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Phaff Collection News

Fall 2017

Phaff collection yeast art on display in Kansas City, Kansas!



'Foundations: Fostering a Better World'. Curator: Dr. Z. Hall



'The Flask'
Kyria Boundy-Mills 2015



'Composition....'
Lauren Enriquez 2015

Many readers of this newsletter have enjoyed receiving our annual “Yeast Art” holiday cards. In Summer 2017, photos of two items of Phaff collection yeast art were enjoyed at the West Wyandotte Branch of the Kansas City Kansas Public Library, as part of the “Foundations” exhibit. The exhibit gathered work that connected microbial processes and art. Photos of two yeast art pieces were on display July-August 2017: “The Flask” by Kyria Boundy-Mills (inspired by “The Vase” by Paul Klee), and “Composition with *Geotrichum*, *Sporidiobolus*, *Cryptococcus*, *Pichia* and *Rhodotorula*” (inspired by a painting by Mondrian), by Phaff collection former technician Lauren Enriquez.

Phaff collection yeasts used in publications

Yeasts from the Phaff Yeast Culture Collection are used by researchers around the world, as well as in-house. The research program of Dr. Boundy-Mills uses and expands the yeast collection. One area of emphasis in recent years has been oleaginous (high lipid) yeasts, particularly by former post doc Irnayuli Sitepu and grad student Tonio Garay. Of 90-some known yeast species that can accumulate over 20% intracellular oil, 30 were discovered to be high in oil in the last few years, using yeasts from the Phaff collection. This type of work can be done in very few labs in the world: few labs have hundreds of yeast species at their disposal. This work was made possible by previous generations of yeast researchers at the University of California, particularly Herman Phaff, who isolated and preserved yeasts for future uses, and users.

Oleaginous yeasts:

In 2017, we continued our analysis of oleaginous yeasts. In collaboration with partners at JBEI, we compared ability of 38 different oleaginous yeast species to tolerate ionic liquids (IL). IL are solvents that could be used to break down the crystalline structure of lignocellulose prior to conversion of the sugars to products such as ethanol and other chemicals. The problem is that the yeast used to make ethanol, *Saccharomyces cerevisiae*, has low tolerance of IL. The aim of this study was to determine whether lipid-synthesizing yeasts might be more tolerant of IL than *S. cerevisiae* is. Through examination of 38 high-lipid species, we found that many high lipid yeast species can tolerate much higher levels of IL than *S. cerevisiae*, and some oleaginous species are much more tolerant than others.

Sitepu, I., Garay, L., Enriquez, L., Fry, R., Butler, J., Lopez, J., Kanti, A., Faulina, S., Nugroho, A., Simmons, B.A., Singer, S., Simmons, C., Boundy-Mills, K. 2017. 1-Ethyl-3-methylimidazolium tolerance and intracellular lipid accumulation of 38 oleaginous yeast species *Applied microbiology and biotechnology*, **101**(23-24), 8621-8631.



Appl Microbiol Biotechnol (2017) 101:8621–8631
DOI 10.1007/s00253-017-8506-z

BIOENERGY AND BIOFUELS



1-Ethyl-3-methylimidazolium tolerance and intracellular lipid accumulation of 38 oleaginous yeast species

Irnayuli R. Sitepu^{1,2} · Luis A. Garay¹ · Lauren Enriquez¹ · Russell Fry¹ ·
John H. Butler¹ · Julian M. Lopez¹ · Atit Kanti³ · Sarah A. Faulina⁴ ·
Agustinus J. Nugroho³ · Blake A. Simmons^{5,6} · Steven W. Singer^{5,6} ·
Christopher W. Simmons¹ · Kyria Boundy-Mills¹

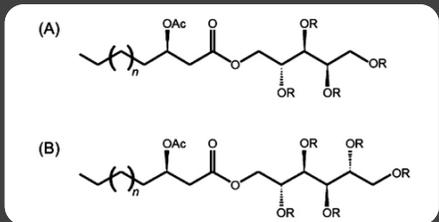
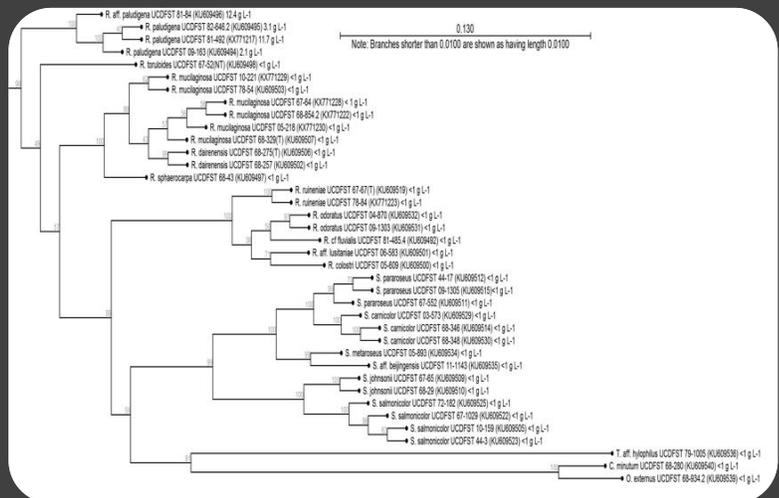
Fall 2017

Glycolipid-secreting yeasts: In 2016, we identified a new class of secreted glycolipids called polyol esters of fatty acids (PEFA), that are secreted in varying amounts by the oleaginous yeast *Rhodotorula babjevae*. In 2017, we discovered that several additional yeast species related to *R. babjevae* also secrete PEFA. We ran bioreactor trials to quantify yields of both intracellular oil and extracellular PEFA produced by the originally discovered PEFA-secreting species *R. babjevae*, and the champion producer, *Rhodotorula aff. paludigena*. The “aff.” in the middle of this species name indicates that this yeast is a novel species: it is a species that does not yet have a scientific name, whose closest named relative is *R. paludigena*. This champion yeast species is the only known strain of this yeast species in any lab in the world. This “champion” producer is also special because of its source: it was **isolated by Herman Phaff from cactus in the 1980s**, as part of his studies of yeast ecology and taxonomy. This discovery was possible because Phaff meticulously isolated, characterized and preserved thousands of yeasts to enable future discoveries.

Garay, L.A., Sitepu, I.R., Cajka, T., Fiehn, O., Cathcart, E., Fry, R.W., Kanti, A., Joko Nugroho, A., Faulina, S.A., Stephanandra, S., German, J.B., Boundy-Mills, K.L. 2017. Discovery of synthesis and secretion of polyol esters of fatty acids by four basidiomycetous yeast species in the order Sporidiobolales. *Journal of Industrial Microbiology & Biotechnology*, 1-14.

Garay, L., Sitepu, I., Cajka, T., Cathcart, E., Fiehn, O., German, J.B., Block, D.E., Boundy-Mills, K. 2017. Simultaneous production of intracellular triacylglycerols and secretion of polyol esters of fatty acids by *Rhodotorula babjevae* and *Rhodotorula aff. paludigena*. *Journal of Industrial Microbiology and Biotechnology*, **44**(10), 1397-1413.

Dozens of yeasts in order Sporidiobolales from the Phaff collection were tested for ability to secrete glycolipids. Several new secreters were discovered.



Structure Polyol Esters of Fatty Acids (PEFA) secreted by six yeast species

Culture collection networking

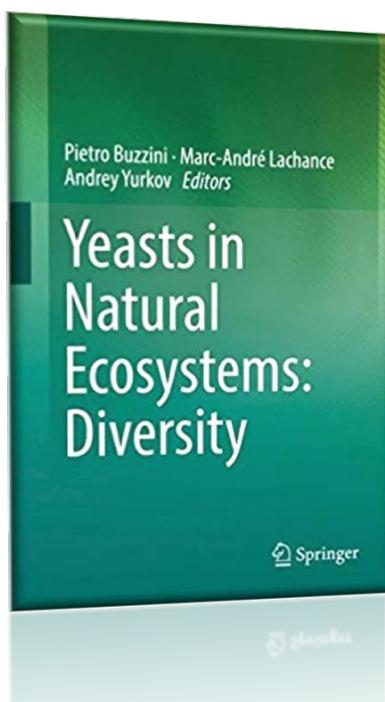
Phaff collection curator Kyria Boundy-Mills is on the executive board of the World Federation for Culture Collections, and the steering committee of the US Culture Collection Network. She has co-authored reviews and book chapters utilizing these connections, to enhance the US and global culture collection community and their users. These articles discuss opportunities and challenges faced by collections and their users, including emerging issues relating to the Nagoya Protocol of the Convention on Biological Diversity.

McCluskey, K., Barker, K., Barton, H., Boundy-Mills, K., Brown, D., Coddington, J., Cook, K., Desmeth, P., Geiser, D., Glaeser, J. 2017. *The US Culture Collection Network responding to the requirements of the Nagoya Protocol on Access and Benefit Sharing*. *mBio* 8: e00982-17.

McCluskey, K., Boundy-Mills, K., Dye, G., Ehmke, E., Gunnell, G.F., Kiaris, H., Richmond, M.P., Yoder, A.D., Zeigler, D.R., Zehr, S. 2017. *The challenges faced by living stock collections in the USA*. *eLife*, 6, e24611.

Boundy-Mills, K., Smith, D., McCluskey, K., Greene, S., Duke, C. 2017. *International Treaty Affects Microbiology Research*. *Microcosm*, 1(Fall 2017), 82-85.

If you isolate yeasts from other countries, or use yeasts from international sources, please educate yourself about the Nagoya Protocol. Countries are enacting legislation about access and benefits sharing. Make sure you comply with the country's requirements such as collecting permits and other agreements.



Are you looking for environmental isolates?

Boundy-Mills and several other yeast collection curators contributed to a book chapter in a book about yeast diversity in natural ecosystems. This book chapter summarizes holdings of environmental yeasts in major public collections.

Groenewald, M., Boundy-Mills, K., Čadež, N., Endoh, R., Jindamorakot, S., Pohl-Albertyn, C., Rosa, C.A., Turchetti, B., Yurkov, A. 2017. *Census of Yeasts Isolated from Natural Ecosystem and Conserved in Worldwide Collections*. in: *Yeasts in Natural Ecosystems: Diversity*, Springer, pp. 455-476.

Phaff collection curator Kyria Boundy-Mills receives Porter award

The American Society for Microbiology annually selects one recipient of the J. Roger Porter Award, which honors a scientist who “has demonstrated the importance of microbial diversity through sustained curatorial or stewardship activities for a major resource used by the scientific community.” Dr. Kyria Boundy-Mills received the award at the 2017 general meeting of the American Society for Microbiology in New Orleans, Louisiana, USA. Since 2001, Boundy-Mills has been the curator of the Phaff Yeast Culture Collection, which is the fourth largest collection of its kind in the world, with over 7,500 strains in the public catalog, belonging to over 1,000 species.

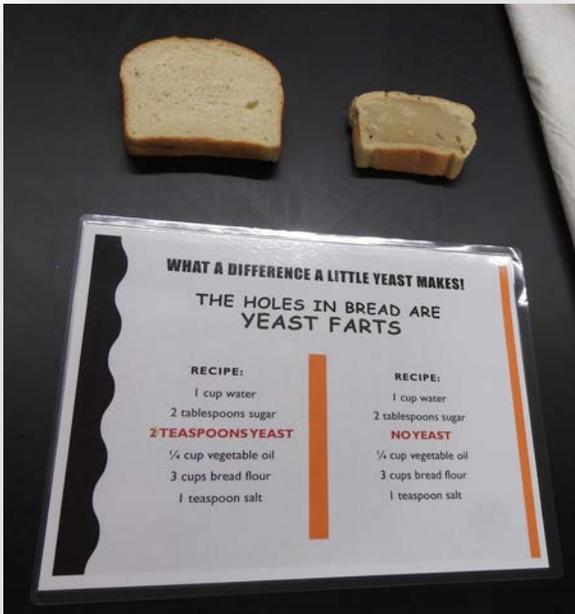
Some quotes from the nomination letter:

Over the last 15 years, Boundy-Mills has revitalized and modernized the collection. These efforts ensure that the collection will survive for future generations, and that use of the collection will continue to expand. The collection is being utilized by academic, government agency and industrial researchers in novel and creative ways, such as studies yeast ecology (insect, plant associations), taxonomy, transcription regulation, comparative genomics, fermented foods and beverages, biofuels, food and feed ingredients, hosts for heterologous protein expression, human and animal pathogenesis. She has revitalized and expanded the yeast collection, making it more valuable for the life science research community. She has trained over 100 undergraduate students in independent research projects, many of whom have gone on to graduate and professional schools and jobs in the food and biotechnology industries. For her many accomplishments, she was awarded the UC Davis Academic Federation Award for Excellence in Research in 2015, the highest campus research award for her academic title.

This award is particularly meaningful to Dr. Boundy-Mills, because Dr. Herman Phaff received the same award in 1984.



Biodiversity Museum Day 2017



If you will be in the Davis area on **February 17, 2018** please come join us at Biodiversity Museum Day! This year our exhibits will be moving to the **Brewery, Winery and Food Processing building in the Robert Mondavi Institute**. The yeast exhibits will be open 9:00 AM to 1:00 PM. Please come join the fun! Even if you've worked with yeasts for decades, we guarantee you will learn something new. The event is free, parking is free. What a deal!!

In February 2017, over 800 visitors learned about microbes when they visited the exhibits about yeast and bacteria (but mostly yeast) put on by the Phaff Yeast Culture Collection (Food Science & Technology department) and the Wine Yeast and Bacteria collection (Viticulture & Enology department) at UC Davis Biodiversity Museum Day.

Because this was the only exhibit of single-celled organisms at the event, the exhibit stations started with: What is a microbe? Visitors learned about industrial and basic research using microbes, and smelled various yeast species on Petri plates. Packets of various bacteria and yeast starter cultures were on display in a station about fermented foods and beverages. Visitors could compare the flavors of Vegemite and Marmite, two foods that have a very strong and memorable yeasty flavor because the main ingredient is yeast extract. Visitors learned about the **history of the Phaff collection, and current research using the yeasts in the collection**. Kids could color and assemble flip books about yeast cell division, and look at yeasts and bacteria under a microscope.

We hope you can join us in February 2018!



Orphaned Yeast Rescue

Friendly advice to yeast researchers: If you spend precious time and money isolating, characterizing and preserving yeasts, please set up a “bequest” plan for long-term preservation of your yeasts AND the associated data.



About 60% of the oiled agar slants were viable; over 90% of the freeze dried yeasts were viable. Consider this as you preserve your yeasts for posterity.

Thousands of new yeasts are being added to the Phaff collection!

We recently acquired over 3,500 cactus- and insect-associated yeasts isolated by yeast ecologists Tom Starmer (Syracuse University) and Phil Ganter (Tennessee State University).

Starmer’s yeasts were stored as oiled agar slants, so this required a visit by UC Davis personnel to Syracuse University to re-package them. Ganter’s yeasts were freeze dried in ampoules, which were easier to ship.

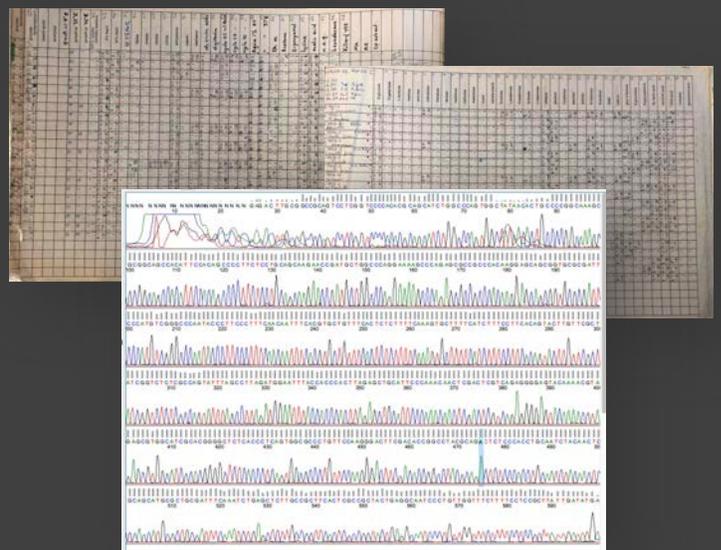
We also acquired field notebooks and strain characterization data sheets. Most of these yeasts were isolated before DNA sequencing became the norm for species ID, so each strain carries **extensive characterization data that is no longer routinely collected** including assimilation of 40 carbon compounds, growth temperatures, killer activity, and tolerance of stresses including high sugar, high salt, and growth inhibitors.

We also have detailed origin data including date isolated, geographic location, and species of host plant or insect.

This project is funded by the NSF Collections in Support of Biological Research program, award number 1561580.



*Three samples of each yeast are being cryopreserved: working stock and backup stock in two separate freezers at UC Davis, and a third sample preserved at the USDA National Center for Genetic Resource Preservation in Fort Collins, Colorado. **Remote preservation is crucial!** The summer 2017 California wildfires came within 40 miles of UC Davis.*



The species ID of each yeast is being validated by ribosomal DNA sequencing (bottom). Most match the previous species ID based on traditional methods (top). This sequence belongs to one of over 250 new strains of Pichia cactophila, bringing the total to over 600 strains! These strains present a great opportunity for a study on pangenomics, biogeography, etc.

CONTACT US:

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Contact curator Kyria Boundy-Mills if you would like to be added to our mailing list to receive our annual Yeast Art holiday card.

**Giving to the
Phaff Collection:**

Researchers in a variety of fields continue to make important discoveries using the Phaff Collection. You can donate to help ensure the continued maintenance of this resource. Make checks out to “UC Regents”, include “Phaff Collection Endowment” on the memo line, and mail to:

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