Phaff Collection News

University of California Davis

December 2016

2016 has been a busy year at the Phaff collection!

We do love yeast....

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YEAST

The Phaff Yeast Culture Collection is the fourth largest collection of its kind in the world, with over 7500 strains belonging to over 850 different species.

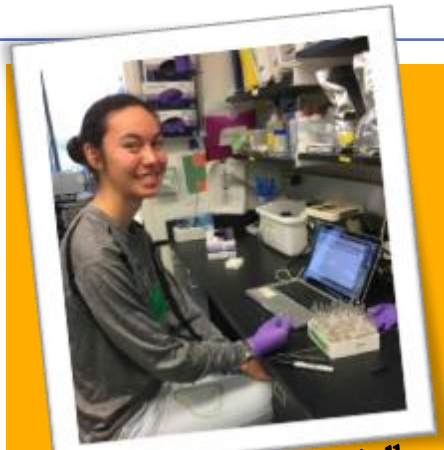
Rescue of two yeast collections

Herman Phaff collected over 2,000 yeasts from cactus over a period of three decades. Kyria Boundy-Mills acquired over 4,000 cactus yeasts in less than a month. How was this possible???

With funding from the National Science Foundation, Boundy-Mills acquired the yeast culture collections of two retiring professors, and is incorporating them into the Phaff Yeast Culture Collection at the University of California Davis. Professor W.T. Starmer was a postdoc with Herman Phaff at UC Davis in the 1970s, where he studied yeast/cactus ecology. He continued to study in this area as a professor at Syracuse University in New York, and collected over 2,000 yeast strains from cacti in North and South America and the Caribbean. In June and July 2016, Boundy-Mills and two technicians, Russell Fry and Erin Cathcart, spent two weeks with Dr. Starmer at Syracuse University packing up over 2600 culture tubes, and organizing field notebooks, lab data sheets, and other documents. Professor Phil Ganter was a postdoc with Dr. Starmer in the 1980s, and also studied yeast/cactus ecology. Due to retirement, he also needed to find a new home for the 2000 yeasts he had collected in North and South America. These yeasts were shipped to UC Davis in summer 2016. NSF is funding the rescue of these yeasts.

Safe and Sound

The yeasts are now safely housed in the Robert Mondavi Institute at UC Davis, and are being deposited in the Phaff Yeast Culture Collection. They will be revived, cryopreserved, and re-identified by ribosomal sequencing to complement the physiological identification previously performed. Three decades of physiological data are being entered into the collection database. These efforts are expected to expand the Phaff collection public catalog by up to 30% over the next two years.



Freshman Meg Campbell inventories lyophilized yeasts from Dr. Ganter

Training

Several UC Davis undergraduate students are learning valuable research skills as they participate in this yeast rescue mission: yeast cultivation, PCR, analysis of DNA sequences for identification of yeast species, and much more.

Technician Russell Fry performs PCR to identify yeasts

UC Davis Biodiversity Museum Day

Did you know that the holes in your bread are YEAST FARTS?

This was one message that stuck in the minds of over 800 visitors who toured the exhibits of the Phaff Yeast Culture Collection at the fifth annual UC Davis Biodiversity Museum Day, held February 13, 2016. Eleven campus collections, including the Bohart Museum of Entomology, Arboretum, Herbarium, Wildlife and Conservation Biology, Paleontology, and others held open houses and public exhibits in this popular campus outreach event, attended by an estimated 2,000 people total.

Tim Li and Lauren Enriquez led visitors through the exhibits on Yeast Love (left) and Research at the Phaff Collection (right)

The Phaff Yeast Culture Collection participated in Biodiversity Museum Day for the first time in 2016. The educational exhibits covered what microbes are, how microbes (especially yeasts) are involved in food and beverage fermentations, and how they are used in basic research and industrial production. Visitors learned about the history and holdings of the Phaff collection, and how the collection is now being used in innovative research. Because the event was the day before Valentine's Day, one station described how yeasts reproduce, and also featured some "yeast art": drawings of hearts using yeasts grown on agar plates.

The next UC Davis Biodiversity Museum Day will be held **Saturday February 18, 2017.** The Phaff collection exhibits will be in the Earth and Physical Sciences Building, across the hall from the Paleontology exhibits. You are invited to stop in to taste Vegemite and Marmite, smell many different yeast species, look at microbes under the microscope, and learn about the Phaff collection.

USCCN Culture Collection Travel Applications

Have you ever wanted to visit a microbe culture collection?

Several US microbe collections are participating in a program funded through the US Culture Collection Network to cover travel expenses to visit a microbe collection for 2-12 days to learn about culture collection management. Participating collections include:

- Phaff Yeast Culture Collection
- Fungal Genetics Stock Center
- UTEX Culture Collection of Algae
- National Center for Marine Algae and Microbiota
- USDA NRRL culture collection.

U.S. students and researchers interested in learning how to preserve, store, and document living microbe specimens are invited to apply to the US Culture Collection Network. Things you could learn at the Phaff collection include:

- How yeasts are cultured and preserved
- How yeasts are identified by ribosomal sequencing
- Database management
- Domestic and international shipping requirements

Find more information at: http://www.usccn.org/Pages/2016InternshipProgram.aspx

Would you like to learn more about yeast collections around the world?


Yeast
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(wileyonlinelibrary.com) DOI: 10.1002/yea.3171

ISSY32 Special Issue

Yeast culture collections in the twenty-first century: new opportunities and challenges

Kyria L. Boundy-Mills[1], Ewald Glantschnig[2], Ian N. Roberts[3], Andrey Yurkov[4], Serge Casaregola[5], Heide-Marie Daniel[6], Marizeth Groenewald[7] and Benedetta Turchetti[8]*

In September 2015, several yeast culture collection curators organized a session about yeast collections at the International Specialized Symposium on Yeast in Perugia, Italy. They then collaborated to co-author and publish a manuscript describing new opportunities and challenges of yeast culture collections. Some key themes: Databases are growing more powerful. The Convention on Biological Diversity and the Nagoya Protocol are impacting how yeasts are collected, preserved, distributed, and used. Contact Kyria Boundy-Mills to access this information.

Phaff Yeast Culture Collection history and holdings

The Phaff Yeast Culture Collection at the University of California Davis is the fourth largest collection of its kind in the world, containing over 7500 strains belonging to over 800 of the 1600 known species, plus upwards of 200 novel species.

This collection was compiled primarily by eminent yeast ecologist and taxonomist Professor Herman J. Phaff (1913-2001), a professor at the University of California from 1943 to 2001. He meticulously maintained and organized the yeasts collected through his career, so that they could be preserved for future generations. Roughly 90% of the strains were collected by Phaff, his collaborators, predecessors, and colleagues, including current curator Kyria Boundy-Mills. The remainder of the collection consists of strains obtained from other researchers and collections, such as type cultures and strains submitted for identification.

Phaff inherited close to 500 yeast strains from his predecessors, including William Cruess and Emil Mrak. The oldest yeast in the collection was collected in 1893 by Bioletti, the cellar master at UC Berkeley. Other "heirloom" yeasts collected prior to the 1940s include dozens of wine yeasts gathered to help the California wine industry recover after the repeal of Prohibition in 1933.

The yeast strains in the Phaff collection are the living legacy of Phaff's research program in yeast taxonomy, physiology and ecology. Phaff's studies are described and summarized in two autobiographical publications, "My Life with Yeast" and "Life with Yeasts during Retirement" . Copies of these publications are available from Phaff collection curator Kyria Boundy-Mills (klbmills@ucdavis.edu).

Phaff set the foundation for our understanding of yeast ecology, which has been called the "Phaff School of Yeast Ecology". Marc-André Lachance summarized Phaff's ecology principles, which include:

- Correct species identification is crucial to understanding the yeast community.
- An adequate sample size is required to draw ecologically meaningful conclusions.
- The habitat is the cornerstone of yeast ecology.

These themes are physically exemplified in the character of the Phaff Yeast Culture Collection: the number and diversity of yeast strains, the large number of independent isolates of a given species, extensive physiological and morphological data, and detailed records of the habitat of origin. These details include, for example, the host cactus species, the pH of the rot, and what species of *Drosophila* larvae are present.

Phaff's explorations of yeast ecology involved several major expeditions, as well as smaller scale activities. For example, for over 20 years Phaff taught a laboratory class on yeast ecology, which included isolation and identification of yeasts. Some of these yeasts were preserved in the collection. Major University of California studies that generated large numbers of yeasts that are still preserved in the Phaff collection include (references available on request):

- 1912-1944: Yeasts in wine
- 1942-47: Yeasts in dried fruits including dates and figs, and prunes
- 1952: Yeasts in shrimp
- 1953-1978: Yeasts in olive fermentation and spoilage
- 1955-56 : Yeasts associated with wild *Drosophila* in tree exudates
- 1956: Yeasts associated with bark beetles
- 1956: Yeasts associated with fermenting olives
- 1961: Yeasts associated with fig wasp
- 1962: Yeasts in insect frass in tree bark
- 1964-: Yeasts in tree fluxes and exudates
- 1967-68: Yeasts in decaying trees in Japan and North America
- 1976 –2001 : Yeasts in cacti and associated cactophilic *Drosophila*

Studies of yeasts associated with cactus and cactophilic drosophilids were particularly fruitful in terms of publications, discovery of basic principles of yeast ecology, and yeast strains preserved in the culture collection: close to 2,000 yeast strains belonging to over 150 different species were isolated from cactus. The public catalog of the Phaff Yeast Culture Collection currently lists 7,523 yeast strains. The collection will be significantly expanded in the next year due to the recent acquisition of the yeast collections of W. T. Starmer (Syracuse University, New York, USA) and P. Ganter (Tennessee State University, USA), which consist primarily of cactus yeasts.

The Phaff collection is particularly suited for studies involving a large number of isolates of a given species.

A list of yeast species in the Phaff collection was included in the 2012 Newsletter. Note: Hundreds of yeast species have been changed in the last 2 years due to extensive taxonomic revisions! This is not convenient for researchers or culture collection curators, but it does make for a more logical phylogeny.

(continued on next page)

Habitats of origin for Phaff collection yeasts, and the number of yeast strains in the Phaff collection:

CATEGORY	NUMBER OF YEAST STRAINS	EXAMPLES
Animal, invertebrate	35	Brine shrimp, zooplankton, copepod, shrimp
Bird	4	Pheasant droppings, penguin feces
Fish	7	Trout gut, smelt
Fresh water	32	Estuary mud, river water, creek water, hot spring effluent, pond, lake water, marsh water
Fungus or mushroom	81	Fungal fruiting bodies, slime mold, puff ball
Insect, insect frass	952	Beetles, *Aulacigaster*, lacewing, weevil, muscoid fly, ant hill, bees, cockroach, wasp nest, bee provision, olive fly, walnut husk fly, walking stick and stick insect, many *Drosophila* species (*D. azteca, D. buzzati, D. californica, D. melanogaster, D. mettleri, D. miranda, D. mojavensis, D. montana, D. nigrospiracula, D. occidentalis, D. persimilis, D. pinicola, D. pachea, D. pseudoobscura, D. sordidapex, D. suzukii, D. viridis*)
Insects in cactus, flowers, trees	290	Ambrosia beetle tunnel in oak, oak grub, bark beetles in Dendroctonus, bark beetle Ips in Pinus, Scolytus in Abies concolor, Pityophthorus in Abies magnifica, Bark beetle in Pinus monophylla, Monarthrum in oak,
Mammal	29	Hare dung, bat liver, moose fecal pellet, aborted calf stomach, brown bear dung, squirrel dung, cow
Manufactured objects	17	Textiles, rope, shoes, tent wall
Plant	67	Kelp, Vicia, Taraxacum, Astragalus, Salix, Gaillardia, Aster, Epilobium, grass, Sun Dew, Argroxiphium bark, ryegrass, coniferous trees, moss
Cactus and succulents	2027	Several *Opuntia* species (*O. elatior, O. ficus-indica, O. lindheimeri, O. megacantha, O. moniliformis, O. phaecantha, O. quimila, O. streptocantha, O. stricta, O. tilcarensis, O. tomentosa, O. wentiana*), organpipe, agria cactus (*Stenocereus griseus, S. gummosus S. hystrix, S. pruinosus*, and *S. thurberi*), saguaro cactus (*Carnegiea gigantea*), *Rathbunia alamosensis*, senita cactus (*Lophocereus schottii*), *Pachycereus pringlei, Lamaeriocereus treleasii, Pachycereus pectin-abvorigenum, Subpilocereus* sp., *Cephalocereus* sp., *Cephalocereus royenii, Trichocereus pasacanna, Lemaireocereus treleasei, Myrtillocactus*, agave, *Trichocereus terscheckii, Pachycereus pectin-aborigenum, Pilocereus royenii, Pachycereus lepidanthus*
Plant leaves	81	Leaves of bromeliad, white oka, carpinus, *Eucalyptus*, palo verde, *Cistus albidus, Arum maculatum, Acer mospessulanum*, pasture plants, *Cheirodendron*, oyster grass, bay tree, spartina grass in estuarine swamp, *Malphigia, Randia malleifera*, incense cedar, elm
Trees		*Quercus* (oak), pinon pine, *Salix* (willow), *Acer* (maple), *Pinus* (pine), *Araucaria, Charpentier* , *Alnus* (alder), *Abies* (fir), *Tetraplassandra, Pisonia, Zelkova* (elm), *Quercus* (oak), *Jugland* (black walnut), *Betula* (birch).
Tree exudate or flux	508	*Abies concolor* (red fir), *Acacia koa, Acer saccharum* (maple), *Actinodaphne lancifolia, Actnidia arguta, Aesculus turbinata* (Japanese horse-chestnut), *Aleurites montana, Alnus rubra* (red alder), *Betula maximowicziana* (monarch birch), *Betula papyrifera* (paper birch), *Betula tauschii, Betula verrucosa* (rough birch), chestnut, *Cornus brachypoda* (dogwood), *Cornus controversa* (giant dogwood), cottonwood, *Cunninghamia lanceolata* (China fir), *Distylium racemosum, Eucalyptus*, hackberry, *Magnolia obovate* (magnolia), *Melaleuca leucadendra* (weeping paperbark), *Myoporum sandwicense* (false sandalwood), *Osmanthus, Pisonia, Populus alba* (white poplar), *Populus tremuloides* (quaking aspen), *Populus trichocarpa* (California poplar), *Prosopis juliflora* (mesquite tree), *Quercus acutissima* (sawtooth oak), *Quercus gambelii* (Gambel oak), *Quercus kelloggii* (black oak), *Quercus petraea* (sessile oak), *Sakaki ochnacea, Salix* (willow), *Stewartia monadelpha, Tilia japonica* (Japanese lime), *Ulmus carpinifolia* (smoothleaf elm), *Ulmus japonica* (Japanese elm), wisteria, *Zelkova serrata*
Rotting wood	30	Pine, *Picea* (spruce), *Aleurites Montana, Nothofagus dombeyi, Pinus sylvestris* (Scots pine), hickory, maple
Salt water	115	Sea water, kelp in sea water, Antarctic sea water, Great Salt Lake water (Utah, USA), Mono Lake water (California, USA), Pacific Ocean water
Soil	159	Swamp soil, lake shore water, soil near glacier, soil under bushes, soil under tree flux, forest soil, soil under cactus rot, soil from bamboo grove, soil in permafrost area
Agriculture and food processing	1971	Wine, beer, bread, distilled beverages, olives, food processing equipment, insects in food processing facilities, honey, juice, fruits, dairy products, meats, agricultural soil, animals and plants, shrimp, grains, soft drinks, other foods
Built environment	18	Zoo, dairy, sewage plant, wood pulp factory, tanning facility
Clinical	228	Human samples (blood, skin, lung, infected tissue, feces, vagina, sputum)
Laboratory	659	Single spore isolates, hybrids, genetically manipulated strains; yeasts from laboratory colonies of *Drosophila, Bactrocera oleae* (olive fly), stick insects
Industry	51	Wood pulp, tanning fluid

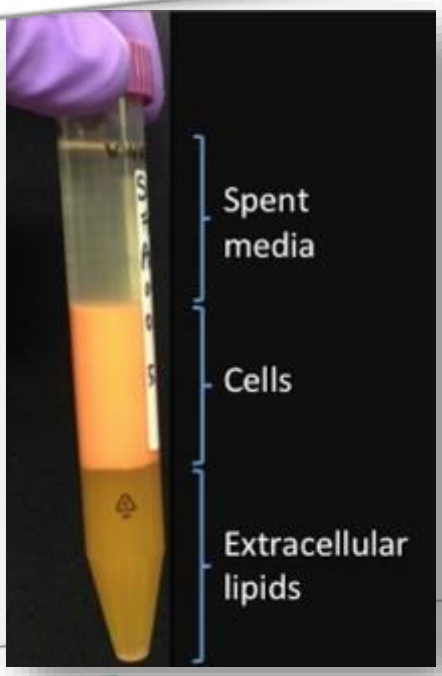
YEAST ART

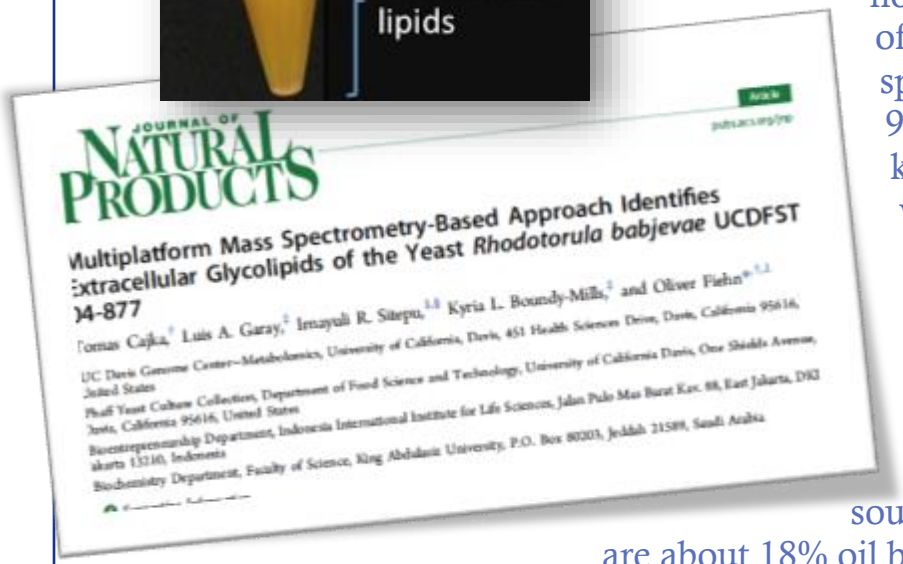
Since 2004, the Phaff collection has mailed out greeting cards with images of yeast art, made from live yeast on agar plates. This year's image, made by Phaff collection curator Kyria Boundy-Mills, was inspired by an oil painting called "The Vase", by Paul Klee. The yeast art version contains a similar image, though some shapes were altered to emulate fungal structures.

Can you find the following in this yeast art:

- Tetrad of yeast spores
- A budding yeast cell
- Pseudohyphae
- Aspergillus-shaped structure

- Erlenmeyer flask
- Ballistospores





RESEARCH PUBLICATIONS

We continue to tap into the impressive biodiversity preserved in the Phaff Yeast Culture Collection, to make new discoveries. In 2016, notable publications include discovery of 18 more oleaginous (high oil) yeast species (Garay et al., 2016). Of the 90+ oleaginous yeast species now known, with over 20% oil by dry weight, 30 species were first shown to be oleaginous using Phaff collection yeasts in our laboratory. These yeasts accumulate up to 60% intracellular triacylglycerol (TAG) by dry weight. To put that in perspective, soybeans, a major source of oil for biodiesel production, are about 18% oil by dry weight.

Our laboratory discovered that some of these oleaginous yeasts have an additional and very unexpected property. They secrete large amounts of glycolipids! Over the past two years, we partnered with researchers at the UC Davis West Coast Metabolomics Center in the Genome Center to determine the chemical structure of these glycolipids. Although similar to sophorolipids in physical properties, these glycolipids are polyol esters of fatty acids (PEFA). Like sophorolipids, PEFA have natural biosurfactant activities.

CONTACT US

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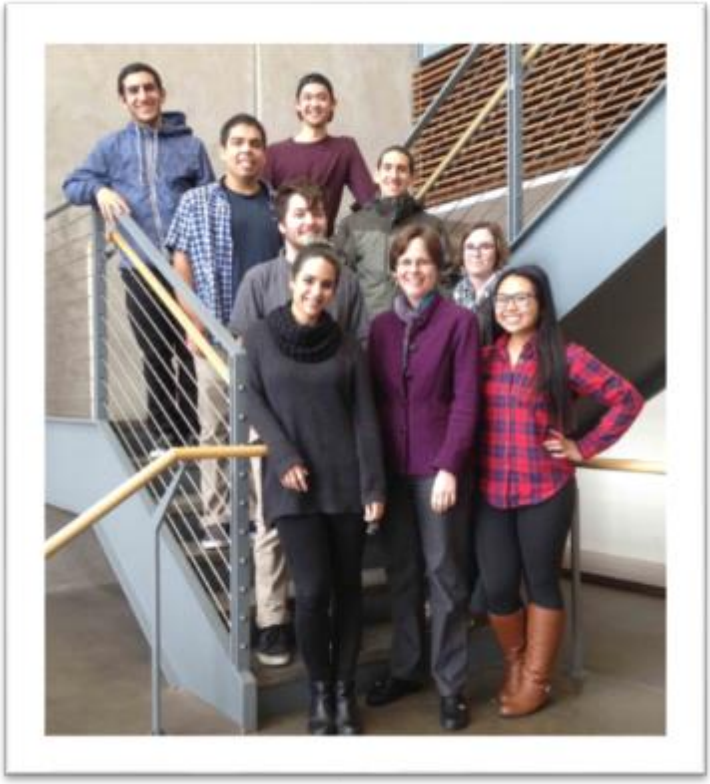
2016 Publications involving the Phaff Collection



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Giving to the Phaff Collection

Researchers in a variety of areas 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" on the memo line, and mail to:

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