

ANNUAL REPORT 2020

International Alliance for Phytobiomes Research







Opening Letter

By Kellye Eversole

Phytobiomes Alliance Executive Director



The idea that all parts of a system are interconnected, dependent on its context and local environment, and, like all complex systems, is evolving, adapting, and shaping other components is the basis of our approach for phytobiomes research. **2020** was a very challenging year for all of us and impacted greatly our ability to travel and network. Nonetheless, we were able to advance our activities and projects as we continued our efforts to increase the Phytobiomes Alliance visibility and to promote research and activities related to phytobiomes as a system.

Throughout the year, we increased the breadth of the Alliance reach by adding nine new members to the scientific Coordinating Committee – as project leaders or representatives of financial sponsors – some of them representing disciplines beyond microbiology, such as artificial intelligence and animal genomics/gut microbiomes. We also welcomed a new sponsor from Belgium: Aphea.Bio.

We expanded the international scope of the Alliance by adding new members to the Coordinating Committee from Australia, Belgium, France, Ireland, and the United Kingdom. Furthermore, we submitted several collaborative interdisciplinary project proposals to funding agencies worldwide to address knowledge gaps in phytobiomes research. We are still awaiting decisions on these proposals, but whatever the outcome, it provided us rich opportunities to continue building the Alliance's international network and visibility.

Advancement in some of our projects which began in 2019 was slowed by lab closures and restrictions in access due to the pandemic, but we still managed to deliver some results. In the LINS project, for example, we completed the sequencing of 144 *Ralstonia solanacearum (Rs)*, a soil born pathogen.

Moreover, through participation to US, UK, and EU projects, the Alliance team contributed to the development of several publications related to standards and priorities for microbiome research.

At a more general level, we were pleased to see an overall increase in funding for agricultural research in 2020, and in particular for agriculturally relevant microbiome research. Additionally, the concept of "embracing complexity" is being adopted increasingly in many disciplinary and policy arenas, with some directly mentioning phytobiomes and systems agriculture. The idea that all parts of a system are interconnected, dependent on its context and local environment, and, like all complex systems, is evolving, adapting, and shaping other components is the basis of our approach for phytobiomes research. We consider it very encouraging that this way of studying complex systems is becoming more and more mainstream.

We began organizing webinars in the fall of 2019, which was timely as, when labs had to shut down in spring 2020, we were able to keep the community connected and engaged while highlighting the latest tools, resources, and developments in phytobiomes research. In total, nine well attended webinars were organized in 2020 and the series will continue in 2021.

Due to the ongoing COVID-19 pandemic, the scientific committee decided to postpone the International Phytobiomes Conference, initially planned for September 2020, to September 2022. This was preferred to holding a virtual event, which was considered not conducive enough for networking, establishing priorities, or encouraging the development of cross-disciplinary international collaborative projects, the outcomes of which are essential for the long-term success of phytobiomes research.

Over the next year, the Alliance will continue to increase its reach, promote pre-competitive research, and engage in activities and projects to advance our understanding of all components of the phytobiome system with a view towards our goal of providing all farmers, regardless of size, phytobiome-based knowledge that can empower site-specific, sustainable and profitable production of food, feed, and fiber.

We look forward to working with all of you in the coming year and hope to see you in Denver (Colorado, USA) in September 2022 for the International Phytobiomes Conference.

In the meantime, stay safe and healthy.

Kellye Eversole

The Phytobiomes Concept

Plants grow in association and interaction with complex communities of organisms, environmental conditions, and management practices. The term "Phytobiomes" encompasses all of this complexity.

A phytobiome is a plant ("phyto") in a distinct geographical unit ("biome") – a field, grassland, greenhouse, garden, or forest. A phytobiome includes the plant itself, all micro- and macro-organisms living in, on, or around the plant – such as microbes, animals, insects, and other plants – and the environment, including soil, air, water, weather, and climate. All these interactions are influenced by management practices.

Phytobiomes have an important role in ensuring the sustained health and productivity of plants and plant ecosystems.



Alliance Mission

Establish a science and technology foundation for site- specific, phytobiomebased enhancement of sustainable food, feed, and fiber production.



By 2050, all farmers have the ability to use predictive and prescriptive analytics based on geophysical and biological conditions for determining the best combination of crops, management practices, and inputs for a specific field in a given year.

A Phytobiomes Vision for Agriculture

Establishing a foundation of knowledge on how phytobiome components interact and affect each other will be critical to ensuring sustainable global food security in the context of climate change and its impact on plant diseases, health, and productivity, while preserving biodiversity and natural resources.

A phytobiomes vision for agriculture encompasses:

- A full integration of biologicals into sitespecific crop management.
- Crop variety/hybrid, microbial communities, nutrient stewardship, and pest control practices that are best suited for sustainable agricultural production of a particular site.
- Rapid, inexpensive diagnostic tools available for growers to empower real-time management decisions and concurrently increase the depth of data for predictive analytics.
- Degraded and depleted lands effectively rehabilitated globally through optimization of microbiomes for soil health and appropriate plant selection.
- An increased profitability of sustainable food production.

Board of Directors

The Board of Directors is in charge of setting the overall vision and mission of the Alliance and provides general oversight for the Alliance operations.



Kellye Eversole Chair of the Board



Gwyn Beattie Iowa State University



Natalie Breakfield Newleaf Symbiotics



Magalie Guilhabert Bayer Crop Science



Jan Leach Colorado State University



Emmanuelle Maguin



Matthew Ryan CABI



Angela Sessitsch AIT Austrian Institute of Technology

Coordinating Commitee

The Scientific Coordinating Committee consists of representatives of financial sponsors and leaders of projects and working groups. The role of the Coordinating Committee is to establish Alliance priorities; identify research, resource, and technology gaps; develop strategies to fill these gaps; and create working groups to lead efforts focused on specific topics. At the end of 2020, the Alliance Coordinating Committee comprised 45 members from 7 countries.

Publications

In 2020, Alliance team member and members of the Board participated in the development of these publications related to the phytobiomes concept, standards and priorities for microbiome research:

- Berg, G., et al., Microbiome definition re-visited: old concepts and new challenges. Microbiome, 2020. 8(1): p. 103. doi: 10.1186/s40168-020-00875-0
- Cohen, S.P. and J.E. Leach, High temperature-induced plant disease susceptibility: more than the sum of its parts. Curr Opin Plant Biol, 2020. 56: p. 235-241. doi: 10.1016/j.pbi.2020.02.008
- Compant, S., et al., The plant endosphere world bacterial life within plants. Environmental Microbiology, 2021. doi: 10.1111/1462-2920.15240
- Dundore-Arias, J.P., et al., Community-driven metadata standards for agricultural microbiome research. Phytobiomes Journal, 2020. 4(2): p. 115-121. doi: 10.1094/pbiomes-09-19-0051-p
- Hohmann, P., et al. (2020). miCROPe 2019 emerging research priorities towards microbe-assisted crop production. FEMS Microbiology Ecology, 2020. 96(10). doi: 10.1093/femsec/fiaa177
- Ryan, M.J., et al., Towards a unified data infrastructure to support European and global microbiome research: a call to action. Environmental Microbiology, 2021. 23(1): p. 372-375. doi: 10.1111/1462-2920.15323
- Ryan, M.J., et al., Development of microbiome biobanks Challenges and opportunities. Trends in Microbiology, 2021. 29(2): p. 89-92. doi: 10.1016/j.tim.2020.06.009
- Trivedi, P., et al., Plant-microbiome interactions: from community assembly to plant health. Nat Rev Microbiol, 2020. 18(11): p. 607-621.

Projects & Activities

The Alliance initiates, participates in, and supports collaborative research projects and activities to address the short-term priorities identified by the Coordinating Committee in order to build a foundation of systems-level knowledge of various phytobiomes.

In 2020, most of those activities related to the generation of knowledge about microbial interactions with the various components of agriculturally relevant phytobiomes, the development of standards for regulatory requirements, and the development of databases for data mining across disciplines.



Genome Sequence-Based Classification System for Microbes (LINS project)

Project funded by the USDA Animal Plant Health Inspection Service – APHIS

The Alliance-coordinated project began in August 2019 and focuses on the select agent *Ralstonia solanacearum (Rs)*, a select agent. Due to delays related to COVID-19, the project is expected to be completed in August 2021.

In this project, a classification system based on whole genome sequences is used to precisely identify microbes and conclusively distinguish pathogenic and non-pathogenic *Rs* strains. Over the long-term and once expanded beyond *Rs*, this method will be beneficial for accelerating the regulatory pathway for international and interstate shipments as well as commercialization of microbial products.



Classification System for Risk Prediction

Project submitted to the USDA Animal Plant Health Inspection Service – APHIS

The Alliance submitted a proposal to develop a "risk prediction" method for beneficial plant bacteria by integrating genome-based circumscription and phenotypic data with an initial focus on *Bacillus* and *Burkholderia* for which biocontrol activity has been identified.

The overall purpose of this project is to leverage genome sequencing and genome-based classification enabling APHIS to rapidly predict risk when assessing field-release permits for bacteria used for plant pest management.



Artificial Intelligence Institute for Microbiome Biology

Project submitted to the US National Science Foundation

The Phytobiomes Alliance supported a proposal submitted to NSF by Clemson University scientists to establish an Al Institute for Microbiome Biology (AIMB). If funded, AIMB will lead AI innovation and advance microbiome biology by 1) making the microbiome domain a driver for AI; 2) catalyzing communitywide AI-enabled microbiome research; 3) nurturing a diverse interdisciplinary workforce, especially from underrepresented groups; and 4) serving as a leader in knowledge transfer. The Phytobiomes Alliance will link industry partners with the AIMB for the purpose of exploring new opportunities of Al to advance the microbiome industry.

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Standards Development

The Alliance is involved in multiple national and international efforts related to the development of standards ranging from microbial sequencing to microbiome studies to regulatory requirements. The Alliance is working directly with several projects through which a variety of standards are developed, including EU CIRCLES, EU MASTER, EU MicrobiomeSupport, Microbiome Centers Consortium, UK Crop Microbiome CryoBank (UK-CMCB), the US Agricultural Microbiome Research Coordination Network, and the International Metagenomics and Microbiome Standards Alliance.



Database to Support Correlation Studies

Efforts started in 2019 to establish a database to support correlation studies between biological and geophysical phytobiome components have been delayed due to COVID-19. The Alliance will continue to coordinate efforts designed to enhance or build such infrastructure(s) to ensure that the projects for which databases are developed will complement and not duplicate other efforts.

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Database to Support Microbiome Studies

The Alliance is in discussions with CABI on the development of a joint microbiome data portal that could provide a common framework for accessing and analyzing microbiome data.



Communications Activities

The Alliance uses its website and social media accounts to increase its visibility, and disseminate news about its activities and its partners.

In the spring and summer of 2020, the Phytobiomes Alliance website was completely redesigned with a new, modern look and moved to a new hosting platform. Alliance Projects, Events, News, Sponsors and members of Board, and Coordinating Committee, as well as sponsor representatives, now have their own dedicated pages or sections. In 2020, the Alliance produced the following communications documents:

- 2019 Annual report
- 1 poster
- 1 press release

Twitter

@phytobiomes

• 3 issues of the newsletter





phytobiomesalliance.org

Website

Events

The Alliance organizes workshops, webinars and a biannual conference to bring together the broad range of disciplines involved in phytobiomes research.

The Alliance organized two **workshops** in early 2020:

- "Exploring Phytobiomes" workshop, Plant and Animal Genome Conference, San Diego, CA, USA – January
- "Defining Datapoints for Metagenomic & Microbial Classification to Set Industry Standards" workshop, 4th Microbiome Movement – AgBioTech Summit, Raleigh, NC, USA – February

The Alliance started organizing **webinars** in October 2019 to showcase research results, tools, and resources from all disciplines involved in phytobiomes research. The webinars are free to attend, and the recordings are posted on the Alliance YouTube channel to allow access for people who cannot attend the live events. In 2020, the Alliance organized nine webinars, with a record attendance from all over the world.

Due to the COVID-19 pandemic, the International Phytobiomes Conference initially scheduled for December 2020 in Denver, Colorado, USA has been postponed to 13-15 September 2022, same location.



Finances

The Alliance is financially supported by sponsors, private companies and research institutions, that support the Alliance vision and contribute to the establishment of the Alliance priorities and strategies through the Coordinating Committee.

Resources



Expenses





2020 Sponsors



Karyosoft

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13-15 SEPTEMBER 2022

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