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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 12.2 of the Provisional Agenda

Seventeenth Regular Session

Rome, 18–22 February 2019

SUBMISSIONS BY MEMBERS AND OBSERVERS ON THE DRAFT WORK PLAN FOR FUTURE WORK ON SUSTAINABLE USE AND CONSERVATION OF MICRO-ORGANISM AND INVERTEBRATE GENETIC RESOURCES

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I. INTRODUCTION

1. The Commission on Genetic Resources for Food and Agriculture (Commission), at its last session, considered the status of its work on the conservation and sustainable use of micro-organism and invertebrate genetic resources for food and agriculture (MIGR) and requested FAO to prepare a draft work plan for future work on the conservation and sustainable use of micro-organism and invertebrate genetic resources, taking into account countries' views, the findings of *The State of the World's Biodiversity for Food and Agriculture* and any other relevant information, for review by the Commission's Intergovernmental Technical Working Groups and the Commission at their next sessions. It requested the Secretary to invite countries to provide their views on the development of the draft work plan.[1]

2. In response to the Commission's request, FAO through Circular State Letter C/CBD-7 of 22 May 2017, FAO invited Members and observers to provide their views in writing by 30 September 2017. The submissions received are compiled in this document; they are presented in alphabetical order and in the language in which they were received.

II. SUBMISSION BY COUNTRY

A. CANADA

At its 16th session in January 2017, the Commission on Genetic Resources for Food and Agriculture (CGRFA) requested the Secretary to invite countries to provide their views on the development of a draft plan for future work on the sustainable use and conservation of micro-organisms and invertebrates (document CGRFA-16/17/Report, para.78). The present document provides Canada's views.

Canada would agree to the Commission establishing an Intergovernmental Technical Working Group (ITWG) on Micro-organisms and Invertebrates, subject to available financial resources:

Canada agrees that the importance of pollinators (in particular honey bees); of micro-organisms relevant to ruminant digestion, food processing and agro-industrial processes; of biological control agents; of mycorrhizal and/or harvestable fungi; and of soil organisms should be recognized and that establishment of an ITWG on micro-organisms and invertebrates would facilitate this, subject to available financial resources. The Secretary should report to the Commission on the costs required to operate the ITWG and the source of funding.

Canada agrees that the Commission should develop a Report on the State of the World's Micro-organism and Invertebrate Genetic Resources for Food and Agriculture (MIGR):

Bacterial, yeast and fungal genetic resources used in food processing and agro-industrial processes, including mycofertilizers (mycorrhizal fungi) and harvestable fungi, should be included in the future Report. The Secretariat should propose to the Commission that the Report should be developed following the Commission's bottom-up process, because establishment of national baselines is important to address issues of relevance to micro-organisms and invertebrates in food and agriculture. Upon completion of the Report, the Commission should decide if it is warranted to develop a Global Plan of Action on MIGR, as has been done for other sub-sectors of the Commission. A Global Plan of Action has provided a framework for countries to implement recommendations made by the Commission.

Canada considers the Commission should invite member countries to designate National Focal Points for MIGR:
National Focal Points for MIGR will facilitate providing the necessary information to achieve the Report.

[1] CGRFA-16/17Report, paragraph 78.

Canada recommends that elements of the draft work plan for MIGR should include:

- identifying and defining the various uses of MIGR (e.g. pollination, biocontrol/pest management, food production, biofertilizers/bioinoculants, bio-fuels, bio-remediation)
- access to MIGR and benefit-sharing (ABS)
- role of pollinators (bearing in mind that the Commission decided that information on pollinators will be channeled to DAD-IS)
- partnerships for MIGR
- taxonomy of MIGR
- biocontrol organisms
- identifying key beneficial organisms in the microbiome of crops and rooting soil

BACKGROUND:

Overview of Impacts

Canada recognizes the importance of microbial and invertebrate biodiversity to food and agriculture globally. Microbial and invertebrate genetic resources are highly important to the global sustainability of food and agriculture. During its Sixteenth Regular Session in 2017, the Commission reviewed the preliminary findings of the *The State of the World's Biodiversity for Food and Agriculture* and noted that knowledge of many invertebrate and micro-organism species, present in and around production systems, have not been recorded or characterized and their functions within ecosystems remain poorly understood. It was also noted that a range of drivers of change are affecting biodiversity, often negatively, but that biodiversity can be used in adapting production systems so they are resilient to the effects of changing climates, can control invasive alien species and can improve disaster preparedness. Although there are upward trends in the implementation of practices such as pollination management, sustainable soil management, organic agriculture, integrated plant nutrient management and integrated pest management, knowledge of how these practices influence the status of biodiversity for food and agriculture needs improvement. Furthermore, development and implementation of effective policy tools for the sustainable use and conservation of biodiversity for food and agriculture are constrained by a lack of awareness among policy-makers of the significance of biodiversity to livelihoods and food security.

The Commission's past work on micro-organisms and invertebrates identified regional needs and priorities in: (i) assessment and monitoring; (ii) conservation and sustainable use; (iii) policies, institutions and capacity; and (iv) regional and international cooperation. Among the priorities identified were: the need to establish national baselines, particularly for soil organisms and pollinators; assessment of the impact of management practices on biodiversity for food and agriculture and ecosystem services; the promotion of research on the roles of micro-organisms and invertebrates in food and agriculture, including soil fertility; strengthening of research networks related to the conservation of micro-organisms and invertebrates; strengthening of policies for the conservation of associated biodiversity, including of pollinators, soil organisms and biological control agents.

Pollinators

Significant progress has been made on conservation and sustainable use of pollinators (CBD COP-13 decision XIII/15). The Biodiversity Convention's initiative, supported by the FAO, led to a global assessment of pollinators, pollination and food production carried out by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). The importance of wild and domestic pollinators to global agriculture has been estimated (US$235-577 billion representing 5-8% of the current global crop production in 2015). Factors that contribute to population declines were identified and trends for the future were documented. Initiatives to develop and implement new tools and strategies to address population declines have also been proposed (Pollinator Health Task Force 2015; Scottish Natural Heritage 2015; OMAFRA 2016; Potts et al. 2017). Canada has invested in a national project to develop protocols to identify parasite and disease stressors of bees and to provide baseline data needed to guide future work on conservation of pollinators.

Ecosystem Effects and Outcomes

Significant progress has been made to demonstrate the value of agricultural micro-organisms for: improvement of food and agricultural production systems and contributing to energy production and waste management (FAO Background Study Paper No. 46); identification and quantification of the microbiota in the rumen (FAO Background Study Paper No. 61); agro-industry uses such as bio-fertilizers and/or bio-inoculants, Effective Micro-organisms (EM) technology, bio-pesticides and bio-remediation indicators (FAO Background Study Paper No. 64); and Food Biotechnology, particularly through basic understanding of mechanisms by which fermentation improves food safety and stability which has contributed to the use of live microbial strains for bio-preservation (FAO Background Study Paper No. 65). Canada's microbiological collections are among the top 10 globally according to the World Federation of Culture Collections (www.wfcc.info/ccinfo/statistics/).

Soil micro-organisms contribute to the delivery of ecosystem services that are essential for human society, such as: transport, storage and provision of clean groundwater; storage of carbon and trace gas emissions critical to climate control; provision of nutrients; pest and pathogen regulation; and supporting plant growth and above-ground biodiversity (FAO Background Study Paper No. 63). Advances in gene marking, DNA fingerprinting, PCR amplification, genomics, proteomics and metabolomics, and associated microarray technologies have enhanced opportunities for discovery, development and conservation of soil micro-organisms. Canada has made significant progress to understand the role of soil micro-organisms, for example, using sequencing to study the molecular mechanism and biology of *Paenibacillus polymyxa* CR1 in enhancing the root size of crops, thereby increasing uptake and fixation of important soil nutrients, like nitrogen (Eastman and Yuan, 2015).

Advances in molecular microbial ecology (based on 16r RNA gene (rrn) phylogeny) have enabled the identification and quantification of the microbiota in the rumen (FAO Background Study Paper No. 61). This work has led to the revelation that complex communities are present that have co-evolved with the ruminant host in response to environmental conditions and gut physiology of the animal. New evidence has shown that there are differences among individuals of the same breed, as well as between species, in the bacterial microbiome and metabolic potentials in the rumen. Canada understands the importance of understanding rumen function in order to find a balance between food production and Greenhouse Gas emissions towards meeting Canada's commitment to reduce these emissions by 30% of 2005 levels by 2030 (ECCC 2017). Canada has also made progress to understand the influence of feed type on micro-organisms in animal digestion, for example, mash feed is associated with lower growth performance but with favorable intestinal changes linked to VFA levels and *E. coli* reduction in the intestine (Longpré et al. 2016).

Pest Control

Micro-organisms and invertebrates are important genetic resources used as agents for biological control (BC) of pests to ensure global sustainability of food and agriculture (e.g. Mason et al. (2013) on introduction to Canada of a parasitic wasp to help control leek moth, an invasive pest of onion and garlic). Significant progress has been made to demonstrate the importance of biological control organisms for managing pests and illustrate the benefits to both donor & recipient countries, and the global community (FAO Background Study Paper No. 47). Canada has made significant progress in developing and releasing new invertebrate biological control agents, most recently against the invasive weed *Linaria dalmatica* (De Clerck-Floate 2015) Furthermore, Canada is contributing to a comprehensive synthesis on the use of biological control agents for the control of invasive alien species being prepared as an outcome of an expert meeting organized by the CBD Subsidiary Body on Scientific, Technical and Technological Advice, in October 2015 (UNEP/CBD/SBSTTA/20/INF/31). This document will address, among other things, misconceptions about biological control. As well, the International Organization for Biological Control's Global Commission on Access and Benefit Sharing has developed best practices for the exchange and use of microbial and invertebrate BC organisms to ensure fair and equitable benefit to all (Mason *et al*. 2017). Canada tends to consider that exchange and use of biological control organisms is a benefit to the global community and this benefit needs to be promoted in future work on the role of micro-organisms and invertebrates in food and agriculture.

Micro-organisms are important in agro-industry as bio-fertilizers and/or bio-inoculants, Effective Micro-organisms (EM) technology, bio-pesticides and bio-remediation indicators (FAO Background Study Paper No. 64). All of these uses are dependent on understanding micro-organism processes and conserving their biodiversity, including the impacts of climate change. Canada has made significant progress in developing new bio-pesticides against insects (e.g. Autographa californica nucleopolyhedrovirus (AcNPV), trade name Loopex) (Erlandson et al. 2017) and weeds (e.g. *Phoma macrostoma*) (Bailey et al. 2017), a new pathogen detection method to improve food safety (Simmons et al. 2016), and using bacteria that feed on the carbon in the wood chips to transform the nitrate from water into nitrogen gas (McKenzie et al. 2017),

Food Processing

Micro-organisms are important in food processing and constitute a major part of Food Biotechnology, particularly through basic understanding of mechanisms by which fermentation improves food safety and stability which has contributed to the use of live microbial strains for bio-preservation (FAO Background Study Paper No. 65). While in industrialized countries the "formal" food processing sector is well organized and access to precisely characterized and defined microbial strains is reliable, the "informal" food processing sector in developing countries is diverse and not as well organized. However, small-scale artisanal enterprises produce a wide range of traditional fermented foods to meet the basic needs of millions of people for access to safe and wholesome foods. Canada has made progress to develop the use of micro-organisms in food technology. For example, *Leuconostoc mesenteroides* is well adapted to increase production of biomass by immobilized cell technology (ICT). This bacterial formulation is beneficial as it provides protection of the viability of these probiotic bacteria during storage, and protection against bacteriophages (Champagne et al. 2010).

Microbial Identification

Taxonomy and associated taxonomic expertise are integral to understanding the diversity of and conserving micro-organisms and invertebrates. The combination of more refined species concepts enabled by DNA sequencing and a mandated unified classification and naming system led to significant progress in our understanding of the taxonomy and diversity of fungi, including industrialized molds, yeasts and other fermenters, blights, wilts, rusts, smuts, mycotoxigenic agents, decay fungi, mushrooms, and microbial pathogens of vertebrates and arthropods. Agriculture and Agri-Food Canada's scientists are world leaders in piloting the science through this necessary transition and publication of internationally agreed upon lists of fungal names. Previously, the biodiversity of fungi associated with agriculture was confounded by the use of multiple generic and species names because of separate classification systems, or when single species concepts concealed multiple species, often with an untested assumption that morphologically similar fungi on different continents were genetically the same. The realization is growing that the geographical distributions of many fungal species, including harvested edible ectomycorrhizal forest mushroom species used locally or exported for food, either fresh, dried or incorporated into processed foods, are more geographically restricted than previously believed (Buyck et al. 2016, Olariaga et. al. 2016, Thorn et al. 2017, Trudell et al. 2017, Wu et al. 2016). Examples are chanterelles and matsutakes. Among microfungi used commercially, the situation is similar. For example, the *Aspergillus niger* complex, well-known as a source of organic acids and enzymes involved in the production of traditional fermented foods, now comprises about 10 species, some of them regulated as potential human pathogens or producers of regulated fumonisin and or ochratoxin that contaminate beer, coffee, wine, and other commodities. Sterile fungal isolates are now more frequently being named as species and placed phylogenetically in known genera, or new genera defined by DNA sequence data. An example is a root and stored-produce pathogen such as *Fibulorhizoctonia*.

DNA sequencing has led to significant progress in the identification of microbial and invertebrate species (as well as other animals and plants associated with agriculture as well as a better understanding of their relationships (Frewin et al. 2013)). The application of this technology is broad-ranging including rapid identification of agricultural pests, pathogens and beneficial organisms, elucidation of previously unrecognized species and understanding of the relationships between species. Knowledge of species relationships can have practical applications such as allowing

predictions of whether new species may be harmful to humans (i.e. pathogenic or an agricultural pest) or beneficial (i.e. an effective pollinator or biological control agent).

Following the progress made in mapping out biological collections helped by Federal institutions (including genebanks, herbaria, clonal and viral banks), preserved collections across Canada, and authoritatively identified specimens in the collections of the Federal Government of Canada, the Department of Agriculture and Agri-Food (AAFC) played a major role in the creation of the Canadian Centre for DNA Barcoding (University of Guelph) DNA barcode library by contributing sequences from tens of thousands of identified specimens collected from around the world. This library has been mined to generate predictions about the diversity of insect species in Canada (Hebert et al. 2016). Furthermore, Canada has made a significant investment over six years to accelerate the DNA analysis, data capture and imaging of specimens from its national collections of over 19 million specimens of insects, plants, fungi, bacteria and nematodes held by AAFC. These data will be integrated in a centralized information management platform that will be publicly accessible through an AAFC collections portal to support research in climate change, rapid identification and prevention of threats to agriculture, as well as future work on the sustainable use and conservation of micro-organisms and invertebrates.

Through advances in microbiomics (the study of microbial communities in a given niche), thousands of times more bacteria and archaea have been discovered than taxonomists have described previously. The microbial taxonomic community has not adopted DNA barcoding and is moving rapidly towards whole genome sequencing for such organisms. For fungi, the magnitude of the unknowns is less but still significant. New technologies like high-throughput next generation sequencing has advanced our abilities to analyze, detect and identify fungi via DNA sequences, from infections, produce, stored harvests, soils, water, air and other environmental samples. They are now important for evaluating fungal, bacterial and archaea diversity at the global scale, and are valuable new tools for quarantine and trade discussions.

Previous Activities of the Commission

At its 16th session in January 2017, the Commission:

(i) requested the Secretary to invite countries to provide their views on the development of a draft plan for future work on the sustainable use and conservation of micro-organisms and invertebrates.
(ii) requested FAO to prepare the draft work plan, taking into account these views, the preliminary findings of *The State of the World's Biodiversity for Food and Agriculture*, and any other relevant information, for review by the Commission.
(iii) reiterated the importance of pollinators (in particular honey bees), of microorganisms of relevance to ruminant digestion, food processing and agro-industrial processes, of biological control agents and of soil organisms, and
(iv) requested that these key groups be reflected in the draft work plan.
(v) stressed the need for FAO to continue building partnerships with other international organizations and initiatives to mobilize expertise on micro-organisms and invertebrates and requested FAO to reflect this in the draft work plan.
(vi) requested the Secretariat to convene an international workshop to assist countries to identify and raise awareness of distinctive features and specific practices of subsectors of GFRA in the context of the ABS Elements.
(vii) requested the Secretariat to gather information on use and exchange practices, relevant voluntary codes of conduct, guidelines and best practices, and/or standards and community protocols as well as model contractual clauses on ABS specifically addressing GRFA.

The Secretary was requested to prepare for the Commission's next session a draft work plan for future work on the sustainable use and conservation of micro-organisms and invertebrates, taking into account the findings of the Report on *The State of the World's Biodiversity of Food and Agriculture* and any other relevant information. (CGRFA-16/17/21, paragraph 7).

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CGRFA-16/17/Inf.10: The State of the World's Biodiversity for Food and Agriculture (Draft)

CGRFA-16/17/Report of the Commission on Genetic Resources for Food and Agriculture

CGRFA-16/17/21: Status of the Commission's Work on the Conservation and Sustainable Use of Micro-Organisms and Invertebrates

CGRFA-16/17/Inf.22: Progress of the International Initiative for the Conservation and Sustainable Use of Pollinators

CGRFA-16/17/Inf.23: Progress of the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity

FAO Background Study Paper No. 46: The Use and Exchange of Microbial Genetic Resources for Food and Agriculture

FAO Background Study Paper No. 47: The Use and Exchange of Biological Control Agents for Food and Agriculture

FAO Background Study Paper No. 61: Micro-organisms and Ruminant digestion: States of Knowledge, Trends and Future Prospects

FAO Background Study Paper No. 63: The Conservation and Use of Micro-organisms and Invertebrates in Root Crop-based Systems: State of Knowledge, Trends and Future Prospects

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B. ECUADOR

Acción: Presentación de opiniones acerca de la elaboración de un proyecto de plan de trabajo para la labor futura sobre la conservación y el uso sostenible de microorganismos e invertebrados

Informe: Para Ecuador el plan de trabajo deberá tener los siguientes elementos:

1. Características distintivas de estos recursos genéticos y su relación con el acceso y distribución de beneficios.
2. Bases de referencia nacionales, en particular para los organismos del suelo y los polinizadores.
3. Evaluación de la repercusión de las prácticas de gestión sobre la biodiversidad para la alimentación y la agricultura y los servicios ecosistémicos.
4. Fomento de la investigación acerca del papel de los microorganismos y los invertebrados en la alimentación y la agricultura.
5. Fortalecimiento de las redes de investigación relacionadas con la conservación de los microorganismos e invertebrados.
6. Caracterización de polinizadores y organismos de los suelos, así como a prácticas agrícolas que favorecen la polinización y la fertilidad y calidad del suelo.

C. SWEDEN

This communication is in response to the requested follow-up action No. 15 (Submission of views on the development of a draft work plan for future work on the conservation and sustainable use of micro-organisms and invertebrates) of document C/CBD-7 - **Commission on Genetic Resources for Food and Agriculture, Follow-up to the 16th Regular Session.**

Sweden,

- acknowledges the invaluable role of invertebrates and micro-organisms for food and agriculture as summarised in information documents CGRFA-12/09/Inf. 15 and Inf. 17, respectively;
- shares the views as expressed by other National Focal Points in document CGRFA-16/17/21, para 4 (page 3) concerning
    - the need for establishing national baselines
    - assessing the impact of management practices on biodiversity for food and agriculture and ecosystem services
    - promoting research on the roles of micro-organisms and invertebrates in food and agriculture, including in soil fertility
    - strengthening of research networks related to the conservation of micro-organisms and invertebrates, and
    - strengthening of policies for the conservation of associated biodiversity, including of pollinators, soil organisms and biological control agents;
- additionally, would like to emphasize
    - properly recognizing and valorising invertebrates and micro-organisms as a major future dietary component (both human food and animal feed)
    - promoting and updating research on the economic value and benefits of invertebrates and micro-organisms for food and agriculture

- strengthening of policies that favour associated biodiversity, including of pollinators, soil organisms and biological control agents, in the field, and
- mitigating policies that are detrimental to their ecosystem services.

III. SUBMISSIONS BY OBSERVERS

A. CABI

There is no substantive improvement in the knowledge of the input of microorganisms and invertebrates to food production and agriculture. Less than 1% of microorganisms can be isolated leaving our knowledge of the contribution of the remaining 90% to limited metagenomics studies. Microorganisms operate in consortia and their positive impact on soil fertility is not contested but the lack of understanding how these work limits the extent of interventions that can be made to augment soil fertility in degraded and "overworked" situations. The report on the *Status of the Commission's work on the Conservation and Sustainable Use of Microorganisms and Invertebrates* endorses the need for further work but simply suggests "the Commission may wish to define future priorities regarding microorganisms and invertebrates". CABI would wish to see are firmer commitment to fund research into soil microbiology (biology) to get a better understanding of the input of microbial (and invertebrate) communities to enable action to reintroduce lost processes to soils to enable improved crop yields. CABI would welcome the opportunity to contribute to the proposed draft work plan for future work on the sustainable use and conservation of microorganisms and invertebrates.