

INSIDER TIPS to Maximize Research Benefits from Microbial Culture Collections

Kyria Boundy-Mills

Curator, Phaff Yeast Culture Collection

University of California Davis



10 June 2024

USCCN Workshop, UC Davis

Q: Why obtain microbes from culture collections?

Quality control

- Viability
- Purity
- Identity

Reproducibility, Comparison

- Previous publications
- Genome sequences

Compliance

- APHIS, IATA shipping
- Nagoya Protocol
- Intellectual property

Data

- Genotype
- Phenotype

Selection

- Decades of deposits
- Database of properties
- Curator expertise

TIP:
Collection databases
include non-public
data

TIP:
Curators love to help
select strains!

Q: Why are there so many different microbe culture collections?

A: Different uses require different strains, data, products

Basic research

- Cell: biochemistry, genetics, molecular biology
- Organism: taxonomy, physiology
- Population: ecology

Applied R&D

- Cell: starter cultures, expression hosts, fermentation
- Products: enzymes, lipids, pigments, anti-microbial compounds
- Genes: metabolite production pathways, feedstock utilization, stress tolerance

Types of Microbe Culture Collections

Many kinds of institutions



Universities



Government agencies

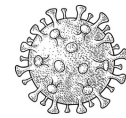


Companies



Non-profit organizations

Many kinds of microbes



Viruses



Bacteria

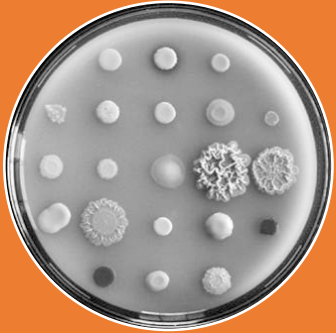


Microalgae



Fungi, Yeasts

Taxonomic range; GMO



Biodiversity collections

- Wild-type
- Hundreds or thousands of species



Germplasm collections

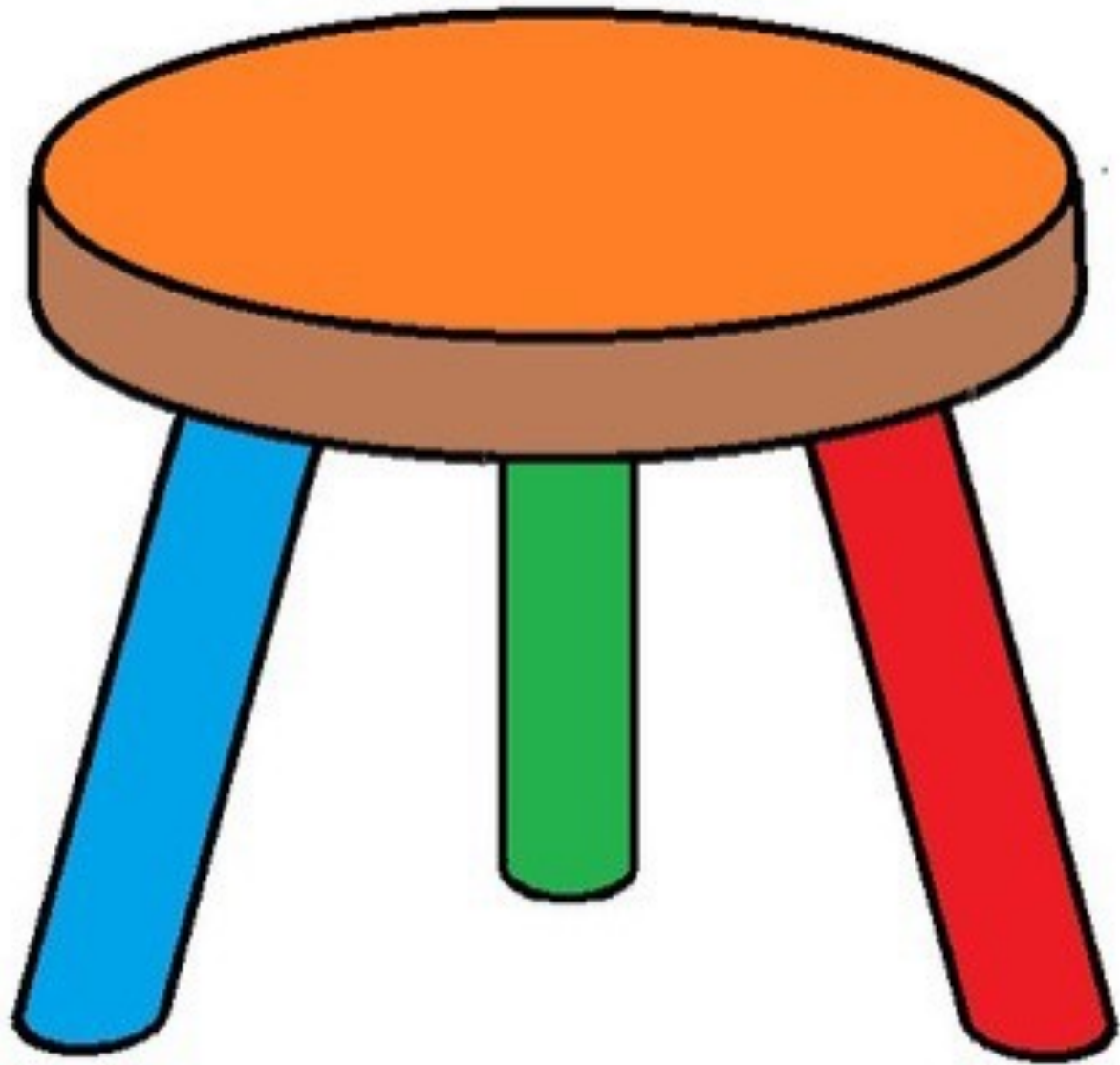
- Wild-type
- Narrower range of species



Genetic stock centers

- Model organisms
- Genetically modified
- One or few species





Resources of culture collections

- Strains
- Data
- Curator

Example of data: Ecology, microbiome

USDA NRRL collection

- Source habitat codes

- AIR, air
- AGO, ag crops
- AGW, ag wastes
- AN, animal source
- BEV, beverage
- BFD, bakery good
- BN, beans
- BR, beer
- BWA, bracing water
- CAC, cactus
- CIT, citrus,
- CL, cloth
- CLN, clinical
- CON, lab contaminant
- CN, corn
- DFD, dairy product
- DG, dung, feces
- DI, distillery yeast
- DPM, decayed plant materia
- FD, food
- FFD, fermented food
- FLO, flowers/pollen
- FR, frass
- FRT, fruit
- FWA, fresh water
- FX, slime flux
- GM, gums
- GRN, grain
- HTR, hardwood trees, angiosperms
- IFM industrial fermentations
- IN, insects
- IW, industrial waste
- LI, lichen
- LV, leaves
- MFD, meat product
- MUS, mushroom
- PET, petroleum
- PLT, plants
- PP, pulp and paper
- PT, paint
- PTR, pine and coniferous trees
- SA, sake yeast
- SD, salad dressing
- SED, seeds
- SEW, sewage
- SFD, seafood
- SI, silage
- SL, soil
- SOF, soft drink, soda
- SWA, salt water
- SWP, swamp/marsh
- TNF, tanning fluid
- TR, tree, unknown
- type, wood lumber,
- sawdust
- VEG, vegetable
- VGO, veg oil
- WA, water
- WH, wheat
- WN, wine, cider,
- fermented juice

Phaff Yeast Culture Collection

- Source habitat fields

The screenshot shows the Phaff Yeast Culture Collection website. On the left, there is a search bar with the text "Search/only" and a "Search" button. Below the search bar, there are input fields for "Strain ID", "Genus", and "Species". On the right, a dropdown menu is open, displaying a list of source habitat fields. The list includes: Food dairy, Food fruit, Food meat, Food or beverage fermentation, Food processing equipment, Fresh water, Fungus or mushroom, insect, Industrial site, Industrial strain, Insect, Insect frass, Insect frass, plant tree, Insect, cactus, Insect, flower, Insect, fruit, Insect, plant, Insect, plant tree, Laboratory media, Laboratory strain, Laboratory strain, Lichen, Mammal, Manufactured objects, Plant, Plant, Plant cactus, Plant cactus flower, Plant cactus fruit, Plant flower, Plant fruit, Plant leaf, and Plant shrub or vine. At the bottom right, there is a "Search / Checkout" button.

NRRL	Strain Name	Source	Isolation Information	Opt. Temp.	Medium	Select
Y-63631	<i>Ambrosiozyma kashinagacola</i> (Endoh, M. Suzuki, Benno & Futai) Kurtzman & Robnett (2013) CBS 10903=JCM 15019=QmPIEG-2-14	Cletus P. Kurtzman, NCAUR from JCM	FR, gallery wall of Ambrosia beetle <i>Platypus quercivorus</i> in <i>Quercus laurifolia</i> , Kyoto, Japan	25C	8	<input type="checkbox"/>
Y-17657	<i>Ambrosiozyma ilanquihuensis</i> (C. Ramirez & A. Gonzalez) Kurtzman & Robnett (2013) ATCC 58894=CBS 8182=JFM 6045=JCM 8918	D. Yarrow, CBS, Delft, The Netherlands	PTR, rotten trunk of <i>Nothofagus obliqua</i> , Valdivian Forest, Chile	25C		<input type="checkbox"/>
Y-63635	<i>Ambrosiozyma malewae</i> (Nakase, Jindamorakot, Am-In, Ninomya, Kawasaki & Limtong) Kurtzman & Robnett (2013) BCC 15003=CBS 11900=NBRC 107644=ST-246	Cletus P. Kurtzman, NCAUR from CBS	MUS, fruit body of unidentified wild mushroom, Hala Bala Wildlife Sanctuary, Narathiwat Prov., Thailand	25C		<input type="checkbox"/>
Y-63632	<i>Ambrosiozyma pseudovanderkiftii</i> (Endoh, M. Suzuki, Benno & Futai) Kurtzman & Robnett (2013) CBS 10904=JCM 15025=QmPIEG-2-9	Cletus P. Kurtzman, NCAUR from JCM	FR, gallery wall of Ambrosia beetle <i>Platypus quercivorus</i> in <i>Quercus laurifolia</i> , Kyoto, Japan	25C		<input type="checkbox"/>
Y-63633	<i>Ambrosiozyma vanderkiftii</i> (Endoh, M. Suzuki, Benno & Futai) Kurtzman & Robnett (2013) CBS 10905=JCM 15029=QmPIEG-1-42	Cletus P. Kurtzman, NCAUR from JCM	FR, gallery wall of Ambrosia beetle <i>Platypus quercivorus</i> in <i>Quercus laurifolia</i> , Kyoto, Japan	25C		<input type="checkbox"/>
Y-8593	<i>Aureobasidium pullulans</i> var. <i>pullulans</i> (de Bary) G. Arnaud UM-553	J. Fell, RSMAS, University of Miami, Miami, Florida				<input type="checkbox"/>
Y-17071	<i>Blastobotrys chiropterorum</i> (Grose & Marinikelle) Kurtzman & Robnett (2007) ATCC 22291=CBS 6064=CCRC 22391=DBVPG 6014=FO 10271=JCM 9597	D. Yarrow, CBS, Delft, The Netherlands	AN, liver of bat (<i>Mormoops megalophylla</i>), Columbia	25C		<input type="checkbox"/>
Y-27120	<i>Blastobotrys mokoensis</i> (Mokwena, Jansen van Rensburg & Myburgh) Kurtzman & Robnett (2007) CBS 8435	D. Yarrow, CBS, Delft, The Netherlands	SL, soil, South Africa	25C		<input type="checkbox"/>
YB-3897	<i>Candida aseri</i> Dietrichson ex van Uden & H. R. Buckley (1970) ATCC 18805=CBS 1913=CCY 29-34-3=Dietrichson V-15=JCM 1689=NRRL YB-4234=UCD-FST 57-14=VKM Y-1425	Dietrichson, Oslo, Norway	CLN, sputum, Norway	25C		<input type="checkbox"/>

Q: How can I quickly find a specific microbe?

WFCC

WDCM

Global Catalog of Microorganisms

- 140 microbe culture collections
- Species, strain
- Geographic region
- Application

The screenshot shows the GCM Global Catalog of Microorganisms search page. The browser address bar displays 'gcm.wdcm.org'. The page header includes the GCM logo and navigation links: Home, Participants, Citations, Data Standards, Data Usage Policy, Contact Us, and Web Service. A search bar contains the text 'Please enter the keyword, Bacillus subtilis' and a 'search' button. Below the search bar, there are tabs for 'Advanced', 'Homology', and 'Species'. The main search area is titled 'Home / Advanced Search' and contains various input fields: Strain Number, Strain Name, Other Collection Numbers, Isolated From, Optimum Temperature, Author, History Of Deposit, Geographic Origin, Application, Literature, Date Of Isolation (with Start Date and End Date fields), and Temperature. There are also fields for Latitude and Longitude with range indicators. A 'Type Strain' toggle is present. Below the search fields, there are sections for 'Organism Type' and 'CCs' (Culture Collections). The 'Organism Type' section has a 'Check All' button and checkboxes for Algae, Chromista, Phage, Yeast, Antibody, Cyanobacteria, Plasmid, Archaea, Fungi, and Protozoa. The 'CCs' section has a 'Check All 146 Culture Collections' button and a grid of checkboxes for various culture collections like ACA-DC, APSPC, BCCM/DCG, BCCM/LMG, etc. At the bottom, there are 'Search' and 'Reset' buttons.

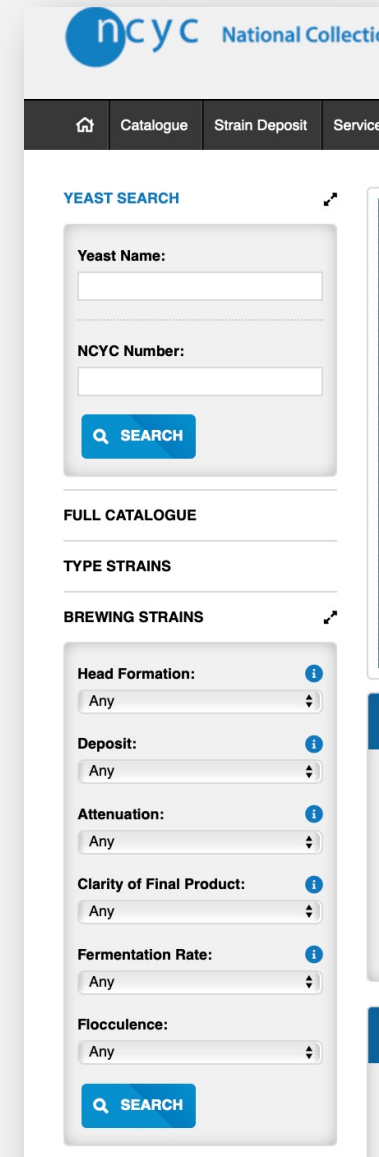
Q: What other data, products and services do microbe collections provide?

Westerdijk Institute (CBS), Netherlands

- Strain data: physiology, morphology, DNA sequences
- Photos of cells, colonies
- Literature references
- Link to taxonomy
- Workshops

NCYC, UK

- Brewing properties
 - Brewing strains
 - Re-sequencing strains
- Up-front license terms



The screenshot shows the NCYC National Collection website interface. At the top, there is a navigation bar with 'Home', 'Catalogue', 'Strain Deposit', and 'Services'. Below this is a 'YEAST SEARCH' section with a search bar for 'Yeast Name' and 'NCYC Number', and a 'SEARCH' button. Below the search bar, there are sections for 'FULL CATALOGUE', 'TYPE STRAINS', and 'BREWING STRAINS'. The 'BREWING STRAINS' section is expanded, showing several filters: 'Head Formation: Any', 'Deposit: Any', 'Attenuation: Any', 'Clarity of Final Product: Any', 'Fermentation Rate: Any', and 'Flocculence: Any'. Each filter has a dropdown arrow and an information icon. A 'SEARCH' button is located at the bottom of the filter section.

Q: I have a bunch of microbes. Which ones should I consider depositing in a public collection?



Criteria:

- Important discoveries
 - Cited in publications
 - Type strain of new species
- Investment in data
 - Genome sequenced
- Immediate access needed
- Costly or impossible to replace
 - “Moon rocks”
 - Classical mutations, habitat destroyed

Adapted from: Flattau, P. E., M. Boeckmann, R. d. I. Cruz, P. Lagasse, N. Mitchell, M. Patterson, and D. Singpurwalla. 2007. Scientific collections: Mission-critical infrastructure for federal scientific agencies. Science and Technology Policy Institute.

Tips for researchers

2019 publication by USCCN

- Organize specimens
 - Cull duplicates; assign unique ID
- Database
 - Source, genotype, phenotype, documentation
 - Share database
- Preserve
- Long-term plan
 - Future home; funding

Boundy-Mills, K., K. McCluskey, P. Elia, J. A. Glaeser, D. L. Lindner, D. R. Nobles Jr, J. Normanly, F. M. Ochoa-Corona, J. A. Scott, T. J. Ward, K. M. Webb, K. Webster and J. E. Wertz (2020). "Preserving US microbe collections sparks future discoveries." Journal of Applied Microbiology **129**(2): 162-174.

To be completed by Phaff collection	
1	UCDFST ID
2	Date of deposit
3	Risk group
4	Depositor's and other collection strain numbers
5	Genus
6	Species
7	Organism group
8	GenBank accession of DNA sequences
9	Date isolated
10	Source habitat
11	Geographic origin starting with country
12	History of Deposit
13	Collected by (name, institution)
14	Restrictions on use including Nagoya protocol compliance conditions
15	ABS related files
16	MTA file
17	Other collection numbers
18	Species name change
19	Synonym
20	Mating type
21	Type strain status
22	GMO
23	DNA sequences
24	Literature reference
25	Comments
26	Optimum temperature for growth
27	Maximum temperature for growth
28	Minimum temperature for growth
29	Medium
30	Application
31	Dual use
32	Quarantine in Europe
33	Comment on taxonomy

The Phaff Yeast Culture Collection accepts strains for deposit that will be made available to the research community. These include for example type strains of new species, yeasts used in genome sequencing projects, or other strains that the depositor would like to make available to the broader yeast research community.

Here's how the strain deposit process works: The Deposit Agreement and Strain Deposit Worksheet (see below) are first completed by the Depositor, emailed to the Phaff collection and approved by the curator. The Phaff collection will confirm how many and which strains will be accepted for deposit. After this is complete, then yeast strains can be shipped to UC Davis. The Phaff collection accepts strains under these conditions:

- The yeast strain is pure, viable, and identified by ribosomal or other DNA sequencing.
- It is not a known human, plant or animal pathogen.
- The depositor and/or their institutional representative completes and signs the [Deposit Agreement](#). Note that if the depositor wishes to make any edits, they must be approved by both the University of California and the depositor's institution.
- Data associated with the yeast strain is provided either within the Deposit Agreement or by filling in the [Strain Deposit Worksheet](#). Note that sample text is provided. Please delete this and replace with text related to your strains, one strain per column. Fields in green are required, and other fields are various levels of optional. For more information about data formats, hover over the red triangle in the corner of the cell in the spreadsheet. We greatly appreciate depositors carefully filling out this spreadsheet as it streamlines the process of importing data into our website, helps prevent errors in data entry, and ensures that the data are in a format that will be useful to future users of the Phaff collection!

After the forms have been submitted and approved by Phaff collection personnel, then yeasts can be shipped to UC Davis using the shipping addresses at the bottom of the Phaff collection home page. The depositor will prepare samples in a format that is compatible with shipping methods. The yeasts are then revived, viability and purity are confirmed. If species ID has not been performed before deposit, then ribosomal or other DNA sequencing will be performed at the expense of the Depositor. The yeast will be cryopreserved in triplicate: working and backup stocks in the -80C freezers at UC Davis, and an archived stock at a remote cryopreservation facility.

The Phaff collection can delay release of yeast strains into the public catalog at the request of the depositor. Please contact that Phaff collection if you have questions.

Documents

- [Phaff Yeast Culture Collection Deposit Agreement](#)
- [Strain deposit worksheet](#)

Deposit Agreement and strain data spreadsheet

Acknowledgments

- My fellow collection curators
- Herman Phaff, Marc-André Lachance, Tom Starmer, Phil Ganter
- Irnayuli Sitepu, Minh Nguyen
- US Culture Collection Network
- World Federation for Culture Collections
- NSF Awards DBI-1349395, DBI-1561580, DBI-2053253

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation

