

# Defining species in *Fusarium* and the FUSARIOID-ID database

**Marileide M. Costa**

**Westerdijk Fungal Biodiversity Institute**

**SASPP Congress, Pretoria, August 2022**

# Outline

**The genus *Fusarium***

**How to define a species - Species concepts**

**The Fusarioid-ID Database**

**Case study**

## The genus *Fusarium*

- 400 species described, grouped in 18 species complexes
- Plant pathogens
- Mycotoxin producers
- Opportunistic human pathogens
- Endophytes and saprotrophs



## The genus *Fusarium*

Species are defined by the use of the:

- Morphological species concept
- Phylogenetic species concept
- Biological species concept

But also by

- biological features like substrate and host
- geographical distribution
- mycotoxin production
- metabolite profile etc.

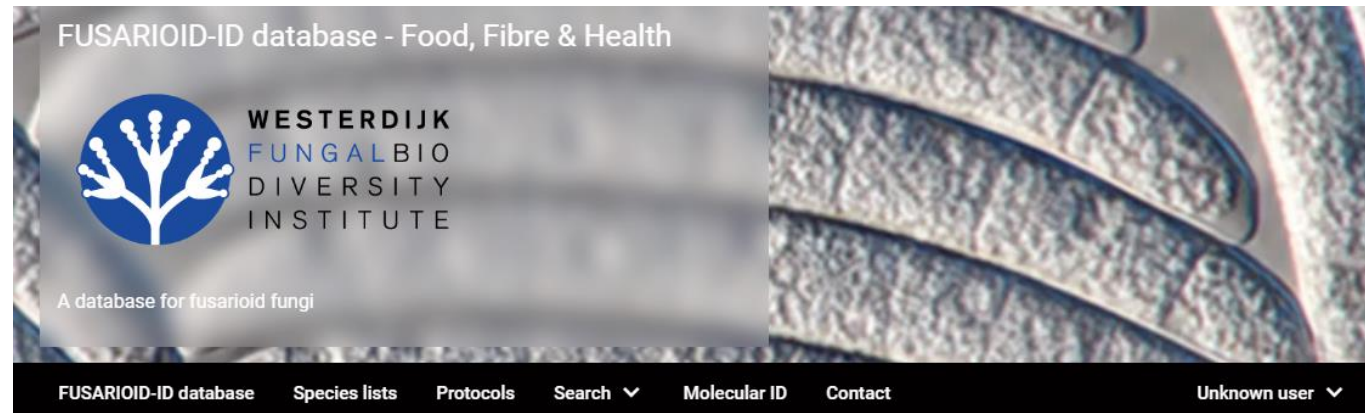




## *Fusarium*: more than a node or a foot-shaped basal cell

P.W. Crous<sup>1,2</sup>, L. Lombard<sup>1\*</sup>, M. Sandoval-Denis<sup>1,3\*</sup>, K.A. Seifert<sup>4</sup>, H.-J. Schroers<sup>5</sup>, P. Chaverri<sup>6,7</sup>, J. Gené<sup>8</sup>, J. Guarro<sup>8</sup>, Y. Hirooka<sup>9</sup>,

- Introduced 4 new genera, 18 new species, and made 16 new combinations
- A new online identification database, Fusarioid-ID, accessible at [www.fusarium.org](http://www.fusarium.org)



# The fusarioid sister genera

Cyanonectria

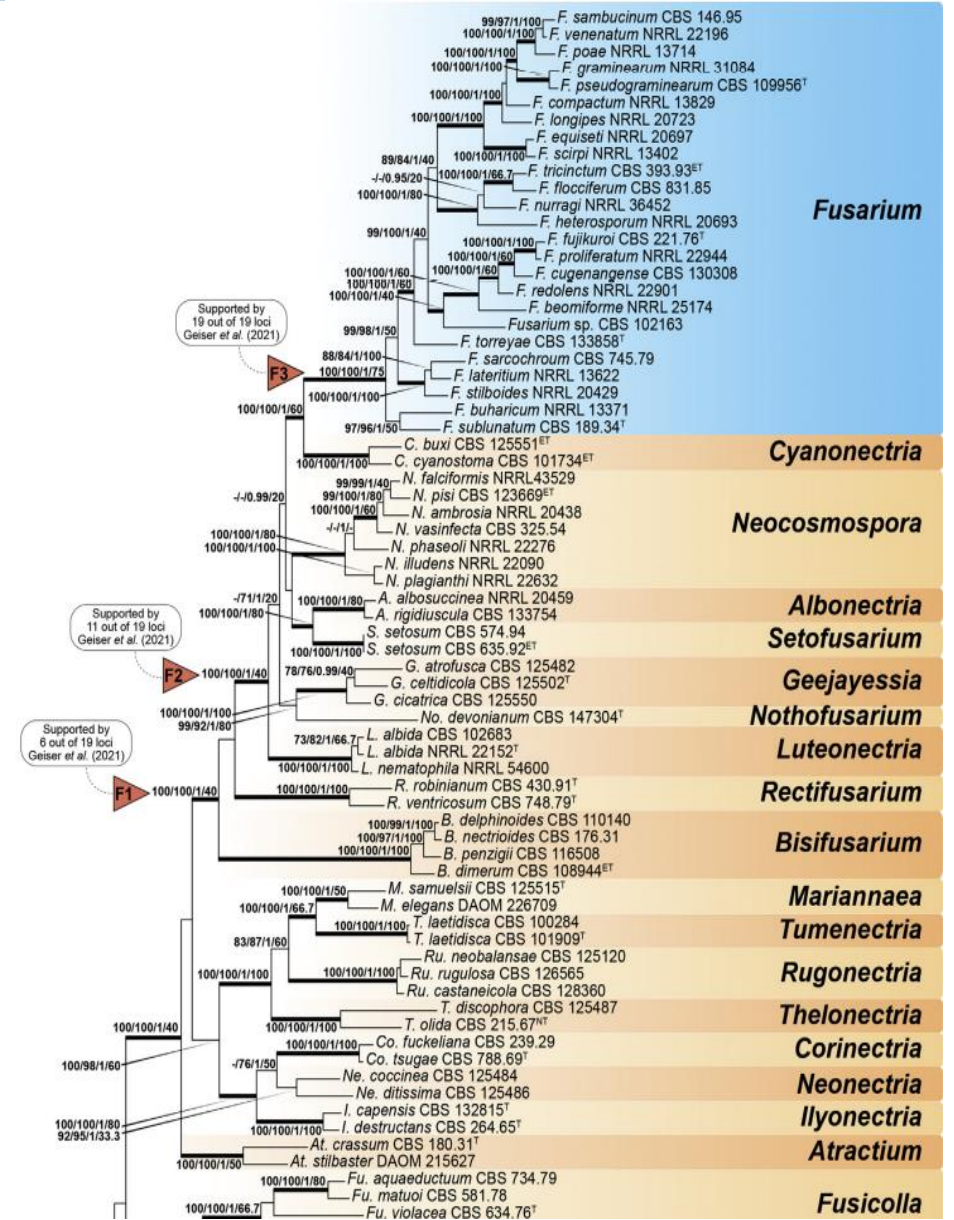
Neocosmospora

Albonectria

Setofusarium

Geejayessia

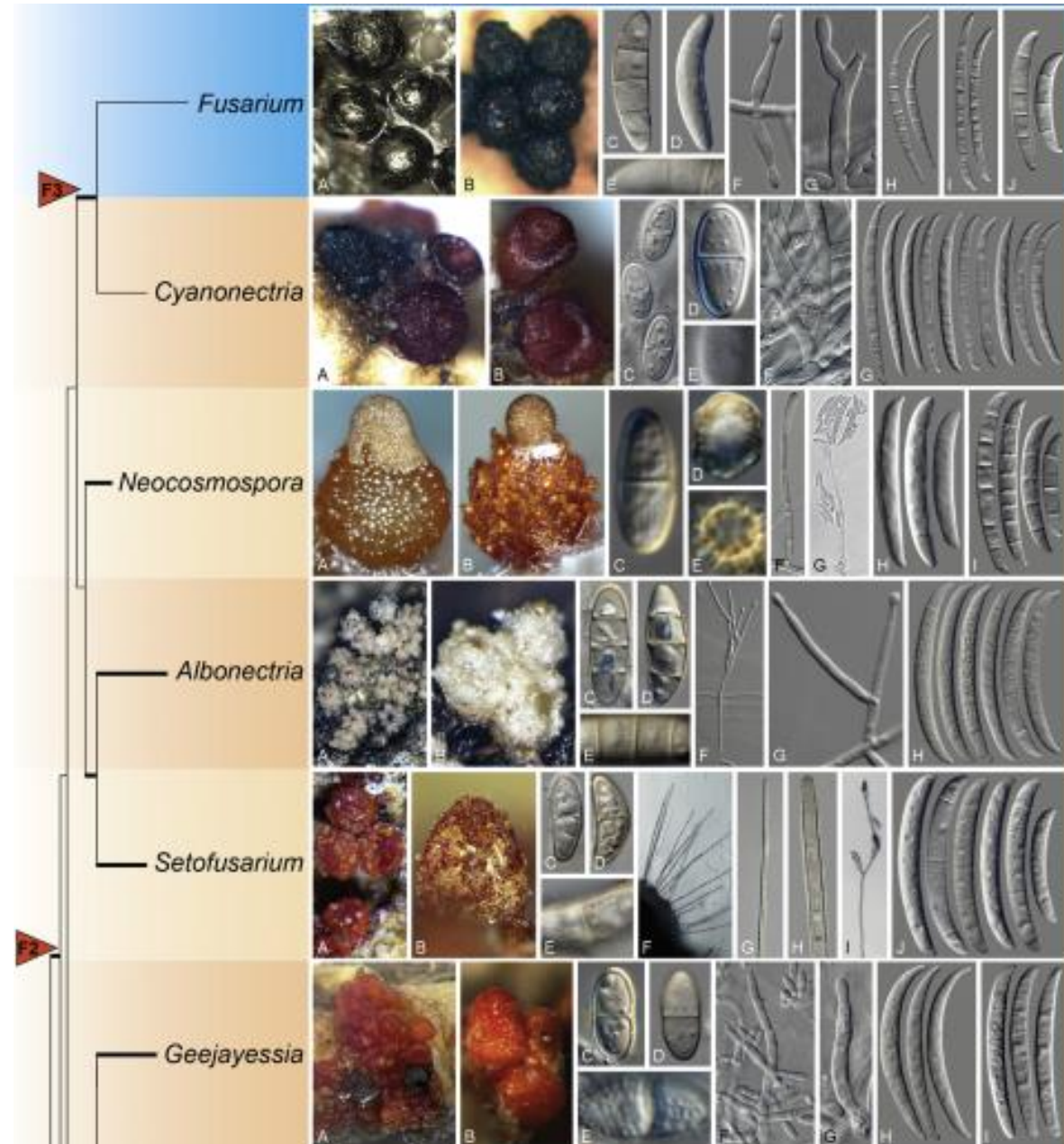
and others



ML-tree, ITS, LSU, rpb1, rpb2, tef1  
Crous et al. 2021

## The fusarioid sister genera

### Characters of the sexual and asexual morph



## Morphological Species Concept MSC

What does the MSC tell us ? It shows the morphotypes !

What is this concept useful for ?

First step in the characterization of field isolates

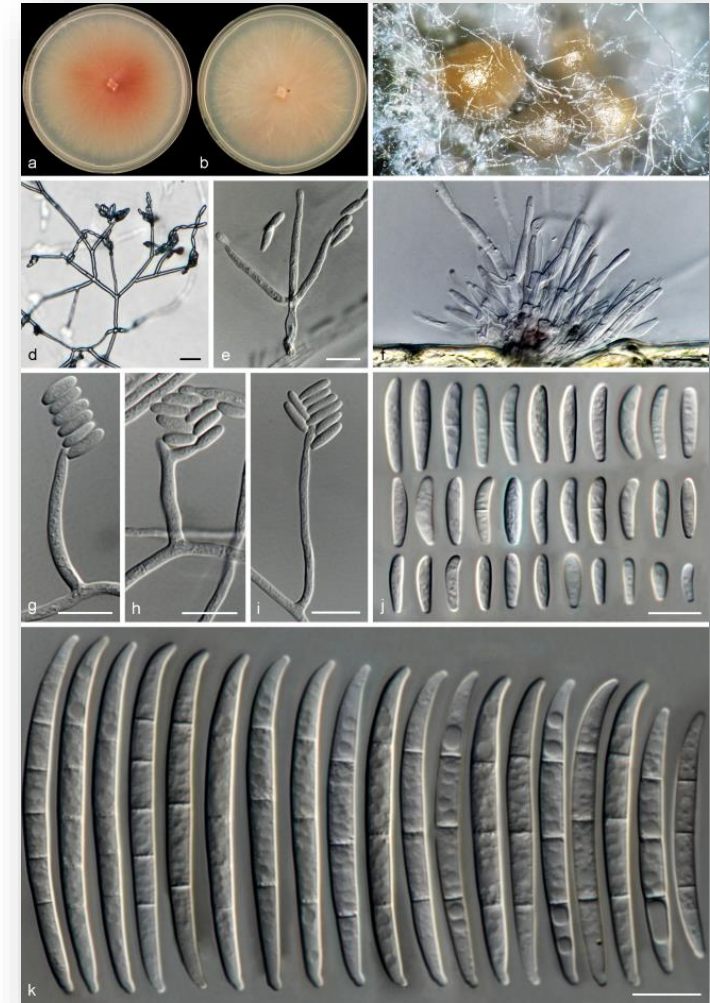
Everyone who has a *Fusarium* manual can use it

How does it work in the lab ?

Evaluating macro- and micromorphological characteristics

Comparing with the literature

**Limitations** There are no morphological markers for all species

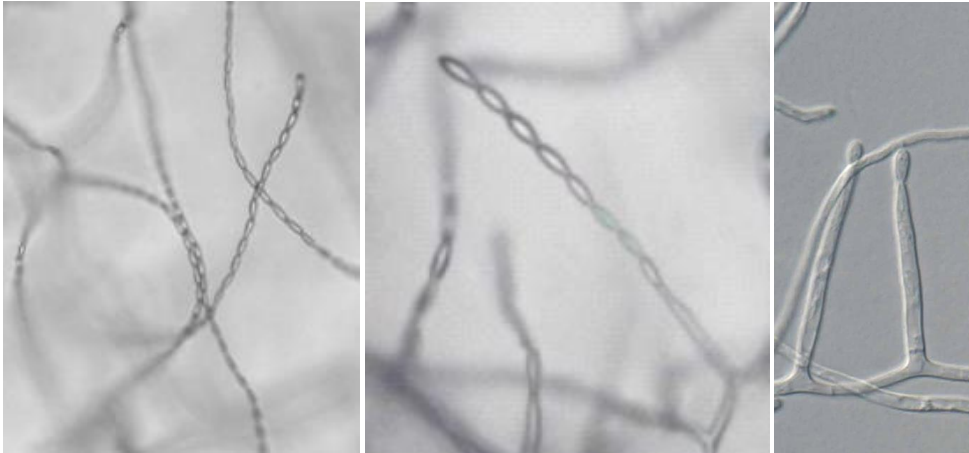




## Morphological Species Concept MSC

Morphotype *Fusarium verticillioides*

Conidia formed in long chains, on monophialides only



Includes

*F. verticillioides*, *F. thapsinum*, *F. napiforme*,  
*F. andiyazi*, *F. musae* ...



Morphotype *Fusarium subglutinans*

Conidia formed in false heads, on polyphialides

Includes

*F. subglutinans*, *F. sacchari*, *F. guttiforme*, *F. tupiense*,  
*F. circinatum* ...

## Biological Species Concept BSC

Population delimited by a reproductive barrier – Mating Population MP

What does the BSC tell us? If the species is a biological species;

Why is it useful to apply this concept?

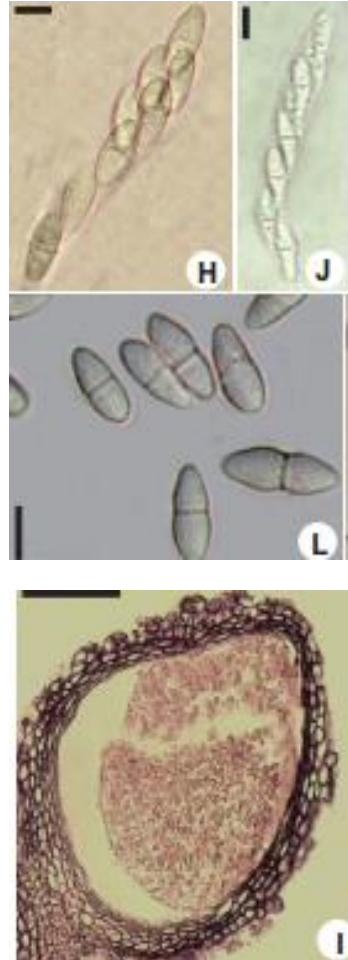
It helps in the differentiation of species, which do not have a morphological marker;  
When a molecular biology laboratory is not available;

### Limitations

It works only on heterothallic species;  
It is not always possible to induce the sexual stage in the laboratory; minimum number of isolates is necessary.

How does it work in nature?

Out of the 18 biological species described in the *Fusarium fujikuroi* species complex, only 5 have been reported in nature so far.



## Biological Species Concept BSC

Group of individuals that interbreeding with each other – Mating Population

### How it works in the lab?

Mating type identification by PCR

Laboratory crosses among isolates with opposite mating type;

Crosses of field isolates with tester strains of other biological species;

Selection of tester strains for each mating type.



## Phylogenetic Species Concept PSC

Populations delimited by the agreement of clusters generated from DNA sequences – clades

Genealogical Concordance Phylogenetic Species Recognition – GCPSR

### What does the PSC tell us?

Shows clusters generated from existing polymorphism in sequences of gene regions;

### Why is it useful to apply this concept?

It allows us to access the real diversity of species;

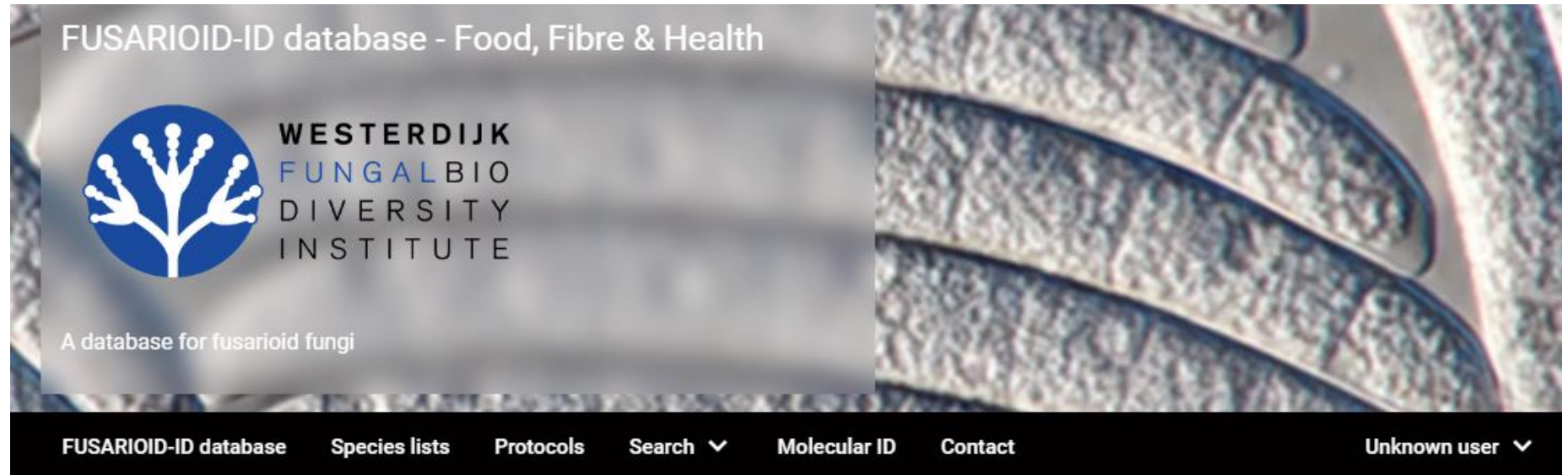
Separates the species that do not have a morphological marker and that do not reproduce sexually;

It allows us to describe new species.

### Questions:

**How many *Fusarium* species are still to be described ?**

**What is the real diversity of species in tropical environments ?**



## FUSARIOID-ID database

**Includes all agricultural, environmental and clinically important fusarioid genera and species, based on curated sequences of several DNA barcode genes.**

## FUSARIOID-ID database

Provide a stable, regularly updated, and user-friendly platform for the identification of *Fusarium* and species in allied genera.

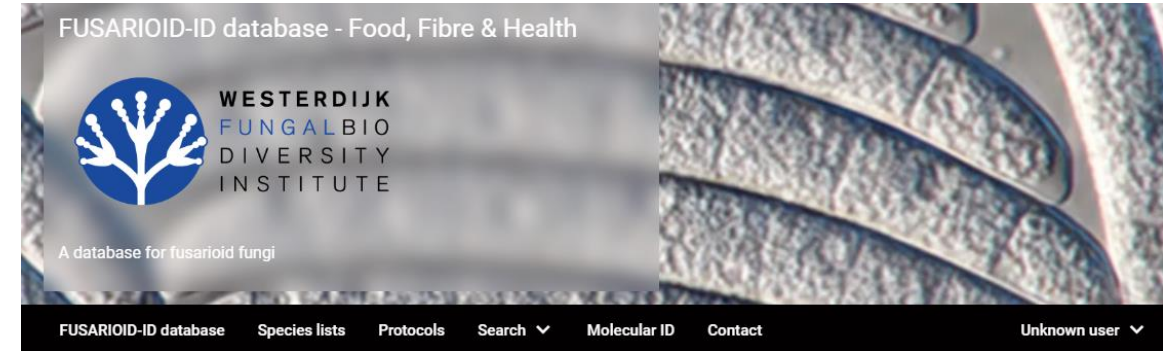
### Some of the genera included in the database

- **Fusarium**
- **Neocosmospora**
- **Cosmosporella**
- **Albonectria**
- **Fusicolla**
- **Cyanonectria**
- **Cyanonectria**
- **Microcera**
- **Macroconia**

Information is provided for the included species and accepted species lists

### Viable data in the FUSARIOID-ID database

- About **500** taxon names
- **21** genera - **300** *Fusarium* species
- **1550** strains

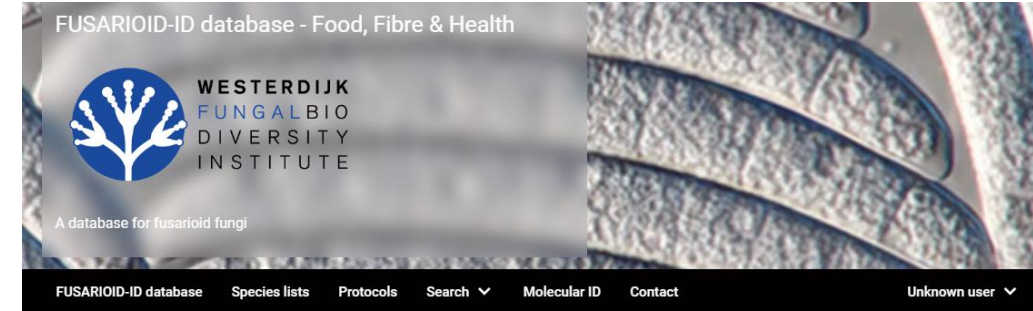


### Viable information in the FUSARIOID-ID database

- **Protocols for species description – morphological and molecular studies**
- **Information about Types and Holotypes of accepted species**
- **Sequences and aliment data for strains**



# FUSARIOID-ID database



How are new data included in the database ?

A case study with novel species found on tropical grasses


Mycological Progress (2021) 20:61–72  
<https://doi.org/10.1007/s11557-020-01658-5>

DGfM

ORIGINAL ARTICLE



## *Fusarium* species from tropical grasses in Brazil and description of two new taxa

Marileide M. Costa<sup>1</sup> • Maruzanete P. Melo<sup>2</sup> • Filipe S. Carmo<sup>1</sup> • Gláucia M. Moreira<sup>1</sup> • Elaine A. Guimarães<sup>1</sup> • Fernando S. Rocha<sup>3</sup> • Sarah S. Costa<sup>1</sup> • Lucas M. Abreu<sup>4</sup> • Ludwig H. Pfenning<sup>1</sup> 

- 47 isolates recovered from seeds of *Brachiaria*
- 12 phylogenetic species reported within the FFSC, FIESC, FCSC
- 3 new species

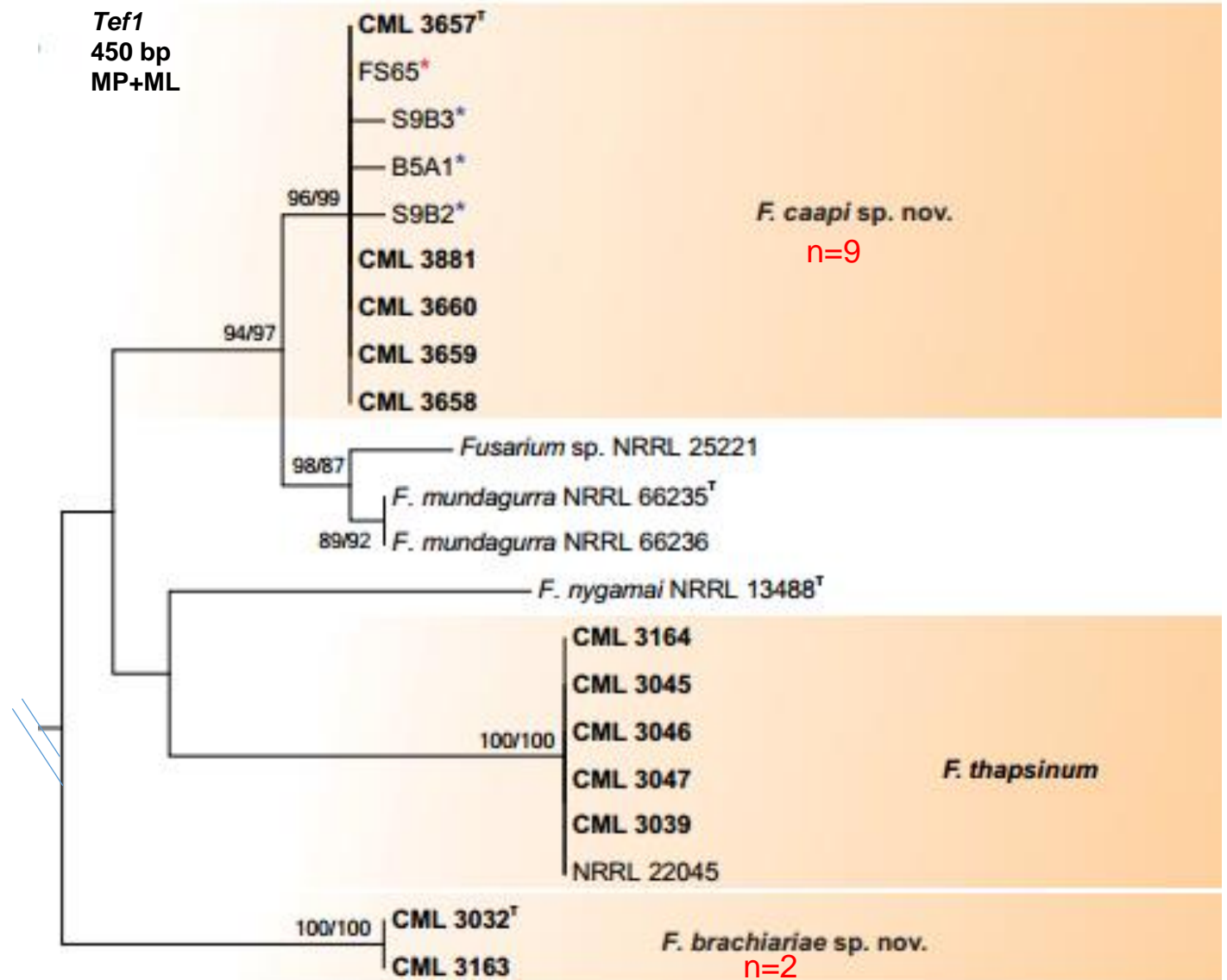
## *F. caapi* sp. nov.

Host: Brachiaria

- Curated sequences from types and other reference material

## *F. brachiariae* sp. nov.

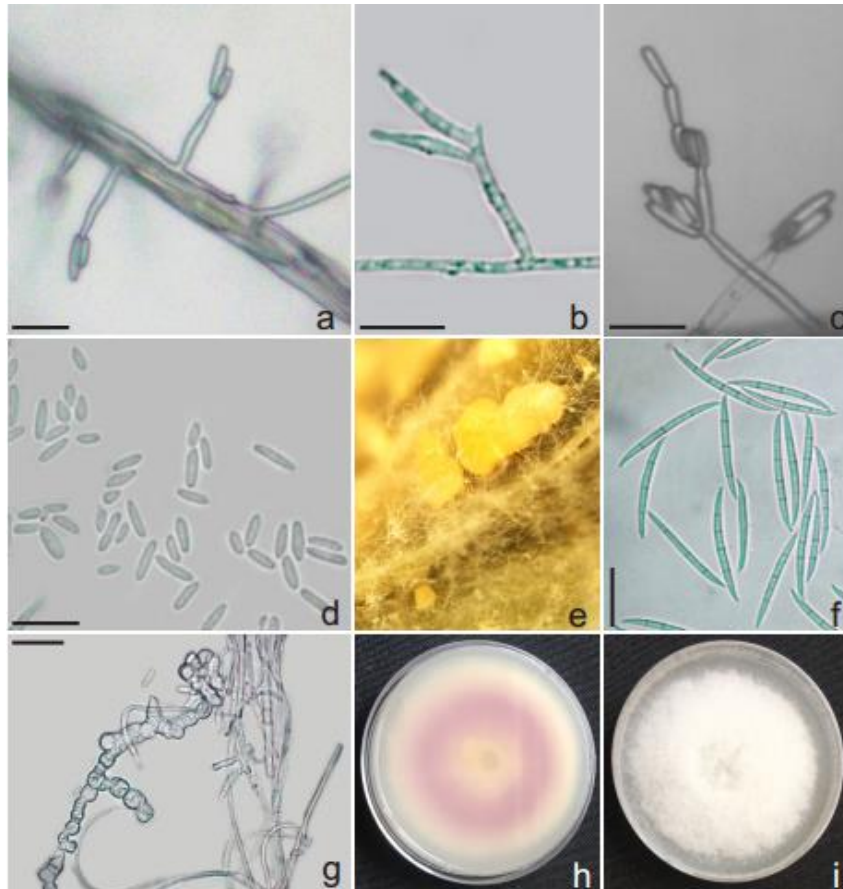
Host: Brachiaria



- Photoplates, showing morphological markers

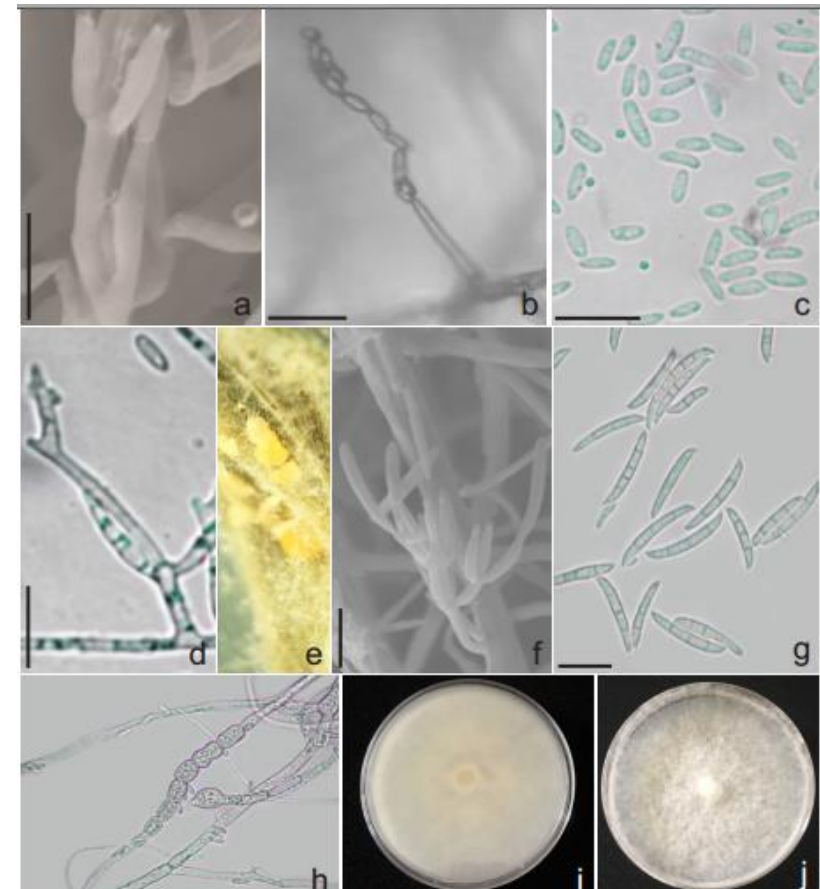
## *F. brachiariae* sp. nov.

Morphotype “*mundagurra*”



## *F. caapi* sp. nov.

Morphotype “*mundagurra*”



# FUSARIOID-ID database

## What new data are included in the database ?

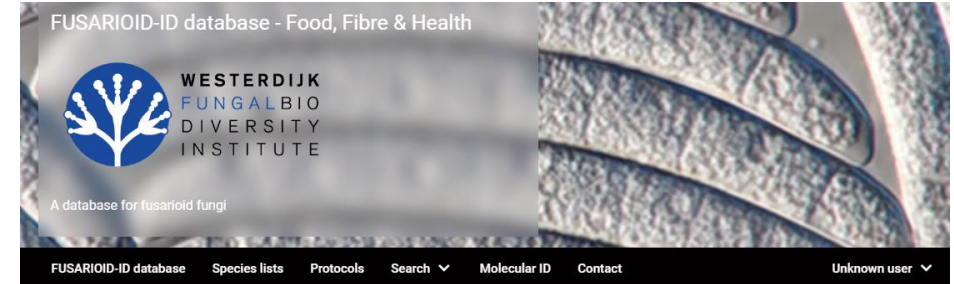
- Information about life style
- Curated sequences from types and other reference material
- Photoplates, showing morphological markers

There is public access to all data, well organized and grouped in the Fusariod-ID database

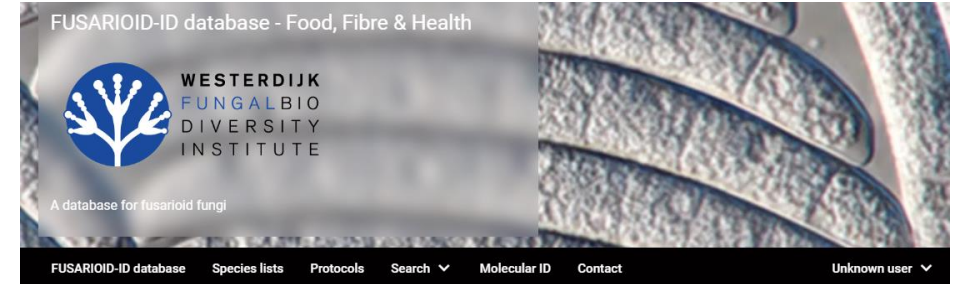
## How can you recover information of *F. brachiariae* from the database ?

Through search functions, like:

- Name
- Ex-type strain
- Substrate-host
- Country
- Sequence



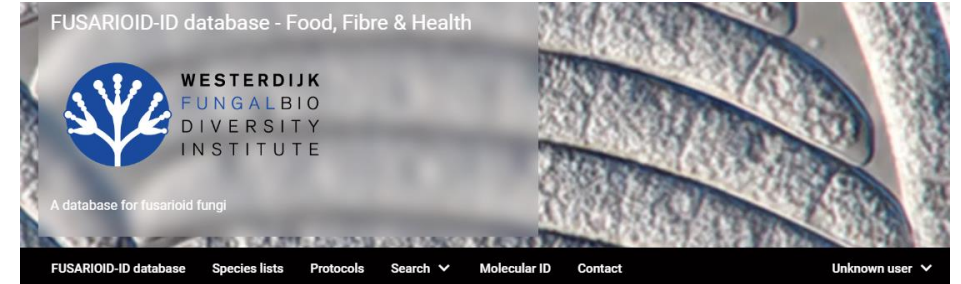
# FUSARIOID-ID database



## Three main challenges still remain

- i. to formally describe already known, distinct phylogenetic lineages;
- ii. to reveal cryptic species within collections, e.g. **IMI, BBA collections**; labelled with names based on morphological characterization only;
- iii. to access still underexplored niches in different ecosystems or peculiar substrates.

# FUSARIOID-ID database



## What do we intend to accomplish ?

- **Standardized template for the description of species.**
- **List of terms for species descriptions.**
- **Interactive monographic compilation of fusarioid fungi that include taxonomic and nomenclatural information with a list of key literature.**

# Acknowledgement



Phytopathology group

Odo van Vloten Foundation

This research benefitted from funding by the European Union's Horizon 2020 research and innovation program (RISE) under the Marie Skłodowska-Curie grant agreement No. 101008129, project acronym "Mycobiomics".



**Funded by  
the European Union**

