unbordered, high-quality JPG format, with the long side (width or height) a minimum of 1500 pixels.

Entrants may submit up to five photographs. A caption must be provided with each photo submitted; photos without captions will not be accepted. Captions should include the locality, subject identification as closely as is known, description of activity if the main subject is other than an insect, and any interesting or relevant information. Captions should be a maximum of 40 words.

The entrant must be a member in good standing of the Entomological Society of Canada. Photos must be taken by the entrant, and the entrant must own the copyright.

The copyright of the photo remains with the entrant, but royalty-free use must be granted to the ESC for inclusion on the cover of one volume (6 issues) of *The Canadian Entomologist,* one volume (4 issues) of the *Bulletin*, and on the ESC website.

The judging committee will be chosen by the Chair of the Publications Committee of the ESC and will include a member of the Web Content Committee.

The Photo Contest winners will be announced on the ESC website, and may be announced at the Annual Meeting of the ESC or in the *Bulletin*. There is no cash award for the winners, but photographers will be acknowledged in each issue the photos are printed.

Submission deadline is **31 July 2014**. Entries should be submitted as an attachment to an email message; the subject line should start with "ESC Photo Contest Submission". Send the email message to: photocontest@esc-sec.ca.

Dixième concours annuel de photographie

Le dixième concours annuel de photographie visant à sélectionner des images pour les couvertures de *The Canadian Entomologist* et du *Bulletin de la Société d'entomologie du Canada* pour 2015 est en cours. Les images sur la couverture doivent représenter l'étendue entomologique couverte par les publications de la Société. Des photos représentant des insectes ou autres arthropodes forestiers, urbains ou agricoles, des paysages, du travail de terrain ou de laboratoire, des gros plans, ainsi que montrant des activités associées à la physiologie, au comportement, à la taxonomie ou à la lutte intégrées seraient souhaitées. Deux « insectes vedettes » (pour le dos et sous le titre) sont également recherchés. Si elle est sélectionnée, votre photo ornera la couverture des deux publications pour l'année entière. De plus, vos photos gagnantes et une sélection de photos soumises seront montrées sur le site Internet de la SEC.

Règlements du concours :

Les photos d'insectes et autres arthropodes à n'importe quel stade, effectuant n'importe quelle activité et dans n'importe quel habitat sont acceptés. Afin de représenter les sujets de la recherche entomologique, nous encourageons également les photos de parcelles de terrain, expériences de laboratoire, impacts des insectes, activités de recherche, équipement d'échantillonnage, etc. Les photos doivent, cependant, avoir un intérêt entomologique clair.

Les images numériques doivent être soumises sans bordure, en format JPG de haute qualité, avec le plus grand côté (largeur ou hauteur) d'un minimum de 1500 pixels.

Chaque participant peut soumettre jusqu'à cinq photographies. Une légende doit être fournie pour chaque photo soumise : les photos sans légendes ne seront pas acceptées. La légende doit inclure la localisation, l'identification du sujet le plus précisément possible, la description de l'activité si le sujet n'est pas un insecte, et toute information intéressante ou pertinente. Les légendes doivent avoir une longueur maximale de 40 mots.

Les participants doivent être membres en bonne et due forme de la Société d'entomologie du Canada. Les photos doivent avoir été prises par le participant, et le participant doit en posséder les droits d'auteur.

Le participant conserve les droits d'auteur de la photo, mais l'utilisation libre de droits doit être accordée à la SEC afin de l'inclure sur la couverture d'un volume (6 numéros) de *The Canadian Entomologist*, un volume (4 numéros) du *Bulletin*, et sur le site Internet de la SEC.

Le comité d'évaluation sera choisi par le président du comité des publications de la SEC et inclura un membre du comité du contenu du site Internet.

Les gagnants du concours de photographie seront annoncés sur le site Internet de la SEC et pourront être annoncés à la réunion annuelle de la SEC ou dans le *Bulletin*. Il n'y a pas de prix en argent pour les gagnants, mais les photographes seront remerciés dans chaque numéro où les photos seront imprimées.

La date limite de soumission est le **31 juillet 2014**. Les soumissions doivent être faites en pièces jointes d'un courrier électronique. L'objet du message doit débuter par « Soumission pour le concours de photographie de la SEC ». Envoyez vos courriels à : photocontest@esc-sec.ca.

Officers of affiliated Societies, 2013-2014
Dirigeants des Sociétés associées, 2013-2014

Entomological Society of British Columbia

President Mike Smirle
President-Elect Steve Perleman
Past President Ward Strong
Treasurer Max Salomon
Editor (Journal) Dezene Huber
Editors (Boreus) Gabriella Zilahi-Balogh
Webmaster Alex Chubaty
Secretary Tracy Hueppelsheuser
Plant Health Unit
B.C. Ministry of Agriculture
1767 Angus Campbell Road, Abbotsford, BC, V3G 2M3
Tel: (604) 556-3031
E-mail: Tracy.Hueppelsheuser@gov.bc.ca
http://www.sfu.ca/biology/esbc/

Entomological Society of Alberta

President Mike Dolinski
Vice-President John Swann
Past President Felix Sperling
Treasurer Caroline Whitehouse
Editor (Proceedings) Megan Evans
Webmaster Alec McClay
Secretary Ken Fry
Olds College
4500 - 50 Steet, Olds, AB T4H 1R6
Tel: (403) 556-8261
E-mail: esalberta@gmail.com
http://www.entsocalberta.ca

Entomological Society of Saskatchewan

President Margie Gruber
Vice-President Dave Halstead
Past President Doug Baldwin
Treasurer Dwayne Hegedus
Newsletter Editor Dave Halstead
Secretary Iain Phillips
Saskatchewan Watershed Authority
101-108 Research Drive, Saskatoon, SK, S7N 3R3
Tel: (306) 933-7474
Email: iain.phillips@swa.ca
http://www.entsocsask.ca

Entomological Society of Manitoba

President L. Robbin Lindsay
President-Elect Richard Westwood
Past President Robert J. Lamb
Treasurer Ian Wise
Newsletter Editors Marjorie Smith
Editor (Proceedings) Terry Galloway
Webmaster Rob Currie
Secretary David Wade
City of Winnipeg Insect Control Branch
1539 Waverley Street, Winnipeg, MB, R3T 4V7
E-mail: dwade@winnipeg.ca
http://home.cc.umanitoba.ca/esm/

Entomological Society of Ontario

President Jeremy McNeil
President-Elect Ian Scott
Past President Jeff Skevington
Treasurer Shiyou Li
Editor (Journal) John Huber
Webmaster Morgan Jackson
Secretary Michelle Locke
Vista Centre
1830 Bank St. P.O. Box 83025
Ottawa, ON K1V 1A3
E-mail: entsocont.membership@gmail.com
http://www.entsocont.ca

Société d'entomologie du Québec

Présidente Véronique Martel
Vice-présidente Caroline Provost
Présidente sortante Jade Savage
Trésorier François Fournier
Rédactrice (Antennae) Louise Voynaud
Webmestre Thierry Poiré
Secrétaire Danielle Thibodeau
Centre de recherche et de développement en horticulture
430, boul. Gouin
Saint-Jean-sur-Richelieu (Québec) J3B 3E6
Tél : 450-346-2097
Email : secretariat@seq.qc.ca
thibodeaudanielle@hotmail.com

Acadian Entomological Society

President Chris Cutler
Vice-President Drew Carlton
Past President Gaétan Moreau
Journal Editor Don Ostaff
Webmaster Rick West
Secretary/Treasurer Rob Johns
Atlantic Forestry Centre
P.O. Box 4000, 1350 Regent Street South
Fredericton, NB, E3B 5P7
Tel: (506) 452-3785
E-mail: treasurer@acadienes.ca
http://www.acadianes.org/index.html

Editor's note: Society Directors and Officers are reminded to check these lists, and submit corrections, including the names and positions of new officers.

Bulletin of the Entomological Society of Canada

Editor: Cedric Gillott
Assistant Editor: Donna Giberson

The *Bulletin of the Entomological Society of Canada*, published since 1969, presents quarterly entomological news, opportunities and information, details of Society business, matters of wider scientific importance and book reviews.

Published by the
Entomological Society of Canada
393 Winston Ave.
Ottawa, Ontario, Canada K2A 1Y8
www.esc-sec.ca/
entsoc.can@bellnet.ca

The Entomological Society of Canada was founded in 1863 primarily to study, advance and promote entomology. It supports entomology through publications, meetings, advocacy and other activities.

Send correspondence to:
Cedric Gillott
Bulletin Editor
Department of Biology
University of Saskatchewan
112 Science Place, SK S7N 5E2
Telephone: (306) 966-4401
Fax: (306) 966-4461
E-mail: cedric.gillott@usask.ca

ISSN: 0071-0741
Customer Account No. 3975533
Publications Mail Agreement No. 40033986
Printed in Canada

Submission deadline for the next issue: 30 April 2014

Bulletin de la Société d'entomologie du Canada

Rédacteur: Cedric Gillott
Rédactrice adjointe: Donna Giberson

Le *Bulletin de la Société d'entomologie du Canada*, publié depuis 1969, présente trimestriellement des informations entomologiques, des occasions, des renseignements sur les opérations de la Société, des dossiers scientifiques d'importance et des analyses d'ouvrages.

Publié par la
Société d'entomologie du Canada
393 Winston Ave.
Ottawa, Ontario, Canada K2A 1Y8
www.esc-sec.ca/
entsoc.can@bellnet.ca

La Société d'entomologie du Canada a été établie en 1863 principalement pour promouvoir l'étude et l'avancement de l'entomologie. Elle soutient l'entomologie par l'entremise de publications, de réunions et d'autres activités.

Envoyer vos soumissions à:
Cedric Gillott
Rédacteur du *Bulletin*
Department of Biology
University of Saskatchewan
112 Science Place, SK S7N 5E2
Telephone: (306) 966-4401
Fax: (306) 966-4461
courriel : cedric.gillott@usask.ca

ISSN: 0071-0741
Numéro de client: 3975533
Numéro de convention: 40033986
Imprimé au Canada

Date de tombée pour le prochain numéro: 30 avril 2014

The last word / Le dernier mot

Donna Giberson, Assistant Editor / Rédacteur adjointe

New Kid on the Block

A few people have asked me over the past few weeks why I volunteered to be Assistant Editor for the Bulletin. The first part of the answer is easy – I think it is important to be involved with one's Society, and this is something I can help out with. The second part of the answer is a bit more complex. I like reading, and I like writing, and I like to help people write.

I'm sure you've heard this before, or a statement just like it: "*The quality of writing in university students is declining at an alarming rate.*" (I've been guilty of saying it myself). The truism is actually that teachers and professors in every age have complained about the quality of their students' writing, and the amount of time they spend grading or editing.

So it may seem a bit odd that with all the editing I do for work, I'm jumping into a new job where more editing is part of the job description. But one thing I've learned in my 22 years of university teaching is that people who are passionate about their subject tend to write well about that subject. The Bulletin is all about people being passionate about Entomology, and is a rich source of interesting writing by interesting people. That's an editor's dream.

My own background is in aquatic entomology, and I've been lucky enough to have traveled to many nooks and crannies in our huge country in search of my watery critters. I work on life histories, distributions, and

La petite nouvelle

Quelques personnes m'ont demandé dans les dernières semaines pourquoi je m'étais proposée pour être rédactrice adjointe du Bulletin. La première partie de la réponse est facile – je pense qu'il est important de s'impliquer dans sa Société, et c'est une tâche pour laquelle je peux aider. La deuxième partie de la réponse est un peu plus complexe. J'aime lire et j'aime écrire, et j'aime aider les gens à écrire.

Je suis sûre que vous avez déjà entendu ça quelque part, ou une phrase du genre « La qualité de l'écriture chez les étudiants universitaires décline à un taux alarmant » (j'ai été coupable de le dire moi-même). Le lieu commun est que les enseignants et professeurs de tout temps se sont plaint de la qualité de l'écriture de leurs étudiants, et du temps qu'ils passaient à noter ou corriger.

Il semble donc peut-être bizarre qu'avec tout le travail d'édition que je fais pour le travail, je saute à pieds joints dans un nouvel emploi où l'édition fait partie de la description de tâches. Mais s'il y a une chose que j'ai apprise durant mes 22 ans d'enseignement universitaire, c'est que les gens qui sont passionnés par leur sujet ont tendance à bien écrire sur celui-ci. Le Bulletin concerne les gens qui sont passionnés par l'entomologie, et est une source riche d'écrits intéressants, par des gens intéressants. C'est le rêve d'un éditeur.

Ma propre expérience est en entomologie aquatique, et j'ai été assez chanceuse de voyager dans de nombreux coins et recoins de notre immense pays à la recherche de mes créatures aqueuses. Je travaille sur l'histoire de vie, la distribution et la biodiversité des insectes aquatiques, particulièrement des éphémères et plécoptères. Dans les dernières années, je me suis concentrée sur l'utilisation de la biodiversité et des données d'histoire de vie en conservation et protection des ruisseaux comme habitats.

biodiversity of aquatic insects, particularly mayflies and stoneflies. In recent years, my focus has been on using biodiversity and life history data in conservation and protection of stream habitats.

I'd like to thank Julia Mlynarek for all her help in the transition these past few weeks, and note that I will have some pretty big shoes to fill, as I jump in to help Cedric put each issue of the Bulletin together. Julia has promised to keep helping out as I learn the ropes, and I really look forward to working with Cedric and Julia over the coming months.

J'aimerais remercier Julia Mlynarek pour son aide avec la transition dans les dernières semaines, et, alors que je saute à pieds joints pour aider Cedric à assembler chaque numéro du Bulletin, la barre est haute pour moi. Julia m'a promis de continuer à m'aider pendant que j'apprends les ficelles du métier, et j'ai vraiment hâte de travailler avec Cedric et Julia dans les prochains mois.

Donna Giberson

Two PEI invaders: *Bombus impatiens* was likely introduced to PEI in the late 1990s for blueberry pollination, but is captured here visitng the iconic, but also invasive, lupin (*Lupinus polyphyllus*) near Blooming Point, PEI.

Entomological Society of Canada, 2013-2014
Société d'entomologie du Canada, 2013-2014

Executive Council / Conseil exécutif

President / Présidente
Rebecca Hallett
University of Guelph
50 Stone Road East
Guelph, ON N1G 2W1
Tel: (519) 824-4120 ext54488
Fax:(519) 837-0442
E-mail: rhallett@uoguelph.ca

First Vice-President / Premier vice-président
Staffan Lindgren
University of Northern British Columbia
Prince George, British Columbia, V2N 4Z9
Tel.: 250-960-5846
Fax: 250-960-5539
E-mail: Staffan.Lindgren@unbc.ca

Second Vice-President / Second vice-président
Terry Wheeler
Department of Natural Resource Sciences
McGill University
Ste-Anne-de-Bellevue, QC, H9X 3V9
Tel: (514) 398-7937
Fax: (514) 398-7990
E-mail: terry.wheeler@mcgill.ca

Past President / Président sortant
Rosemarie De Clerck-Floate
Agriculture and Agri-Food Canada
5403 - 1 Avenue South, PO Box 3000
Lethbridge, Alberta T1J 4B1
Tel: (403) 317-2270, Fax: (403) 382-3156
E-mail: Rosemarie.Declerck-Floate@agr.gc.ca

Directors-at-Large / Conseillers
Chris MacQuarrie (2014)
Zoë Lindo (2015)
Kirk Hillier (2016)

Regional Directors / Directeurs régionaux
Bill Riel (ESBC), Rob Longair (ESA), Jeff Boone (ESS), Kateryn Rochon (ESM), Patrice Bouchard (ESO), Annabelle Firlej (SEQ), Gaetan Moreau (AES)

Student Representative / Représentant des étudiants
Paul Abram
University of Montreal
E-mail: paul.abram@umontreal.ca

Trustees / Fiduciaires

Treasurer / Trésorier
Scott Brooks
Entomological Society of Canada
393 Winston Ave. Ottawa, ON K2A 1Y8
Tel: (613) 694-2718 Fax: (613) 759-1927
E-mail: scott.brooks@agr.gc.ca

Secretary / Secrétaire
Alec McClay
Tel: (780) 464-4962, Fax: (780) 410-0496
E-mail: secretary@esc-sec.ca

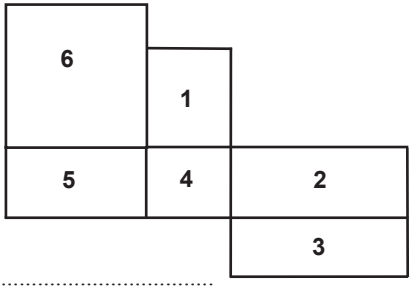
Bulletin* Editor / Rédacteur du *Bulletin
Cedric Gillott
Dept of Biology, University of Saskatchewan
112 Science Place, SK S7N 5E2
Tel: (306) 966-4401, Fax: (306) 966-4461
E-mail: cedric.gillott@usask.ca

Asst. *Bulletin* Editor / Rédactrice adj. du *Bulletin*
Donna Giberson
Dept. of Biology
University of Prince Edward Island
Charlottetown, PE, C1A 4P3
Tel: (902) 566-0797
E-mail: giberson@upei.ca

Webmaster / Webmestre
Dicky Yu
Agriculture and Agri-Food Canada
K.W. Neatby Building, Rm.2125
960 Carling Avenue
Ottawa, Ontario K1A 0C6
Tel: 613-792-2045
Fax: 613-759-1970
E-mail: dickyyu@gmail.com

The Canadian Entomologist
Editor-in-Chief / Rédacteur en chef
Christopher Buddle
McGill University
Ste-Anne-de-Bellevue, QC H9X 3V9
Tel: (514) 398-8026
E-mail: chris.buddle@mcgill.ca

Head Office / Siège social
Derna Lisi (Office manager)
Entomological Society of Canada
393 Winston Ave., Ottawa, ON K2A 1Y8
Tel: (613) 725-2619, Fax: (613) 725-9349
E-mail: entsoc.can@bellnet.ca
www.esc-sec.ca



Images

Beneath the title: *Cucullia lychnitis* caterpillar on a stem of Verbascum (Escalona, Aragon, Spain) 1 July 2011. Photo: Francois Lieutier

1 Young Entomologist Aya Hoover in action inspecting a frame of honey bees (*Apis mellifera*) (Beaverlodge Research Farm, Alberta, Canada). Photo: Shelley Hoover

2 One of Canada's rare stag beetles, *Sinodendron rugosum*, walks across the moss (Burnaby Mountain, British Columbia, Canada), 31 July 2013. Photo: Sean McCann

3 Female *Phiddipus regius* (Lake Placid, Florida, United States of America). Photo: Guillame Dury

4 Cabbage seedpod weevil (*Ceutorhynchus obstrictus*), an invasive pest of canola (Delémont, Switzerland). Photo: Tim Haye

5 Treehoppers (Membracidae) found along a small tree in Guyana being tended by ants (not shown). Photo: Steven Paiero

6 Cicada, *Platypedia areolata*, emerged from its chrysalis (Idaho, United States of America). Photo: Malcolm Furniss

Back cover: An undetermined Orthoptera (too many tarsomeres for a shorthorned grasshopper) moving its biomass up the food chain. Say's phoebe is doing the honours... Photo: Bob Lalonde

Français à l'intérieur de la couverture avant.

www.esc-sec.ca

Entomological Society of Canada
Société d'entomologie du Canada
393 Winston Avenue
Ottawa, Ontario, Canada K2A 1Y8
E-mail: entsoc.can@bellnet.ca

Date of issue: March 2014 / mars 2014

ISSN: 0071-0741