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## CONTACT INFORMATION

Centre for Biodiversity Genomics  
University of Guelph  
Guelph, ON, Canada N1G 2W1  
Phone: 1-519-824-4120 EXT 56250  
Email: [phebert@uoguelph.ca](mailto:phebert@uoguelph.ca)

## WEBSITES

[www.biodiversitygenomics.net](http://www.biodiversitygenomics.net); [www.boldsystems.org](http://www.boldsystems.org); [www.ibol.org](http://www.ibol.org)

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## POSITIONS HELD

2000–Present Professor, Department of Integrative Biology, University of Guelph  
2001–Present Tier 1, Canada Research Chair in Molecular Biodiversity, University of Guelph  
2015–Present Founding Director, Centre for Biodiversity Genomics, University of Guelph  
2009–Present Scientific Director, International Barcode of Life Consortium  
2018–Present Member, Board of Directors, Canada's Genomic Enterprise  
2017–Present Member, Ad Hoc Technical Expert Group on Digital Sequence Information on Genetic Resources, Secretariat for the Convention on Biological Diversity  
2015–Present Head of Delegation (International Barcode of Life Consortium) – Global Biodiversity Information Facility  
2005–2018 Founding Director, Biodiversity Institute of Ontario, University of Guelph  
2013–2017 Member, Science Advisory Board, Agropolis Foundation, Montpellier  
2013 Visiting Professor, University of Malaya  
2005–2010 Director, Canadian Barcode of Life Network  
1998–2003 Board Chair, Huntsman Marine Science Centre  
1993–2003 Founding Director, CyberNatural Software  
1992–1996 Vice-Chair (Research), Huntsman Marine Science Centre  
1991–1993 Member, Advisory Committee on Environmental Health to Ontario Minister of Health  
1990–2000 Chair and Professor, Department of Zoology, University of Guelph  
1990–1991 Visiting Professor, Research School of Biological Sciences, Australian National University  
1988–1993 Member, MISA Advisory Committee to Ontario Minister of the Environment  
1986–1990 Director, Great Lakes Institute, University of Windsor  
1985 Visiting Professor, Limnology, Czech Academy of Sciences  
1982–1983 Visiting Professor, Research School of Biological Sciences, Australian National University  
1981–1990 Professor, Department of Biological Sciences, University of Windsor  
1977–1980 Associate Professor, Department of Biological Sciences, University of Windsor  
1976–1977 Assistant Professor, Department of Biological Sciences, University of Windsor  
1976 Rutherford Fellow (Royal Society), Natural History Museum (UK)

1972–1975 Rutherford Fellow (Royal Society), Department of Biological Sciences, University of Sydney

## EDUCATION

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1972–1975 PDF – University of Sydney, Australia  
1972 PhD (Genetics) – University of Cambridge, UK  
1969 BSc (Biology) – Queen’s University, Canada

## HONORARY DEGREES

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2020 DSc (NTNU - Trondheim)  
2018 DSc (Western University)  
2012 LLD (University of Windsor)  
2011 DSc (University of Waterloo)

## CANADIAN HONOURS

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2015 Officer, Order of Canada  
2015–2022 Tier 1 Canada Research Chair in Molecular Biodiversity  
2012 Fellow, Royal Canadian Geographic Society  
2008–2015 Tier 1 Canada Research Chair in Molecular Biodiversity  
2001–2008 Tier 1 Canada Research Chair in Molecular Biodiversity  
1992 Fellow, Royal Society of Canada  
1969 Medal in Biology, Queen’s University

## INTERNATIONAL FELLOWSHIPS

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2013–2014 Distinguished Professor, King Abdulaziz University  
2010 Honorary Professor, Institute of Zoology - Chinese Academy of Sciences  
1972–1976 Rutherford Fellow – Royal Society (UK).  
1969–1972 Commonwealth Scholar (UK)  
1969 Woodrow Wilson Fellow (USA)

## EDUCATIONAL AWARDS

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2001 Richards Education Prize – Federation of Ontario Naturalists  
2000 Award of Excellence – Association for Media Technology in Education in Canada  
1999 Award of Excellence – Association for Media Technology in Education in Canada  
1999 Best Biological Website – Pirelli International Award  
1998 Best Educational Website – Sony Prize

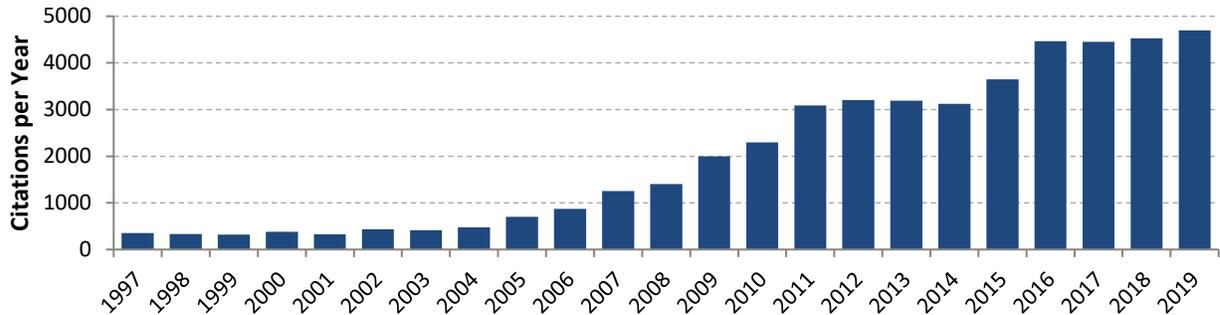
## SCIENTIFIC PRIZES

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2020 MIDORI Prize in Biodiversity – AEON Foundation  
2018 Dr. A. H. Heineken Prize for Environmental Sciences – Royal Netherlands Academy of Arts & Sciences  
2014 Aster Award – Toronto Botanic Gardens  
2008 Government Organization Innovation Award – Ontario Innovation Excellence  
2003 Premier’s Research Excellence Award – Ontario  
2001 Premier’s Research Excellence Award – Ontario  
1998 Excellence in Research Award – Sigma Xi Society

## I. CONTRIBUTIONS TO KNOWLEDGE

My 505 publications (Appendix 1, page 14) have generated an h-index of 93 on the ISI Web of Science and 113 on Google Scholar with 52,000 and 78,000 citations respectively. Our first paper on DNA barcoding has received more than 10,000 citations, a count achieved by <1,000 of the 60 million scientific publications.



*Citations per year for 1997 to 2019 for PDN Hebert (ISI Web of Science).*

I was included on the Thomson Reuters list of Highly Cited Researchers in 2014 and 2015, and in its successor index (Clarivate Analytics) in 2018. The BOLD Datasystem ([www.boldsystems.org](http://www.boldsystems.org)), created with my colleague Sujeevan Ratnasingham, is one of just 418 data repositories included in the Data Citation Index (Clarivate Web of Science).

Although citation activity provides one metric of scientific impact, there are other indicators of global interest in DNA barcoding. Over its lifespan (2004–2011), the Consortium for the Barcode of Life, based at the Smithsonian’s National Museum of Natural History in Washington, involved more than 200 member organizations in 50 nations. As well, participation in the biannual International Barcode of Life Conferences has now risen to more than 500 delegates (230 at London in 2005, 340 at Taipei in 2007, 400 at Mexico City in 2009, 460 at Adelaide in 2011, 480 at Kunming in 2013, 540 at Guelph in 2015, 550 at Kruger National Park in 2017, 500 at Trondheim in 2019). There has also been a rapid rise in research activity which has led to the genesis of more than 12,000 publications on DNA barcoding. Reflecting this fact, *Molecular Ecology* established a section in 2006 dedicated to articles on DNA barcoding while *PLOS ONE* promoted itself as a vehicle for publications on this theme. A journal was established on DNA barcoding (*DNA Barcodes*) in 2010 and the world’s oldest scientific journal, *The Philosophical Transactions of the Royal Society*, has published two special issues on DNA barcoding, the first in 2005, and the second in 2016.

## RESEARCH THEMES

### OVERVIEW

I have had a lifelong interest in biodiversity. My earliest work (1965–1975) focused on the examination of species diversity patterns in the Lepidoptera of Canada and Papua New Guinea. The challenge of ‘learning’ the 1000 species present at one Canadian site provided a personal encounter with the limited capability of the human mind to discriminate species, while Papua New Guinea made it clear to me that morphology-based approaches were overwhelmed by the immense diversity of tropical insect communities. As a result, I redirected my research for 25 years (1975–2000) towards the analysis of processes involved in generating biodiversity, rather than its quantification. However, I have now spent 20 years formulating and building support for an expedited protocol for biodiversity assessment – DNA barcoding. I am confident this

approach will resolve the most critical problem facing biodiversity science – the need for a hugely augmented capacity to monitor the diversity and shifting distributions of species in response to global change. Such information is essential to guide efforts to protect the species which share our planet.

### **ORIGINS AND IMPACTS OF ASEQUALITY (1970–2000)**

My laboratory had a long involvement in work probing the implications of breeding system transitions with more than 100 papers on this theme. These studies made important contributions to our understanding of the genetic attributes and origins of asexual species. For example, they revealed the high genetic diversity of asexuals, a pattern which I linked to recurrent transitions to asexuality. Our work also helped to demonstrate that ancient asexual lineages are very rare. Aside from probing the causes and impacts of breeding system transitions, my laboratory examined the factors governing clonal coexistence in asexual species, work that revealed the intriguing interplay of physical and biological factors in structuring their distributions. Finally, my laboratory examined the nature and extent of genome size variation in asexual lineages, providing new details on the geographic distribution of polyploids and the mechanisms responsible for their origin.

### **CRUSTACEAN EVOLUTION (1980–2000)**

My laboratory extended understanding of species diversity and speciation processes in freshwater crustaceans, exploiting members of the genus *Daphnia* as a model system. Our work provided new insights into the distributional patterns of passively dispersed freshwater organisms, revealing more endemism than previously recognized. My digital monograph on the taxonomy of the *Daphnia of North America* was the first of its kind on freshwater life, and remains the standard reference for this fauna. My laboratory also carried out work to advance understanding of speciation processes in aquatic life. My studies on Australian and North American *Daphnia* revealed the importance of hybridization and introgression in their speciation. My laboratory was also the first to employ DNA sequence data to ascertain phylogenetic relationships and character state transitions among daphniids, work that revealed both sustained periods of morphological stasis and the prevalence of convergent evolution.

### **INVASION BIOLOGY (1985–2000)**

My laboratory discovered the zebra mussel in the Great Lakes in 1987, and soon after we showed the dramatic impacts of this and other invaders on resident species. This observation led me to direct efforts towards gaining a better understanding of historical patterns of species dispersal using genetic approaches. For example, we employed mitochondrial DNA markers to reconstruct the past positions of glacial refugia in North America and the subsequent recolonization of Canada by freshwater fishes and zooplankton. We used the same approach to gain new insights into biological invasions, establishing that current rates represent nearly a 50,000-fold increase from background levels.

### **BARCODE OF LIFE (2000–2020+)**

The detailed understanding of biodiversity is critical for scientific progress in fields such as ecology and evolution. It is also an important element for conservation programs, for the designation of protected areas, and for marketplace surveillance. Yet most species are unknown and the identification of known species is complex. My work has focused on empowering biodiversity science by creating a DNA-based identification system to resolve the taxonomic impediment.

My laboratory first proposed and has subsequently led the development of a research program that employs sequence diversity in short, standardized gene regions (DNA barcodes) for specimen identification and

species discovery. Our work over the past 20 years has established that most species have long enough histories and tight enough reproductive isolation to permit their diagnosis with very limited sequence information. As a result, highly effective identification systems can be based on the sequence characterization of a single or, at most, a few gene regions. Termed DNA barcoding, this approach has now gained general acceptance as transformative technology. My research team plays a key role in the global DNA barcoding enterprise as it operates the largest facility for sequence analysis and the informatics platform which stores barcode data. In fact, 73% of the current 8 million DNA barcode records were gathered in our core facility.

DNA barcoding represents a fundamental shift from the past reliance on morphological characters to identify and discover species. This transition from identification systems based on analogue characters to digital systems employing DNA is leading to higher precision, to the automation of specimen identifications, and to universal accessibility to biodiversity information. This shift has important practical implications; it promises better protection of forestry and agriculture, earlier interception of invasive species, an enhanced capacity for ecosystem monitoring, and an aid to conservation programs. However, DNA barcoding also has important implications for basic science. For example, it provides a screening system for species whose mitochondrial genomes possess an unusual nucleotide composition or rate of evolution. It is also enabling the first evaluations of species richness in groups that have received little taxonomic attention, and it is providing a newly detailed understanding of food webs and species interactions. Reflecting the broad academic interest in DNA barcoding, my laboratory now collaborates with researchers in many nations.

## PRESENTATIONS AND MEETINGS

My intense involvement in fund raising has forced a reduction in speaking engagements, but I have delivered more than 150 invited presentations since 2002 to broaden understanding of DNA barcoding. These included talks (Appendix 2, page 41) in 28 nations (Argentina, Australia, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Portugal, Saudi Arabia, Spain, South Africa, South Korea, Sweden, Switzerland, Venezuela, UK, USA). Some recent presentations to large (500–2500) audiences included STARMUS (June 2017), Heineken Prize for the Environment Sciences (September 2018), SMRT Leiden (June 2019), and Biodiversity Next (October 2019).

I have also devoted substantial effort towards the organization of workshops and conferences on DNA barcoding. These efforts began with my co-leadership of a workshop on *DNA and Taxonomy* at the Cold Spring Harbor Laboratory in March 2003 and a second workshop in September of that year. I was subsequently on the Steering Committee for a *Canadian Census of Marine Life* meeting in November 2004, and then organized an international workshop at Guelph in June 2005 which launched the *Fish Barcode of Life* campaign. Shortly later (September 2005), I served on the Organizing Committee for a workshop at Harvard University which launched the *All Birds Barcode Initiative*, and co-organized a meeting in Amsterdam in May 2006 that activated a major barcode program on marine life. I also co-organized three workshops for the Canadian Barcode of Life Network. The first was held at the University of Guelph in April 2007, the second at the Royal Ontario Museum in May 2008, and the third in Mexico City in November 2009. More recently, I have organized many meetings linked to activation of the International Barcode of Life Consortium (iBOL). These efforts began with the assembly of 75 researchers from 20 countries at the University of Guelph in June 2007, a meeting which provoked a series of high-level discussions and workshops in other nations. September 2010 saw the formal launch of iBOL at a meeting in Toronto, and this was followed by iBOL's adoption as a formal collaborative program with the

Secretariat for the Convention on Biological Diversity at the COP10 in Nagoya, Japan. I served as Scientific Co-Chair for the 5<sup>th</sup> International Barcode of Life Conference in China in 2013, and co-hosted the 6<sup>th</sup> International Barcode of Life Conference in 2015, a meeting which allowed Canada to showcase its achievements in the field. Since this time, I have served on the Organizing Committees for the 7<sup>th</sup> and 8<sup>th</sup> International Barcode of Life Conferences. I have also organized annual meetings of iBOL's Scientific Steering Committee since 2010.



*Participants in the 6<sup>th</sup> International Barcode of Life Conference at Guelph in August 2015.*

## **II. ADOPTION OF DNA BARCODING**

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By advancing our capacity to identify species, DNA barcoding has already impacted public policy with the strongest impacts on biodiversity conservation and surveillance as well as marketplace regulation.

### **BIODIVERSITY CONSERVATION**

Twenty-eight years ago, the Convention on Biological Diversity (CBD) recognized the need to identify the causes, the scale of impacts, and steps that could be taken to lower the risks of species extinction. The Secretariat for the CBD soon developed action plans and strategies to track progress toward these goals, many of which require an enhanced capacity to monitor biodiversity. Because of its leadership role in biodiversity conservation, we have sought opportunities to work with the CBD. In 2015 and 2016, the CBD Secretariat provided \$0.5 million from the Japan Biodiversity Fund to allow our Centre to provide training in DNA barcoding. In response, we developed and delivered an on-line course on DNA barcoding to 40 senior biodiversity scientists from developing nations and followed this up with hands-on training for the 20 researchers who showed the strongest performance. The CBD Secretariat rated these activities as highly successful and built upon them by sponsoring courses on DNA barcoding in 11 nations in 2018. Each of these courses was led by a researcher who participated in our training program. The CBD's promotion of DNA barcoding reflects a resolution adopted by the nations at COP13 in December 2016 in Cancun which recognized DNA barcoding as a key innovation for biodiversity assessment. Discussions on DNA barcoding also featured prominently at COP14 in Sharm El-Sheikh in November 2018. Our work with the CBD continues through support from the Japan Biodiversity Fund which is enabling us to develop material in support of the Global Taxonomy Initiative and COP15.

In addition to our involvements with the CBD, we have a strong relationship with the Global Biodiversity Information Facility in Copenhagen focused on advancing the use of genomic data to hugely increase information on species occurrences. In addition, I have obtained funding to aid biodiversity conservation

in other nations. For example, I obtained \$2.1 million from the Canadian International Development Agency to support the participation of six nations (Argentina, Costa Rica, Kenya, Pakistan, Peru, South Africa) in the first project led the International Barcode of Life Consortium. These involvements with the CBD, GBIF, and IDRC contribute to biodiversity conservation by advancing knowledge of species diversity and distributions.

Aside from efforts to expand usage of DNA barcoding in the general support of biodiversity science, my colleagues and I have been actively involved in its use to both detect and prosecute cases that contravene the ban on trade in endangered species. Most of this activity has been focused on prosecutions linked to the contravention of CITES regulations, work that has involved cases in in Canada and other nations, particularly South Africa.

### **BIODIVERSITY SURVEILLANCE**

The activation of the Canadian Barcode of Life Network (2005-2010) stimulated the early adoption of this approach by all of our federal Departments with involvements in the biodiversity science portfolio. The Departments joined forces in 2011 to secure \$10 million from the Genomics R&D Initiative to allow DNA barcoding to be developed as an interdepartmental research theme. Agriculture & Agri-Food is employing it to track organisms that impact plant health, while Natural Resources Canada uses it to detect invasive species. Environment and Climate Change Canada is employing DNA barcoding to measure water quality with emphasis on surveillance programs linked to the oil sands development. The Department of Fisheries and Oceans is employing DNA barcoding to gain a better understanding of parasite transmission pathways, while Parks Canada joined with us to gather detailed information on species distributions in all of our national parks. In 2018, we joined forces with Polar Knowledge Canada, a recently established crown agency, to develop a bio-surveillance program for the Canadian arctic based upon the coupling of high-throughput sequencing with a DNA barcode reference library. Although DNA barcoding gained early adoption for biosurveillance in Canada, there has now been strong uptake by other nations. For example, researchers from 20 nations have contributed to our Global Malaise Trap Program which is assembling the baseline information on patterns of arthropod diversity needed to assess the factors underlying the major collapses in insect abundance. Activity in some nations is gaining momentum. For example, the South African National Parks Service deployed the rangers at 25 sites in its largest park, the Kruger, to oversee the collections for a year-long monitoring program in 2019. Plans call for extension of this program to their other 19 national parks in future years.

### **MARKETPLACE REGULATION**

Because species are often difficult to identify, especially once processed, there is considerable incentive for fraud. The earliest use of DNA barcoding in the detection of marketplace substitution involved seafood. Our work received much public attention when we analyzed samples from cities across the USA for the Oceana Foundation, studies which revealed that 25% of the seafood was mislabeled. These results and others led to legislative action within the USA. The Canadian Food Inspection Agency (CFIA) has responsibility for food safety and authenticity in our nation, and it has also adopted DNA barcoding to help fulfill its mandate. We established a formal collaboration with the CFIA in 2016, focused on the application of DNA barcoding to assess food fraud and contamination.

Studies in other nations have revealed massive marketplace fraud involving commodities ranging from meat to medicines. An issue of *Business Week* in early 2014 discussed the rise of DNA-based surveillance of food in China (*Keeping the mystery out of China's meat*), a trend motivated when studies showed that minced carcasses from fur farming operations were being sold as pork. Similar problems erupted in Europe with horsemeat sold as beef. Because species substitution can be readily detected through DNA barcoding, it

has gained adoption as the primary tool for detecting marketplace fraud. The FDA now employs DNA barcoding as the standard approach for the detection of seafood substitution and has worked with us to develop the chain-of-custody protocols required for legal action. The problem of product adulteration appears particularly severe in herbal supplements. In 2015, the Office of the Attorney General (State of New York) filed suit against several major corporations for selling adulterated herbal products and specifically cited our role in revealing this deception. The heavy publicity (*New York Times*, *Washington Post* and hundreds of other print and digital media) surrounding these charges has led to requests for assistance to aid investigations of product adulteration in other states (Delaware, California, Ohio).

### **PRIVATE SECTOR UPTAKE**

Over the past five years, I have strengthened the CBG's interactions with the private sector with emphasis on three areas.

### **INFORMATICS**

My Informatics unit has gained international recognition for its development of BOLD, the Barcode of Life Data System, stimulating a linkage with the SAP-Canada. Our collaboration led to the development of a mobile app which supports key steps in the DNA barcode analytical chain. Termed LifeScanner<sup>TM</sup>, it gained release in late 2014 accompanied by kits for sample collection. Attracted by its capacity to support audit trails, the Food and Drug Administration has adopted LifeScanner for use by its field agents. In 2016, the Biodiversity Authority in South Africa adopted LifeScanner for its efforts to suppress illegal trade in wildlife. We are also collaborating with Pacific Biosciences, a leading manufacturer of high-throughput sequencers, to advance the use of DNA barcoding for bio-surveillance by integrating a DNA barcode reference library with the informatics tools needed to drive species assignments from sequence records.

### **ENVIRONMENTAL IMPACT ASSESSMENTS**

Biodiversity analysis is an important component of the Environmental Impact Assessments that are required for all forestry and mining activities. DNA barcoding has the capacity to improve their accuracy while reducing costs. My presentations to key industry associations, such as International Petroleum Industry Environmental Conservation Association and the Canadian Mining Association, have led to our involvement in several projects. We monitored the environmental impacts of a Brazilian mine owned by Kinross Gold, and evaluated the effectiveness of site restoration activities at a mine site in British Columbia for New Gold from 2012–2016. These involvements with Canada's mining industry have subsequently expanded with work now underway with five firms. As well, we received \$0.5 million from the Japanese International Cooperation Agency in 2016 for work that employed DNA barcoding to monitor the impacts on biodiversity of a major geothermal power installation in Costa Rica.

### **DNA SEQUENCING**

The Canadian Centre for DNA Barcoding that I established in 2007 now receives more than \$2 million annually for its provision of analytical services. In recent years, this core faculty has supported the work of more than 250 researchers, research organizations, and private sector firms based in 38 nations.

## **III. MANAGEMENT OF RESEARCH ACTIVITIES**

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I enjoy the organization of large-scale scientific enterprises, and first became engaged in such activity while a postdoctoral fellow at the University of Sydney where I led two expeditions (1973–1974) to Papua New Guinea. My next involvement in science administration arose in 1983 when I joined forces with a colleague at the University of Windsor to establish the Great Lakes Institute. I became its Director in 1986 and led it until 1990 when it attained an annual budget of \$2 million. I focused our research on protecting the

Great Lakes from both chemical contaminants and biological invasions. The Institute still prospers and remains the flagship research enterprise at the University of Windsor.

I served as Chair of the Department of Zoology at Guelph for a decade (1990–2000), and concurrently was active at the Huntsman Marine Science Centre (HMSC), the premier research institute for this discipline in Canada’s Atlantic region. I served as Vice-President of Research at the HMSC from 1992–1998 and as Board Chair from 1998–2003. With an annual budget of approximately \$3 million, the HMSC plays an important role in near-shore marine bio-surveillance, and in aiding the development of better aquaculture practices.

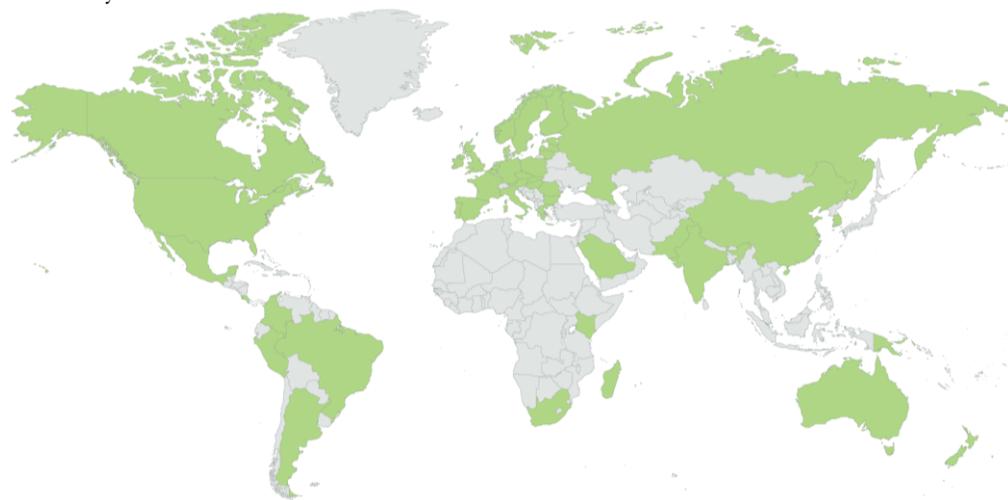
I have spent the last 20 years building momentum for a major DNA barcoding enterprise. Over this interval, I have raised more than \$100 million from varied organizations and individuals in Canada and internationally (Appendix 3, page 47). These funds have supported the construction of specialized research facilities and have allowed the development of a research team with outstanding capabilities in biodiversity science, informatics, and genomics. This initiative gained early momentum through the intervention of two US foundations, but Canadian agencies have now provided major support.

Motivated by my meeting with one of its Directors, the Alfred P. Sloan Foundation (New York City) directed more than \$10 million to progress global understanding of DNA barcoding by supporting the Consortium for the Barcode of Life (CBOL) at the Smithsonian’s National Museum of Natural History in Washington from 2004 through 2012. I was a member of its founding Executive Committee, first Chair of its DNA Working Group, and a member of its Implementation Board. While the Sloan Foundation supported CBOL, the Gordon and Betty Moore Foundation (San Francisco) provided my laboratory with an initial award of \$3 million from 2004–2007 to test the efficacy of DNA barcoding, and it has provided several subsequent grants to aid our work.

Although these two foundations made early investments, Canadian agencies subsequently made awards that have enabled our nation to lead a rapidly growing research program. The Canada Foundation for Innovation and the Ontario Ministry of Research provided \$9.8 million in 2005 to construct the Biodiversity Institute of Ontario, a 15,000 ft<sup>2</sup> facility that houses the Canadian Centre for DNA Barcoding. These organizations subsequently provided \$14.5 million to allow a 38,000 ft<sup>2</sup> extension (Centre for Biodiversity Genomics) which saw completion in April 2012, providing space for our Informatics and Collections Units. These two buildings allowed rapid growth of the DNA barcode research program at Guelph with collateral benefits for other Canadian and international researchers. NSERC, Genome Canada, and five federal Departments provided \$15 million in operating funds from 2005–2010 to permit activation of the first national research network focused on DNA barcoding, and I was its Director.

The accomplishments of this Network set the stage for a larger scientific endeavor, the International Barcode of Life Consortium (iBOL). Its first project, BARCODE 500K, was a 5-year, \$125 million effort to assemble DNA barcode records for 500,000 species. Involving research organizations in 25 nations, this project saw ratification as a collaborative program with the Convention on Biological Diversity in October 2010 at the 10<sup>th</sup> Convention of the Parties in Nagoya. My Centre hosted its Secretariat, its central informatics platform, and its largest sequencing facility. As well, Canadian funders provided \$30 million to support our nation’s contributions to BARCODE 500K from 2010 through 2015. Because this project led to major scientific advances and established productive collaborations, iBOL’s Scientific Steering Committee decided to launch a second project, BIOSCAN, which will analyze more than 100 million specimens while also extending the DNA barcode reference library to provide coverage for 2 million species. BIOSCAN is a 7-year, \$180 million project that will greatly improve our capacity to protect biodiversity. It will develop the analytical approaches, the informatics platform, and sequencing protocols needed to activate the Planetary Biodiversity Mission in 2026, a \$500 million research program that will

complete the inventory of all multicellular species within 20 years, while also activating a global biosurveillance system.



*Nations in green are members of the International Barcode of Life Consortium.*

## **SCIENCE SERVICE**

For my first decade as a faculty member, my contributions were restricted to the review of scientific papers and grant applications, but I have now had the chance for diverse involvements. I was a member of the NSERC Grant Selection Committee for Ecology and Evolution from 1985–1986 and chaired the Committee in 1987. During the 1990's, I was a member of two provincial Advisory Committees; one reported to the Minister of Health and the other to the Minister of Environment. I subsequently joined NSERC's Fellowships Committee in 1996 and its Program Review Committee from 1997–2000. I also served on the Life Sciences Council of the Royal Society of Canada in 2005. During 2010, I was a member of the Expert Panel convened by the Canadian Council of Academies to investigate the status of natural history collections and the future of taxonomic research in our nation. I was one of three scientific advisors to the Quarantine Barcode of Life Network, a major research program funded by the European Community from 2008 to 2011. I was also a member from 2011–2016 of the Scientific Advisory Panel of the Agropolis Foundation, a French organization with involvements in agriculture and biodiversity science in the developing world. I now serve on the Board of Canada's Genomic Enterprise, a \$100 million program that involves the largest DNA sequencing facilities in our nation. Aside from these opportunities to provide scientific advice, I served as an Associate Editor of the *Canadian Journal of Zoology* from 1988–1995, of *EcoScience* from 1995–2000, and of *Molecular Ecology* from 1999–2008.

## **IV. LEADERSHIP IN THE TRANSFER OF KNOWLEDGE**

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I have devoted substantial effort towards three activities aimed at expanding understanding of science with an emphasis on biodiversity, genomics, and Canada's arctic.

### **PUBLIC ENGAGEMENT**

I have been active in raising public awareness of the need for investments in science. The rise of DNA barcoding has provided many new opportunities to reach out to the public. Feature articles on our work have appeared in *Canadian Geographic*, *Chemical and Engineering News*, *Discover*, *Esquire*, *National Geographic*, *New Scientist*, *On Nature*, *Popular Science*, *Science*, *Science News*, *Scientific American*, *University Affairs*, *Wired*, and in nearly every major national and international newspaper. This interest in our work has proven persistent, generating a steady flow of barcode articles as well as radio and television interviews over the last 15 years.

*United Airlines* highlighted DNA barcoding in the *Big Ideas* section of its March 2014 issue of *Hemispheres*, its inflight magazine, while *Forbes* magazine ran an article on our work to develop a handheld DNA barcode analyzer in January 2014. Another article focusing on our work to recover DNA barcode sequences from museum specimens appeared in *The Scientist* in May 2014, while BBC Radio 4 featured the goals and progress of the International Barcode of Life Project on its *Inside Science* program. During 2015, our work on marketplace deception gained renewed attention with a focus on herbal supplements. The Attorney General for New York State filed suits against several major corporations for selling adulterated products and noted our role in revealing this deception. This provoked considerable media attention (e.g. *New York Times*, *Washington Post*), and coverage continued throughout 2015 because of matters arising from the 6<sup>th</sup> International Barcode of Life Conference. The activation of BIOSCAN in 2019 provoked another round of interest from the media.

## DIGITAL MEDIA AND INFORMATICS

Convinced that digital media would provide an exciting opportunity to energize biodiversity science and to share information, I founded and directed *CyberNatural Software* for a decade (1993–2003). Over this interval, I secured more than \$2 million for its operation, allowing the recruitment of the staff needed to develop world-class educational products. Our work generated several websites and seven CD-ROMs which won national and international awards (1998 Sony Prize, 1999 & 2000 Canadian Association for Media and Technology in Education Awards, 1999 Pirelli Prize). I closed this organization in 2003, channeling my subsequent involvements in digital media towards websites linked to the barcode initiative. I am particularly proud of BOLD, the Barcode of Life Data System ([www.boldsystems.org](http://www.boldsystems.org)), which has become one of the most important informatics platforms for biodiversity science. BOLD has gained this status because it bridges a chasm in bio-informatics infrastructure by coupling detailed specimen information with sequence data and analytical tools. Moreover, it meets the key requirement for a DNA-based identification system -- the consolidation of barcode records into a single informatics platform and their vigilant curation to excise spurious records. As a result of these attributes, BOLD now has 24,000 registered users and received visits from more than a million different IP addresses during 2019. It has become the go-to site for DNA-based identifications, and I am confident it will sustain this status.

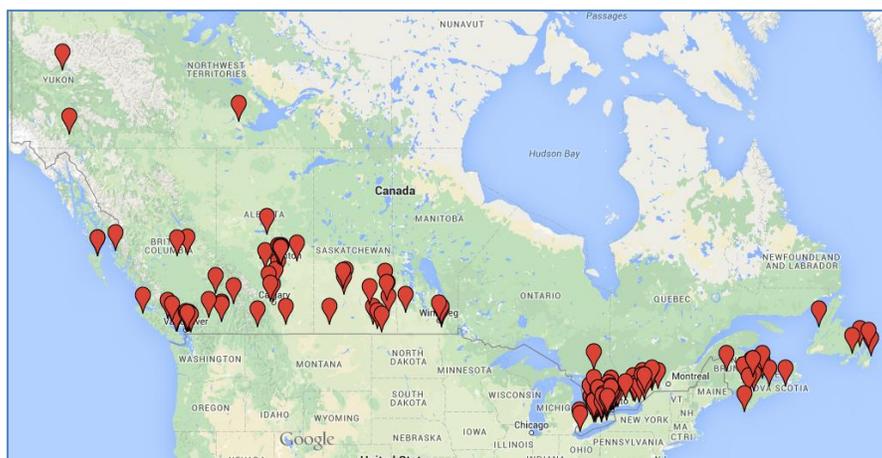
## SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION

DNA barcoding has gained recognition as a powerful approach for STEM education as evidenced by major awards from NSF and the selection of a DNA barcoding project as the top STEM project in 2013 (*Science* 342: 1462–1463). I established an Education and Outreach Division in 2012 to provide young Canadians with the opportunity to learn more about biodiversity science and genomics through involvements in DNA barcoding.



*Malaise trap and images of school children involved in the School Malaise Trap Program.*

This goal has been nicely achieved by our School Malaise Trap Program which exposes students to DNA barcoding by involving them in the collection of biodiversity in their school yard. We dispatch a Malaise trap which the students deploy for two weeks at their school. They track the number of specimens collected and send them to us for analysis. The program has received an extremely positive response from teachers and students at both the primary and secondary levels. More than 400 schools and 15,000 students have participated in this program since its launch in 2013 (<http://malaiseprogram.com/>). Their collections led to barcode records for 9,500 species, including 500 species that have only been collected by students. Each school receives a report on the species present in its collection together with a photograph of each species and notes on any unusual or new species. The success of this program has led to its adoption by the World Wildlife Fund Canada.



*Locations of 240 schools that participated in the School Malaise Trap Program in fall 2016.*

Because of its value as a tool for STEM education, DNA barcoding is gaining application in other contexts. For example, we are enabling the Bamfield Marine Science Centre's inclusion of DNA barcoding as a key element in its educational programs for high school students. With support from NSERC's PromoScience, students at Bamfield are collecting specimens which see deposition in the Royal British Columbia Museum and sequence characterization at the CBG. In this fashion, Bamfield students are contributing new information on biodiversity in the Pacific Northwest. We are also working with two educational programs in California which have received large grants from the NSF to employ DNA barcoding in STEM education. Work at the University of California–San Diego is exposing college instructors to DNA barcoding, while the initiative at Coastal Marine Biolabs targets high school students. Both programs rely upon us for informatics support, and they have contributed more than \$300,000 to enable our development of modules for educational activity.

The Education and Outreach Division has also developed several web-based courses which provide a detailed introduction to the conceptual and analytical basis of DNA barcoding and the new opportunities for scientific progress enabled by high-throughput sequencing platforms.

## **V. TRAINING OF HIGHLY QUALIFIED PERSONNEL (HQP)**

I have trained 50 postdoctoral fellows over my career; 20 now hold faculty positions and 13 others are research scientists (Appendix 4, page 49). My 21 PhD and 36 MSc students have been gender balanced (27 women, 30 men), and most remain active in science (Appendix 5, page 50). All 12 Canadian students who completed a PhD with me were awarded a NSERC postdoctoral fellowship, and one also received the

Alper Prize in 2003, NSERC's highest award for a doctoral graduate. Twenty-two of my former graduate students now hold faculty positions, five are research scientists and others are advancing through the academic ranks. I currently advise three PhD and 1 MSc students, as well as four postdoctoral fellows. In recent years, I have directed effort toward the supervision of students from China and Mexico because these countries are such important reservoirs of biodiversity. My Centre also provides an active training program for international researchers. Over the past two years, we have hosted 38 researchers from 14 countries for visits ranging in duration from two weeks to a year.

Aside from my supervision of 107 graduate students and postdoctoral fellows, I have provided hundreds of undergraduate students with research experience. For more than 30 years, I delivered at least one field course each year, staging them in settings that were designed to inspire – the high Arctic, Australia, meso-America. However, I felt a particular need to expose students to Canada's north because so few training opportunities are available. From 1979 to 2010, I delivered courses at arctic venues including Churchill, Iqaluit, Igloodik, and Resolute. These courses were always oversubscribed, and the student response to their brief immersion in arctic science was hugely positive. I have also been strongly committed to providing summer research positions throughout my career and have recently been able to increase their number to as many as 50 annually. Motivated by this research experience, many continued to graduate school, and several now hold faculty positions in evolutionary biology. Because of this overlap in our interests, there have been occasions when we have found ourselves in competition for a particular grant, and their record of success in such contests is rising. It is exhilarating to see one's former students prosper.

Over the past decade, I have had the opportunity for a greater range of mentoring opportunities linked to my development of an administrative and scientific support system for the DNA barcode research program at Guelph which now has an annual operating budget of \$6 million, all grant-derived, and a staff that has grown to more than 100 individuals. I have responded to this challenge by carefully evaluating the performance of those working with me and giving new responsibility to those who are ready. Many of my staff members have prospered. For example, the Informatics Director at the Centre joined my research group as a junior programmer. Because of his capabilities, I steadily advanced his status until he now directs a large team. His contributions to biodiversity informatics have been so profound that he received the 2010 Ebbe Nielsen Prize, an honour that carries much prestige and an award of 40,000 Euros. It represented the first time that a Canadian researcher has won this Prize.

<b>Category</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Administrative Support Staff	6	7	6	5	6	6	5
Faculty	5	4	4	4	4	4	4
Graduate students	23	21	15	12	10	12	7
Informatics Staff	19	22	21	20	17	20	17
Laboratory Technicians	36	47	41	39	31	30	33
Postdoctoral / Research Associates	23	21	19	17	16	18	19
Undergraduate Students	39	34	37	45	44	54	41
<b>Total HQP</b>	<b>151</b>	<b>156</b>	<b>143</b>	<b>148</b>	<b>128</b>	<b>144</b>	<b>126</b>

*Number of staff, students and faculty working in the Centre for Biodiversity Genomics over the past seven years.*

## APPENDIX 1: PUBLICATIONS TO JUNE 2020

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1. Ovaskainen O, N Abrego, P Somervuo, I Palorinne, and 11 additional co-authors including PDN Hebert. 2020. Monitoring fungal communities with the Global Spore Sampling Project. *Frontiers in Ecology and Evolution* **7**: 1-9.
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3. Huemer P, O Karsholt, L Aarvik, K Berggren and 10 additional co-authors including PDN Hebert. 2020. DNA barcode library for European Gelechiidae (Lepidoptera) suggests greatly underestimated species diversity. *ZooKeys* **921**: 141-157.
4. Pentinsaari M, S Ratnasingham, SE Miller and PDN Hebert. BOLD and GenBank revisited – do identification errors arise in the lab or in the sequence libraries. *PLOS ONE*: doi.org/10.1371/journal.pone.0231814
5. Hardulak L, J Moriniere, A Hausmann, L Hendrich, S Schmidt, D Doczhal, J Muller, PDN Hebert and G Haszprunar. 2020. DNA metabarcoding for biodiversity monitoring in a national park: screening for invasive and pest species. *Molecular Ecology Resources*: doi:10.1111/1755-0998.13212
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7. Knox MA, ID Hogg, CA Pilditch, JC Garcia, PDN Hebert and D Steinke. 2020. Contrasting patterns of genetic differentiation among amphipod taxa along New Zealand’s continental margins. *Deep-Sea Research Part 1*: doi.org/10.1016/j.dsr.2020.103323.f
8. Ckrkic J, A Petrovic, K Kocic, M Mirivic, and 4 co-authors including PDN Hebert. Phylogeny of the subtribe Monoctonina (Hymenoptera, Braconidae, Aphidiinae). *Insects* **11**: doi:10.3390/insects11030160.
9. Quicke DLJ, SA Belokobylskij, Y Braet and 8 additional co-authors including PDN Hebert. 2020. Phylogenetic reassignment of basal cyclostome braconid parasitoid wasps (Hymenoptera) with description of a new, enigmatic Afrotropical tribe with a highly anomalous 28S D2 secondary structure. *Zoological Journal of the Linnean Society*: doi.org/10.1093/zoolinnean/zlaa037.
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## PATENTS

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I have acquired one informatics patent and a second patent is pending on an advanced sequencing protocol.

US Provisional Patent 62/206487. *Method to Amplify DNA Sequences from Degraded Sources*. Filed: 18/09/2015

US Patent 20,160,103,958,2016 *Systems, Methods, and Computer Program Products for Merging a New Nucleotide or Amino Acid Sequence into Operational Taxonomic Units*. Granted: 16/06/2016

## APPENDIX 2: INVITED PRESENTATIONS MARCH 2007 – JANUARY 2020

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- Jan 24, 2020 ***BIOSCAN: Illuminating Species, their Interactions, and Dynamics.*** Centre for Livestock Improvement. Animal Biosciences, University of Guelph.
- Nov 24, 2019 ***BIOSCAN Meets AI: Prospects for Collaboration.*** Waterloo Institute for Artificial Intelligence, University of Waterloo.
- Nov 19, 2019 ***Biodiversity Genomics – Implications for Biodiversity Science.*** Guelph-Wellington Men's Club.
- Oct 23, 2019 ***Revealing the Diversity, Dynamics and Interactions of Life Through DNA.*** Biodiversity Next Conference. Leiden, The Netherlands.
- Oct 20, 2019 ***TRACE: Tracking the Response of Arthropods to Changing Environments.*** Consortium of European Taxonomic Facilities Workshop, Leiden.
- June 18, 2019 ***BIOSCAN: Illuminating Species, their Interactions, and Dynamics.*** 8<sup>th</sup> International Barcode of Life Conference. Trondheim, Norway.
- May 10, 2019 ***BIOSCAN: Illuminating Species, their Interactions, and Dynamics.*** Sanger Institute, Hinxton, England.
- May 9, 2019 ***BIOSCAN: Illuminating Species, their Interactions, and Dynamics.*** Natural History Museum, London.
- May 7, 2019 ***BIOSCAN: Illuminating Species, their Interactions, and Dynamics.*** SMRT Leiden Conference, The Netherlands.
- Sept 26, 2018 ***A Mission to Protect Planetary Biodiversity.*** Heineken Lecture in the Environmental Sciences. Leiden, The Netherlands.
- Jan 24, 2018 ***Avoiding the Sixth Mass Extinction.*** Third Age Learning, University of Guelph.
- Nov 18, 2017 ***Revealing and Reading Life Through Deep Barcoding.*** 7<sup>th</sup> International Barcode of Life Conference. Kruger National Park, South Africa.
- July 11, 2017 ***Sanger to SMRT: Liberating Sequences from Museum Specimens.*** Royal Botanic Garden, Edinburgh, UK.
- June 23, 2017 ***A Mission for Planetary Biodiversity.*** STARMUS Science Festival. Trondheim, Norway.
- June 22, 2017 ***Planetary Biodiversity Mission.*** STARMUS Side-Event. Biodiversity and Humanity. NTNU University Museum. Trondheim, Norway.
- June 20, 2017 ***The Path from DNA Barcodes to Planetary Biodiversity.*** Department of Biology, University of Copenhagen, Denmark.
- Nov 23, 2015 ***A Mission for Planetary Biodiversity.*** 3<sup>rd</sup> National Conference for the Mexican Barcode of Life Network. Mexico City, Mexico.
- Nov 11, 2015 ***A Mission for Planetary Biodiversity.*** 1<sup>st</sup> National Symposium on Biodiversity and DNA Barcoding. Trondheim, Norway.
- Oct 26, 2015 ***Planetary Biodiversity – Agents of Change.*** Derry Lecture, Huron College, London, Canada
- Oct 26, 2015 ***A Mission for Planetary Biodiversity.*** Department of Biology, Western University, London, Canada
- Aug 15, 2015 ***From iBOL to Planetary Biodiversity.*** 6<sup>th</sup> International Barcode of Life Conference. Guelph, Canada
- June 3, 2015 ***International Barcode of Life – Automating Biodiversity Science.*** 3<sup>rd</sup> DNA Barcoding Symposium. Utrecht, Netherlands.

- Nov 30, 2014 ***Planetary Biodiversity - Agents of Change.*** Genomics: The Power & the Promise. Ottawa, Canada.
- Oct 25, 2014 ***Progress Toward iBOL Goals.*** Zoological State Museum, Munich, Germany.
- May 14, 2014 ***The Planetary Biodiversity Project.*** Canadian Institute for Advanced Research. Toronto, Canada.
- Apr 1, 2014 ***DNA Barcodes and Biodiversity.*** King Abdulaziz University, Jeddah, Saudi Arabia.
- Mar 31, 2014 ***DNA Barcoding: a Short History.*** King Abdulaziz University, Jeddah, Saudi Arabia.
- Nov 29, 2013 ***Genomics and the International Barcode of Life Project.*** Sanger Centre, Cambridge, UK.
- Nov 28, 2013 ***Probing Biodiversity with DNA barcodes.*** Queen Mary University of London, London, UK.
- Oct 30, 2013 ***Barcodes and BINs reveal 4500 Undescribed Species of Australian Lepidoptera.*** 5<sup>th</sup> International Barcode of Life Conference. Kunming, China.
- Oct 28, 2013 ***DNA Barcoding - Then, Now, Next.*** 5<sup>th</sup> International Barcode of Life Conference. Kunming, China.
- Oct 22, 2013 ***The International Barcode of Life Project.*** University of Malaya, Kuala Lumpur, Malaysia.
- July 23, 2013 ***Revealing Biodiversity with DNA Barcodes.*** Akita Prefectural University, Akita, Japan.
- July 20, 2013 ***Revealing Insect Diversity with DNA barcodes.*** Entomological Society of Japan, Kyushu University, Fukuoka, Japan.
- July 15, 2013 ***Barcodes, Organelles, Genomes and Organisms.*** Gordon Conference on Ecological and Evolutionary Genomics. University of New England, Maine USA.
- May 15, 2013 ***From Inventory to Interactions: the Role of DNA in Probing Ecosystems.*** CSEE Symposium, Kelowna, Canada.
- Feb 12, 2013 ***DNA Barcodes - Prospects for Plants.*** Symposium on Barcoding Medicinal Plants. UNAM, Mexico City, Mexico.
- Jan 14, 2013 ***Barcoding the World - One Backyard at a Time.*** Canadian Consulate, San Diego, USA.
- Jan 14, 2013 ***Digital Biodiversity for Bioliteracy.*** Illumina Corporation, San Diego, USA.
- June 28, 2012 ***The Future of Natural History Museums.*** Celebrating the 200<sup>th</sup> Anniversary of the Museo Argentino de Ciencias Naturales. Buenos Aires, Argentina.
- June 27, 2012 ***Towards a Barcoded World.*** Celebrating the 200<sup>th</sup> Anniversary of the Museo Argentino de Ciencias Naturales. Buenos Aires, Argentina.
- May 31, 2012 ***Towards a Barcoded World – Implications for Conservation.*** Conservation Biology Symposium. University of New Orleans, New Orleans, USA.
- Apr 19, 2012 ***Digital Biodiversity: From DNA Barcode Libraries to Applications.*** DNA Barcodes in Canada's National Interest Stakeholders Workshop. Agriculture and Agri-Food Canada. Ottawa, Canada.
- Mar 15, 2012 ***The Evolutionary Implications of DNA Barcodes.*** Department of Biology, Laval University, Quebec, Canada.
- Mar 5, 2012 ***Probing Biodiversity Through DNA Barcodes.*** 5<sup>th</sup> Max Planck Society Symposium "Biodiversity". Berlin, Germany.
- Feb 14, 2012 ***65% of the World's Geometrid Moth Species are DNA Barcoded.*** Forum Herbulot. Mogale's Gate, South Africa.

- Feb 14, 2012 *ANIC Barcode Blitz: Accelerating the Targeted Capture of DNA Barcode Data.* Forum Herbulot. Mogale's Gate, South Africa.
- Jan 24, 2012 *Natural History Collections and the Barcode of Life.* Agriculture and Agri-Food Canada. Ottawa, Canada.
- Jan 13, 2012 *A Census of All Life.* Department of Biology, University of Western Ontario, London, Canada.
- Dec 3, 2011 *Barcodes, Organelles, Genomes, and Organisms.* 4<sup>th</sup> International Barcode of Life Conference. University of Adelaide, Adelaide, Australia.
- Nov 15, 2011 *Towards a DNA Barcode Library for Marine Life.* Australian Institute for Marine Ecology. Southern Cross University, Coffs Harbour, Australia.
- Sept 9, 2011 *The International Barcode of Life Project.* Barcoding Swiss Biodiversity Conference. University of Geneva, Geneva, Switzerland.
- May 17, 2011 *Probing Biodiversity with DNA Barcodes.* University of Helsinki, Helsinki, Finland.
- May 14, 2011 *Digital Biodiversity.* International Symposium - For love of insects. Station Linne, Oland, Sweden.
- May 13, 2011 *Digital Biodiversity.* Life, Earth, Time and Space Seminar Series. Swedish Museum of Natural History, Stockholm, Sweden.
- Apr 30, 2011 *Digital Biodiversity.* Biodiversity Research Centre, University of British Columbia, Vancouver, Canada.
- Apr 29, 2011 *Barcodes, Organelles and Genomes.* iBOL-Canada: The future of DNA Barcoding in Canada. Beaty Biodiversity Museum, University of British Columbia, Vancouver, Canada.
- Feb 28, 2011 *The Canadian Barcode of Life Network.* Workshop- Y ahora que? ... como publicar datos sobre codigos de barras. ECOSUR, Chetumal, Mexico.
- Feb 14, 2010 *DNA Barcoding and the Census of All Life.* Simposio Internacional Herramientas Moleculares para el Estudio de la Biodiversidad. Centro de Ecología - IVIC, Caracas, Venezuela.
- Nov 18, 2010 *Revealing Polar Life with DNA Barcodes.* Arctic Biodiversity Symposium. Canadian Museum of Nature, Ottawa, Canada.
- Nov 11, 2010 *Rapid Biodiversity Assessment Through DNA Barcodes.* College of Life Sciences, Hebei University, Hebei, China.
- Nov 10, 2010 *Digital Biodiversity.* Bin-Zhi Forum. Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
- Aug 10, 2010 *DNA Barcodes for Arctic Life.* Churchill Northern Studies Centre, Churchill, Canada.
- July 27, 2010 *DNA Barcoding and the Census of All Life.* International Conference on Evolution and Biodiversity. Nagoya City University, Nagoya, Japan.
- June 29, 2010 *Geometrids and the International Barcode of Life Project.* Forum Herbulot. University of Florida, Gainesville, USA.
- June 17, 2010 *The International Barcode of Life Project.* Better Planet Project Launch, University of Guelph, Guelph, Canada.
- June 2, 2010 *A Census of All Life.* Biodiversity 2010 and Beyond: Science and Collections. Joint Conference of the Canadian Botanical Association and the Society for the Preservation of Natural History Collections. Ottawa, Canada.
- May 4, 2010 *Getting Off the Ground in Biodiversity Genomics.* Genomes at Large: Prospects and Priorities Workshop. Biodiversity Institute, University of Guelph, Guelph, Canada.

- Mar 7, 2010 ***Biodiversity and Barcodes.*** Toronto Field Naturalists Club. University of Toronto, Toronto, Canada.
- Feb 17, 2010 ***DNA Barcodes and Biodiversity Surveillance.*** DNA Barcoding Colloquium. South California Coastal Water Research Project, Costa Mesa, USA.
- Feb 3, 2010 ***DNA Barcodes and the Census of All Life.*** Distinguished Speaker Seminar Series. Department of Molecular and Cellular Biology, University of Guelph, Guelph, Canada.
- Jan 27, 2010 ***Glimpsing the Future - New ways to Accelerate Discovery and the Application of Taxonomic Knowledge.*** UNESCO International Year of Biodiversity Science Policy Conference. UNESCO, Paris, France.
- Jan 15, 2010 ***DNA Barcodes: Implications for Marketplace Surveillance.*** Canadian Food Inspection Agency, Ottawa, Canada.
- Dec 15, 2009 ***DNA Barcodes and Biodiversity.*** CSIRO Division of Entomology, Canberra, Australia.
- Dec 3, 2009 ***DNA Barcodes and Biodiversity.*** Biota - FAPESP International Symposium on DNA Barcoding. Universidade de Sao Paulo, Sao Paulo, Brazil.
- Nov 9, 2009 ***The International Barcode of Life Project.*** Third International Barcode of Life Conference. Mexico City, Mexico.
- Oct 28, 2009 ***Biodiversity, Evolution, Barcodes.*** Biodiversity Research Centre, University of British Columbia, Vancouver, Canada.
- Oct 5, 2009 ***The International Barcode of Life Project.*** DNA Barcoding and Brazil. Universidade de Sao Paulo, Sao Paulo, Brazil.
- Sept 30, 2009 ***DNA Barcoding for Bio-Assessment.*** International Petroleum Industry Environmental Conservation Association Workshop. Calgary, Canada.
- June 22, 2009 ***Resolving Biodiversity - Digitally.*** DNA Barcoding - the Future of Taxonomy? University of Geneva, Geneva, Switzerland.
- May 29, 2009 ***Evolutionary Insights Through DNA Barcoding.*** Evolution: The Molecular Landscape. 74<sup>th</sup> Cold Spring Harbor Symposium, Cold Spring Harbor, USA.
- May 8, 2009 ***Towards a Census of All Life.*** Centraalbureau fur Schimmelculture, Utrecht, Netherlands.
- May 7, 2009 ***A Status Report on DNA Barcoding.*** Quarantine Barcode of Life Meeting. University of Wageningen, Wageningen, Netherlands.
- May 2, 2009 ***The International Barcode of Life Project (iBOL).*** Consortium for the Barcode of Life Regional Meeting. Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
- Apr 17, 2009 ***Species Identification and Discrimination Using Barcodes.*** DNA Barcoding of Marine Biodiversity. Alfred-Wegener-Institut, Bremerhaven, Germany.
- Mar 13, 2009 ***Barcoding Biodiversity.*** Darwin's Legacy: Biodiversity as Natural Capital. University of Wageningen, Wageningen, Netherlands.
- Mar 3, 2009 ***BOLD: An Informatics Support System for DNA Barcoding.*** Instituto de Biologia, UNAM, Mexico City, Mexico.

- Mar 2, 2009 *Towards a Barcoded World.* The Barcode of Life in Mexico. Instituto de Biología, UNAM, Mexico City, Mexico.
- Feb 26, 2009 *Biodiversity Surveillance Through DNA Barcodes.* Department of Biology, Universidad de Colima. Colima, Mexico.
- Feb 18, 2009 *An Overview of DNA Barcoding.* Barcoding - Towards a DNA PDA Workshop. Ontario Genomics Institute. Toronto, Canada.
- Jan 27, 2009 *The International Barcode of Life - Bringing Genomics to Biodiversity.* Genome British Columbia Symposium. Simon Fraser University, Vancouver.
- Jan 22, 2009 *Barcoding Life.* Smithsonian Tropical Research Institute. Panama City, Panama.
- Jan 21, 2009 *DNA Barcodes and Biodiversity Conservation.* Recent Advances in Conservation Genetics. Smithsonian Tropical Research Institute, Balboa, Panama.
- Jan 19, 2009 *Lifelines: The Barcode of Life Project.* Rideau Club, Ottawa, Canada.
- Dec 17, 2008 *Australia's Role as a Regional Node in iBOL.* Australian Barcode of Life Meeting, CSIRO Division of Entomology, Canberra, Australia.
- Dec 4, 2008 *The International Barcode Of Life Project.* International Workshop on DNA Barcoding. National Agricultural Science Complex, New Delhi, India.
- Dec 1, 2008 *India and the Barcode of Life Project.* National Workshop on Barcoding of Marine Life. National Institute of Oceanography, Goa, India.
- Oct 14, 2008 *An Introduction to the International Barcode of Life Project.* iBOL Meeting of China and Canada. Institute of Zoology, Chinese Academy of Sciences. Beijing, China.
- Sept 19, 2008 *iBOL, the International Barcode of Life Project.* Identifying and Protecting European Biodiversity using DNA Barcoding. EuroBioforum, Strasbourg, France.
- Sept 3, 2008 *The International Barcode of Life Project.* South Africa and the International Barcode of Life. National Zoological Gardens, Pretoria, South Africa.
- July 21, 2008 *DNA Barcodes as a Tool to Study Biodiversity.* Euroscience Open Forum. Barcelona, Spain.
- June 24, 2008 *Towards a DNA Barcode Library for Geometridae.* Forum Herbulot - Global Strategies for Plotting Geometrid Biodiversity. Zoological State Collection, Munich, Germany.
- June 3, 2008 *Exposing Soil Invertebrate Diversity Through DNA Barcodes.* Conservation and Sustainable Use of Soil Biodiversity. Colorado State University, Fort Collins, USA
- Nov 3, 2007 *The DNA Barcode of Life in Korea.* Global Research Laboratory Program. Seoul, Korea.
- Oct 18, 2007 *Fractals, Genomes and a Barcoded World.* Genome Canada Conference. Quebec City, Canada.
- Oct 10, 2007 *Barcodes and Biodiversity.* Linnaeus 2007: The Nature of Species 300 Years After Linnaeus. Vancouver, Canada.
- Oct 7, 2007 *Polar Barcoding and the International Barcode of Life.* Trondheim, Norway.
- Oct 3, 2007 *The Canadian Centre for DNA Barcoding.* DNA Barcoding in Europe. Leiden, Netherlands.

- Oct 3, 2007 *The International Barcode of Life Project*. DNA Barcoding in Europe, Leiden, Netherlands.
- Oct 1, 2007 *The Compleat Linnaeus*. Linnaeus 300- the Future of his Science. Amsterdam, Netherlands.
- Sept 18, 2007 *Towards a Barcoded World*. Second International Barcode of Life Conference. Academia Sinica, Taiwan.
- Sept 17, 2007 *Progress Towards Barcoding North American Fishes*. Second International Barcode of Life Conference. Academia Sinica, Taiwan.
- Sept 14, 2007 *DNA Barcodes and Biodiversity*. Korea Forest Research Institute, Seoul, Korea.
- Sept 13, 2007 *DNA Barcodes and Biodiversity*. Seoul National University, Seoul, Korea.
- Sept 13, 2007 *DNA Barcodes and Biodiversity*. National Institute of Biological Resources, Seoul, Korea.
- Sept 4, 2007 *Towards a Barcoded World*. 53<sup>rd</sup> Brazilian Genetics Congress, Aguas de Lindoia, Brazil.
- May 17, 2007 *Probing Biodiversity and Evolutionary Processes Through DNA Barcoding*. EMBO workshop, Rome.
- Apr 13, 2007 *The International Barcode of Life Project*. Mexico City.
- Apr 13, 2007 *The Barcode of Life*. UNAM, Mexico City.
- Apr 12, 2007 *The International Barcode of Life Project*. CONABIO, Mexico City.
- Apr 11, 2007 *The Barcode of Life*. ECOSUR Annual General Meeting. Tapachula, Mexico.
- Apr 9, 2007 *The Barcode of Life*. ECOSUR, Chetumal, Mexico.
- Mar 28, 2007 *The Changing World of Science- DNA Barcoding Life*. Canadian Museum Association, Ottawa.
- Mar 15, 2007 *All Birds and All Fishes: What We Learn From Global Barcode Campaigns*. Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina.
- Mar 15, 2007 *Large-scale Barcode Production: from Sequences to Synthesis*. Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina.

## APPENDIX 3: RESEARCH FUNDING FOR 2000–2020

### OVERVIEW

Since 2000, I have led applications that have received more than \$100 million. Two awards (\$29 million) from the Canada Foundation for Innovation and the Ontario Ministry of Research and Innovation enabled construction of the Biodiversity Institute of Ontario in 2007 and the Centre for Biodiversity Genomics in 2012. I raised \$10 million to support the Canadian Barcode of Life Network from 2005–2010 and \$35 million from 2010–2015 to support our contributions to the first project led by the International Barcode of Life Consortium. I have also been a co-applicant on many other grants over the past decade. The largest of these awards (\$76.7 million from the Canada First Research Excellence Fund) will provide \$20 million to my Centre over seven years to extend its contributions to biodiversity genomics.

### AWARDS (PRINCIPAL INVESTIGATOR)

TIME	FUNDER	AMOUNT (* multiyear total)
2020-2022	CANARIE – Informatics	344,000*
2020-2023	Polar Knowledge Canada – ARCTIC BIOSCAN	1,800,000*
2019-2021	Walder Foundation – BIOSCAN	1,350,000*
2019-2021	Guanacaste Dry Forest Conservation Fund – BIOSCAN	1,350,000*
2019	Gordon & Betty Moore Foundation – Sequel II Grant	661,500
2018-2021	Canada First Research Excellence Fund – CBG Platform	6,000,000*
2018-2021	Canada First Research Excellence Fund – CBG Research	1,500,000*
2018-2020	Polar Knowledge Canada – ARCTIC BIOSCAN	1,799,750*
2018-2021	MRI – Bioinformatics & Computational Biology	180,000* + S. Adamowicz
2018-2021	Genome Canada – Bioinformatics & Computational Biology	250,000* + S. Adamowicz
2018-2023	NSERC – Advancing Biodiversity Science Through Barcodes	275,000*
2017	NSERC-RTI – Stable Isotope Facility	150,000
2016-2018	Canada First Research Excellence Fund – CBG Platform	5,800,00*
2015-2022	CRC – Tier 1, Molecular Biodiversity	1,400,000*
2015-2019	MRI Research Excellence – DNA Barcodes to Biomics	3,555,000*
2014-2017	CFI – Major Science Initiative – Biodiversity Institute	717,000*
2015-2018	Anonymous Donor – iBOL	3,000,000*
2014-2017	Life Technologies – iBOL	1,200,000*
2013-2016	CFI – Digital Biodiversity – From Informatics to Applications	654,000*
2013-2016	MRI – Digital Biodiversity – From Informatics to Applications	654,000*
2012-2018	NSERC – Comprehensive DNA Barcode Library for Churchill	62,500*
2012-2018	NSERC – Probing Biodiversity Through DNA Barcodes	300,000*
2012-2014	Moore Foundation – DNA Barcodes from Type Specimens	490,000*
2012-2015	Genome Canada – iBOL	7,500,000*
2011	CSIRO – Accelerated DNA Barcode Library Construction	60,000
2011-2014	NSERC – MRS for Biodiversity Institute	450,000*
2011	Genome Canada – iBOL	2,000,000
2010	Genome Canada – iBOL	4,600,000
2010-2015	Anonymous Donor – School Malaise Trap Program	300,000*
2010-2015	MRI – International Barcode of Life	8,082,900*
2010-2013	IDRC – iBOL in Developing Nations	2,190,000*
2010	Environment Canada – Endangered Species	50,000
2009-2011	NSERC – MRS for Biodiversity Institute	265,000*

2009	Genome Canada – iBOL	2,000,000
2009	CFI – Centre for Biodiversity Genomics	7,345,000
2009	MRI – Centre for Biodiversity Genomics	7,345,000
2008-2013	MRI – iBOL	5,000,000*
2008-2015	CRC Tier 1 – Molecular Biodiversity	1,400,000*
2008-2011	Kinross Brazil Barcoding – Barcoding Brazil	59,280*
2008	MRI – International Strategic – iBOL	150,000
2008	Genome Canada Technology – Envir Barcoding	800,000
2008	MRI Technology – Environmental Barcoding	400,000
2008	Environment Canada Technology	250,000
2007	Gordon & Betty Moore Foundation – Next Gen sequencer	250,000
2007-2012	NSERC Discovery – DNA Barcoding Lepidoptera	475,000*
2007-2010	NSERC Accelerator – DNA Barcoding	120,000*
2007-2010	NSERC International Supplement – Barcoding	600,000*
2007	Genome Canada Conference – iBOL	50,000
2007	Sloan Foundation Conference – iBOL	50,000
2007	MRI – Canadian Barcode of Life Network	1,000,000
2006	Gordon & Betty Moore Foundation – Sequencer	160,000
2006	NSERC Discovery – DNA Barcoding	90,000
2005-2010	NSERC Research Network – Barcode Network	5,000,000*
2005-2008	Genome Canada Comp III – Barcode Network	4,800,000*
2005	Alfred P. Sloan Foundation – Fish Barcoding	60,000
2005-2008	AAFC – Canadian Barcode of Life Network	150,000*
2005-2010	NRCan – Canadian Barcode of Life Network	250,000*
2005	DFO – Canadian Barcode of Life Network	15,000
2005-2010	EC – Canadian Barcode of Life Network	250,000*
2005	Ontario Genomics Institute – Fish Barcoding	5,000
2005-2010	Parks Canada – Canadian Barcode Network	250,000*
2004-2005	Canadian Wildlife Service – Barcoding Birds	20,200
2004-2008	CFI – Biodiversity Institute	4,900,000
2004-2008	OIT – Biodiversity Institute	4,900,000
2004-2007	Gordon and Betty Moore Foundation – DNA Barcoding	2,700,000*
2004-2008	U of Pennsylvania – Lepidoptera Barcoding	200,000*
2004-2005	Environment Canada – Barcoding Birds	23,364
2003	DINA – Arctic Fieldwork	5,000
2003	Canadian Wildlife Service – Barcoding Birds	11,000
1999-2005	NSERC Discovery – Evolution in Aquatic Life	590,000*
2003	OCAG – Barcode Informatics	76,000
2002-2003	CFI/OIT – CRC Equipment	352,000
2002	HRDC – Digital Media – Arctic Website	7,900
2002	Canada's Digital Collections – Arctic Website	49,500
2001	Industry Canada – Arctic Website	49,800
2001-2008	CRC Chair – Molecular Biodiversity	1,400,000*
2001	DINA – Arctic Fieldwork	8,700
2001	Ministry of Environment	5,000
2001	PCSP – Arctic Logistics	35,000
2000	PCSP – Arctic Logistics	45,000
2000	NSERC – Equipment	26,449
2000	NSERC – Equipment	25,624
2000	Bronfman Foundation – Arctic Website	5,000
2000	EJLB Foundation – Arctic Website	20,000
2000	Gordon Foundation – Arctic Website	50,000
2000	Helen McCrea Peacock Foundation – Arctic Website	3,000
2000	Human Resource Dev. Canada – Arctic Website	48,500
2000	Millennium Fund – Arctic Website	100,800
2000	Min. Energy, Science Tech. – Arctic Website	45,000
2000	Canada's Aquatic Environments	24,132
2000	DINA – Arctic Fieldwork	10,500
<b>2000-22</b>	<b>TOTAL AWARDS</b>	<b>\$102,018,000</b>

## OTHER AWARDS AS CO-INVESTIGATOR (# OF CO-APPLICANTS)

TIME	FUNDER	AMOUNT (*multi-year total)
2019-2021	Horizon (France) – Horizontal Gene Transfer (5)	\$1,200,000*
2016-2018	ANR (France) – SPHINX (15)	\$693,000*
2016-2018	BWF (Austria) – Alpine Lepidoptera Barcoding (3)	\$166,000*
2015-2017	CESAB (France) – ACTIAS (7)	\$300,000*
2014-2017	Marie Curie Fellowship (EU) - Vlad Dinca (2)	\$130,000*

## APPENDIX 4: TRAINING HQP – POSTDOCTORAL FELLOWS

Postdoctoral Fellow	Years	Area of Research	Current Position
Hann, Brenda	1980-1982	Genetics of <i>Simocephalus</i>	Faculty, University of Manitoba
Yallop, Marion	1982-1984	Great Lakes phytoplankton diversity	Faculty, University of Bristol
Schwartz, Steven	1981-1985	Zooplankton ecology	Faculty, Oklahoma State (now retired)
Zielinski, Barbara	1983-1984	Zooplankton developmental biology	Faculty, University of Windsor
Pugsley, Christopher	1983-1985	Contaminant monitoring in Lake St Clair	Environmental Consultant
Billington, Neil	1983-1986	Ecology of Arctic ponds and fish mtDNA diversity	Faculty, Troy University (now deceased)
Innes, David	1983-1986	Breeding system evolution in <i>Daphnia</i>	Faculty, Memorial University
Weider, Lawrence	1984-1986	Genetic variation in Arctic <i>Daphnia</i>	Faculty, University of Oklahoma
Kolasa, Jurek	1986-1988	Freshwater fish ecology in the Great Lakes	Faculty, McMaster University
Havel, John	1987-1989	Genetic variation in ostracods	Faculty, Missouri State University (now retired)
Danzmann, Roy	1988-1989	Fish community structure in Lake St Clair	Faculty, University of Guelph
Chaplin, Jenny	1992-1994	Genetic variation in ostracods	Faculty, Murdoch University (Australia)
Simon, Jean-Christophe	1993-1995	Genetic variation in aphids	Research Scientist, INRA (France)
Cywinska, Alina	1997-1999	Genetic variation in asexual ostracods	Research Associate, Brock University
Taylor, Derek	1998-1999	Evolution of <i>Daphnia</i>	Faculty, University of Buffalo
Schwenk, Klaus	1997-1998	Evolution of <i>Hyalodaphnia</i>	Faculty, Frankfurt University
Remigio, Ed	1998-2000	Anostracan phylogeny	Research Associate * (now retired)
Sacherova, Veronika	1999-2001	Genetic diversity in chydorid crustaceans	Faculty, Charles University (Czech Republic)
Ball, Shelly	2001-2003	DNA barcoding of aquatic insects	Research Scientist, Environment Canada
Costa, Filipe	2003-2005	DNA barcoding of marine crustaceans	Faculty, Universidade do Minho (Portugal)
Hajibabaei, Mehrdad	2003-2008	DNA barcoding of tropical Lepidoptera	Faculty, University of Guelph
Smith, Alex	2004-2008	DNA barcoding of Hymenoptera	Faculty, University of Guelph
Borisenko, Alex	2004-2007	DNA barcoding of mammals	Director, International Development, CBG
Ivanova, Nataly	2004-2008	DNA barcode methods development	Senior DNA Scientist, CBG
Steinke, Dirk	2006-2008	DNA barcoding of fishes	Director, Research Co-ordination, CBG
Terzin, Tom	2007-2008	DNA barcoding of Arthropoda	Faculty, University of Alberta
Rougerie, Rodolphe	2006-2010	DNA barcoding of Lepidoptera	Curator, Natural History Museum (Paris)
Zhou, Xin	2006-2010	DNA barcoding of aquatic insects	Faculty, China Agricultural University
Zakarov, Evgeny	2007-2009	DNA barcoding of Lepidoptera	Director, Genomics Division, CBG
Porco, David	2008-2010	DNA barcoding of soil invertebrates	PDF, University of Roen
McDonald, Tara	2009-2010	DNA barcoding of disease vectors	Research Scientist, Agriculture Canada
Fernandez-Triana, Jose	2008-2011	DNA barcoding of parasitic wasps	Taxonomist, Canadian National Collection
Schonfield, Justin	2008-2012	Structural variation in the barcode region	Bio-informatics Consultant
Blagoev, Gerry	2009-2012	DNA barcoding of spiders	Research Scientist, CBG
Kuzmina, Masha	2009-2013	DNA barcoding of plants	Research Scientist, CBG
Stahlhut, Julie	2009-2012	DNA barcoding of Hymenoptera	PDF, University of Missouri
Webb, Jeff	2011-2012	DNA barcoding of Ephemeroptera	Environmental Consultant
deWaard, Jeremy	2011-2012	DNA barcoding of Lepidoptera	Director, Collections Division, CBG
Hernandez-Triana, Luis	2011-2012	DNA barcoding of biting arthropods	Research Scientist, Department of Environment, UK
Zahari, Reza	2012-2014	DNA barcoding of Noctuoidea	Curator, University of Hamburg
Gwiazdowski, Rodger	2012-2014	DNA barcoding of Hemiptera	PDF, Rutgers University
Radulovici, Adriana	2012-2014	DNA barcoding marine crustaceans	International Programs, CBG
Zemlak, Tyler	2012-2013	DNA barcode applications	Development Lead, Lang School of Business, Guelph
Locke, Sean	2013-2014	DNA barcoding parasites	Faculty, University of Puerto Rico
Dinca, Vlad	2014-2017	DNA barcoding butterfly faunas	Academy of Finland Fellow, University of Oulu
Kekkonen, Mari	2014-2017	DNA barcodes and NGS	PDF, University of Helsinki
Lait, Linda	2016-2018	Insect Phylogeography	PDF, Department of Fisheries & Oceans, Halifax
Braukmann, Thomas	2015-	High-throughput Sequencing	In progress
Pentinsaari, Mikko	2015-	DNA barcoding beetles	In progress
D'Souza, Michelle	2018-	Tropical Insect Diversity	In progress
Rewicz, Thomas	2019-	Freshwater amphipods	In progress
Jung, Jibom	2020-	Invasive crabs	In progress

## APPENDIX 5: TRAINING HQP – GRADUATE STUDENTS

Graduate Student	Year Thesis	Current Position
Reeleder, David (MSc)	1978 Ecological variation in the pea aphid	Faculty, University of Toronto
Mort, Mona (MSc)	1979 The ecological significance of cyclomorphosis	Author
Woodrich, Denise (MSc)	1980 Patterns of genetic variation in <i>Daphnia</i>	Research Technician
Crease, Teresa (MSc)	1980 Allozyme variation in <i>Daphnia pulex</i>	Faculty, University of Guelph
McWalter, David (MSc)	1981 Clonal diversity in arctic members of the <i>D. pulex</i> complex	Software Developer, Maxxam Analytics
Good, Allan (MSc)	1981 Physico-chemical variation in zooplankton distributions	Faculty, University of Alberta
Loaring, Jaime (MSc)	1982 Clonal coexistence in <i>Daphnia pulex</i>	Medical Doctor, Windsor
Emery, Christopher (MSc)	1984 Adaptive significance of melanization in arctic <i>Daphnia</i>	Manager, Hamilton Health Science Centre
Barker, David (MSc)	1986 Genetic control of sex ratios in <i>Daphnia magna</i>	Consultant, Educational Software
Muncaster, Bernard (MSc)	1987 Monitoring toxic contaminants in bivalve molluscs	CEO, Muncaster Environmental Planning
Grewe, Peter (MSc)	1987 Mitochondrial DNA diversity in <i>Salvelinus</i>	Research Scientist, CSIRO Oceanography
Beaton, Margaret (MSc)	1988 Patterns of ploidy level variation in <i>Daphnia</i>	Faculty, Mt Allison
Boileau, Marc (PhD)	1989 Genetic diversity in calanoid copepods	Research Coordinator, University of Guelph
Stanton, David (PhD)	1989 Mitochondrial DNA diversity in asexual <i>Daphnia</i>	Faculty, Saginaw Valley State University
Murdoch, Mary (MSc)	1992 Genetic diversity in ictalurids (Order Siluriformes)	Environmental Consultant, Stantec
DeMelo, Rita (MSc)	1993 Speciation in freshwater zooplankton.	High School Biology Teacher, Toronto
Turgeon, Julie (MSc)	1993 Genetics diversity in <i>Cyprinotus</i> and <i>Cypricerus</i>	Faculty, Laval University
Taylor, Derek (PhD)	1994 Systematics and evolution of the <i>D. longispina</i> group	Faculty, University of Buffalo
Wilson, Christopher (PhD)	1995 Phylogeography and postglacial dispersal of <i>Salvelinus</i>	Research Scientist, Min. Natural Resources
Little, Tom (MSc)	1995 Reproduction and speciation in freshwater ostracodes	Faculty, Edinburgh University
Beaton, Margaret (PhD)	1995 Patterns of endopolyploidy and genome evolution in <i>Daphnia</i>	Faculty, Mt Allison
Thompson, Graham (MSc)	1995 Probing termite social systems through allozymes and mtDNA	Faculty, University of Western Ontario
Dufresne, France (PhD)	1995 Genetic relationships among arctic <i>Daphnia</i>	Faculty, U Quebec- Rimouski
Chen, Junjian (PhD)	1998 Multi-level analyses on mitochondrial DNA mutations	Faculty, Liaoning Medical University
Witt, Jonathan (MSc)	1998 Cryptic amphipod species in the Laurentian Great Lakes basin	Faculty, University of Waterloo
Colbourne, John (PhD)	1999 A documentary on the evolutionary history of <i>Daphnia</i>	Faculty, University of Birmingham
Rowe, Chad (MSc)	2000 Global distribution, phylogeny and taxonomy of <i>Holopedium</i>	Director, Destiny Solutions Software
Cox, Andrea (MSc)	2001 Freshwater phylogeography	Research Technician, UNB
Rhydderch, James (MSc)	2001 Microphylogeographic patterns of <i>Salvelinus malma</i>	Research Technician, Washington
Dery, Alison (MSc)	2001 Genetic and ecological diversity in saline lake rotifers	Faculty, U Montreal
Adamowicz, Sarah (MSc)	2002 Speciation of the <i>Daphnia</i> of Argentina.	Faculty, University of Guelph
Gregory, T. Ryan (PhD)	2002 The C-value enigma	Faculty, University of Guelph
Hardie, David C. (MSc)	2002 Genome size in fishes	Research Scientist, DFO
Dooh, Robert (MSc)	2003 Patterns of genetic divergence in glacial relict crustaceans	Company Director, Digital Media
Cristescu, Melania (PhD)	2004 Speciation in ancient lakes	Faculty, McGill University
DeWaard, Jeremy (MSc)	2004 Lifestyle transitions and rates of animal molecular evolution	Research Director, University of Guelph
Witt, Jonathan (PhD)	2004 A crustacean lineage in time	Faculty, University of Waterloo
Zemlak, Tyler (MSc)	2005 Counting fishes through DNA barcodes	Business Development, University of Guelph
von Konigsow, Taika (MSc)	2009 Automated tools for working with large DNA sequence data sets	Veterinarian, University of Guelph
Carr, Christina (MSc)	2010 Polychaeta of Canada: Exploring diversity using DNA barcodes	Lecturer, University of Northern Iowa
Kerr, Kevin (PhD)	2010 Exploring the efficacy of DNA barcoding within the class Aves	Curator of Birds, Toronto Zoo
Wilson, John (PhD)	2010 DNA barcoding and Lepidoptera taxonomy	Faculty, University of South Wales
Corstophine, Erin (MSc)	2010 DNA barcoding of echinoderms	Environmental Consultant, Genivar
Clare, Elizabeth (PhD)	2010 MtDNA Diversity in Neotropical bats: Molecular systematics	Faculty, Queen Mary University of London
Nazari, Vazrick (PhD)	2011 DNA barcoding of Lepidoptera	Researcher, Agriculture Canada
Cuellar, Blanca (MSc)**	2011 DNA barcoding the Lepidoptera of the Yucatan Peninsula	Research Technician, ECOSUR
Jingjing Wang (PhD)**	2010 DNA barcoding Arctic Diptera	PDF, Kunming Biodiversity Centre
Layton, Kara (MSc)	2012 DNA barcoding of Acarina	Faculty, Aberdeen University
Young, Monica (MSc)	2012 DNA barcoding of Marine Mollusks	PhD Student, University of Guelph
Zhaofu, Yang (PhD)**	2014 DNA barcoding the Crambidae of China	Faculty, Northwest Ag & Forestry University
Chambers, Anne (MSc)	2014 DNA barcoding North American Amphibians and Reptiles	PhD student, University of Texas at Austin
Hotke, Katie (MSc)	2015 DNA barcoding of Cnidaria	DVM
d'Souza, Michelle (PhD)	2013 DNA Barcoding Tropical Insects	PDF, University of Guelph
Yu, Iris (MSc)	2019 Character State Variation in Canadian Insects	Research Technician, University of Guelph
Young, Monica (PhD)	2019 DNA barcodes for Canadian Acarina	Researcher, Agriculture Canada
D'Ercole, Jacopo (PhD)	2015* DNA barcoding continental butterfly faunas	In Progress
Schultz, Jessica (PhD)	2017* DNA Barcoding Pacific Marine Invertebrates	In Progress

\* Start Date

\*\* Co-advisor