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Review

The Fungal Genetics Stock Center in the context of a world wide community of *ex situ* fungal germplasm repositories

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ABSTRACT

Most fungal biology researchers depend on culture collections, or more aptly, *ex situ* fungal germplasm repositories, either for the materials upon which they work, or as a long-term home for their materials after their projects are finished. These collections are broadly distributed and typically supported by the local government. The large number of collections, notwithstanding, some collections have greater impact than others. This review will discuss the fungal germplasm repositories around the world with special attention paid to the Fungal Genetics Stock Center. To facilitate their activities collections have joined together in networks, both locally and internationally. Additional information on public policy and how it impacts collections will be presented and the impact of collections will be highlighted.

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1. Introduction

Ex situ biological repositories preserve materials away from their natural environment. Because they sequester the materials, they eliminate the impact of most natural and artificial selection. In this regard, they provide a genetic image of the environment at the time of their isolation. Essentially, repositories of genetically characterized or manipulated materials serve as a *de facto* time machine for biological materials. The materials are made available without regard to the passage of time and assure that future researchers can build upon the accomplishments of past researchers. Repositories exist for all manner of biological materials, although some organisms are more amenable to live storage than others. Plants (Li and Pritchard, 2009) and agriculturally important animals (Roosen *et al.*, 2005) are maintained both as living mature specimens in experimental farms and gardens and as preserved

living material in *ex situ* repositories. These repositories are different from herbaria and natural history museums in that the materials are living and can be used for future experimental biology as well as for agricultural, industrial, or pharmaceutical development and production. Similarly, repositories of microbial germplasm maintain living material which is used for research and development across every industry (Stern, 2004). These repositories include materials used for taxonomic purposes (Stackebrandt, 2011), industrial production (Bentley and Bennett, 2008), myriad applications in agriculture (Martin and Bull, 2002), and pharmaceutical science (Demain and Adrio, 2008). While there are a growing range of collections which preserve environmental or clinical specimens (Riegman *et al.*, 2008), these collections are not typically focused on preserving living materials, but rather on providing access to material associated with human genetics or healthcare delivery.

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Collections, or to use the term currently in vogue, Biological Resource Centers, provide more than just strains. In addition to the traditional deposit and accession of microbial strains, these centers also provide significant services and materials. Among these are safe deposit, strain identification, preservation, training and consultation. Some collections will provide biological or other materials including genomic DNA, genome or gene libraries, antibiotics, enzymes or antibodies, or specialized glassware for manipulating or storing microorganisms.

While culture collections often have a taxonomically broad mandate, there exist repositories that are dedicated to fungal germplasm (Tables 1 and 2) and such repositories serve every part of the scientific community. Most *ex situ* fungal germplasm repositories hold type specimens or strains used in the chemical or pharmaceutical industry. Others hold materials important for industry and agriculture. The US National Science Foundation supports collections of which emphasize genetics through its Living Stock Collection program. Along

with the Fungal Genetics Stock Center, this program supports collections of genetically characterized strains of *Escherichia coli*, *Bacillus*, and *Chlamydomonas*, as well as collections of *Drosophila*, algae, and other higher eukaryotes. While each of these collections could serve as the focus of a review of their impact on their respective research communities, this is beyond the scope of the current review which focuses on the Fungal Genetics Stock Center as an example of global *ex situ* fungal germplasm repositories.

2. The FGSC

The FGSC was established in 1960 and has survived the retirements of two directors (Raymond Barratt and John A. Kinsey) as well as three moves (McCluskey, 2003). The FGSC collection has grown to over 23,000 accessioned strains as well as tens of thousands of non-accessioned strains (Fig. 1). These latter strains are mostly comprised arrayed sets of Magnaporthe,

Table 1 – *Ex situ* fungal germplasm repositories

Name	Support	Scope
Fungal Genetics Stock Center	US National Science Foundation	Genetic systems
Forest Products Laboratory	US Department of Agriculture	Forest pathogens and symbionts
USDA NRRL	US Department of Agriculture	
Fusarium Research Center	Penn State University	Fusarium
International Culture Collection of VA Mycorrhizal Fungi	US National Science Foundation	VA Mycorrhizae
USDA–ARS collection of entomopathogenic fungal cultures	US Department of Agriculture	Entomopathogenic fungi
Pfaff yeast collection	University of California	Wine and environmental yeast
World Oomycete collection	US Department of Agriculture/USDA	Oomycetes
ATCC fungal collection	NSF/Fees	Type strains, Patent deposit
Centraalbureau voor Schimmelcultures	Royal Netherlands Academy of Arts and Sciences	Taxonomy, Patent deposit
Deutsche Sammlung von Mikroorganismen und Zellkulturen	Federal Ministry of Research and Technology	Type strains, Patent deposit
Mycothèque de l'Université catholique de Louvain	Belgian Federal Science Policy	Agro-Industrial fungi and yeasts
The University of Alberta Microfungus Collection and Herbarium	Natural Sciences and Engineering Research Council of Canada	Fungal diversity, medical fungi
Colección Española de Cultivos Tipo	University of Valencia	Taxonomy and diversity
Portuguese Yeast Culture Collection	Fundação para a Ciência e a Tecnologia	Yeast
Micoteca da Universidade do Minho	Micoteca da Universidade do Minho	Service
UK National Culture Collection	Biotechnology and Biological Sciences Research Council (UK)	Taxonomy, Service
CABI	Self Supporting non-profit	Taxonomy, Service, Patent
Center for Fungal Genetic Resources (Korea)	Government supported	Magnaporthe mutants
Korea Research Institute of Bioscience and Biotechnology BRC	Government supported	Taxonomy, Service, Patent
Nite BRC	Government supported	Taxonomy, Service, Patent
IMCAS Biological Resource Center	Institute of Microbiology, Chinese Academy of Sciences	Taxonomy, Service, Patent
Agricultural Culture Collection of China	Chinese Academy of Agricultural Sciences	Taxonomy, Service
IBT Culture Collection	Technical University of Denmark	Taxonomy, Service
VTT Culture Collection	Technical Research Centre of Finland	Identification, Service, Patent
Collection des Champignons de l'Institut Pasteur	Centre de Ressources Biologiques de l'Institut Pasteur	Taxonomy, Service
All-Russian Collection of Microorganisms (VKM)	Russian Academy of Sciences	Taxonomy, Service, Identification, Patent

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