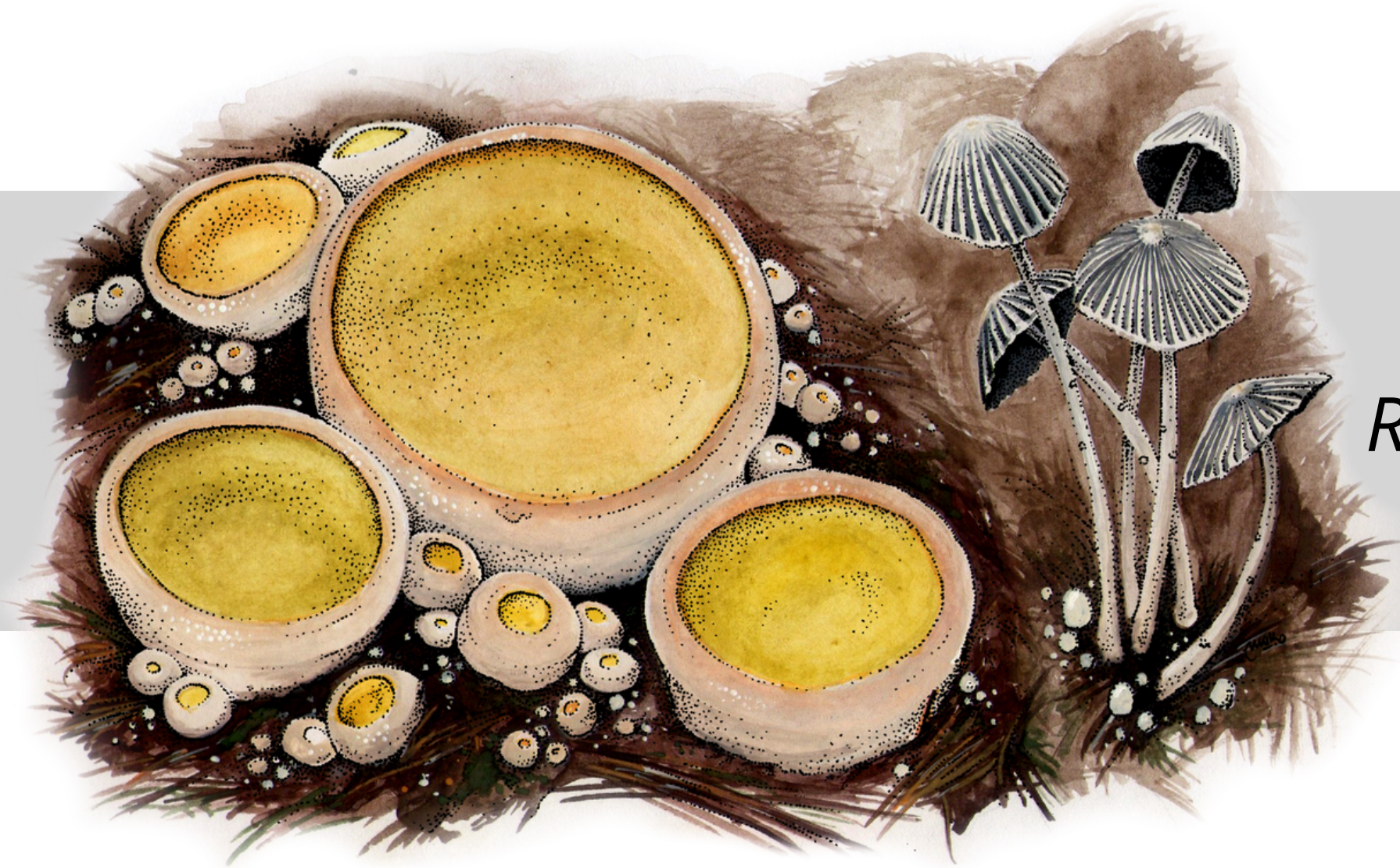




The 8th National Fungus Day of Egypt Online
"Mycology by Amateur and Young Mycologists"



Dung Fungi from Brazil

*Recent advances and future perspectives on the
Brazilian copromycodiversity*

Dr. Francisco Calaça

Mycologist and Science Communicator - Anápolis, Goiás, Brazil

A little about me as Young Mycologist:



Graduated in Biological Sciences at **Universidade Estadual de Goiás**;
MSc. in Environmental Sciences at **Universidade de Brasília**;
Ph.D. in Natural Resources of Cerrado at **Universidade Estadual de Goiás**.

- Graduation monograph: **Coprophilous Fungi from Goiás and the Federal District: Taxonomic and Ecological Diversity.**
- MSc. thesis: **Mycorrhizal and saprophytic mycobiota in different Cerrado's phytophysionomies in the Federal District, Brazil.**
- Ph.D. thesis: **Copromycodiversity - taxonomy and ecology of dung-inhabiting fungi.**

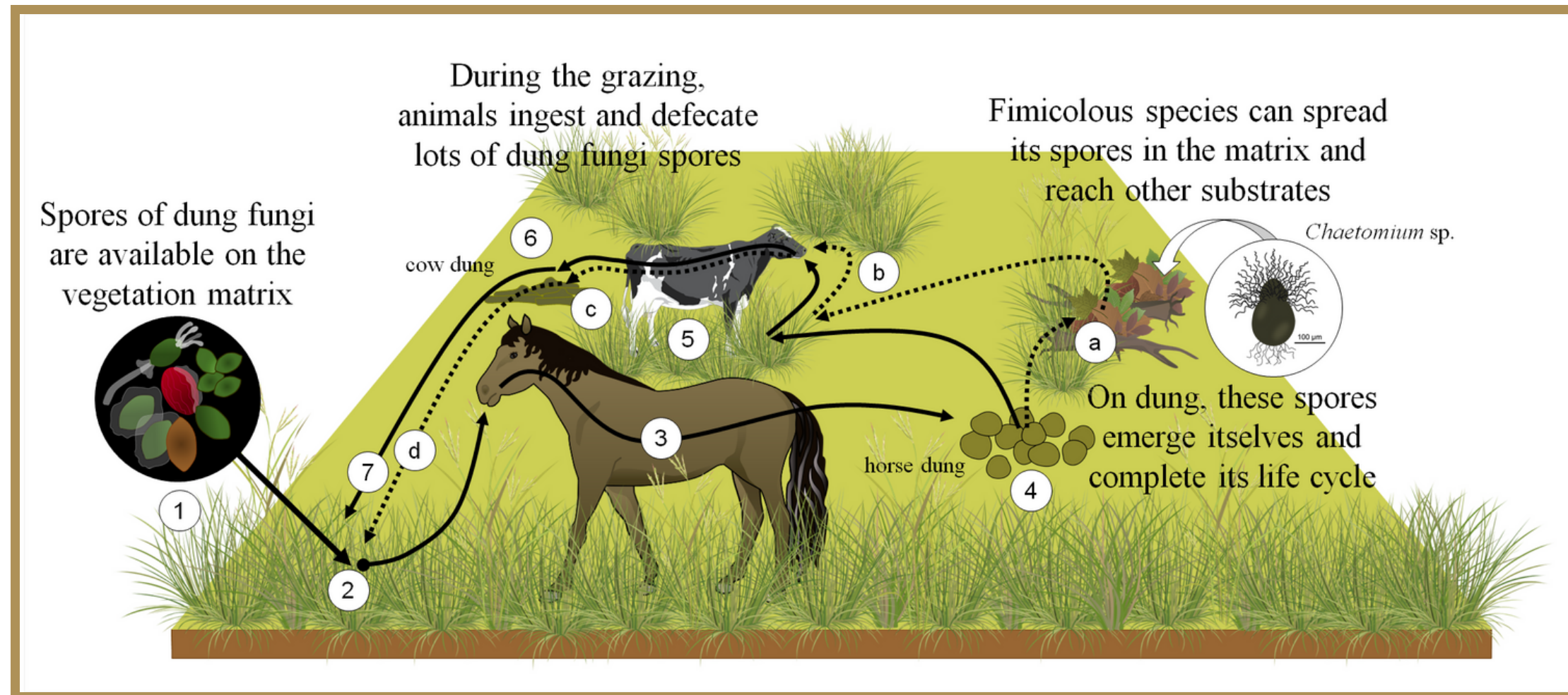
Currently...

- Researcher on dung-inhabiting fungi (*lato sensu*);
- Teacher on Basic Education;
- Specialist member of the group "IUCN SSC Brazil Fungal Specialist Group"
- Head Mycologist and Science Communicator on Mykocosmos - Mycology and Science Communication.



Firstly... What is dung (-inhabiting) fungi?

- **Dung-inhabiting fungi** *sensu lato* (Fungi Kingdom, Amoebozoa, and some Myxobacteria) are adapted to live on dung;
- **Coprophilous** fungi and **fimicolous** fungi;
- This fungal group is responsible for the **maintenance of supporting ecosystem services**, essential for life as we know it, acting in the **cycling of matter** and **energy** via **dung decomposition**.



Life cycle of dung-inhabiting fungi *sensu lato*. The cycle includes the trajectory for non-obligate coprophilous species, i.e., fimicolous species, a route not included in previous cycles.

Firstly... What is dung (-inhabiting) fungi?

Energy cycling in ecosystems and the **role of fungi**:

Composition and decomposition systems

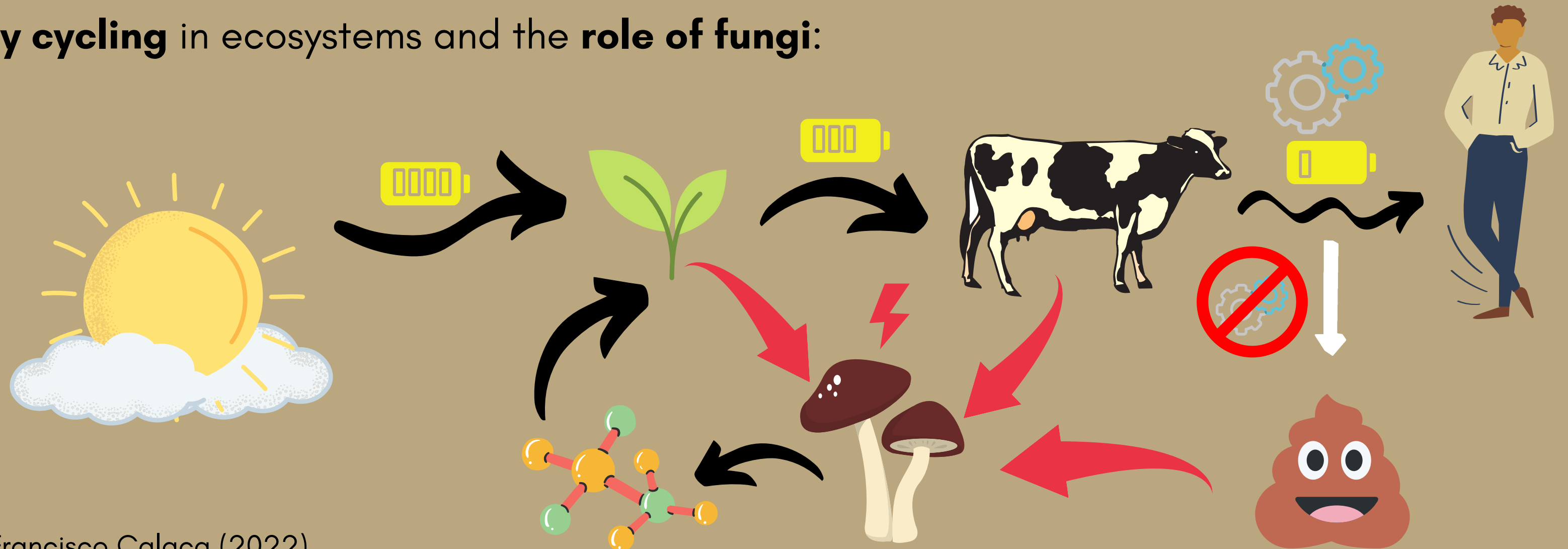


Figure: Francisco Calaça (2022)

I consider nature a vast chemical laboratory in which all kinds of compositions and decompositions are formed.

Antoine Lavoisier

Firstly... What is dung (-inhabiting) fungi?

The egested energy is unavailable to the animal that produced it, with some exceptions (obeying the 2nd Law of Thermodynamics);

This energy becomes available to other life form:



Paulo H. P. Ribeiro



Coprophilous organisms

But what is defined as **DUNG**?

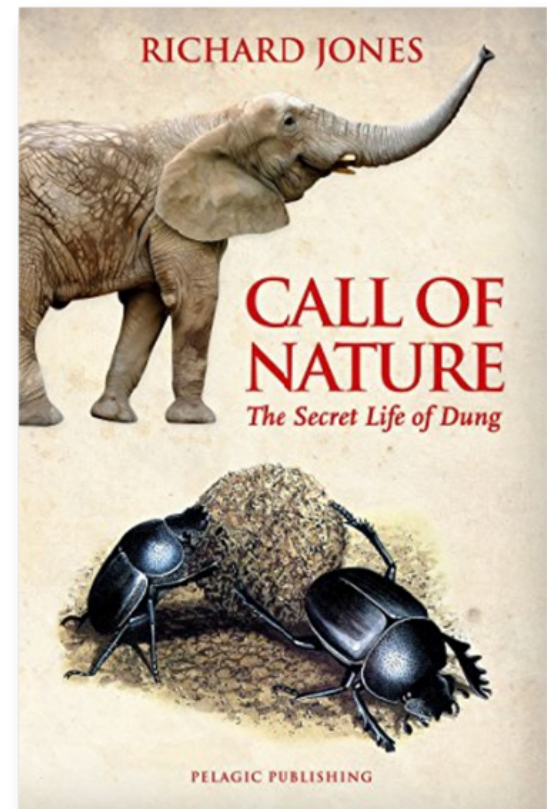


$$\text{food} - \text{nutrition} + \text{residues} = \text{dung}$$

(Jones 2017)



Water, pH between 7.3 to 8.3, **cellulose**, **lignin** and **hemicellulose**, **P**, **K**, **N**, **Ca**, **Fe** and others.



Firstly... What is dung (-inhabiting) fungi?

Representatives of Kingdom Fungi:

Mucoromycota, Ascomycota and Basidiomycota

Representatives of other Kingdoms:

Myxomycetes and Myxobacteria.



COPROMYCODIVERSITY

(Calaça & Xavier-Santos 2017)

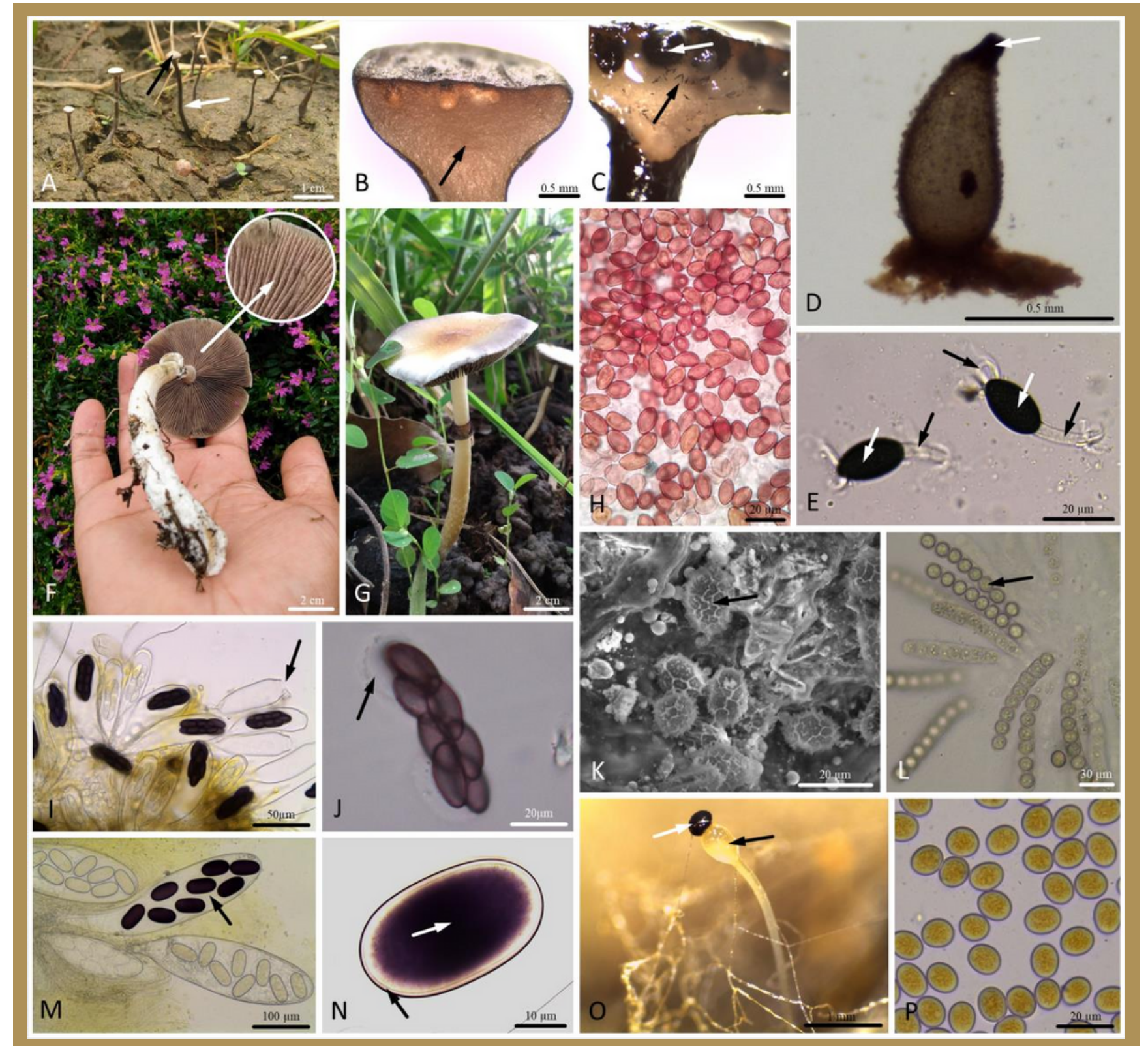
Morphological, physiological, functional, and ecological diversity of an assemblage of dung-inhabiting fungi.

Firstly... What is dung (-inhabiting) fungi?

Dung durability has become an optimal selective pressure for dung-inhabiting fungi:



Active and explosive-type spores release in *Ascobolus scatigenus*. © Vinícius Pereira



Habits, strategies and adaptations observed in dung-inhabiting fungi

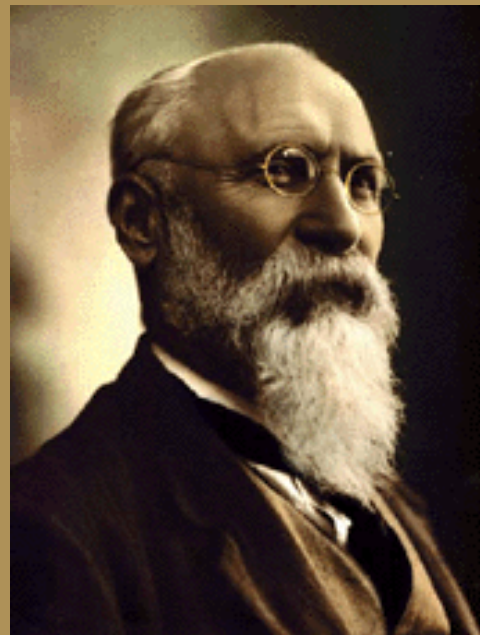
Dung Fungi from Brazil - the past, the present, and the future...



Studies on dung fungi in **Brazil**: Carlos Luis Spegazzini (1858–1926), with *Psilocybe merdaria* (Fr.) Ricken;

Professor Dr. **Augusto Chaves Batista** (1916–1967), especially between the decades of **e 1950 and 1960**.

In the last 10 years: **increased** interest in research involving dung fungi.



Pioneers



First ecological study



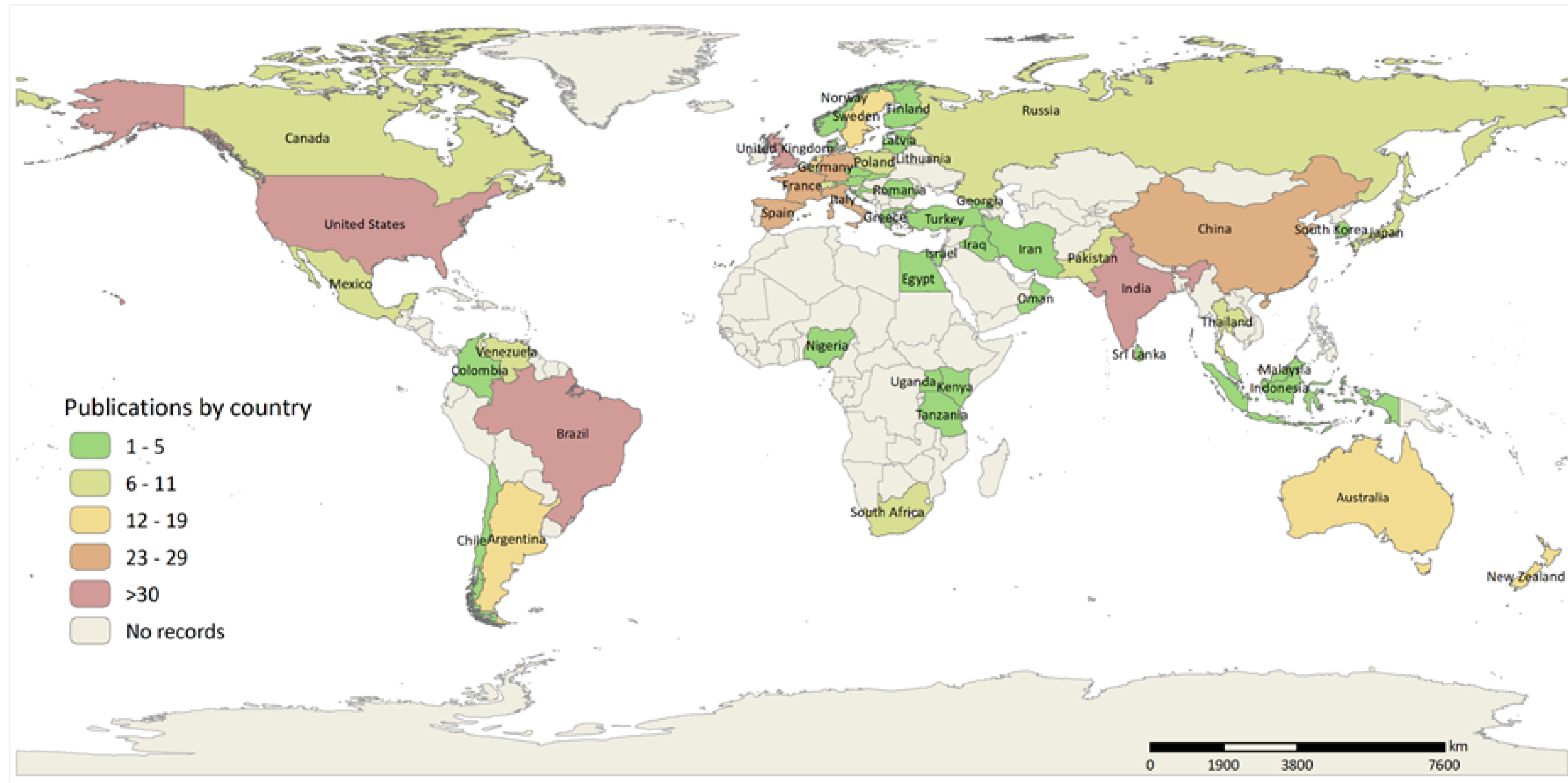
Important studies in the Northeast region of Brazil



Important studies in the Midwest region of Brazil

Dung Fungi from Brazil - the past, the present, and the future...

Fifteen countries, out of a total of 54, concentrate more than half (65%) of the productions:

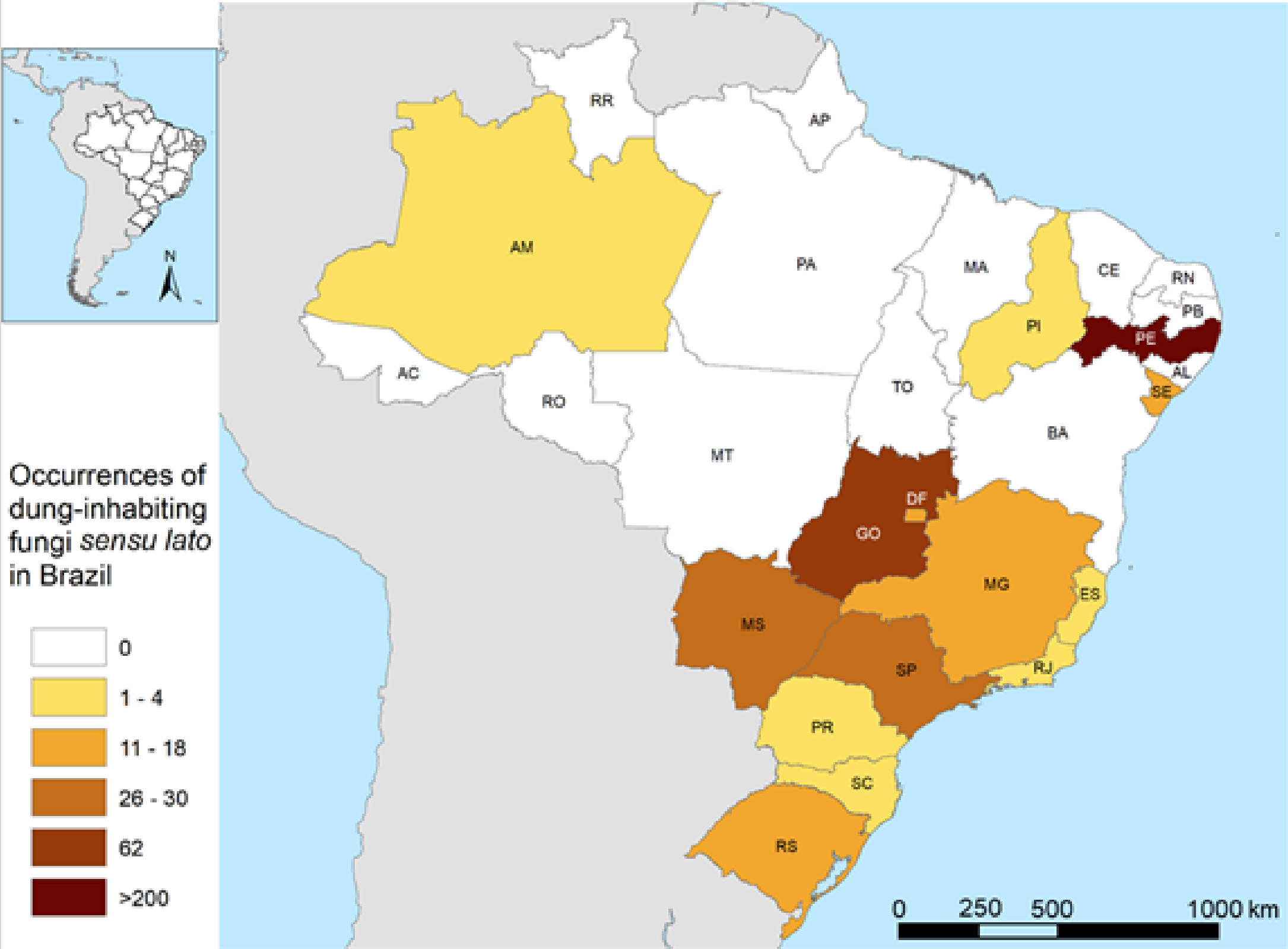


Global distribution of articles on dung-inhabiting fungi.

Dung Fungi from Brazil - the past, the present, and the future...

Gaps in knowledge and **deficit of professionals** dedicated to the group;
Two groups in Brazil: Recife, PE and Anápolis, GO.

Updated occurrence of dung-inhabiting fungi in Brazil. →



Dung Fungi from Brazil - the past, the present, and the future...

We recorded 302 new occurrences (↑113%);
 Total of 166 spp., 98 new to Brazil (↑46%);
 In seven states of country.

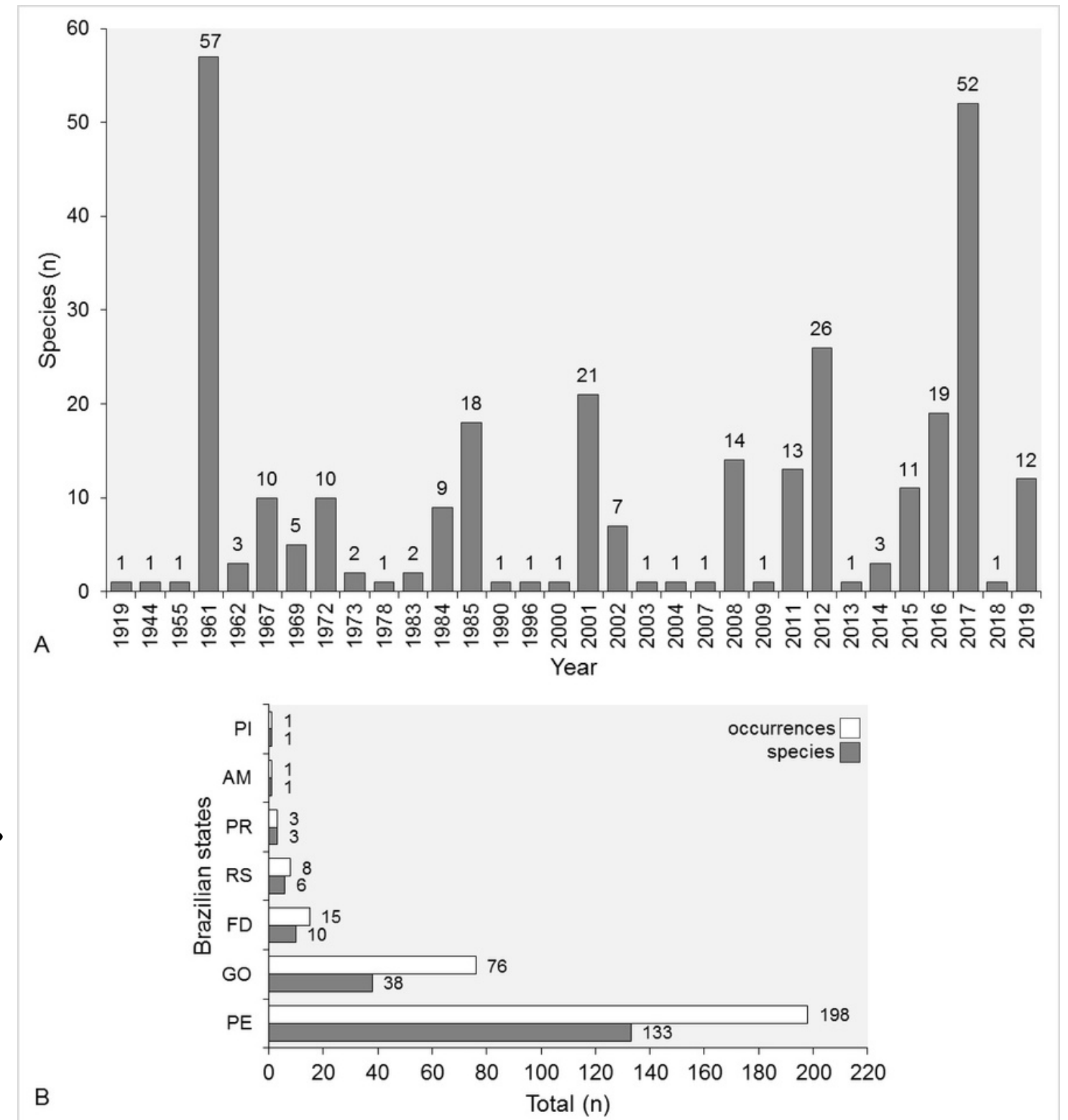
07 phyla , **21** orders, **41** families and **75** genera

Ascomycota: 117 spp. (70% total of spp.);
 Mucoromycota: 23 spp. (13.8%);
 Basidiomycota: 20 spp. (12%).

Occurrences of dung-inhabiting fungi in Brazil, last 100 years.

A: new spp. added per year. B: number of spp. and occurrences, from 2014 to 2019, by state (additions). →

Pernambuco: 133 spp., 198 occurrences (65.5%);
Goiás: 38 spp., 76 occurrences (25%);
Federal Distric: 10 spp., 15 occurrences (5%).



Dung Fungi from Brazil - the past, the present, and the future...

- In 10 years, there was a **significant increase** in the number of spp. of dung fungi in Brazil;
- **Two groups** accounted for **most of these records** (Goiás and Pernambuco states);
- The **few studies in a continental country**, with a wide diversity of ecosystems and substrates, **emphasize the need for greater attention to the biodiversity** of poorly studied microorganisms;
- Entire states and ecosystems **without any study**;
- **Importance of checklists**: it allows **evaluating the distribution of these fungi**, to **visualize hotspots of occurrence** of certain groups, substrates, endemism, etc. These broad datasets may be of interest to mycologists who study aspects of the biology, ecology, and evolution of the group, and direct attention to ecosystems that are little or not studied.

Dung Fungi from Brazil - the past, the present, and the future...

Biologia
https://doi.org/10.2478/s11756-020-00578-9

ORIGINAL ARTICLE



Fimicolous myxomycetes: overview of their global distribution and scientific production

Francisco J. Simões Calaça¹ · Jéssica C. Araújo¹ · Gabriele Cacialli² · Nathan C. Silva¹ · Carlos Rojas³ · Solange Xavier-Santos¹

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1 **First record of artillery fungus *Sphaerobolus stellatus* (Geastrales: Sphaerobolaceae) in** 2 **the Brazilian Cerrado**

3 **Abstract:** *Sphaerobolus* (Geastrales: Sphaerobolaceae) is an interesting fungal genus known as
4 artillery fungus due to its strategy to eject its mature peridiole, involving an osmotically
5 powered eversion catapult mechanism. The peridiole can reach up to six meters towards light.
6 Members of this genus are known to have a coprophilous or fimicolous habit in their life cycle.
7 In Brazil, up to date, there were records of *Sphaerobolus stellatus* only in Atlantic Forest and
8 Pampa ecosystems in the South Region of the country. During field expeditions to survey
9 copromycodiversity in Brazil, basidiomes of *Sphaerobolus* were found growing on cattle dung.
10 The collected material was examined macro and microscopically and taxonomically determined
11 as *S. stellatus*. Herein, we present the first records of the family Sphaerobolaceae, with genus
12 *Sphaerobolus*, from the Brazilian Cerrado. Our data contributes to expanding the known
13 geographical distribution of this genus in the country and adding new insights to the
14 copromycodiversity of Brazil.

15 **Keywords:** dung fungi, dung-inhabiting fungi, Geastrales, new record.

Karstenia

ORIGINAL
RESEARCH

doi:10.29203/ka.2020.503
Karstenia, Volume 58 (2020), Issue 2, pages 374–384
www.karstenia.fi

First reports of fimicolous myxomycetes (Protozoa: Amoebozoa) from Brazilian Cerrado and Pantanal biomes

Francisco J. Simões Calaça^{*}, Jéssica C. Araújo, Vanessa B. Tereza, Izabel C. Moreira, Solange Xavier-Santos

1 **A pooping case: does the structure of dung-inhabiting fungi respond to** 2 **the type of diet or type of animal's digestive system?**

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4 Ferreira^{c†}, Solange Xavier-Santos^a

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6 Ciências Exatas e Tecnológicas (CCET), Universidade Estadual de Goiás (UEG), BR 153, nº
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Dung Fungi from Brazil - the past, the present, and the future...

Additions to a checklist of coprophilous fungi and other fungi recorded on dung from Brazil: an overview of a century of research

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ABSTRACT—In 2014 we published the first checklist of fungi *sensu lato* recorded on dung from Brazil, as a result of an effort to maintain an easily accessible database on the knowledge of the diversity of these fungi. In the last 10 years there has been a significant increase in the number of publications involving this ecological group, and we are presenting an update which summarizes data from a century of research (from 1919 to 2019). We present an annotated list of all species and occurrences added to the Brazilian copromycodiversity, the annual accumulation of records, and occurrence by substrate. There were 302 records of 166 species, 98 of which are new for Brazil, all of them reported from seven Federation states (including two new). Most of the occurrences are reported from the northeast region of the country (Pernambuco and Piauí states), followed by the midwest (Goiás and Federal District) and southern regions (Paraná and Rio Grande do Sul). Amazonas and Piauí are states with new records of these organisms, with one record each. There are now 568 occurrences and 308 species of dung-inhabiting fungi recorded in Brazil.

KEY WORDS—dung-inhabiting fungi, new occurrences, species distribution, substrates



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VOL. 16, NUM. 6

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doi: 10.14808/sci.plena.2020.066201

Dung fungi from Brazil: *Agrocybe pediades* (Fr.) Fayod (Basidiomycota) in Cerrado

Fungos coprófilos do Brasil: *Agrocybe pediades* (Fr.) Fayod (Basidiomycota) no Cerrado

F. J. S. Calaca^{1*}; V. G. Cortez²; S. Xavier-Santos¹

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(Recebido em 27 de fevereiro de 2020; aceito em 05 de junho de 2020)

In the survey of copromycodiversity from Brazil, we present the first records of the genus *Agrocybe* for the Cerrado biome, represented by the species *A. pediades*, found on cattle dung in the state of Goiás, central Brazil. We also present detailed morphological descriptions, illustrations, and comments about its distribution and the fimicolous habitat, as well as the cultural characteristics of the specimens.

Keywords: Agaricales, dung-inhabiting fungi, Strophariaceae.

FUNGOS COPRÓFILOS: AMIGOS DAS FEZES, AMIGOS DA NATUREZA

Autor: Francisco J. Simões Calaca
Orientadora: Solange Xavier Santos

Introdução

Os Fungos Coprófilos

Quando pensamos em biodiversidade, nos vem logo em mente os animais e as plantas, com sua imponência característica. Como se a biodiversidade se resumisse à Fauna e à Flora, especialmente àquelas espécies facilmente alcançadas pelos nossos olhos. No entanto, outros grupos de seres vivos compõem essa riqueza da vida. Entre eles, os fungos, que são organismos muito exuberantes, com uma infinidade de formas e tamanhos. Alguns são grandes, mas outros tão pequenos que nem conseguimos enxergar sem o auxílio de lentes especiais. Eles estão presentes em praticamente todos os ambientes do planeta e, no passado, já foram considerados plantas. Mas hoje eles têm o seu próprio reino: o reino Fungi. Os fungos podem crescer sobre o solo, rochas, plantas e animais, vivos ou mortos, e até mesmo nas fezes (ALEXOPOULOS et al., 1996). E é sobre esses fungos que iremos falar aqui, os chamados fungos coprófilos, ou seja, aqueles que se desenvolvem sobre fezes. O termo “coprófilo” vem do latim e significa amigo das fe-

Fungal Biology

Ahmed M. Abdel-Azeem Editor

Recent Developments on Genus Chaetomium

Springer

Dung Fungi from Brazil - the future...



Scientists "just talk" with other Scientists



In a language that the rest of humanity doesn't understand

Communicating science in an accessible, clear, and popular way is essential to bring citizens closer to the scientific issues that profoundly affect everyone's lives.



We are a mycophobic society, how can we change that using the technologies and resources we have in our favor?

Dung Fungi from Brazil - the future...



The neologism originates from the Greek terms *mykés* (fungus) and *kósmos* (worlds) in reference to the “many worlds of Mycology” covered by the channel.



Dung Fungi from Brazil - the future...

ATÉ ONDE AS MICORRIZAS PODEM CHEGAR?
Ao infinito e além!

Passa para o lado!

Em termos práticos, a micorriza é o nome dado à associação de certos fungos com as plantas por meio das raízes.

O termo deriva dos radicais gregos *mykes* (fungo) e *rhiza* (raiz) e representa uma **associação mutualística do tipo simbiótica**. Nesta associação, ambas planta e fungo são beneficiados: o fungo aumenta a capacidade da planta em adquirir nutrientes limitantes e água, dentre outros benefícios, enquanto a planta lhe retribui com produtos de sua fotossíntese.

Fungos micorrízicos são essenciais para a vida na Terra!

As micorrizas são consideradas **uma regra na natureza** uma vez que **cerca de 80% das plantas** terrestres formam esse tipo de associação. Da planta que você cuida em casa às árvores do bioma onde você mora, a **associação micorrízica está em praticamente todo lugar!**

Esta associação pode ser considerada como uma das principais forças que mudaram a História Natural do planeta. Poucas vezes na biologia, dois organismos, planta e fungo, se associaram de forma tão perfeita que a associação se formasse tão abundante e bem estabelecida, possuindo cerca de 140 milhões de anos de história evolutiva, e hoje é associada à emergência das plantas para os ambientes terrestres.

As associações micorrízicas podem ser divididas em dois grandes grupos: as **ectomicorrizas**, onde a associação ocorre entre certos fungos dos filos *Basidiomycota* e alguns *Ascomycota*, sendo comum em regiões temperadas do planeta. Já as **endomycorrizas** são associações com fungos micorrízicos arbusculares, membros do filo *Glomeromycota*, caracterizados como **simbióticos obrigatórios**, ou seja, **dependem dessa simbiose para viver e completarem seu ciclo de vida**.

Ectomicorrizas: os fungos se associam externamente às raízes e não penetram nas células vivas das mesmas, as hifas crescem entre as células do córtex da raiz. *Calceolilla rigida!*

Endomicorrizas: a associação é internalizada, por meio de estruturas específicas, permitindo contato célula-célula entre planta e fungo.

Só não é mais perfeito porque...

O conhecimento sobre os fungos micorrízicos se restringe basicamente aos cientistas!

E aposto que você não sabia que esses fungos, essenciais para a vida, estão ameaçados devido às mudanças ambientais globais!

As pessoas só vão conhecer e se sensibilizar sobre a importância dos fungos se os conhecerem, e podemos fazer isso por meio da **Divulgação Científica!**

Chamar a atenção da sociedade para a importância dos fungos micorrízicos, da divulgação científica como estratégia de conservação e ensino e a questão dos efeitos das mudanças ambientais globais sobre estes fungos é o objetivo do artigo desenvolvido por um grupo de pesquisadores de vários países, membros da **South American Mycorrhizal Research Network!**

Mycorrhizal science outreach: Scope of action and available resources in the face of global change

Para saber mais detalhes, leia o artigo, disponível no **Material de Mykocosmos!**

"Alcance da ciência micorrízica: escopo de ação e recursos disponíveis em face das mudanças globais"

Existe uma série de recursos que podem (e devem) ser explorados para realizar a divulgação científica!

TIPO DE RECURSO	RECURSO	LINK
Artigos	Artigo de revisão sobre as micorrizas	https://doi.org/10.1007/978-94-007-5000-0_1
	Artigo de revisão sobre as micorrizas	https://doi.org/10.1007/978-94-007-5000-0_1
	Artigo de revisão sobre as micorrizas	https://doi.org/10.1007/978-94-007-5000-0_1
	Artigo de revisão sobre as micorrizas	https://doi.org/10.1007/978-94-007-5000-0_1
Livros	Microbiologia do solo	https://doi.org/10.1007/978-94-007-5000-0_1
	Microbiologia do solo	https://doi.org/10.1007/978-94-007-5000-0_1
Vídeos	Microbiologia do solo	https://doi.org/10.1007/978-94-007-5000-0_1
	Microbiologia do solo	https://doi.org/10.1007/978-94-007-5000-0_1

Acreditamos que informar as pessoas sobre os benefícios dos fungos micorrízicos e da simbiose em face da mudança global aumentará a consciência geral sobre pesquisas relevantes e ajudará nos esforços de conservação.

Silva-Flores et al. (2022)

A Rede de Pesquisa Micorrízica da América do Sul integra pesquisadores de vários países da América do Sul e também de outros continentes. A rede é voltada para o progresso das aplicações, pesquisa e divulgação pública de sobre micorrizas na América do Sul (e, por que não, no mundo!).

Na publicação, destacamos a importância da divulgação e promoção de atividades científicas para e com a sociedade, como meio de informar, ensinar e chamar a atenção da sociedade sobre a importância desses fungos.

Para reforçar isso, propusemos a "hashtag" abaixo, para ser utilizada cada vez que uma atividade de divulgação científica sobre micorrizas for comunicada.

#MYCORRHIZALSCIENCEOUTREACH

Para saber mais detalhes, leia o artigo, disponível no **Material de Mykocosmos!**

Silva-Flores et al. (2022). Mycorrhizal science outreach: Scope of action and available resources in the face of global change. *Plants, People, Planet*. DOI: <https://doi.org/10.1002/psp3.10315>.

#mycorrhizal science outreach



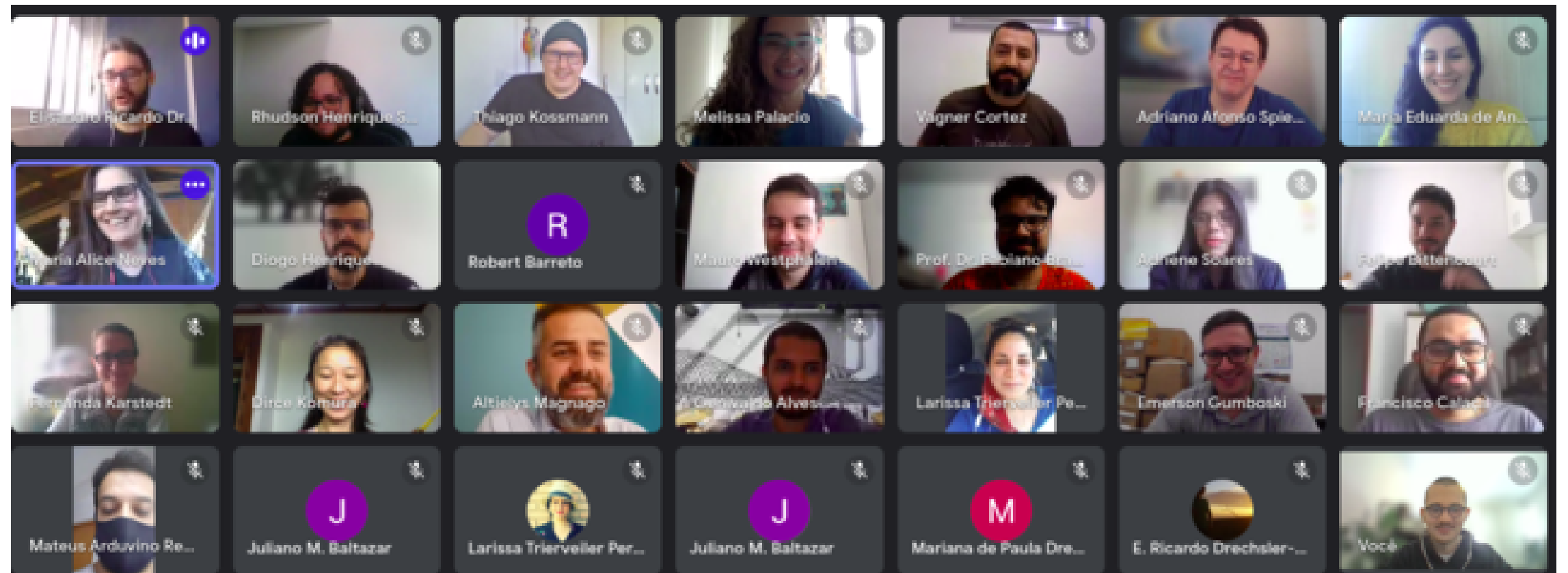
Xavante - Wedepöire - cogumelo
Gavião - Piñr japac - cogumelo
Kraho - Pi japac - orulha-de-pau



Dung Fungi from Brazil - the future...



**Give Fungi the
recognition they
deserve!**



Participation of 17 Brazilian mycologists in the 1st IUCN Workshop for the Conservation of Fungi and Lichens

Dung Fungi from Brazil - the future...

Give Fungi the recognition they deserve!



Vision: "Brazil, a country that values and conserves Fungi".
Fungal Specialist Group (IUCN Species Survival Commission)

Thank you!



Francisco J. Simões Calaça

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Pequenos cosmos em toda parte!