Diversity and natural production of wild edible fungi from African ectomycorrhiza-dominated forests

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A project with interests in

- Taxonomy of tropical African fungi
- Training local scientists & capacity building
- Ecosystem functioning and services
- Conservation
- Tools for valorisation

It’s about people and Fungi

Introduction

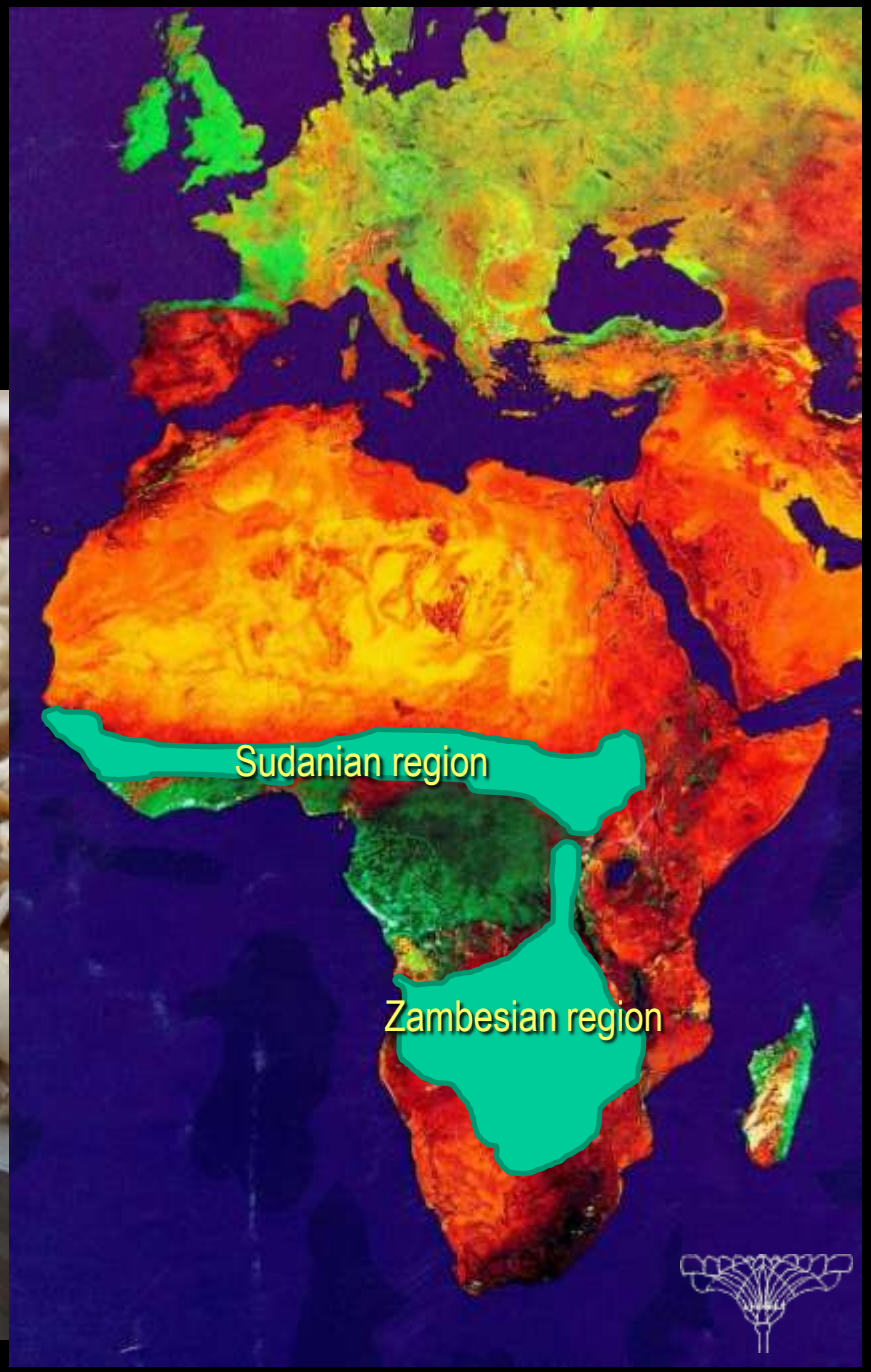
- In tropical Africa about 400 species of wild edible fungi are used for food.
- Across the entire region all edible taxa have a socio-economic significance for local communities.

Introduction

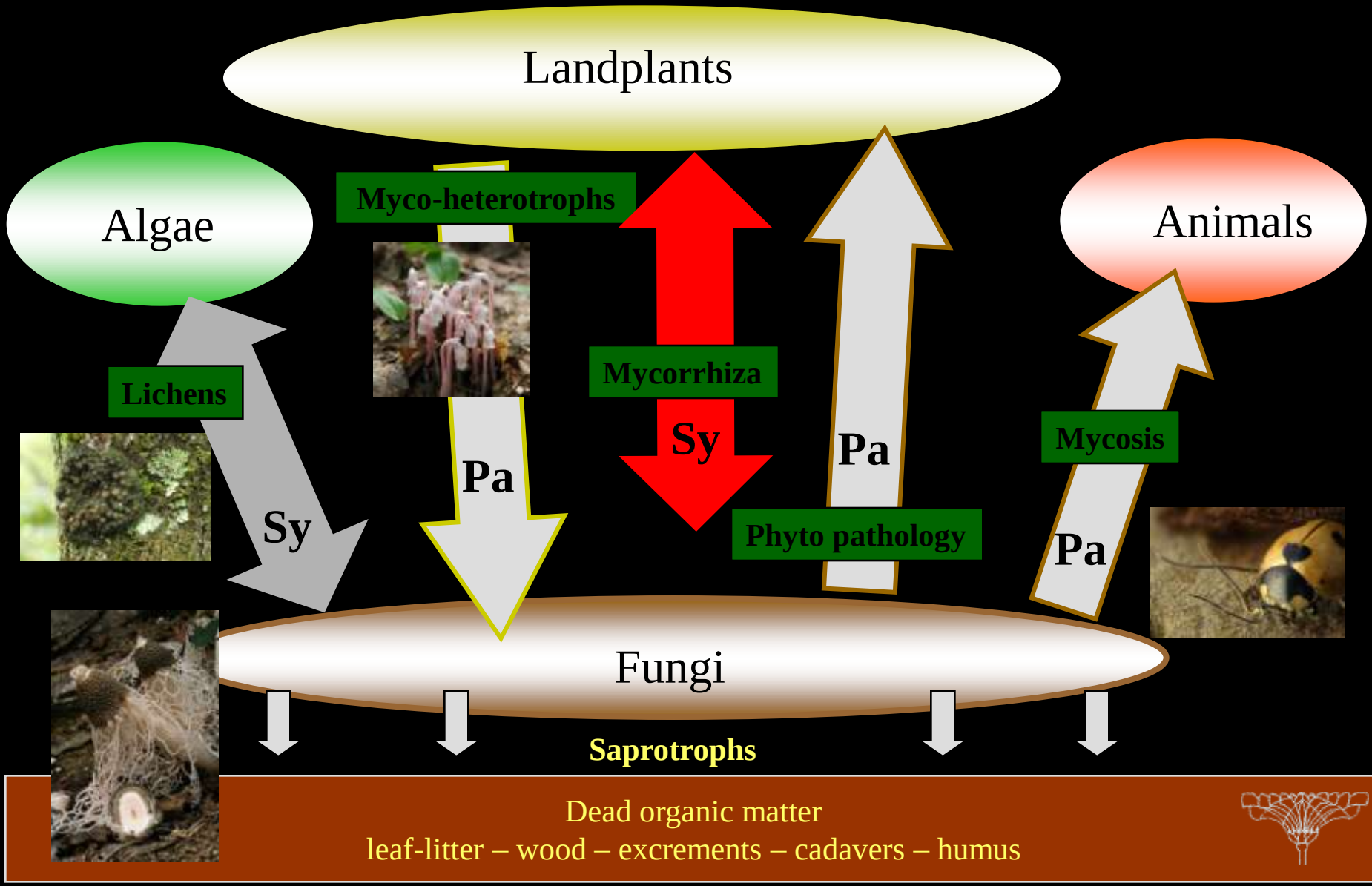
There is a unique and diverse set of wild edible fungi in each phytogeographical zone.

A species inventory in the Zambezian and Sudanian ecozone shows the predominance of ectomycorrhizal taxa.

All are associated with trees



Position of ectomycorrhizal taxa



Mutual advantages of EcM associations

For the plant

- water uptake

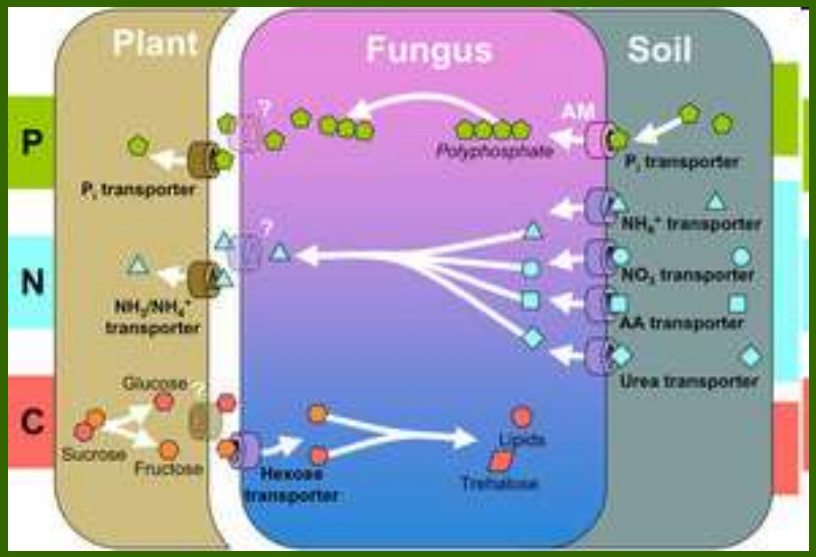
- draught and salt tolerance

- uptake of macro-elements

- uptake of oligo-elementen

- tolerance towards metal polluted soils

- protection against pathogen (nematodes, bacteria, …)



For the fungus

- carbo hydrates

Ectomycorrhizal forest

Ectomycorrhizal fungi


Afroboletus luteolus


Amanita masasiensis

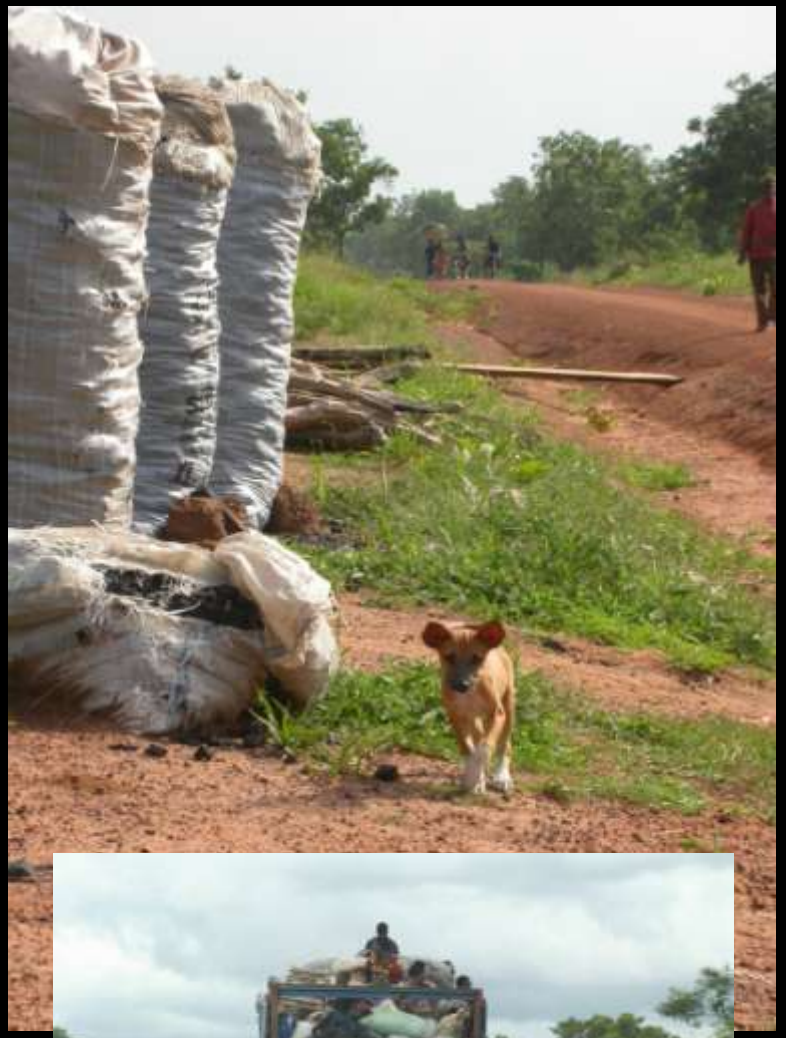

Russula congoana


Lactarius kabansus

But, there is a problem ….

Sudanian and Zambezian miombos are under severe threat for the mass-production of charcoal.

This activity is widespread and big business. It is encouraged by an increasing demand from the cities.



…. with a result

After a complete slash and burn, most types of miombo forest regenerate only slowly, or not at all.

Desertification, lateritisation and erosion are strengthened by global change.

Question

…. how to convince and induce change ?

What is the value of edible fungi

…. how to gather this information ?

Yields of wild fungi from different countries (source FAO, Boa 2004)

COUNTRY	DETAILS OF ANNUAL YIELDS	AMOUNT (Kg/Ha)	SOURCE
Russian Federation (central Siberia)	"Most popular (edible) mushrooms"	**65–170**	
Russian Federation (Arkhangelsk)	(a) *Lactarius torminosus*, (b) "red-headed mushroom" - ?*Russula*	(a) **2–14**(b) 9	Chibisov and Demidova, 1998
Finland(north)	All edible mushrooms at Sotkamo (a) 1976 and (b) 1977	(a) **30**(b) **85**	Koistinen, 1978
Finland	*Gyromitra esculenta* (note fluctuations; 1973 and 1974 good; 1975 and 1976 poor; 1977 mediocre)	**50–100**	Jalkanen and Jalkanen, 1978
Estonia(northwest)	Average for all edible fungi at three sites, from 1978 to 81 *	**124, 499,143**	Kalamees and Silver, 1988
Estonia(northwest)	Average for (a) *Suillus variegatus* – one site and (b) *Lactarius rufus* – three sites *	(a) **41**(b) **20; 24; 405**	Vladyshevskiy, Laletin and Vladyshevskiy, 2000
Mexico	All edible species from two sites	**85**	Lopez, Cruz and Zamora-Martinez, 1992
Mexico(Veracruz)	All edible species, two sites (a) and (b) for 1983 and 1985 resp.	(a) **1759**; **234**(b) **747**; **180**	Villarreal and Guzmán, 1985; 1986a
Mexico(Veracruz)	(a) *Suillus granulatus*; (b) *Cantharellus cibarius* (c) *Amanita caesarea*; (d) *Boletus edulis*For 1983 and 1985 resp.	(a) **246; 75**(b) **4; 8**(c) nd; **38**(d) **150; 9**	Villarreal and Guzmán, 1985; 1986a
United States(Pacific northwest)	(a) *Tricholoma magnivelare*; (b) *Morchella* spp.; (c) *Cantharellus*	(a) **3–15**(b) **1–6**(c) **2– 0**	Pilz and Molina, 2002

Objectives (to convince)

- Not estimate, but measure & compare how much edible fungi a selection of woodland ecosystems can deliver
- A qualitative (species) & quantitative (weight) approach
- Demonstrate that this service is renewable and that it is socio-economically more interesting than large-scale charcoal production.

Termitomyces microcarpus, not ectomycorrhizal

Method: continuous sampling in permanent plots

- plots of 30 x 30m, 3 per forest type
- phytosociological relevé per plot
- weekly sampling, throughout the entire rainy season (1-3 years consecutively).
- fresh weight and number of fruitbodies is recorded per species.

Cantharellus densifolius

Clavulina wisoli

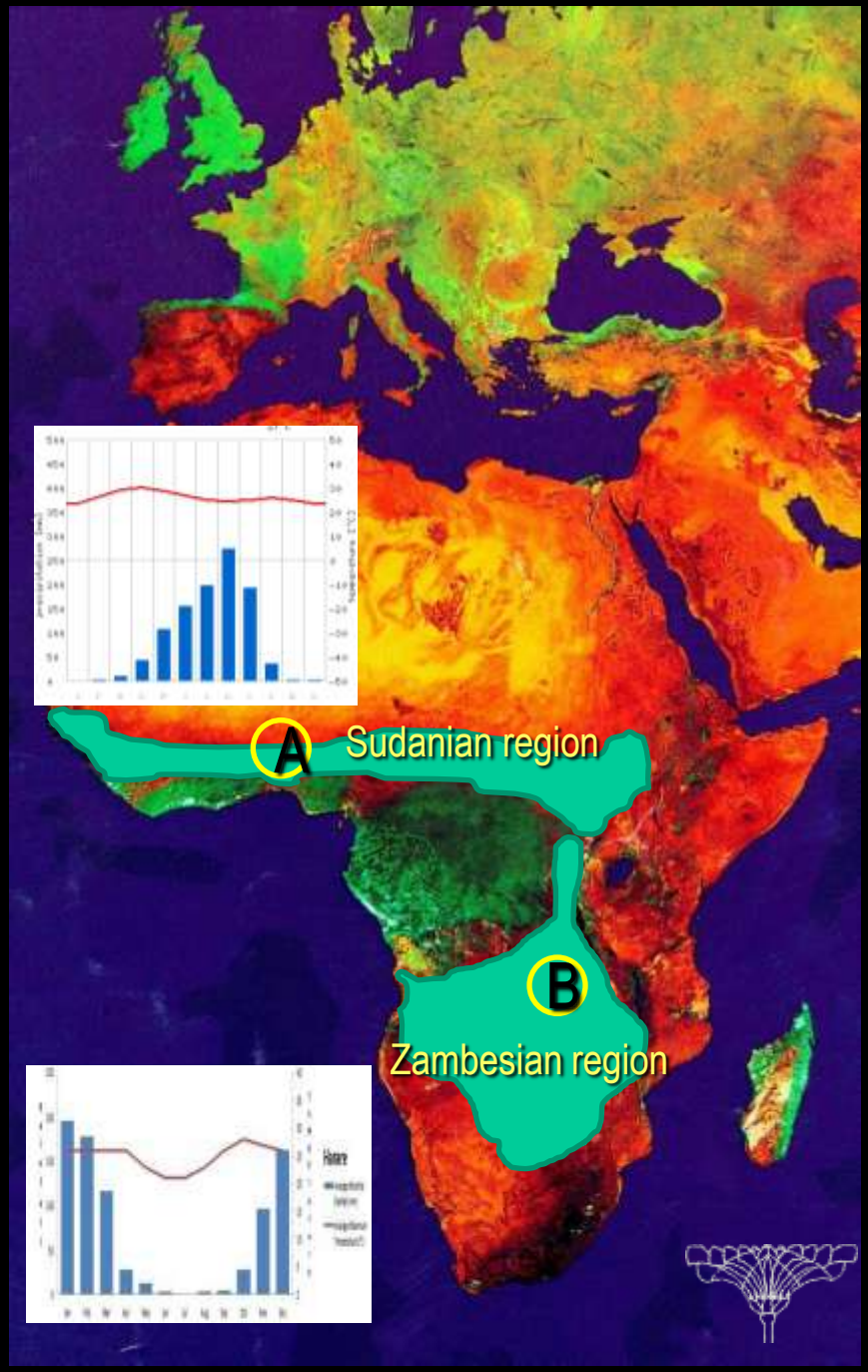
Where ?

Areas with 3-6 months dry season, followed by a rainy season. Annual rainfall 700-1450mm/m². Miombo forest plots mainly dominated by ectomycorrhizal trees and without termite hills. Well protected from picking, logging and intensive human disturbance …. not so easy.

Sites: 4 types of miombo forest in Bénin and also 4 in the DR Congo

A. Sudanian region : Mont kouffé (Benin, West Africa), 4 EcM forest types = 12 plots

B. Zambezian region : Mikembo sanctuary (Katanga, DR Congo) 4 EcM forest types = 12 plots



Local knowledge was previously collected in both regions and completed with all available data from the litterature

Pleurotus cystidiosus

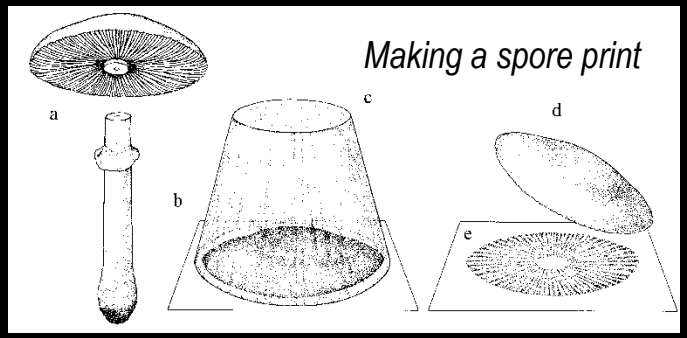
Volvariella volvacea

Collecting reference specimens

- Collecting material, tags, collection data
- Photographing (in & ex situ)
- Spore prints

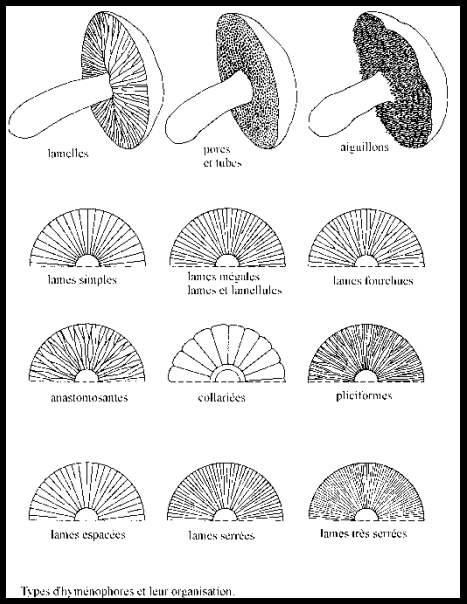
Color chart Pantone and setup for technical photography

Cantharellus aff. rufopunctatus



Collecting reference specimens (2)

- Description form: 50 features (standard form)
- Drying
- Herbarium storage



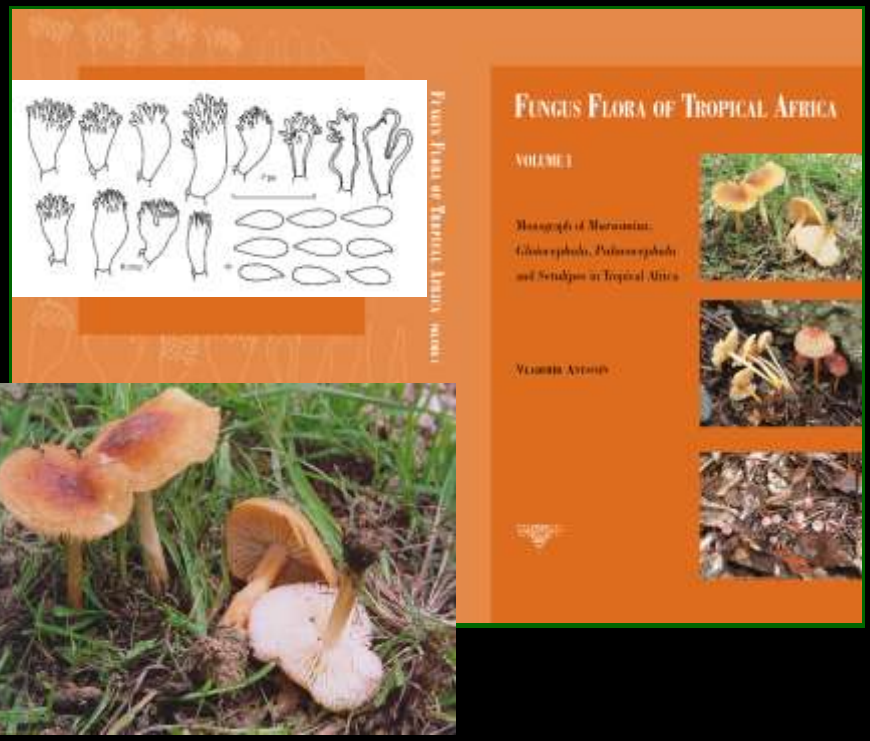
Some festures of Macromycetes

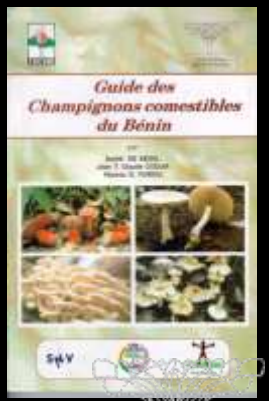
Field dryer

Storing dried collections

Identification

- Based on morphological and whenever necessary also molecular characteristics (*Cantharellus*)
- Litterature surveys
- Herbarium consultation and comparison with type material in BR





Taxonomic issues with *Cantharellus*

Cantharellus afrocibarius newly described in 2013

Taxonomic issues with *Cantharellus*

Cantharellus platyphyllus …. a good taxon, but very variable

Natural production of *Lactarius* s.l. in the Sudanian woodland plots (Bénin)

Edible taxa	Forest type	SA	SB	FC	FI
			(in kg/ha)		
Lactifluus gymnocarpoides Verbeken		**5.6** (318)	**23.9** (3143)	**115.2** (6533)	**121.4** (6238)
Lactifluus densifolius Verbeken & Karhula		**54.4** (1122)	**15.7** (307)	-	**1.1** (26)
Lactarius afroscrobiculatus Verbeken & Van Rooij		-	**1.2** (26)	**34.5** (662)	**5.8** (71)
Lactifluus flammans Verbeken		-	**25.1** (1088)	**5.4** (926)	**3.8** (1078)
Lactarius saponaceus Verbeken		-	**8.1** (548)	-	**12.9** (740)
Lactarius tenellus Verbeken & Walleyn		**6.7** (3733)	**2.3** (1526)	**0.6** (710)	**0.3** (250)
Lactarius baliophaeus Pegler		**7.1** (559)	-	-	-
Lactifluus luteopus Verbeken		-	**0.9** (93)	**1.9** (137)	2.0 (204)

Ta
SA
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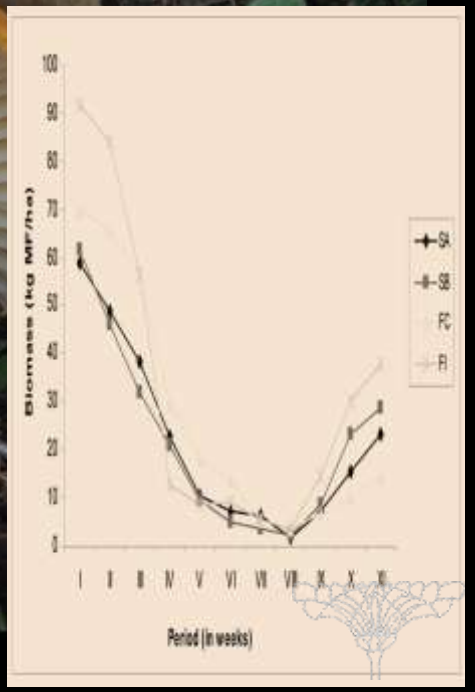
In Bénin, *Lactarius* is the more dominant genus, both in terms of appreciation by local people and yields per ha per year.
This foodsource is, by far, unexploited

Lactarius flammans



Results

Total annual production of edible fungi

	Sudanian plots	Zambezian plots
Number of plots	12	12
Total number of forest types	4	4
Caesalpiniaceae dominated	3	2
Phyllantaceae dominated: *Uapaca*	1	1
Dipterocarpaceae dominated: *Marquesia*	0	1
Edible fungi (all species)	30	67
Ectomycorrhizal species	26 (86,6%)	51 (76,1%)
• *Amanita*	6	6
• Boletes (sensu lato)	2	5
• *Cantharellus*	1	18
• *Lactarius* (incl. *Lactifluus*)	8	14
• *Russula*	7	6
Average	**140 kg/ha.y**	**184,5 kg/ha.y**

Socio-economic considerations

Edible fungi	**Sudanian plots**	**Zambezian plots**
Least productive forest type (fresh weight)		
Most productive forest type (fresh weight)		
Average	**140 kg/ha.y**	**184,5 kg/ha.y**

The average local market price for edible fungi fluctuates between 0,5 and 1,5 $/kg
If 10% reaches the market, a single hectare of miombo delivers (184/10 x 1$) = 18.4$/year

Considering the actual market price, 1 hectare of slashed miombo delivers about 400$ of charcoal. Since miombo forest regenerates in 30 years, charcoal conversion delivers 400/30 = 13.3$/year

Facts and conclusions

- There is a unique diversity of wild edible fungi in the Zambezian and Sudanian centres of endemism.
- All these taxa have a socio-economic significance for local communities
- Fungal ectotrophic taxa dominate among edible fungi. *Lactarius* in the West-African study area, *Cantharellus* and many more in Eastern Africa
- The woodland ecosystem delivers substantial amounts (100-300kg/ha.year) of edible fungi (all taxa) and this function is annihilated by large-scale charcoal production.
- The cash generated from charcoal conversion does not outweigh the income accumulated from mushroom harvesting.
- Maintaining the ecosystems‘ function is financially and culturally more beneficial for local people than charcoal conversion.

Future research

- A socio-economic study, including all NTFP, for the conservation and sustainable use of miombo forests.

Concluding remarks

- Let there be no doubt that the massive production of charcoal has become the biggest threat to all EcM dominated forests in the whole of tropical Africa.

- Using miombo forests for charcoal production leads to long term loss of biodiversity. For local people it definitely leads to a substantial loss of income from all their forest products.

- Conservation of miombo forests is the better way to a long-term improvement in the livelihood of millions of rural people.

- Although forest products, including edible fungi, are often highly valued by local inhabitants, much effort is still needed to promote awareness.

- Capacity building in learning how to find and build effective tools for conservation and sustainable use is highly needed.

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Mycoamaranthus congolensis

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