Fungal Genomics for Energy and Environment

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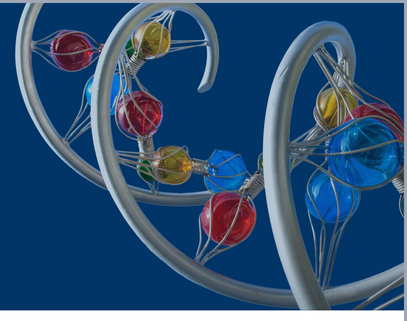


Abstract

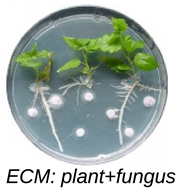
Genomes of fungi relevant to energy and environment are in focus of the Fungal Genomic Program at the US Department of Energy Joint Genome Institute (JGI). One of its projects, the Genomics Encyclopedia of Fungi, targets fungi related to plant health (symbionts, pathogens, and biocontrol agents) and biorefinery processes (cellulose degradation, sugar fermentation, industrial hosts) by means of genome sequencing and analysis. New chapters of the Encyclopedia can be opened with user proposals to the JGI Community Sequencing Program (CSP). Another JGI project, the 1000 fungal genomes, explores fungal diversity on genome level at scale and is open for users to nominate new species for sequencing. Over 200 fungal genomes have been sequenced by JGI to date and released through MycoCosm (www.jgi.doe.gov/fungi), a fungal web-portal, which integrates sequence and functional data with genome analysis tools for user community. Sequence analysis supported by functional genomics leads to developing parts list for complex systems ranging from ecosystems of biofuel crops to biorefineries. Recent examples of such 'parts' suggested by comparative genomics and functional analysis in these areas are presented here.

Fungi for Energy

Grigoriev, *et al., Mycology,* 2011

Fungal Systems & Metagenomes

S.commune



ECM: plant+fungus

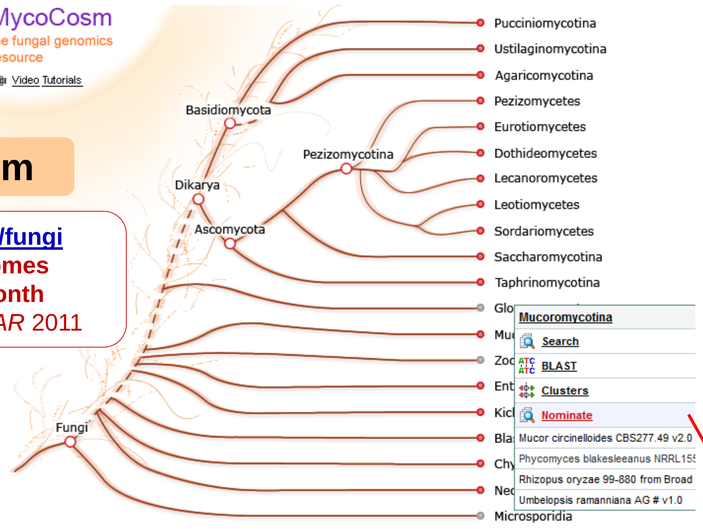
Lichen: alga+fungus

Soil metagenomes

Model fungi → Simple systems → Complex environments

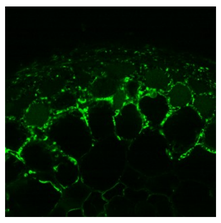
MycoCosm

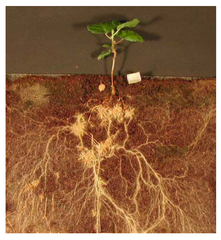
http://jgi.doe.gov/fungi
200+ fungal genomes
5000+ visitors/month
Grigoriev *et al.*, *NAR* 2011



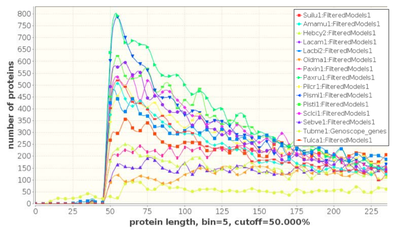
The Genomic Encyclopedia of Fungi

Symbionts

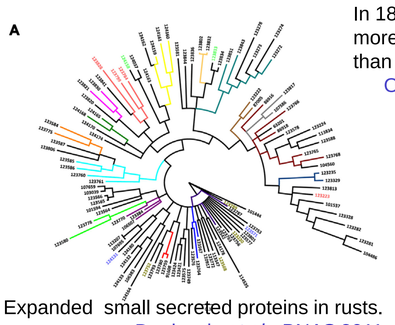




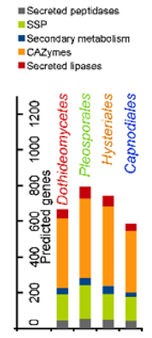
Small secreted proteins (SSP) were expanded in poplar symbiont *L. bicolor* and overexpressed in ECM tissue (on left; Martin *et al., Nature* 2008) .
Comparative analysis of 15 mycorrhizal genomes shows SSP expansions in many of them (see below)



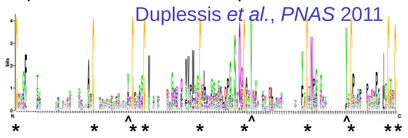
Plant Pathogens



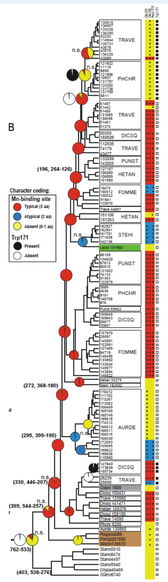
In 18 Dothideomycetes SSP are more expanded in nechrotrophs than biotrophs.
Ohm *et al., PLoS Path.* 2012.

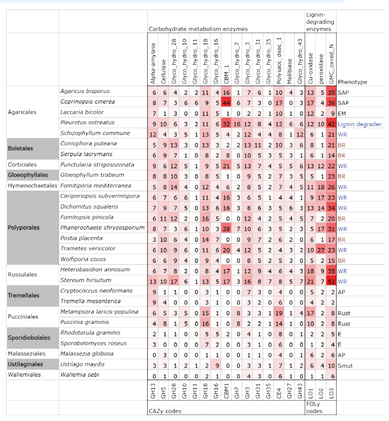


Expanded small secreted proteins in rusts.
Duplessis *et al.*, *PNAS* 2011



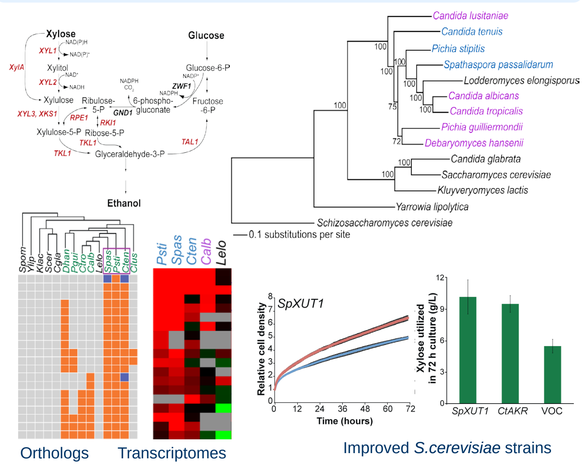
Wood Decayers





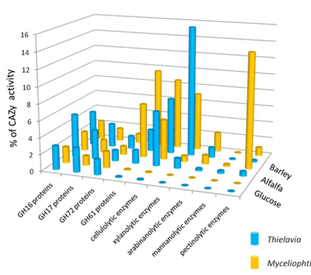
A comprehensive catalog of lignocellulolytic enzymes derived from comparative genome analysis of wood decaying fungi
Floudas *et al., Science* 2012
Riley *et al.. in prep.*

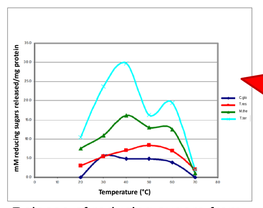
Xylose Fermenters



Comparative genomics and transcriptomics of *xylose fermenters* and *xylose growers* revealed candidate genes for *S.cereviseae* strain improvement. Wohlbach, *et al. PNAS* 2011

Thermophiles



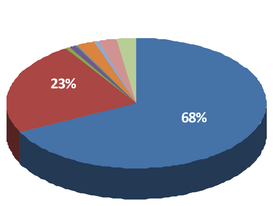


Release of reducing sugars from alfalfa straw by extracellular enzymes

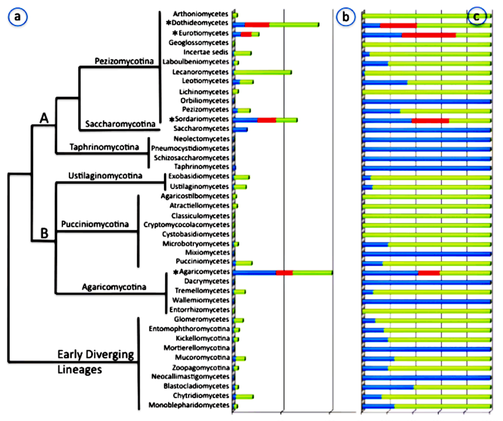
Thermophilic biomass-degrading fungi *M.thermophila* and *Thielavia terrestris,* the first with completely finished genomes, are new candidates for cell factories with secreted thermostable enzymes.
Berka *et al., Nat Biotech* 2011.

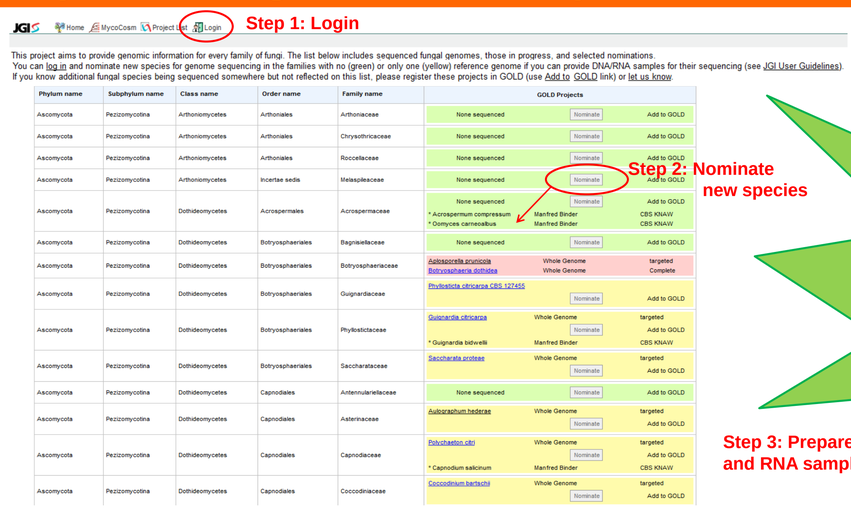
Submit a CSP proposal to open a new chapter of the Encyclopedia!

Fungal Diversity: 1000 Fungal Genomes Project



Sequencing 1000 fungal genomes from across the Fungal Tree of Life will provide references for research on plant-microbe interactions and environmental metagenomics.
Spatafora *et al.*, CSP12.





Nominate new species for sequencing for families of Fungi with no sequenced genomes!

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