

CANADIAN BOTANICAL ASSOCIATION/ L'ASSOCIATION BOTANIQUE DU CANADA - RESPONSE TO CANADA'S FUNDAMENTAL SCIENCE REVIEW -

Prepared by the CBA/ABC Ad Hoc Science Policy Committee:

Chair: Iain E.P. Taylor (Professor Emeritus), University of British Columbia;

Members: Phil Burton (Professor), University of Northern British Columbia; Cindy Ross-Friedman (Professor), Thompson Rivers University; Laura Super (Ph.D. student), University of British Columbia; Liette Vasseur (Professor), Brock University

Endorsed by the CBA/ABC Executive: Art Davis (President), University of Saskatchewan; John Markham (Past-President), University of Manitoba; Julian Starr (President-Elect), University of Ottawa

Preamble

The Canadian Botanical Association/L'Association Botanique du Canada (CBA/ABC) represents Canada's researchers and scholars in the plant sciences from various disciplines including ecology, genomics, systematics (taxonomy), development, and teaching. The CBA/ABC supports holistic research on photosynthetic organisms like plants and algae that includes the study of organisms that affect plant health and productivity, such as the fungi and bacteria. Accordingly, the CBA/ABC provides formal, expert, peer-reviewed and credible input to national, provincial and local governments on matters pertaining to plant technologies and the sustainable management of ecosystems.

This input into the Fundamental Science Review has been considered in the current world context of the 2030 Sustainable Development Goals (SDGs) and the Paris Agreement. Researchers in plant sciences contribute to Canada's and the world's economies and development in many ways by doing a wide range of fundamental and applied research. Their results are integrated in many domains such as agriculture, forestry, horticulture, and urban planning. These research results and informed opinions are often part of larger contributions, and are crucial for human wellbeing.

Introductory questions

Botany and some of its sub-disciplines (such as ecology, systematics, and anatomy) are often considered "old-fashioned" subjects and not as attractive as genomics or medical research. However, as documented in the attached CBA/ABC position paper on Global Change, these disciplines are essential to better understand how plants, which make up the foundation for nearly all food webs on Earth, will respond to a changing climate and other environmental impacts. For example, through the discovery of biodiversity and its evolutionary relationships, modern plant systematics provides the core knowledge required for endangered species protection, biodiversity conservation, ecosystem management, and environmental impact assessment. There is a need to better integrate fundamental research with more advanced technologies (e.g., DNA barcoding, geographic genomics), but the current funding trend is to neglect basic research questions in disciplines like ecology and systematics that provide the foundation for making scientific breakthroughs using exciting new technologies. However, the editorial of *Nature* (August 25, 2016, Vol. 536, p.373) pushes for replicated studies as they are needed to ensure that we can really detect the trends. With about 5000 plant species in Canada, and new invasive weeds and cultivars arriving every year, it is important to understand their distinctive attributes and interactions, even if such investigations have been conducted on other systems before. This is especially important in ecological studies because of Canada's large and diverse geography with ecosystems responding differently to environmental and climatic changes. Interestingly, such research can be highly

integrative, especially when linked to agriculture, for instance. This integrative work is another very important need to be addressed in Canada's research programming.

With regard to the question of other programming features of other countries that might be worth emulating, the obvious one is the European Commission's Horizon 2020 program in Europe, which encourages more integrative research.

Funding of fundamental research

Many basic questions regarding our fundamental understanding of plant life remain unanswered, such as how many species are there? Funding for fundamental research in Canada has been unbalanced for some time as a strong emphasis has been placed on research that uses advanced technologies or genomics. However, as explained in our position paper, basic research in ecology, phycology, mycology, and systematics still remains to be done to make full use of modern technologies. The current format of the granting councils is not convenient for these researchers who cannot compete with the genomics people in the same committee. The emphasis on innovation (often targeting patents or new technologies or genomes) reduces the capacity of Canada to respond to more pressing, fundamental questions. Because of these conditions, it is often felt that the current system is not completely fair and not sufficiently flexible to allow research that is essential but unlikely to make the media's headlines.

NSERC training initiatives like NSERC CREATE have made a difference, but by increasing scholarship numbers, academic research laboratories nationwide could train more highly qualified personnel (HQP) at the undergraduate and graduate levels. NSERC should put more money into helping postdoctoral fellows and graduate students work together and mentor undergraduates in research (through tri-mentoring), so these valuable skills can be fostered early in the next generation of scientists. Supporting students in botany needs to start at the undergraduate and Masters level. The current funding system places a strong emphasis on Ph.D. mentorship despite the fact that the private sector is now looking for more Masters level graduates and many smaller universities do not possess Ph.D. programs, and recognizing that a B.Sc. alone does not guarantee a job. The nurturing of HQP also requires that support is needed for them to go to conferences (not always possible with some grants). Given the costs of training an individual to the Ph.D. level, the NSERC requirement of only being able to apply once for postdoctoral funding should be revised so HQP will not be easily lost by the system before they become successful researchers in government, academia, or private industry.

Funding of facilities/equipment

It is difficult to get funding for greenhouses, growth chambers, and field equipment (including environmental dataloggers, monitoring stations and field vehicles), as they often do not fit into Canadian Foundation for Innovation grants, especially if they are for ecological work, and their costs are too high for the NSERC Research Tools and Instruments grants program. There is a need to find ways to support infrastructure that is needed but cannot be completely put on the budget of universities. Some sort of basic sustained competitive funding would help maintain existing equipment and allow forward planning for its eventual replacement and upgrading as needed.

Better support for research facilities can be a bridge for international collaborations if they are well maintained, not just replaced a few years after they break down. To be competitive, Canada needs to develop a funding strategy to take advantage of other international calls for proposals when they open, and to support Canadian researchers so they can participate. The country has been slow to

respond to such competitions and many opportunities have been lost, especially in regards to climate change adaptation and biodiversity research.

Funding of platform technologies

With the growing needs for advanced computing and the mining of large datasets, platform technologies are a must, and Canada needs to have a strategy to ensure research sustainability. It cannot be an ad hoc system where these groups must compete for funding on a regular basis. These technologies could be more accessible to ecological research if there was support for the curation and maintenance of long-term data sets. Considering the vastness and diversity of our ecological systems, this would be a great advantage to researchers at home and abroad, and to Canada's land and resource managers. There is currently no official depository for the storage and quality assurance of ecological monitoring data. Irreplaceable data have been and continue to be lost as professors retire and research centres or libraries are closed. The net result is that many questions related to long-term biological and ecological trends remain difficult to answer, despite the fact that we had the required information at one time!

Conclusion

Support for fundamental research in the biology and ecology of plants should support the highest ideals of curiosity-driven science and humankind's quest to understand how life on Earth works. Canadian contributions are significant because of the diversity of our biota and the importance of our resource-based economies. The size of the country further requires researchers to recognize that impacts of changing climate can be different in apparently similar ecosystems. For example, the boreal forest covers such a wide swath of Canada that differences in latitude and floristics require similar (but coordinated) studies to be conducted in multiple locations across the country. A laudable example involved nation-wide investigations of blueberry pollination by CANPOLIN (NSERC Strategic Network) researchers during 2008-2013. It is not enough to fund one example of each kind of plant science research, or only the new and "innovative" approaches. What some review panels now condemn as "mere replication" is, in fact, important place-based, context-specific, and unique exploration of plant life.

The current emphasis on patents and innovations instead of basic research is a dangerous path for Canada to respond to the rapidly changing issues of today's world and the unforeseen challenges of the near future. Botany, especially some sub-disciplines like ecology and systematics, has been marginalized at a time where it is most needed to respond to human challenges. It is time to review what fundamental research means.