



UNIVERSITY
OF TARTU



Welcome to the course

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Organisers

Mycology and Microbiology Center, University of Tartu
Department of Botany, University of Tartu

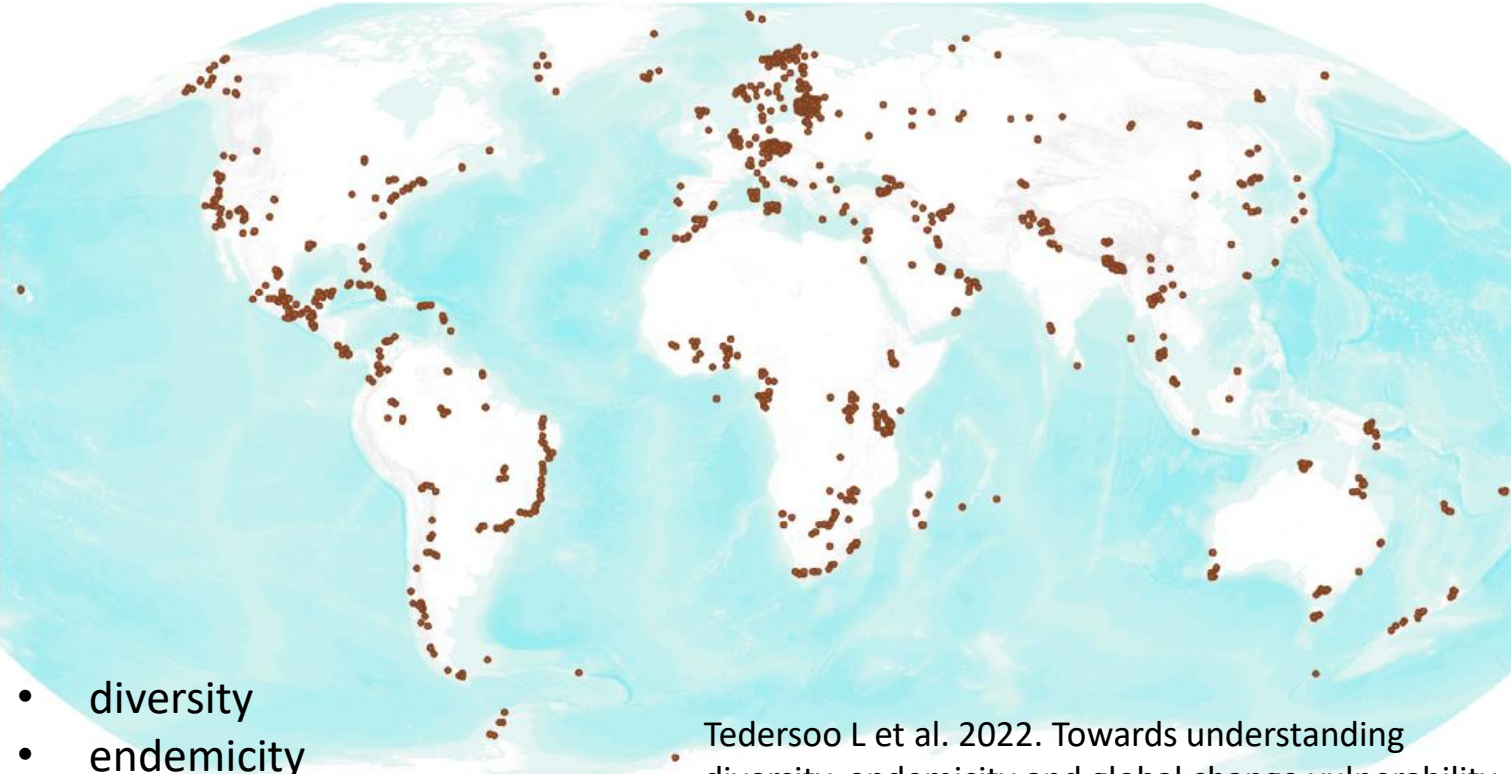
Two professors
Five (senior) researchers
Five PostDocs
Fifteen PhD students
Three lab assistants
+ students in practice

Liivi 2 campus
January 2022



GSMc

- Public dataset of 3200 plots x 722,682 OTUs
- Standardised sampling / molecular analyses
- Samples include metadata
- Taxa include taxonomic and functional identification



- diversity
- endemism
- climate change vulnerability

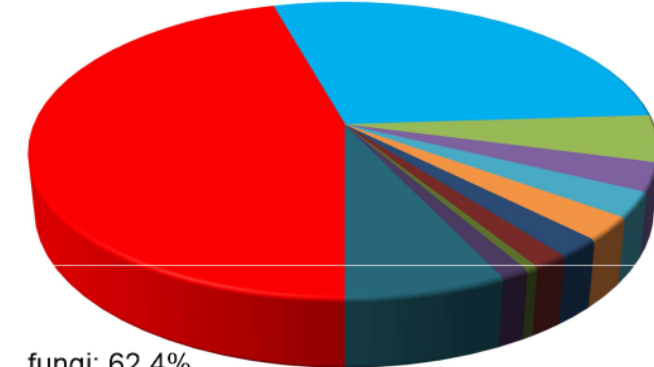
Tedersoo L et al. 2022. Towards understanding diversity, endemism and global change vulnerability of soil fungi. bioRxiv 2022:484796.

The Global Soil Mycobiome consortium dataset for boosting fungal diversity research¶

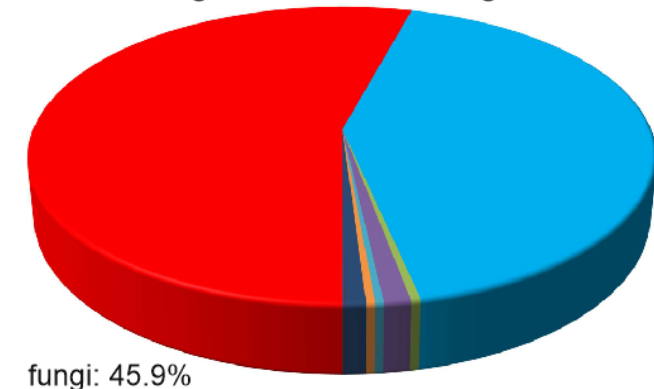
Leho Tedersoo^{1*}, Vladimir Mikryukov^{1,2}, Sten Anslan^{1,2}, Mohammad Bahram³, Abdul Nasir Khalid⁴, Adriana Corrales⁵, Ahto Agan¹, Aida M. Vasco-Palacios⁶, Alessandro Saitta⁷, Alexandre Antonelli⁸, Andrea C. Rinaldi⁹, Annemieke Verbeke¹⁰, Bobby P. Sulisty¹¹, Boris Tamgnoue¹², Brendan Furneaux¹³, Camila Duarte Ritter¹⁴, Casper Nyamukondiwa¹⁵, Cathy Sharp¹⁶, César Marin¹⁷, D. Q. Dai¹⁸, Daniyal Gohar¹, Dipon Sharmah¹⁹, Elisabeth Machteld Biersma^{20,21}, Erin K. Cameron²², Eske De Crop¹⁰, Eveli Otsing¹, Evgeny A. Davydov²³, Felipe E. Albornoz²⁴, Francis Q. Brearley²⁵, Franz Buegger²⁶, Genevieve Gates²⁷, Geoffrey Zahn²⁸, Gregory Bonito²⁹, Indrek Hiiesalu^{1,2}, Inga Hiiesalu^{1,2}, Irma Zettur¹, Isabel C. Barrio³⁰, Jaan Pärn², Jacob Heilmann-Clausen³¹, Jelena Ankuda³², John Y. Kupagme¹, Joosep Sarapu², Jose G. Maciá-Vicente³³, Joseph Djeugap Fovo³⁴, József Geml³⁵, Juha M. Alatalo³⁶, Julieta Alvarez-Manjarrez³⁷, Jutamart Monkai³⁸, Kadri Põldmaa^{1,2}, Kadri Runnel^{1,2}, Kalev Adamson³⁹, Kari A. Bråthen⁴⁰, Karin Pritsch⁴¹, Kassim I. Tchan⁴¹, Kestutis Armolaitis³², Kevin D. Hyde³⁸, Kevin K. Newsham²⁰, Kristel Panksep⁴², Lateef A. Adebola⁴³, Louis J. Lamit^{44,45}, Malka Saba⁴⁶, Marcela E. da Silva Cáceres⁴⁷, Maria Tuomi⁴⁰, Mariëke Gryzenhout⁴⁸, Marijn Bauters⁴⁹, Miklós Bálint⁵⁰, Nalin Wijayawardene⁵¹, Niloufar Haghighi-Doust^{1,2}, Nourou S. Yorou⁵², Olavi Kurina⁵³, Peter E. Mortimer⁵⁴, Peter Meidl¹³, R. Henrik Nilsson⁵⁵, Rasmus Puusepp¹, Rebeca Casique-Valdés⁵⁶, Rein Drenkhan³⁹, Roberto Garibay-Orijel⁵⁷, Roberto Godoy⁵⁸, Saleh Alfarraj⁵⁹, Saleh Rahimlou¹, Sergei Pölme¹, Sergey V. Dudov⁶⁰, Sunil Munda⁶¹, Talaat Ahmed⁶², Tarquin Netherway³, Terry W. Henkel⁶³, Tomas Roslin³, Vladimir E. Fedosov⁶⁰, Vladimir G. Onipchenko⁶⁰, W. A. Erandi Yasanthika³⁸, Young Woon Lim⁶⁴, Meike Piepenbring⁶⁵, Darta Klavina⁶⁶, Urmaz Köljalg^{1,67} and Kessy Abarenkov^{1,67}¶

Fung. Divers. 111: 573-588.

GSMc ITS-full dataset: fungi



Global Fungi ITS2 dataset: fungi



Legend

- Ascomycota
- Basidiomycota
- Rozellomycota
- Glomeromycota
- Chytridiomycota
- Mortierellomycota
- Mucoromycota
- Zoopagomycota
- GS01
- other phylum
- unknown phylum

Other large projects

- FunAqua – global sampling of water and sediments: all life
- FunLeaf – global sampling of plant leaves: fungi and oomycetes
- FunHome – global sampling of household dust: fungi and arthropods
- Global lichen holobiont – lichen-associated fungi and bacteria
- Silva Nova – climate- and biodiversity-friendly afforestation
- SUCC – Understanding biodiversity and C retention in young forests
- MycoPhylo field experiment: tree and mycorrhizal type diversity
- Taxonomy and traits databases

Methods development

- Long read metabarcoding (PacBio and ONT MinION)
- Target capture for metabarcoding (PacBio)
- MGI-Tech sequencing (short reads)
- HTS methods in DNA barcoding and haplotype detection
- Optimal solutions in data filtering, trimming and databasing
- Measures of community specificity and indicators
- Teaching: Interactive and shared writing:

https://docs.google.com/document/d/13eX8r-oknnFLVRENPFBEFsu_yU2rNenpWtZUJ5wpjbUM/edit?usp=sharing

PacBio sequencing

Pacific BioSciences Inc. SMRT sequencing

„PacBio sequencing“

- Sequel II platform

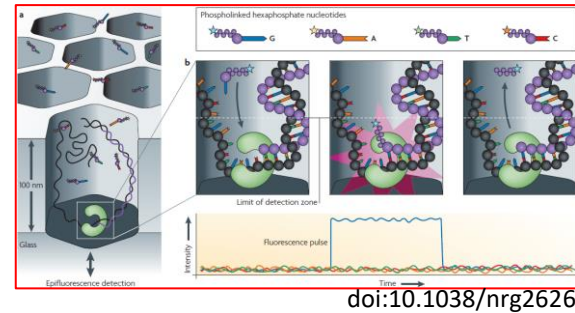
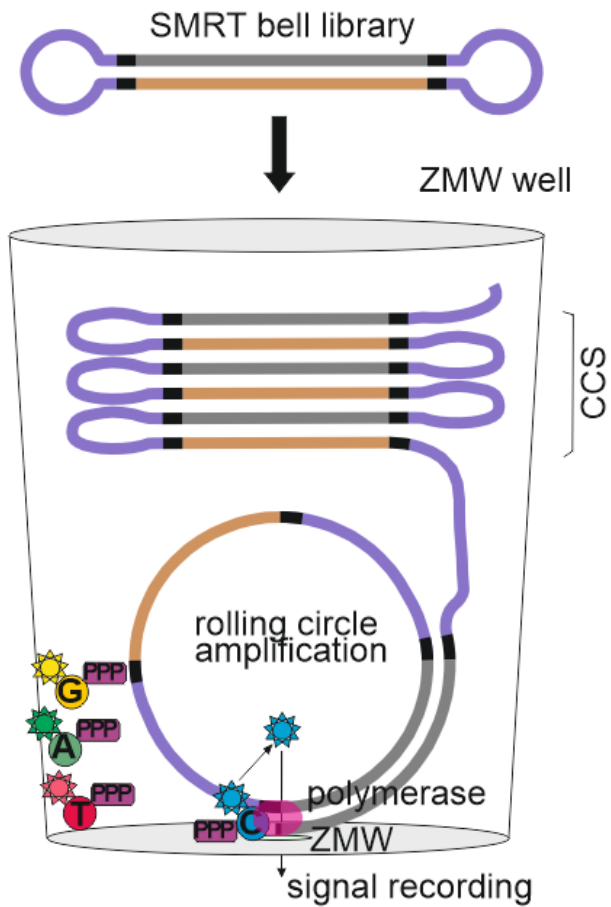
+ long reads (200 kb)

+ epigenome seq.

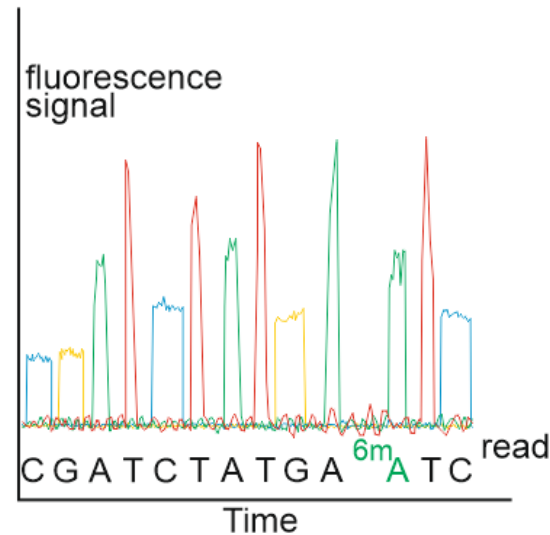
+ **low CCS error rate**

- high raw error (5%)

- costly library prep



sequencing
by synthesis



PacBio Sequel II

UNITE (v 8.3)

- Hosts mostly rRNA **ITS sequences of all eukaryotes** (2,688,805 ITS reads)
- **Taxonomic annotation** by the research community (extd. UNITE team)
- **Functional + metadata annotation** by the FungalTraits consortium
- **Taxon and species hypotheses (DOIs)** for eukaryote species-level taxa
- UNITE SH **DOIs are implemented in GBIF** taxonomic backbone
- Release of **reference data for identification and chimera filtering**

Eukaryote Species Hypotheses (except fungi)		
Threshold	1.0 %	Ir
<ul style="list-style-type: none">▶ Viridiplantae (DOI: TH005112) (85,393)▶ Unidentified (68,074)▶ Metazoa (DOI: TH005095) (12,757)▶ Alveolata (DOI: TH005109) (3,782)▶ Stramenopila (DOI: TH005094) (3,579)▶ Eukaryota kgd Incertae sedis (DOI: TH005114)▶ Rhizaria (DOI: TH005103) (1,665)▶ Protista (DOI: TH005105) (650)▶ Rhodoplantae (DOI: TH005093) (460)▶ Amoebozoa (DOI: TH005117) (354)▶ Euglenozoa (DOI: TH005106) (323)▶ Ichthyosporia (DOI: TH005102) (62)▶ Heterolobosa (DOI: TH005097) (55)▶ Haptista (DOI: TH005090) (46)▶ Cryptista (DOI: TH005092) (45)▶ Parabasalia (DOI: TH005113) (28)		
<hr/>		
Fungi (DOI: TH005107) (>145,000)		

FungalTraits

Genus-based traits annotations

- Experts annotated 10,210 fungal and 151 stramenopile genera

- 17 lifestyle related traits

- + general lifestyle/guild

- + biotrophic interaction capacities

- + decomposition capacity

- + fruitbody and hymenium type

- + growth form

- + aquatic habitat

- + interacting taxa

- + addn: ectomycorrhizal and lichenized fungi

Fungal Diversity (2020) 105:1–16
<https://doi.org/10.1007/s13225-020-00466-2>



FungalTraits: a user-friendly traits database of fungi and fungus-like stramenopiles

Sergei Pölme^{1,2} · Kessy Abarenkov² · R. Henrik Nilsson^{3,4} · Björn D. Lindahl⁵ · Karina Engelbrecht Clemmensen⁶ · Havard Kauserud⁷ · Nhu Nguyen⁸ · Rasmus Kjoller⁹ · Scott T. Bates¹⁰ · Petr Baldrian¹¹ · Tobias Guldberg Frøslev¹² · Kristjan Adojaan¹ · Alfredo Vizzini¹³ · Ave Suija¹ · Donald Pfister¹⁴ · Hans-Otto Baral¹⁵ · Helle Järv¹⁶ · Hugo Madrid^{17,18} · Jenni Nordén¹⁹ · Jian-Kui Liu²⁰ · Julia Pawlowska²¹ · Kadri Pöldmaa¹ · Kadri Pärtel¹ · Kadri Runnel¹ · Karen Hansen²² · Karl-Henrik Larsson^{3,23} · Kevin David Hyde²⁴ · Marcelo Sandoval-Denis²⁵ · Matthew E. Smith²⁶ · Merje Toome-Heller²⁷ · Nalin N. Wijayawardene²⁸ · Nelson Menolli Jr.^{29,30} · Nicole K. Reynolds²⁶ · Rein Drenkhan³¹ · Sajeewa S. N. Maharachchikumbura²⁰ · Tatiana B. Gibbertoni³² · Thomas Læssøe³³ · William Davis³⁴ · Yuri Tokarev³⁵ · Adriana Corrales³⁶ · Adriene Mayra Soares³⁷ · Ahto Agan¹ · Alexandre Reis Machado³² · Andrés Argüelles-Moyao³⁸ · Andrew Detheridge³⁹ · Angelina de Meiras-Ottoni³² · Annemieke Verbeken⁴⁰ · Arun Kumar Dutta⁴¹ · Bao-Kai Cui⁴² · C. K. Pradeep⁴³ · César Marín^{44,45} · Daniel Stanton⁴⁶ · Daniyal Gohar¹ · Dhanushka N. Wanasinghe⁴⁷ · Eveli Otsing¹ · Farzad Aslani¹ · Gareth W. Griffith³⁹ · Thorsten H. Lumbsch⁴⁸ · Hans-Peter Grossart^{49,50} · Hossein Masjoli⁵¹ · Ina Timling⁵² · Inga Hiiesalu¹ · Jane Oja¹ · John Y. Kupagme¹ · József Geml⁵³ · Julieta Alvarez-Manjarrez³⁸ · Kai Ilves¹ · Kaire Loit⁵⁴ · Kalev Adamson³¹ · Kazuhide Nara⁵⁵ · Kati Küngas¹ · Keilor Rojas-Jimenez⁵⁶ · Krišs Bitenieks⁵⁷ · Laszlo Irinyi^{58,59} · László Laszlo Nagy⁶⁰ · Liina Soonvald⁵⁴ · Li-Wei Zhou⁶¹ · Lysett Wagner⁶² · M. Catherine Aime⁶³ · Maarja Öpik¹ · María Isabel Mujica⁶⁴ · Martin Metsoja¹ · Martin Ryberg⁶⁵ · Martti Vasar¹ · Masao Murata⁵⁵ · Matthew P. Nelsen⁴⁸ · Michelle Cleary⁶⁶ · Milan C. Samarakoon²⁴ · Mingkwan Doilom⁴⁷ · Mohammad Bahram^{1,67} · Niloufar Hagh-Doust¹ · Olesya Dulya^{1,68} · Peter Johnston⁶⁹ · Petr Kohout¹¹ · Qian Chen⁶¹ · Qing Tian²⁴ · Rajasree Nandi⁷⁰ · Rasekh Amiri¹ · Rekhani Hansika Perera²⁴ · Renata dos Santos Chikowski³² · Renato L. Mendes-Alvarenga³² · Roberto Garibay-Orijel³⁸ · Robin Gielen¹ · Rungtiwa Phookamsak⁴⁷ · Ruvishika S. Jayawardena²⁴ · Saleh Rahimlou¹ · Samantha C. Karunaratna⁴⁷ · Saowaluck Tibpromma⁴⁷ · Shawn P. Brown⁷¹ · Siim-Kaarel Sepp¹ · Sunil Mundra⁷² · Zhu-Hua Luo⁷³ · Tanay Bose⁷⁴ · Tanel Vahter¹ · Tarquin Netherway⁶⁷ · Teng Yang⁷⁵ · Tom May⁷⁶ · Torda Varga⁶⁰ · Wei Li⁷⁷ · Victor Rafael Matos Coimbra³² · Virton Rodrigo Targino de Oliveira³² · Vitor Xavier de Lima³² · Vladimir S. Mikryukov¹ · Yongzhong Lu⁷⁸ · Yosuke Matsuda⁷⁹ · Yumiko Miyamoto⁸⁰ · Urmaz Köljal^{1,2} · Leho Tedersoo^{1,2}

FungalRoot

- Updated database (v. 2.1 available) of plant mycorrhizal status and colonisation level

Methods

FungalRoot: global online database of plant mycorrhizal associations

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(a) Arbuscular mycorrhizal colonization



(b) Ectomycorrhizal colonization



Number of records per location

0 - 2

2 - 5

5 - 15

15 - 30

30 - 50

50 - 90

90 - 150

150 - 260

(c) Ericoid mycorrhizal colonization



(d) Nonmycorrhizal plants





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