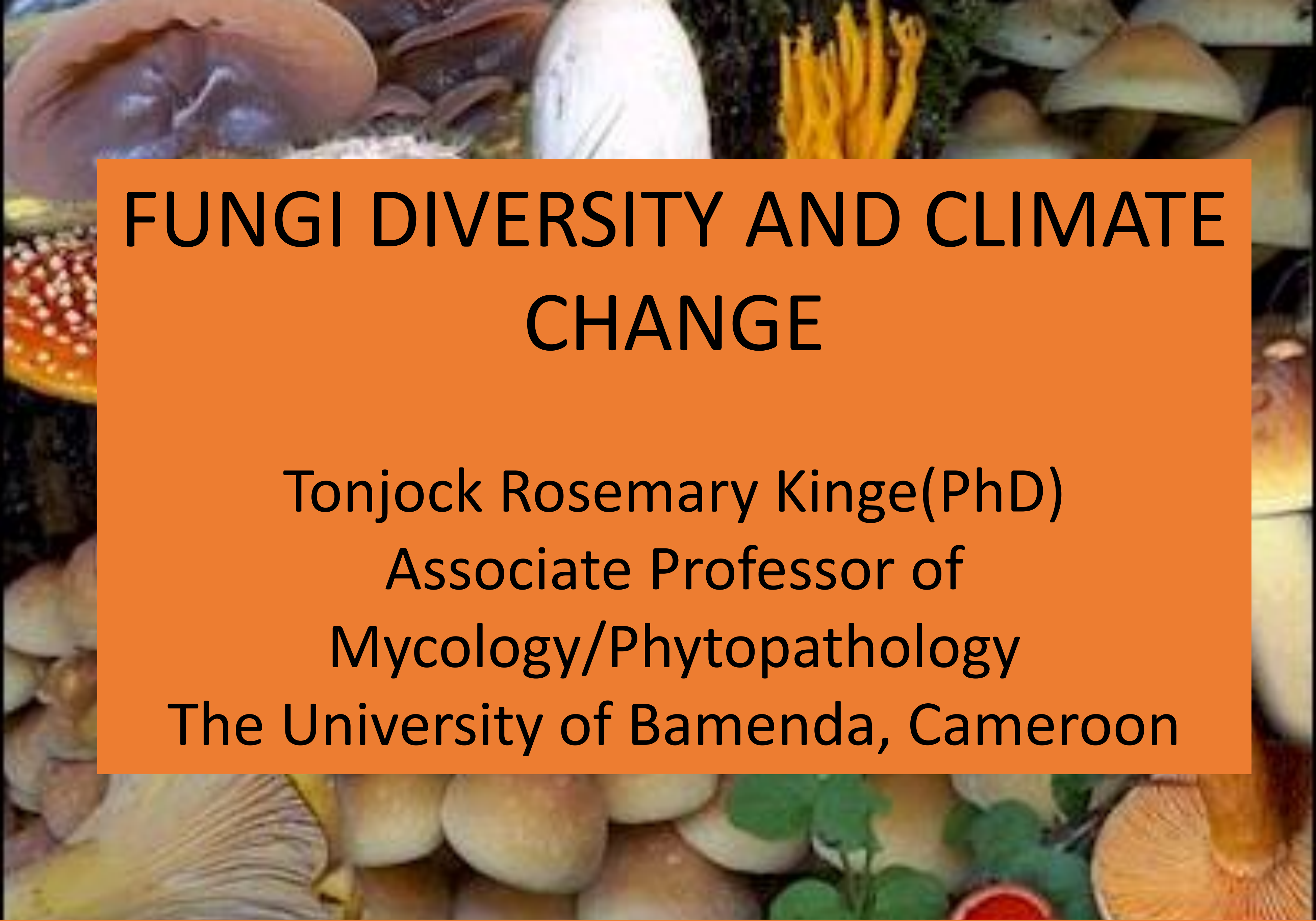


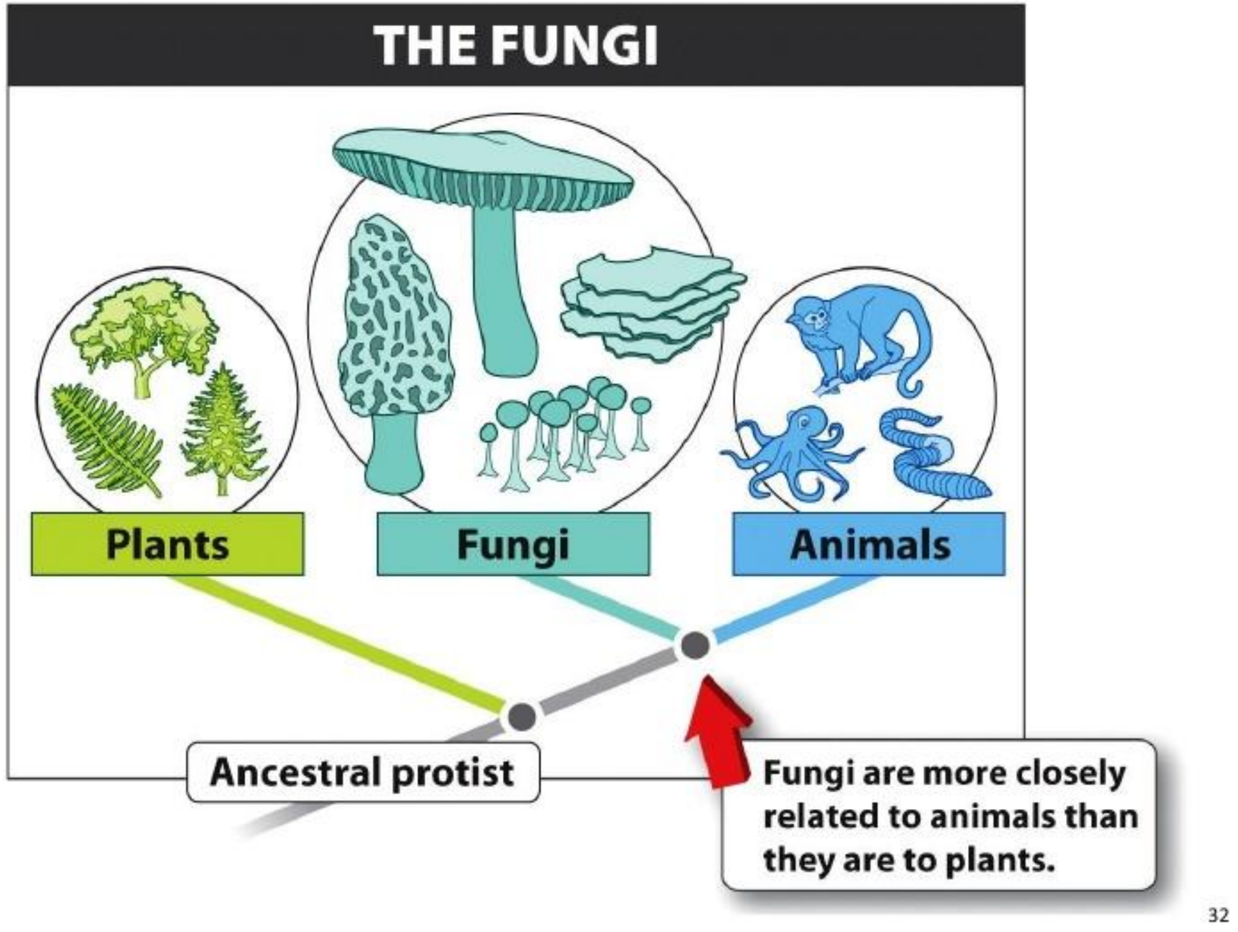
FUNGI DIVERSITY AND CLIMATE CHANGE

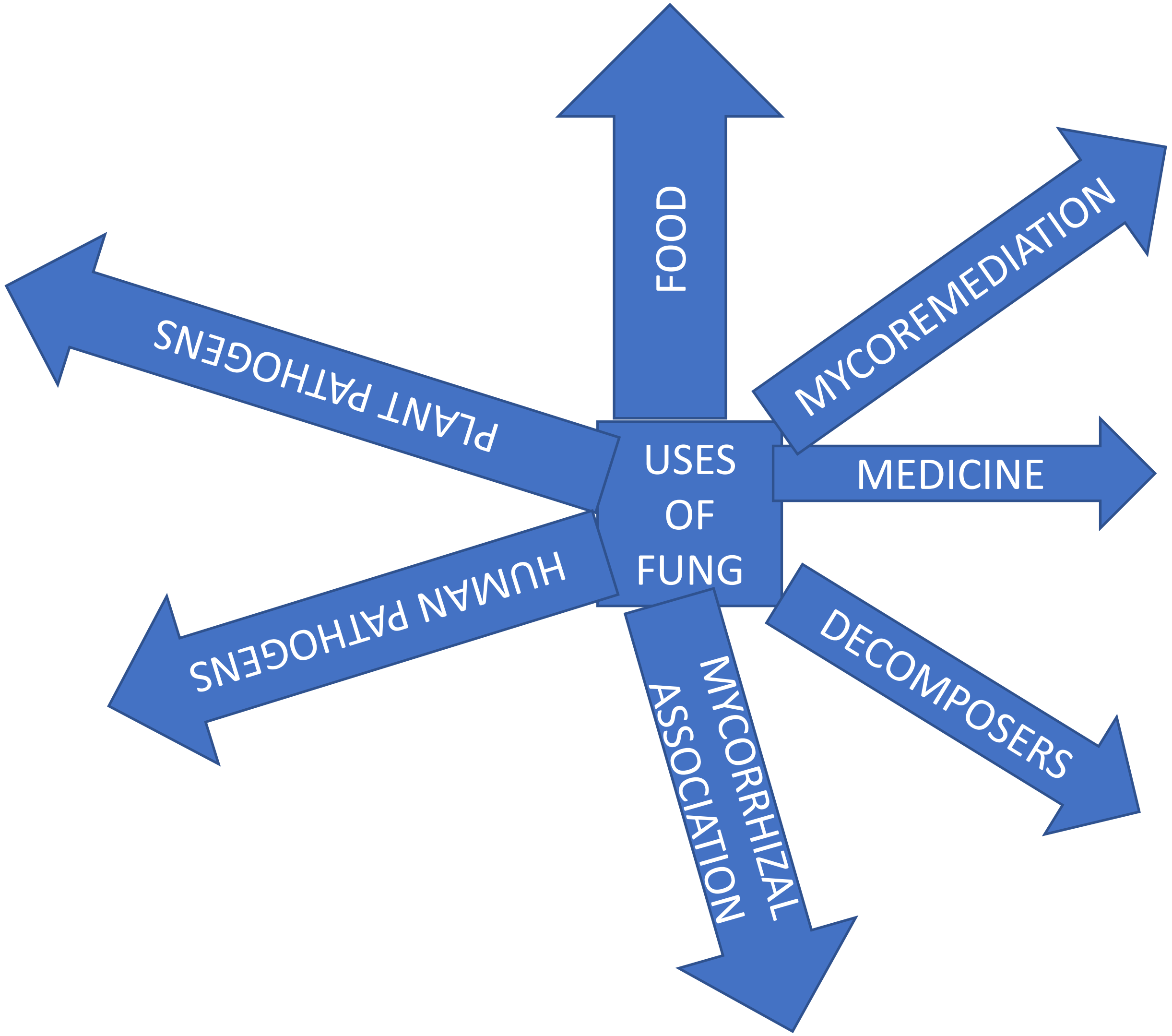
Tonjock Rosemary Kinge(PhD)
Associate Professor of Mycology/Phytopathology
The University of Bamenda, Cameroon

rosemary32us@yahoo.com

INTRODUCTION

- Fungi are eukaryotic microorganisms that play fundamental roles in regulating key ecosystem processes.
- Cell walls - made of chitin.

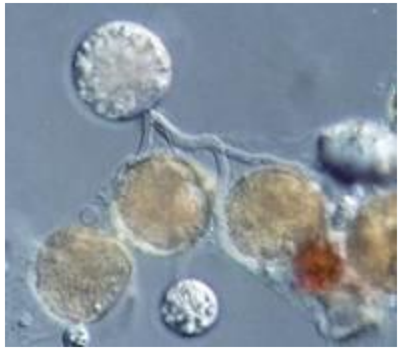



USES OF FUNG
FOOD
MYCOREMEDIATION
MEDICINE
DECOMPOSERS
MYCORRHIZAL ASSOCIATION
HUMAN PATHOGENS
PLANT PATHOGENS

Fungi Diversity

- Biological diversity or Biodiversity is defined as the variety & value of life on earth at genetic, organism and ecological level.
- Fungal biodiversity means variety and variability of fungus on earth.
- The biodiversity found in genes, species, ecosystems, and ecosystem processes is vital to sustaining life on earth.

Phyla of Fungi

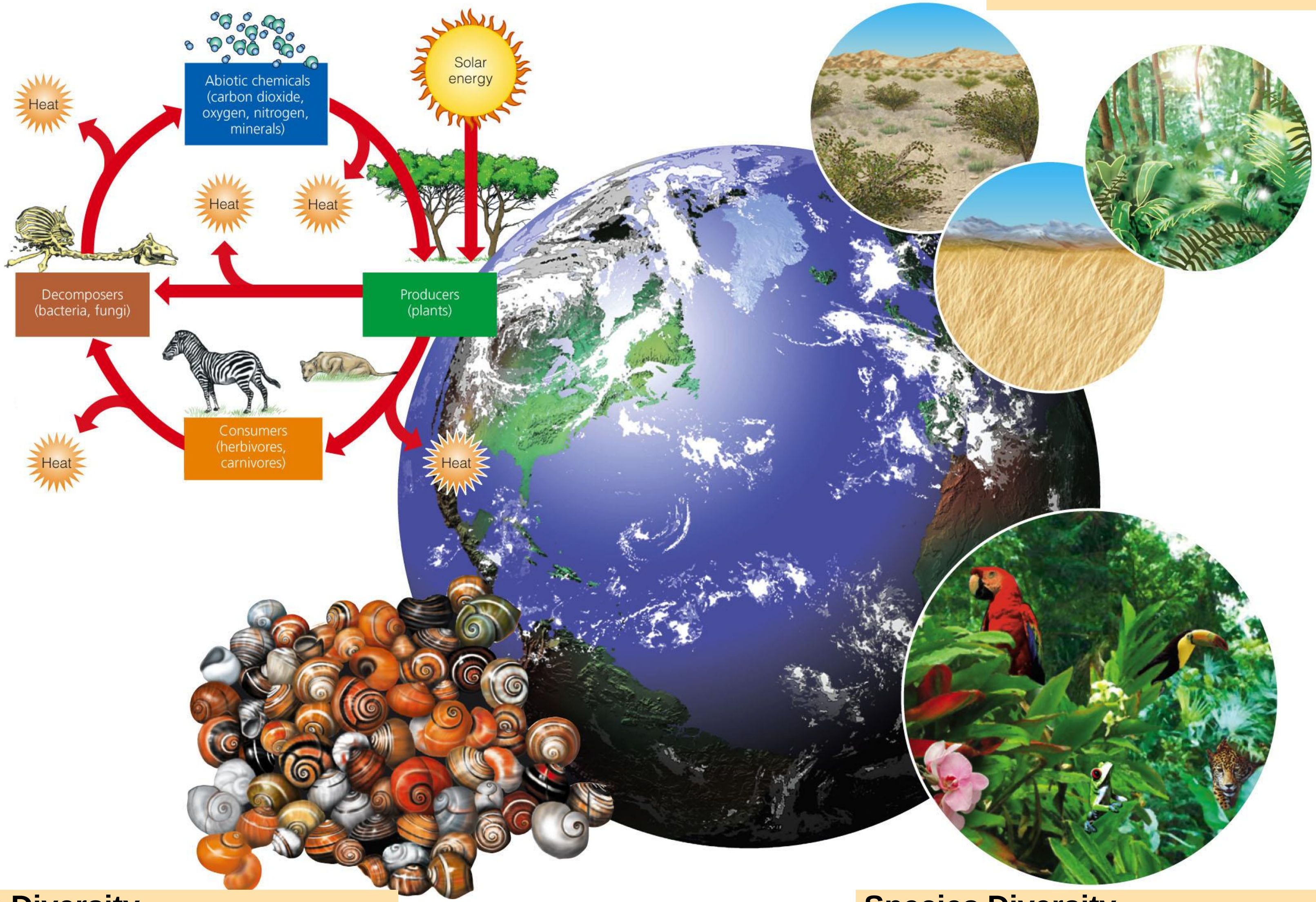



1. Chytridiomycota - Chytrids
2. Zygomycota – Common Molds
3. Ascomycota – Sac Fungi
4. Basidiomycota – Club Fungi
5. Deuteromycota – Imperfect Fungi




Functional Diversity
The biological and chemical processes such as energy flow and matter recycling needed for the survival of species, communities, and ecosystems.

Ecological Diversity
The variety of terrestrial and aquatic ecosystems found in an area or on the earth.



Genetic Diversity
The variety of genetic material within a species or a population.

Species Diversity
The number and abundance of species present in different communities

Fig. 4-2, p. 61

- To date, worldwide, approximately 135,000 species of fungi have been described (Kirk 2019b).
- Total global fungal diversity is, however, undoubtedly much greater.
- A figure of 1.5 million species (Hawksworth 1991) was, for many years, used as a working estimate.
- Currently, however, most mycologists believe the number is even greater, with a conservative estimate now placed in the range of 2.2–3.8 million species (Hawksworth and Lücking 2017).
- Numerous species of fungi are thought to remain undiscovered in tropical regions and biodiversity hotspots (Hawksworth and Lücking 2017).

- Scientific information about biodiversity distribution is indispensable for nature conservation and sustainable management of natural resources.
- For several groups of animals and plants, such data are available, but for fungi, especially in Africa, they are mostly missing.

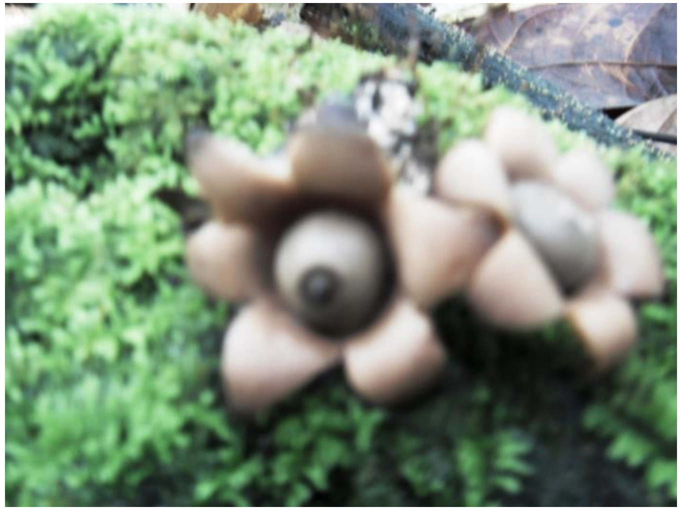
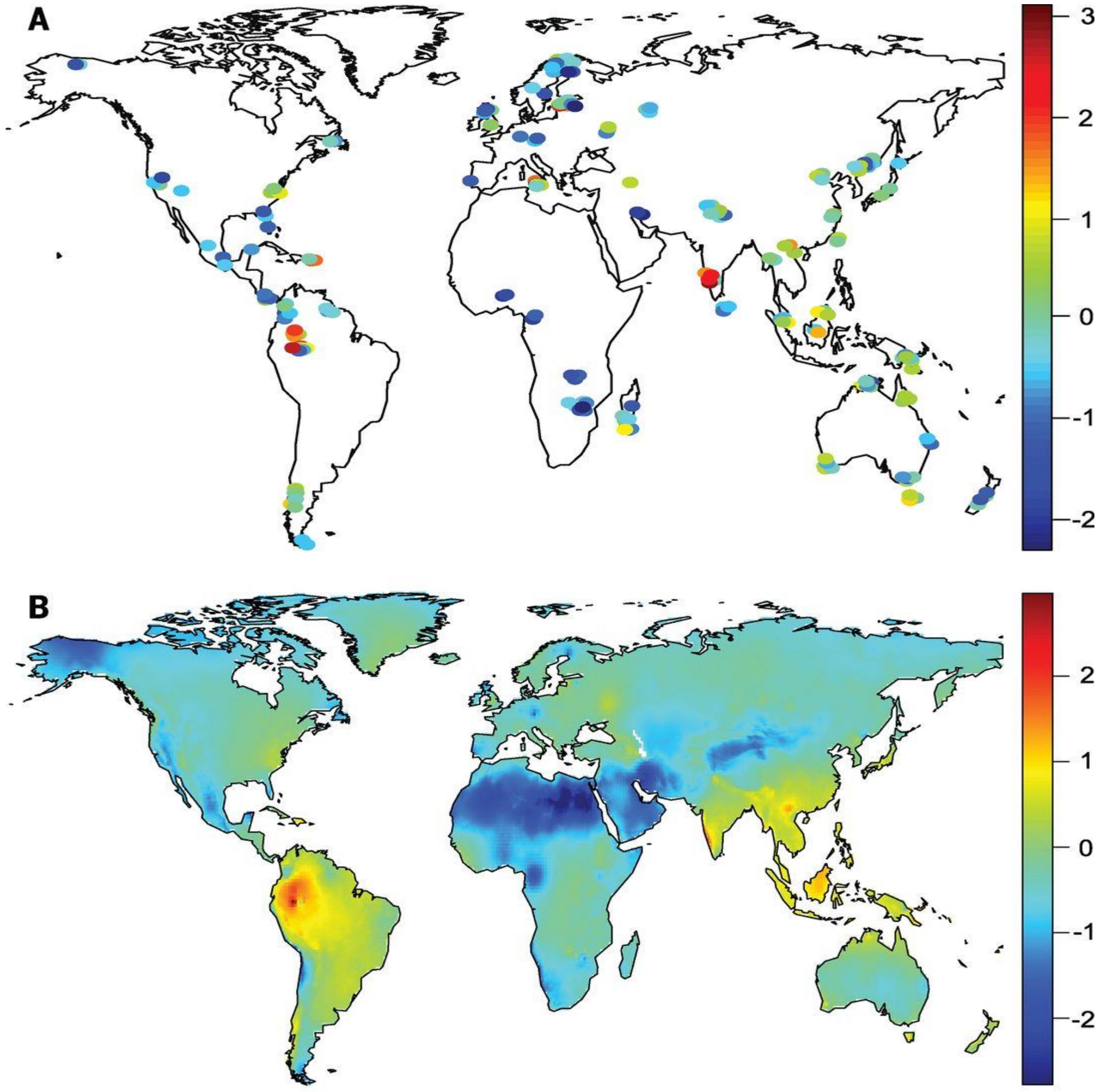


Table 1: Estimates for global species diversity of macrofungi based on two assumptions of the ratio between macrofungal and flowering plant species diversity: (a) 2:1; two plant species to each species of macrofungus in each region, and (b) 2:1 and 5:1; two plant species per macrofungus species in temperate zones and five plant species per macrofungus species for tropical regions

Region	**Flowering plant to macrofungal species ratio employed**	
	2:1	**2:1 for temperate zone** **5:1 for tropical zone**
North America	10,000	10,000
Central America	15,000	6,000
Tropical South America	35,000	14,000
Temperate South America	3,000	3,000
Western Europe	6,250	6,250
Africa	**25,000**	**10,000**
Temperate Asia	22,500	22,500
Tropical Asia	25,000	10,000
Australasia	8,000	8,000
Hawaii		
Total macrofungi/total flora	2,800	1,120
Native macrofungi/native flora	478	191
Estimated totals for world[a]	85,000–110,000	53,000–65,000

Findings:
In all, 21,679 names of macrofungi were compiled extrapolating our estimate of 53,000– 110,000 of macrofungi to Fung i would give an estimate of 530,000– 1.1 million species of fungi.
Most regions of the world are severely undersampled, irrespective of employed ratio.

(**Mueller *et al.*, 2017**)



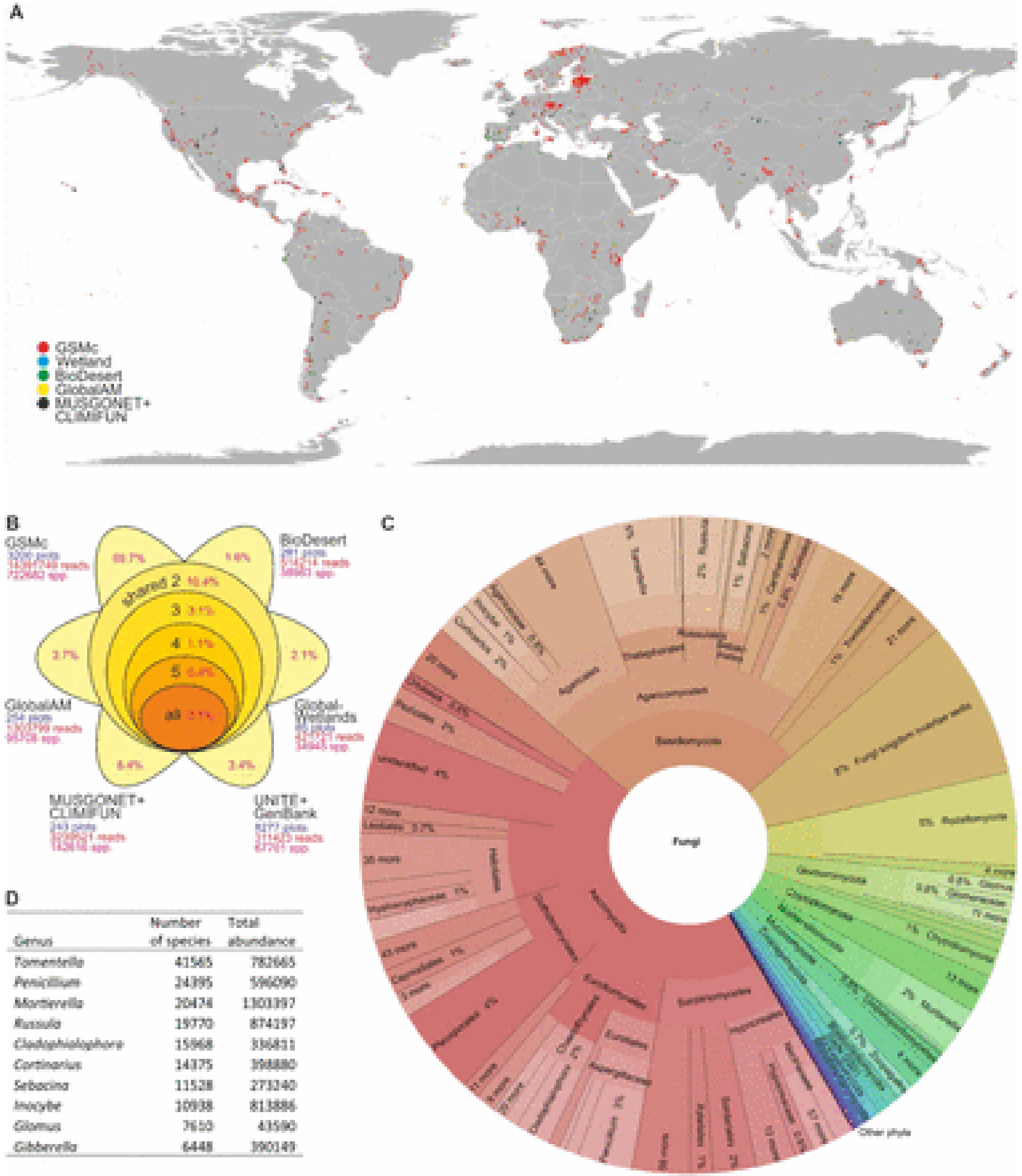
FINDINGS: The plant-to-fungus richness ratio declines exponentially toward the poles. Climatic factors, followed by edaphic and spatial variables, constitute the best predictors of fungal richness and community composition at the global scale. Fungi show similar latitudinal diversity gradients to other organisms, with several notable exceptions.

Fig. 1 Maps of global sampling and interpolated taxonomic richness of all fungi.

(A) Map of global sampling. Circles indicate study sites.

(B) Interpolated taxonomic richness of all fungi using IDW algorithm and accounting for the relationship with mean annual precipitation (based on the best multiple regression model).

(Tedersoo *et al.*, 2014)

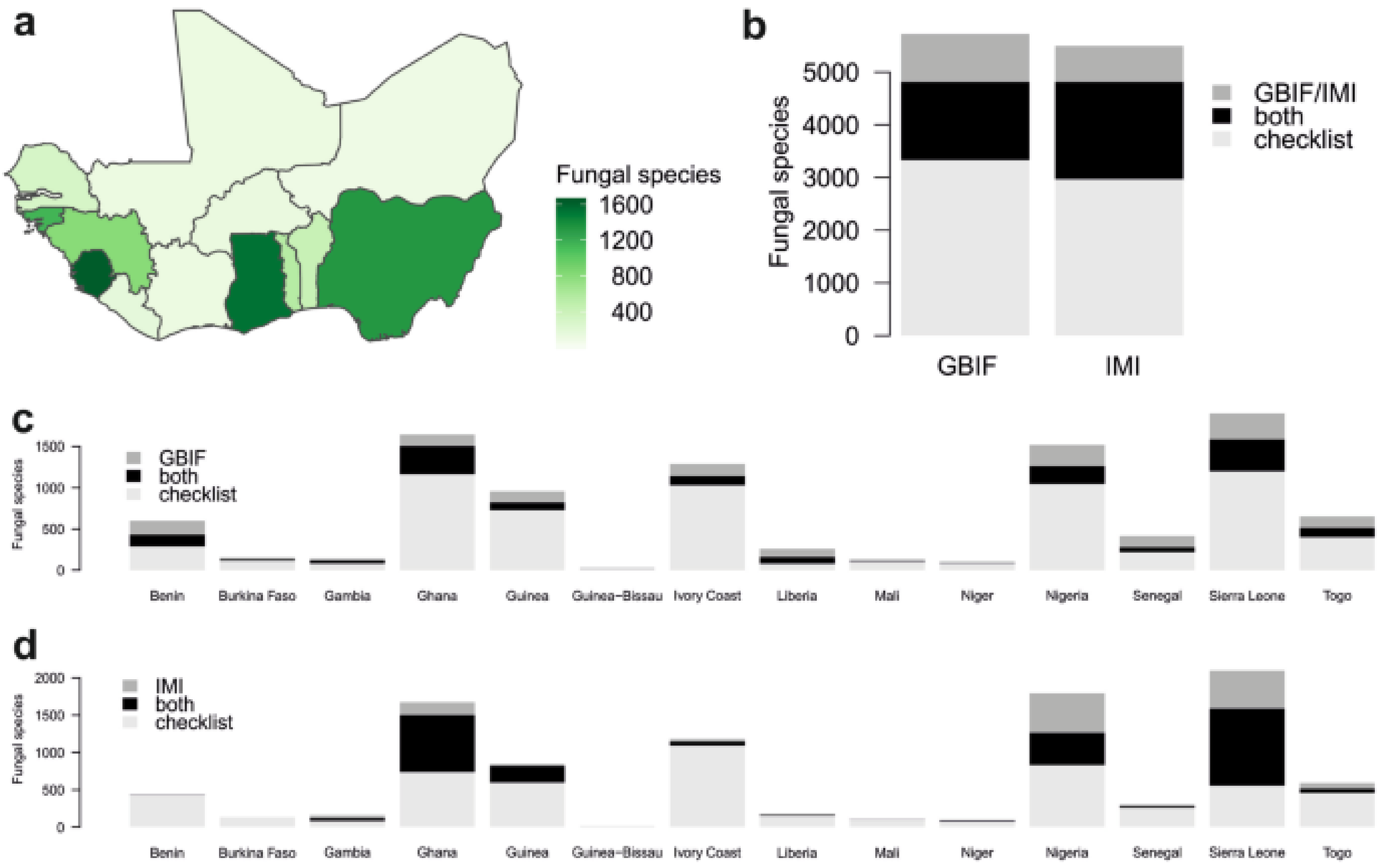


Genus	Number of species	Total abundance
Tomentella	41565	782665
Penicillium	24395	596090
Mortierella	20474	1303397
Russula	19770	874197
Cladophialophora	15968	336811
Cortinarius	14375	398880
Sebacina	11528	273240
Inocybe	10938	813886
Glomus	7610	43590
Gibberella	6448	390149

(Tedersoo *et al.*, 2022)

Findings: The genera *Tomentella* (Basidiomycota), *Penicillium* (Ascomycota), and *Mortierella* (Mortierellomycota) were the most species-rich

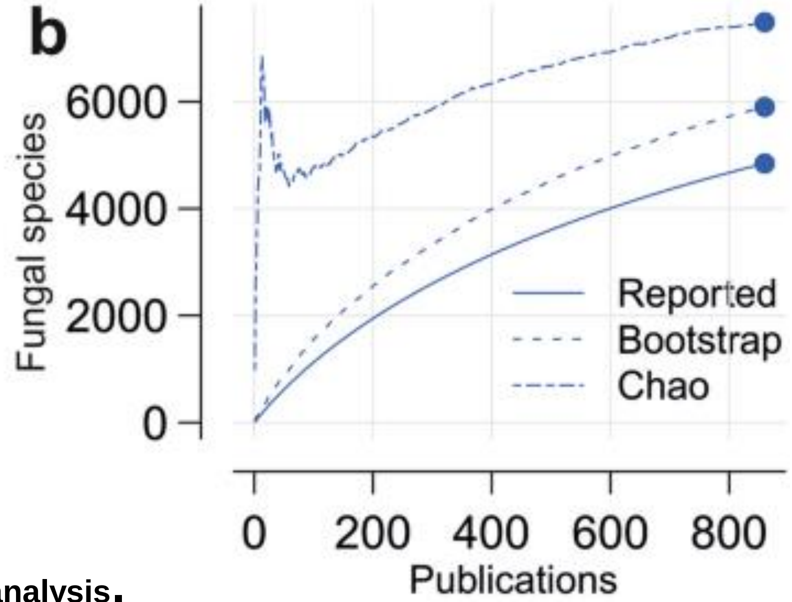
Fig. 2: Distribution of samples and fungal species across datasets.(A) Global sampling map, with different symbols representing different datasets; (B) species distribution of fungi among datasets, with the proportion of unique and shared species indicated in the diagram; (C) Krona chart indicating taxonomic distribution of fungal species (interactive chart can be browsed at https://plutof.ut.ee/#/doi/10.15156/BIO/2483900); (D) species richness and total read abundance of the top 10 most diverse fungal genera.



Findings: Fungal richness ranges from **19 species (Guinea Bissau) to 1595 (Sierra Leone**

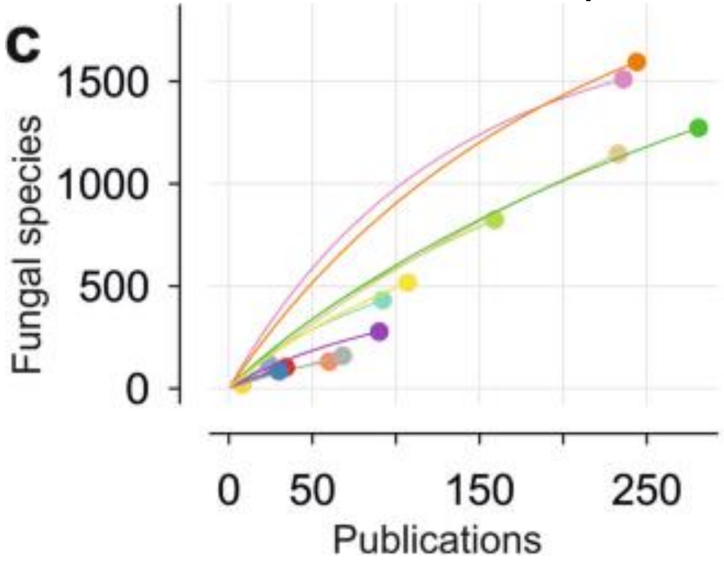
Fig. 3: Knowledge of fungal species diversity in West Africa and West African countries **(Piepenbring *et al.,* 2020)**.

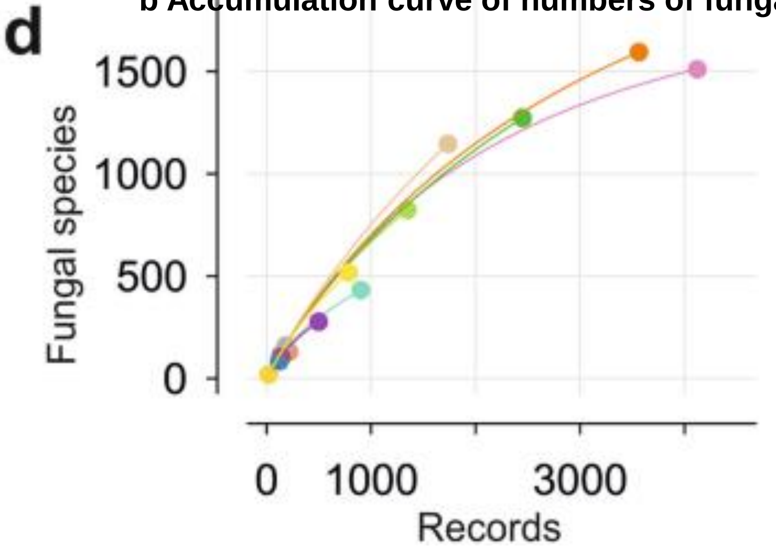
a Countries of West Africa considered for the present analysis.



b Accumulation curve of numbers of fungal species known for West Africa reported by publications.

Findings: More than 16,000 records of fungi representing 4843 species and infraspecific taxa were found in 860 publications relating to West Africa.





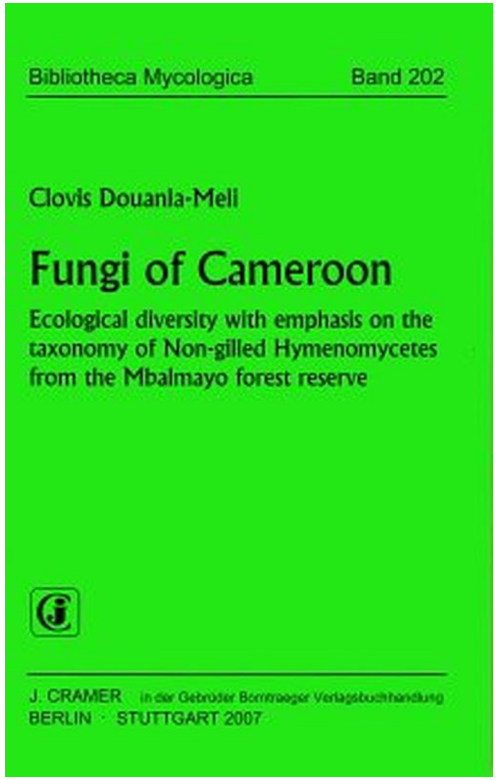
(Piepenbring *et al.,* 2020)

C Numbers of fungal species based on increasing publication

d Fungal species known by increasing number of records

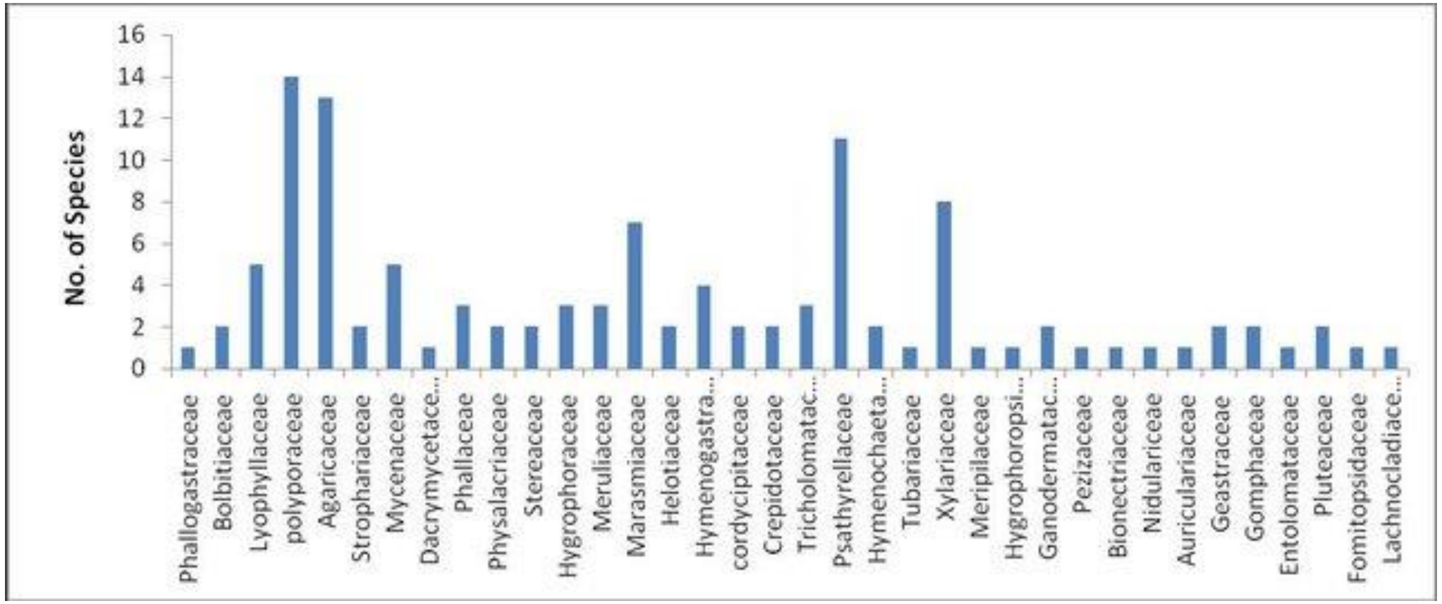
Fig. 4: Numbers of fungal species and estimations for fungal species richness in West Africa and West African countries

Fungal diversity in Central Africa



(**Douanla-Meli, 2007**)

More than 700 species collected and described.
Findings: 78% basidiomycetes
Ascomycetes accounted for 21% of the samples.
The identification of about 85% of all collected specimens with modern mycotaxonomic techniques, yielded 271 distinct species, 110 genera in 58 families



(**Teke *et al.*, 2017**)

Fig. 5: Orders of macro-fungi found at the Kilum-Ijim forest in northwestern Cameroon.

Fungal diversity in Southern Africa

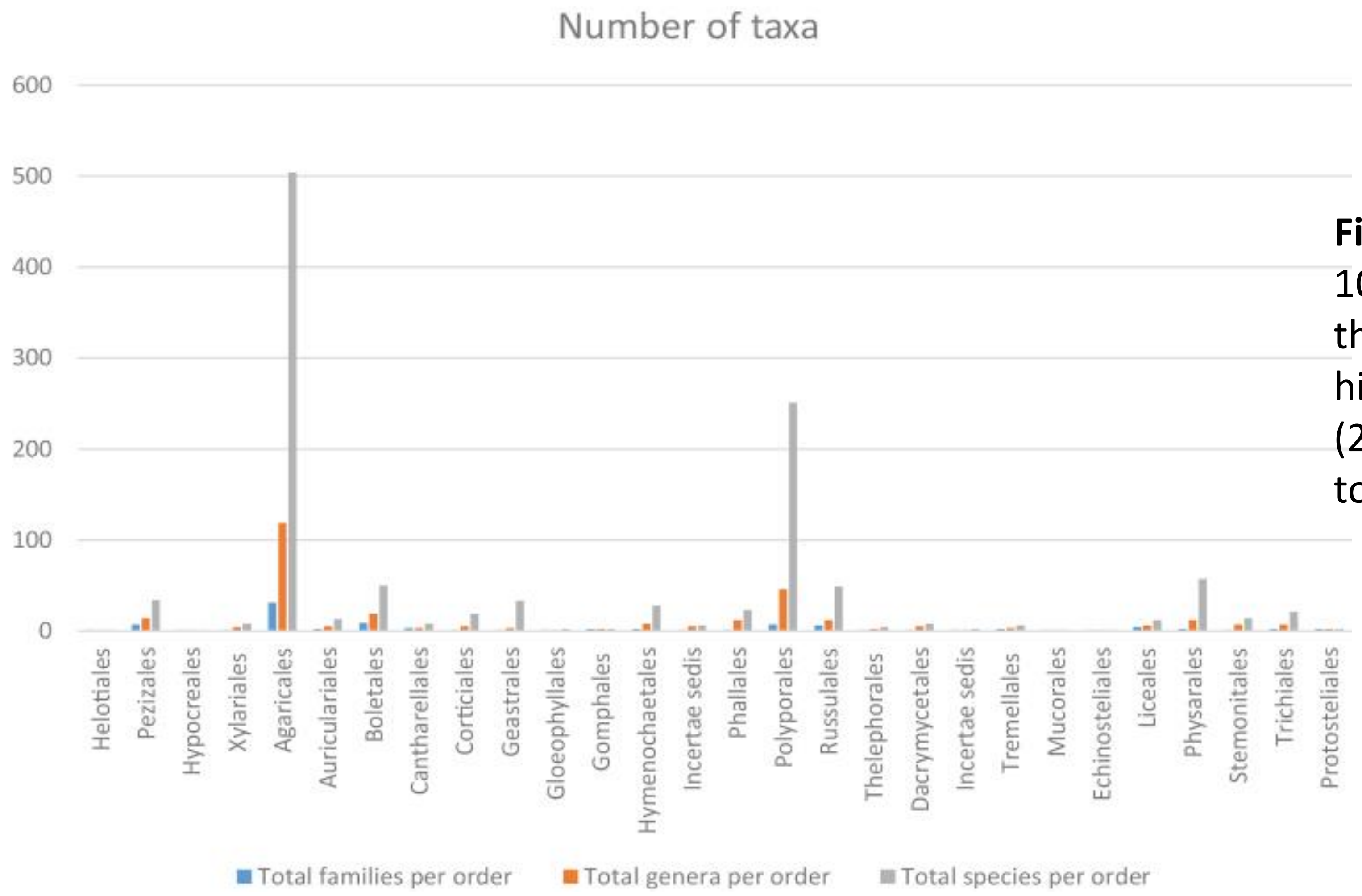
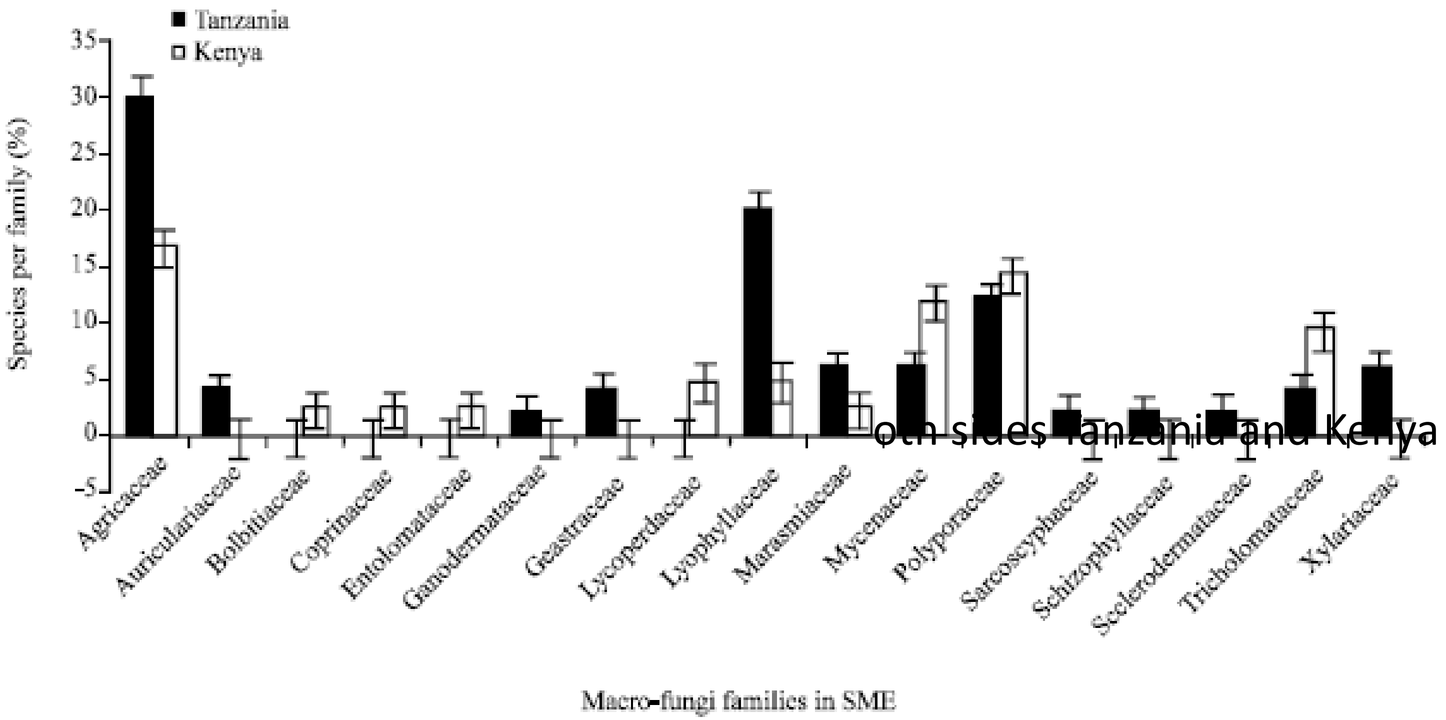


Fig. 6: Fungal species diversity in South Africa

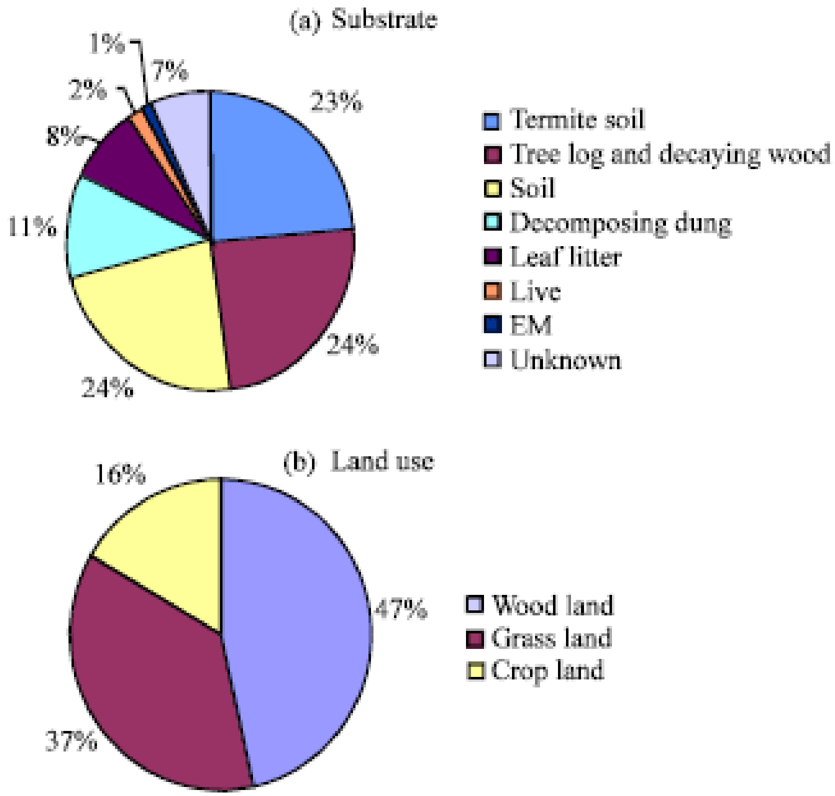
Findings: The Basidiomycota consisted of 1008 species, 251 genera and 72 families. At the class level, the Agaricomycetes had the highest number of species (992), genera (242), and families (68) hosting 86% of the total number of species of macrofungi.

(Kinge *et al.*, 2020)

Fungi Diversity in East Africa



oth sides Tanzania and Kenya



(Tibuhwa et al., 2014)

Fig. 7: Number of species in different families encountered in the study area from both sides Tanzania and Kenya

Fig. 8. Quantitative distribution of macrofungi in the SME based on (a) substrate (b) Land use types from both sides Tanzania and Kenya

Fungi Diversity in North Africa

- Knowledge of truffle diversity largely confined to the northern of Africa, with little known occurrence along the central equatorial belts.
- The genus Tuber includes a collection of species that form ectomycorrhizal associations with a range of host tree species and woody shrubs.
- Currently, this genus is represented by five known species from North African countries: *T. aestivum* syn. uncinatum, *T. asa*, *T. borchii*, *T. oligospermum*, and *T. rufum*. A sixth species, *T. melanosporum*, is also known and its introduction to the continent is included in this review as the geographic spread and local importance of this species is increasing (Thomas *et al.*, 2019).

Why Are Fungi Vanishing?

- Habitat loss and fragmentation
- Prolonged drought
- Increased ultraviolet radiation
- Pollution
- Climate change
- Overharvesting

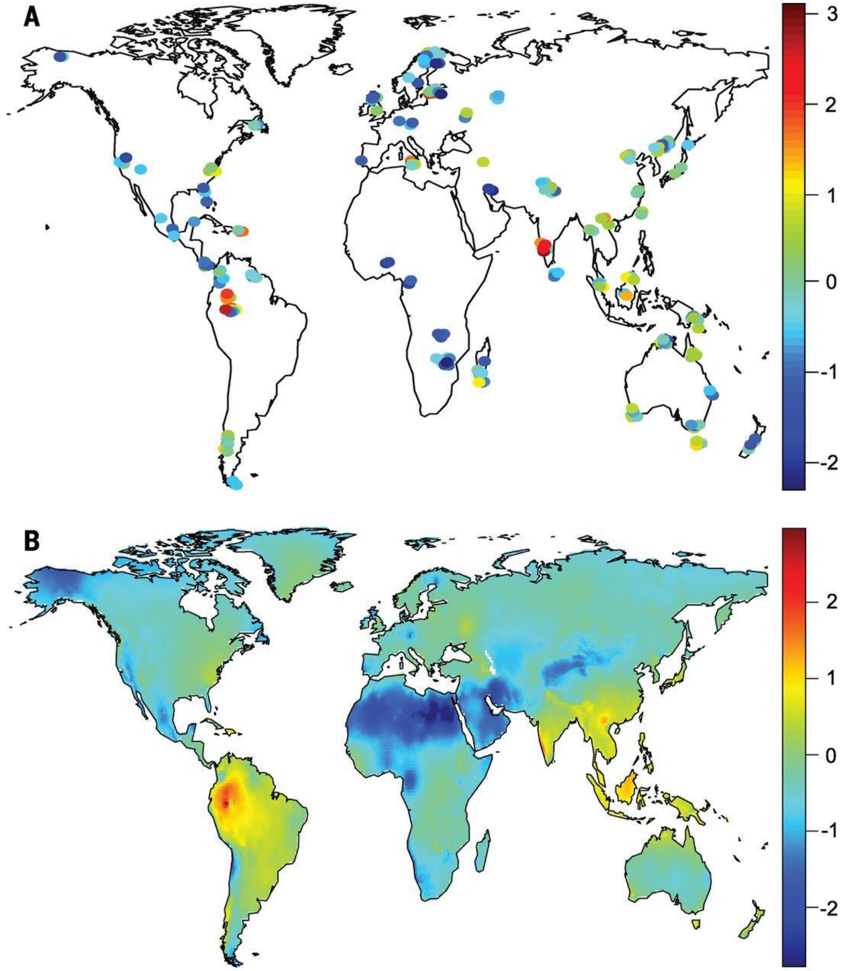
What is climate change?

- According to United Nations Climate Change Action, Climate change refers to long-term shifts in temperatures and weather patterns.
- Earth's climate has gone through different changes, and it is now warming at an increasing rate.
- Over the last few decades, we've also been witnessing;
- the warming of the atmosphere and the ocean,
- the decrease of snow and ice,
- droughts, and
- the rise of sea levels….

Consequences of Earth’s Long-Term Climate Change

- Cooling and warming periods affect evolution and extinction of species
- Opportunities for the evolution of new species
- Climate changes can alter the structure of fungal communities and may favour fungi over other organisms. **One of the reasons for this is the acidification of soils that tends to inhibit certain micro-organisms and favour fungal growth up to certain pH values.**
- Recent climate change has resulted in changes in the timing of phenological events in many organisms (Menzel *et al.,* 2006).
- Many species go extinct.

Findings: Diversity in all fungi compositions were explained by paleoclimatic and contemporary environmental variables paleoclimate explained higher variance in community compositions



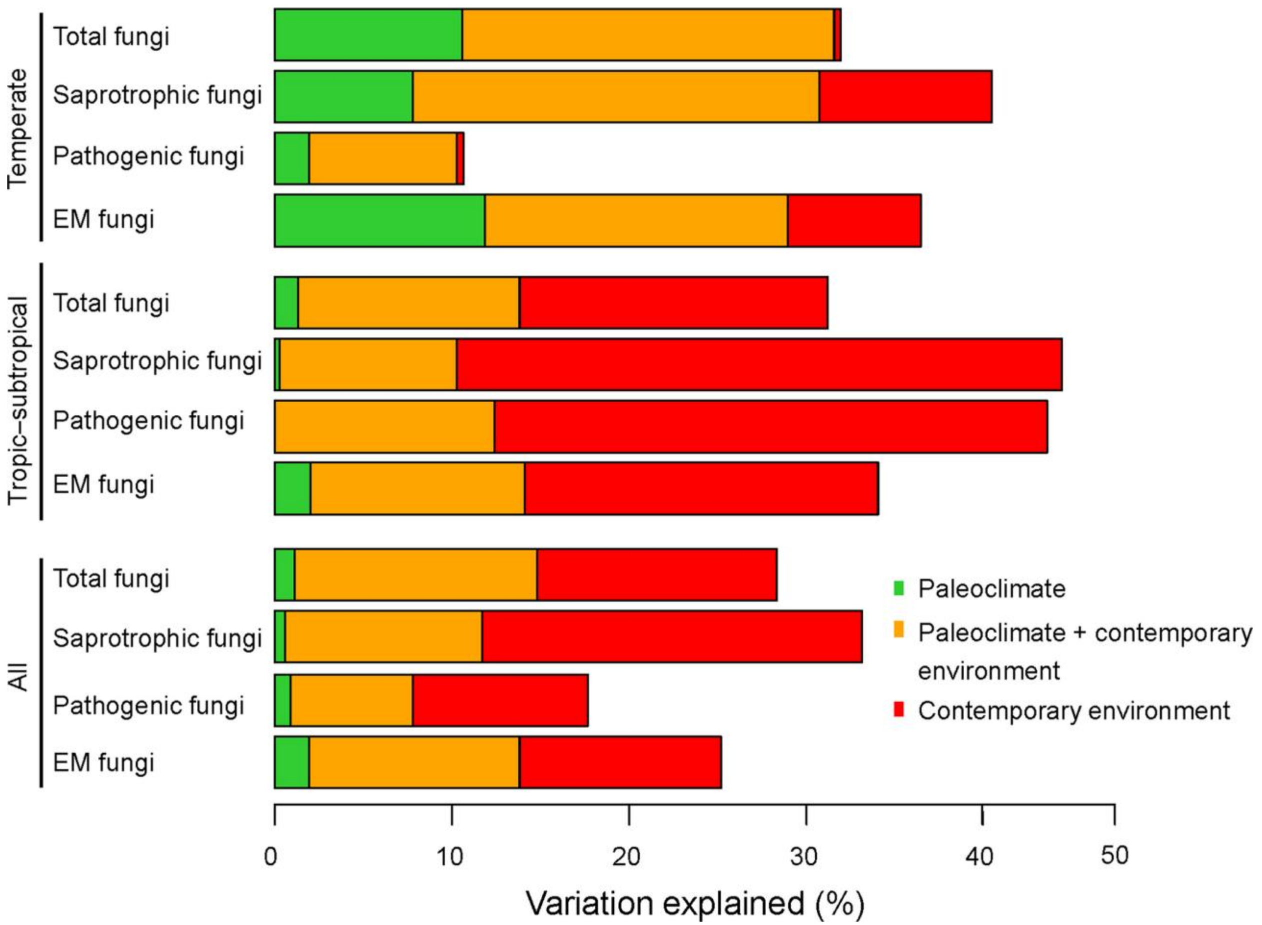
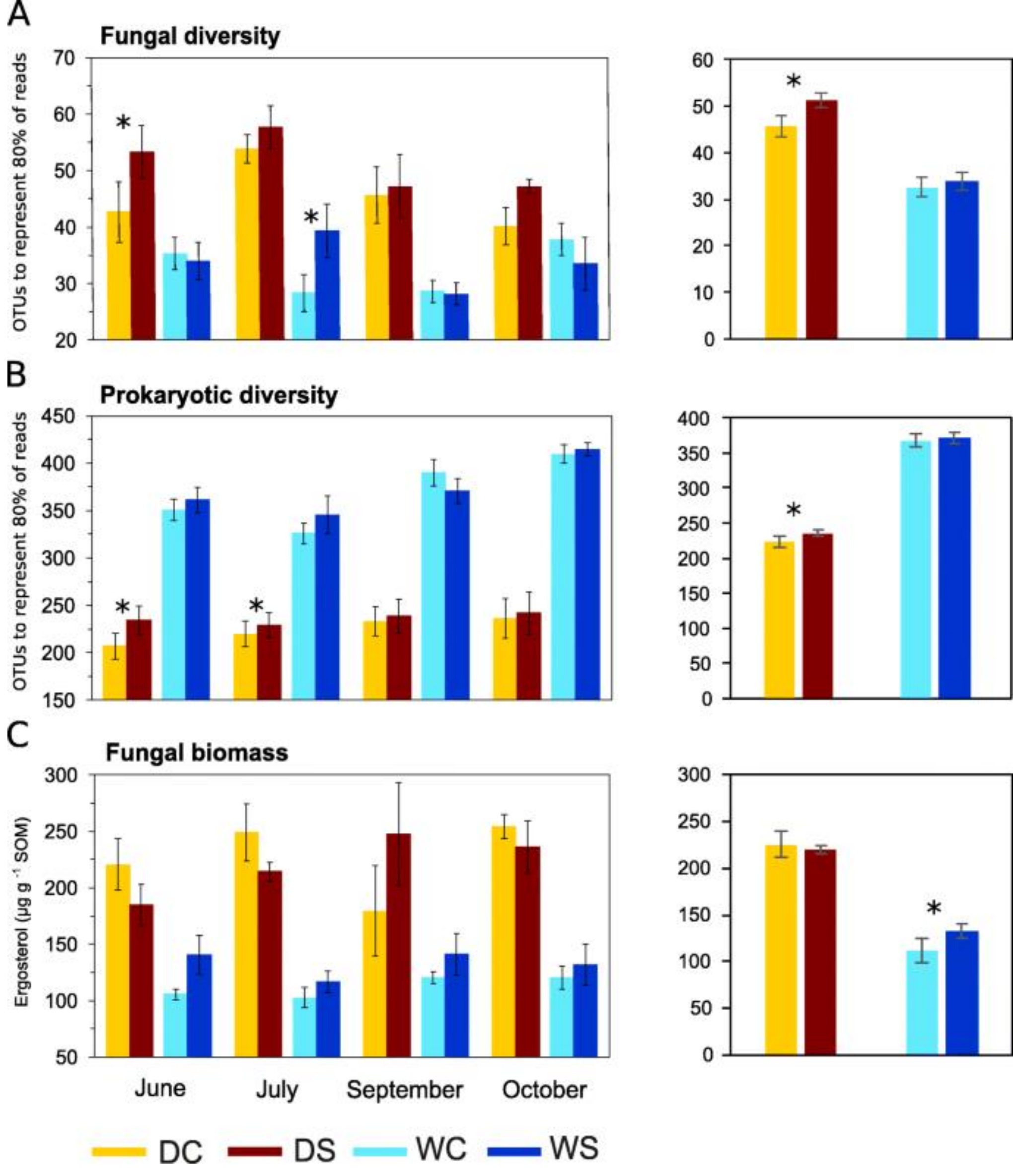


Fig. 10: Relative contribution of the different predictors used to model total and functional group fungal community compositions in temperate, tropic–subtropical, and all forests. **(Ji *et al.,* 2019)**



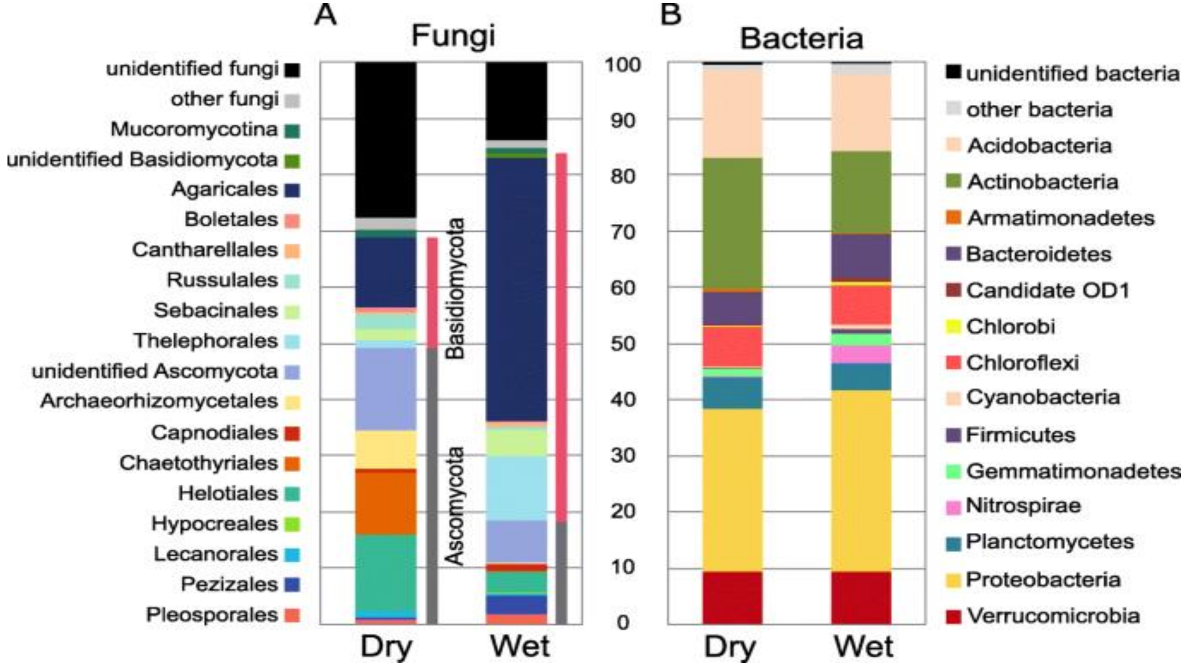


Fig. 12: Phylogenetic Assignments

Findings: -Fungal and bacterial communities at both sites were significantly affected by short-term increased snow cover manipulation.

-Fungal community composition was more affected by deeper snow cover compared to prokaryotes.

-Taxonomic and ecological groups of fungi changes due to climate manipulation.

-More basidiomycetes (Agaricales)

Fig. 11: Fungal (a) and bacterial (b) diversity estimates and fungal biomass (ergosterol content) (c) in the dry (D) and the wet (W) tundra soil in control (C) and snow-manipulated (S) plots by season and as a seasonal average (column chart). Diversity is expressed as the number of the most abundant OTUs (operational taxonomic units), which represented 80% of all sequences.

(Voříšková *et al.*, 2019)

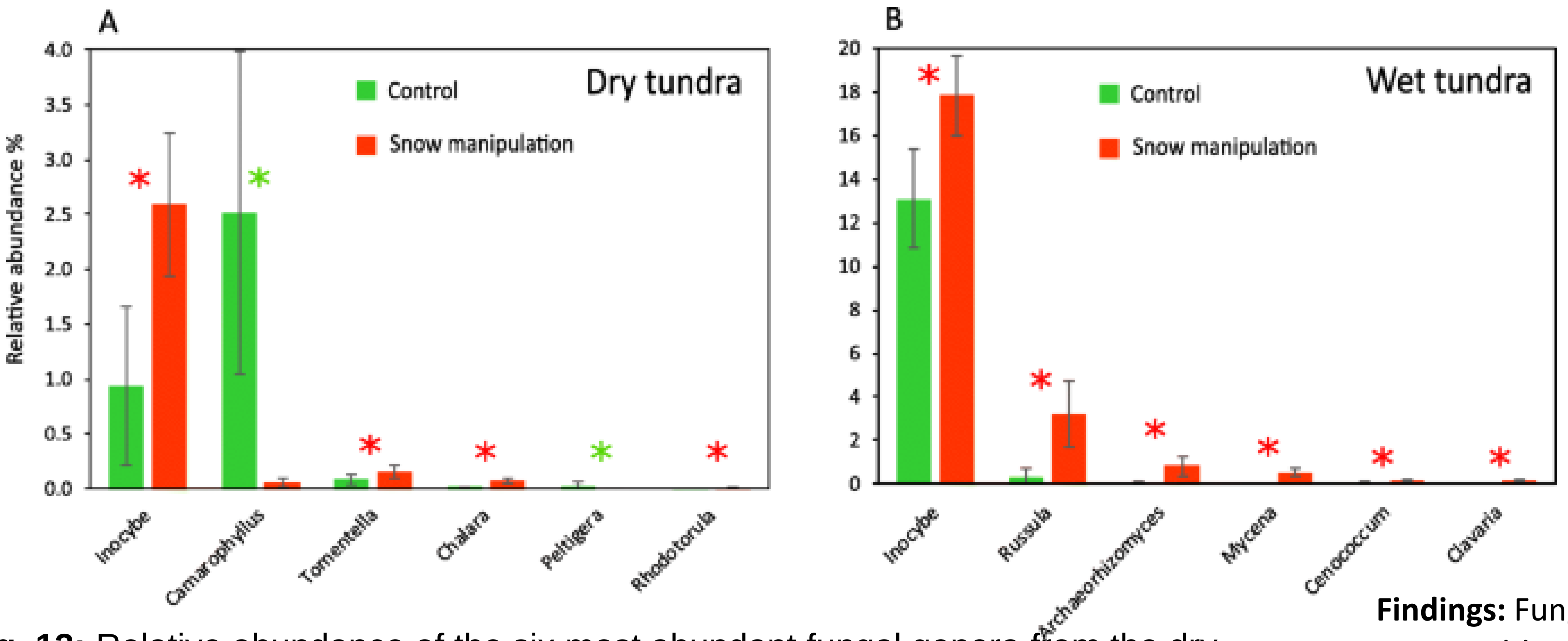


Fig. 13: Relative abundance of the six most abundant fungal genera from the dry

(a) and the wet (**b**) tundra soil with statistically significant difference between control (green)
(b) and snow-manipulated (red) plots across all seasons (DESeq2, Benjamini-Hochberg correction, $P < 0.05$).
(c) Green asterisk indicates significantly higher abundance in control plots,
(d) red asterisk indicates significantly higher abundance in snow-manipulated plots.
(e) The data represent the means with standard errors ($n = 24$)

Findings: Fungal communities showed higher richness at the dry site whereas richness of prokaryotes was higher at the wet tundra site.

(Voříšková *et al.*, 2019)

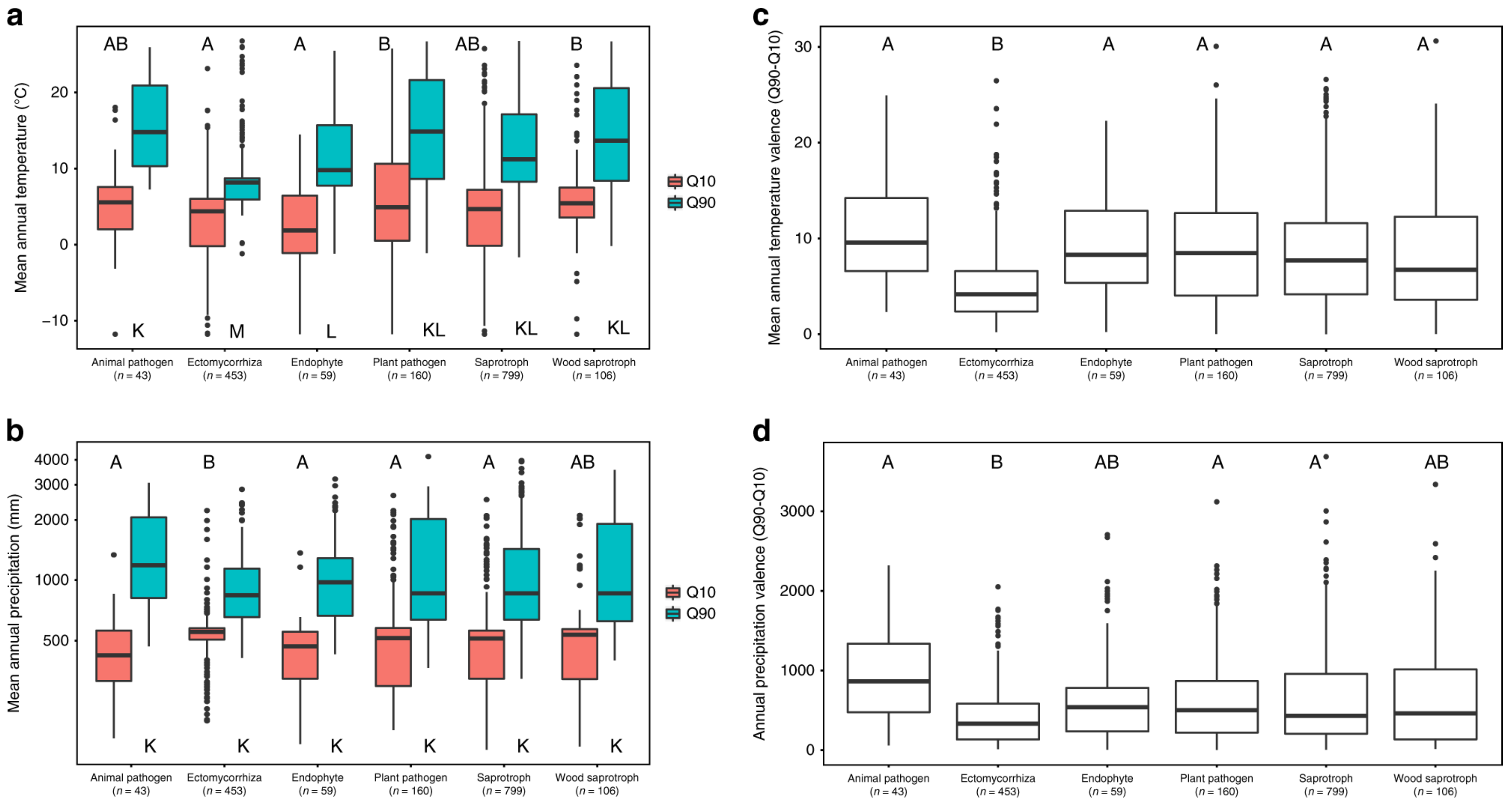
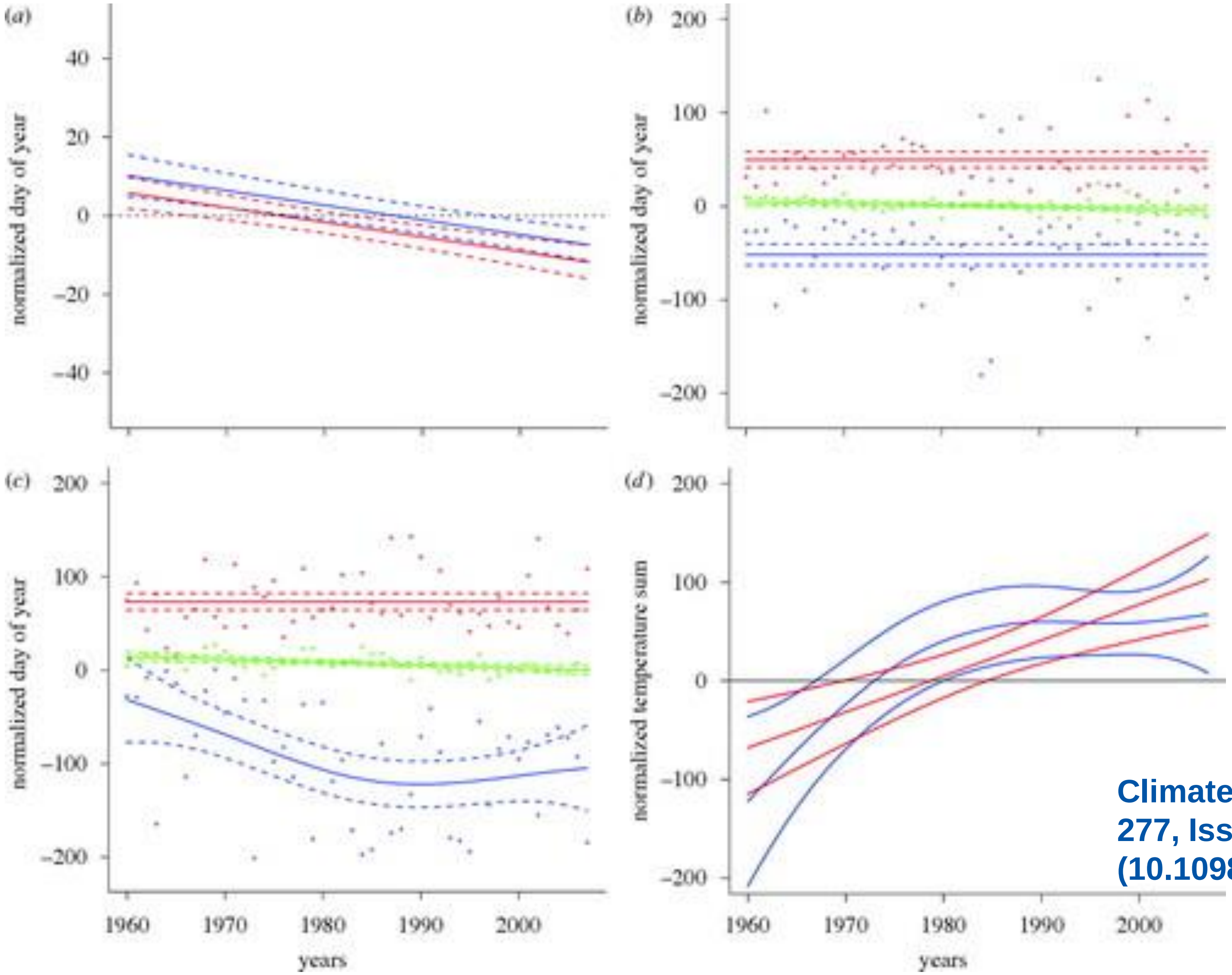


Fig. 14. From: A meta-analysis of global fungal distribution reveals climate-driven patterns **(Větrovský *et al.*, 2019)**

Findings: meta-study identifies climate as an important driver of different aspects of fungal biogeography, including the global distribution of common fungi as well as the composition and diversity of fungal communities. Mycorrhizal fungi appear to have narrower climatic tolerances than pathogenic fungi



Findings: the autumnal fruiting season has been significantly delayed both for mycorrhizal and saprotrophic taxa, which has been coupled to an extended growing season and, hence, a delayed arrival of the autumn and of climatic conditions that favour fruiting.

Climate change and spring-fruiting fungi, Volume: 277, Issue: 1685, Pages: 1169-1177, DOI: (10.1098/rspb.2009.1537)

(Kauserud *et al.,* 2010)

Fig. 15: (*a*) Temporal changes in the mean annual fruiting date (thick lines) during the period 1960–2007 for spring fungi in Norway (red) and the UK (blue). *b*) Norway and (*c*) the UK (*d*) Temporal changes in the mean thermal time (temperature sum) to fruiting during the period 1960–2007 for spring fungi in Norway (red) and the UK (blue).

TAKE HOME MESSAGE

- More diversity studies needs to be undertaken in Africa
- Climate change could affect ecosystem functioning because of the narrow climatic tolerances of key fungal taxa.
- Fungi are vulnerable mostly to drought, heat, and land cover change.
- We need more studies and research in order to better plan our future actions and adapt to the changes we cannot prevent or avoid.
- Understanding fungal mechanisms that allow extreme-tolerant and extremophile fungi to thrive and be metabolically active in harsh environments might help us to put in place adaptation measures and better plan our actions on Earth.

Acknowledgment

- Organizers of this African fungus day


nothing but
Pictures. Leave
but footprints.