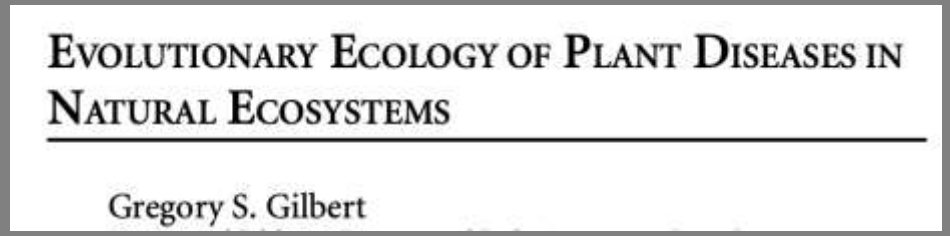
Types of diseases

- Foliar diseases and blights
- Stem diseases: cankers, wilts, systemic
- Trunk rots
- Root diseases
- Seedling diseases
- Fruit and flower disease



Seed diseases

- Up to 88% mortality in tropical Uganda
- More significant when seed production is episodic

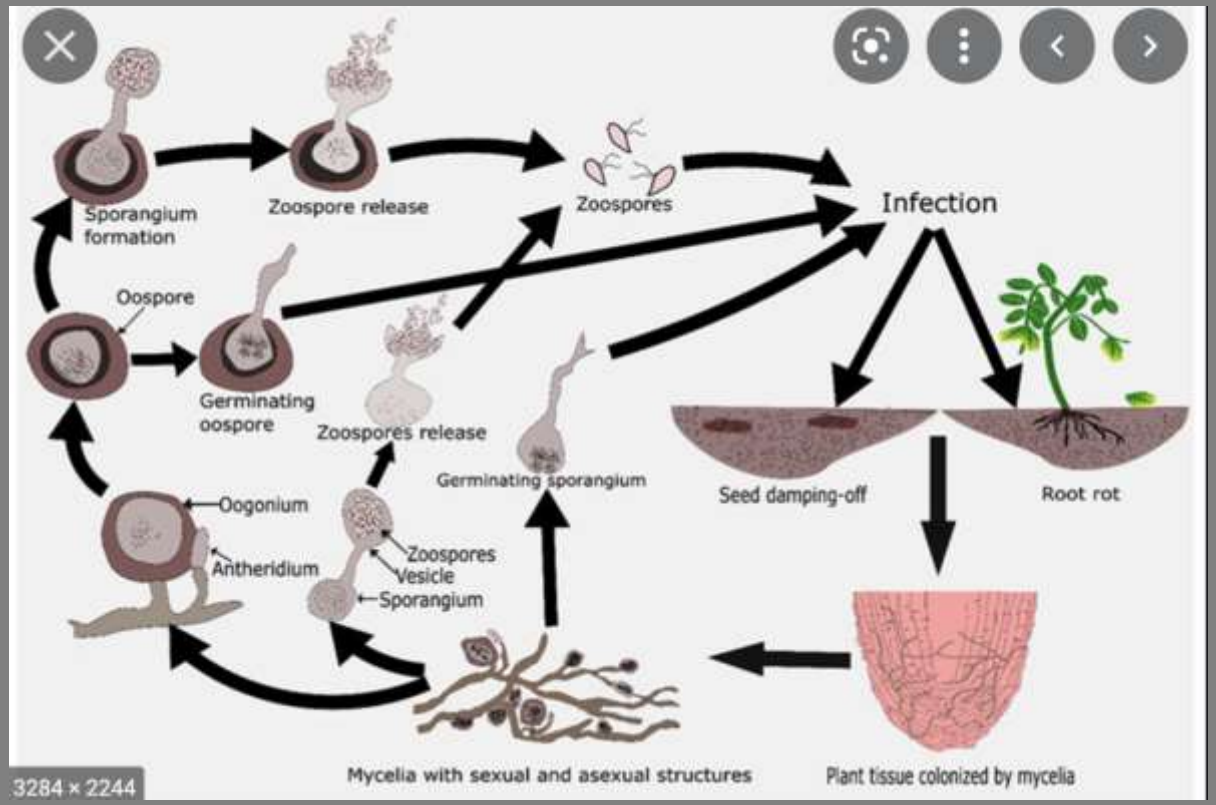
Figure 239. Swollen Chihuahua pine cone infected with C. conigenum and sporulating. An uninfected cone is on the right.

Stress cone crop

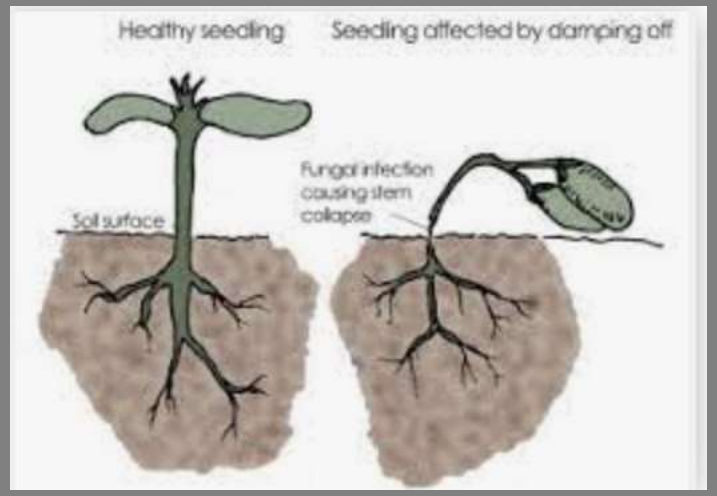
BS on DF

Seedling diseases

- Specific diseases, but also diseases of adult trees can affect seedlings
- *Pythium*, *Phytophthora*, *Rhizoctonia*, *Fusarium* are the three most important ones
- Pre- vs. post-emergence
- Impact: up to 65% mortality in black cherry. These diseases build up in litter
- Shady and moist environment is very conducive to these diseases



Reason why reforestations are done on mineral soil!



Foliar diseases

- In general they reduce photosynthetic ability by reducing leaf area. At times this reduction is actually beneficial
- Problem is accentuated in the case of small plants and in the case other health issues are superimposed, or when
- Often, e.g. with anthracnose and rust diseases leaves are point of entry for twig and branch infection with permanent damage inflicted

Foliar diseases (continued)

- Reduction of photosynthesis in small plants makes them not competitive and/or directly debilitates them
- When leaf infection is the preferred avenue to infect and kill branches

Sycamore anthracnose

Foliar diseases (continued2)

- When defoliation is severe on adult trees

- AND

- It repeats itself for 2 or three years

The California oak worm

(*Phryganidia californica*)

- Oaks can survive one and even two years of defoliation, but not three
- Other stresses can worsen the situation
- Warm winters can actually worsen the attacks, maybe because oakworm virus populations remain low in mild climate

Systemic infections

- Viral?
- Phytoplasmas
- *Peronospora* and smuts can lead to over 50% mortality
- Endophytism: usually considered beneficial
- Vascular disease

Blackstain Root Disease is vascular

Smut of corn caused by *Ustilago nuda*

Grass endophytes

- Clavicipetaceae (fungi) and grasses, e.g. tall fescue
- Mutualism: antiherbivory, protection from drought, increased productivity
- Classic example of coevolutionary development: *Epichloe* infects “flowers” of sexually reproducing fescue, *Neotyphodium* is vertically transmitted in species whose sexual reproductive ability has been aborted

Schardl, C., Leuchtmann, A., and Spiering, M. (2004). Symbioses of grasses with seedborne fungal endophytes. *Annu. Rev. Plant Biol.* 55, 315–340. doi: 10.1146/annurev.arplant.55.031903.141735

Vertical transmission of symbiotic *Epichloë* endophytes from host grasses into progeny seed is the primary mechanism by which the next generation of plants is colonized. This process is often imperfect, resulting in endophyte-free seedlings which may have poor ecological fitness if the endophyte confers protective benefits to its host

Endophytes—>Pathogens

- Endophytic stage can be relatively short (1 year) to extremely long (hundreds of years)

- Protoplasts known as “mycosomes”

Novel Symbiotic Protoplasts Formed by Endophytic Fungi Explain Their Hidden Existence, Lifestyle Switching, and Diversity within the Plant Kingdom

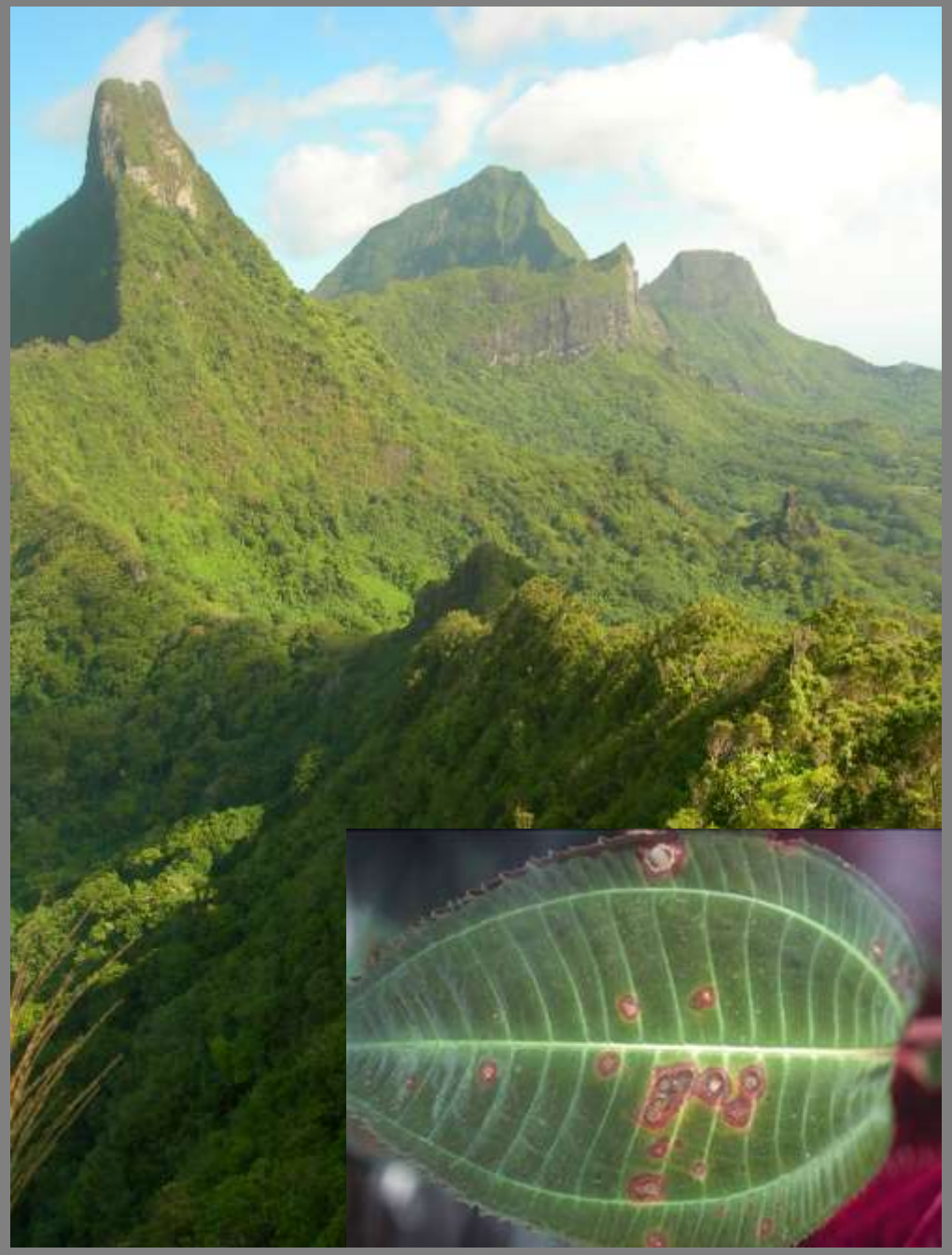
Peter R. Atsatt[1]*, Matthew D. Whiteside[2]

Endophytes in trees:

- Protect from herbivory
- Protect from fungal pathogens
- Increase drought tolerance
- Protect from fungal biocontrol

The *Miconia calvescens* study

- The Purple scurge, invasive plant escaped from botanical gardens in Polynesia (both Hawaii and Tahiti)
- Huge reproductive potential, turns diverse tropical forests into monodominant Miconia stands
- Shallow Miconia roots make slopes unstable



French Polynesia, Island of

Mo’orea

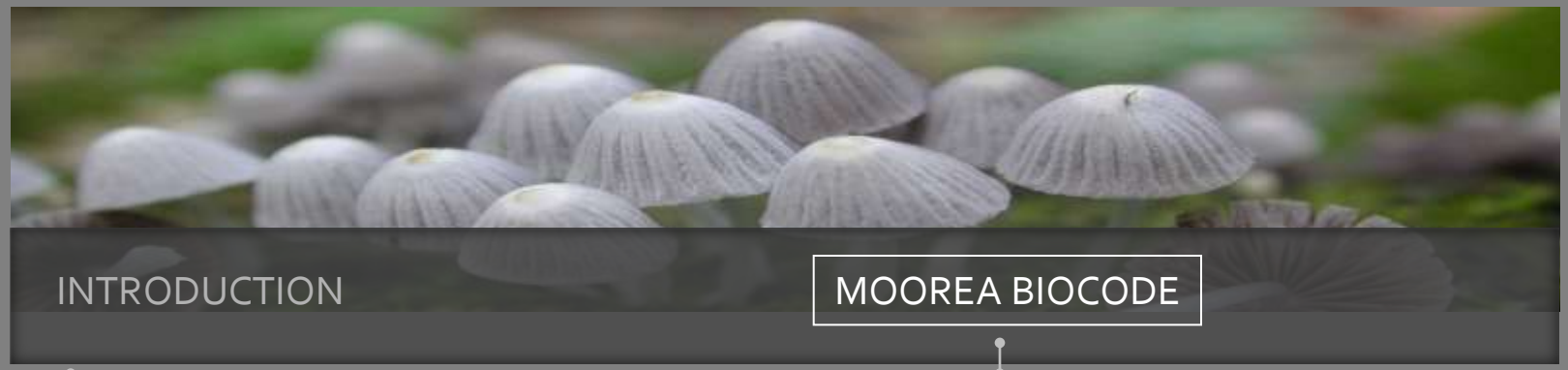
1)- Described over 200 macrofungi and their likely origin, In press About 50% new to science

2)- Understood one of the mechanisms why biocontrol of *Miconia calvescens* is failing

Garbelotto et al. 2019. Evidence for inhibition of a fungal biocontrol agent by a plant microbiome.

THE MOOREA BIOCODE PROJECT

- DNA barcoding an entire biome



INTRODUCTION

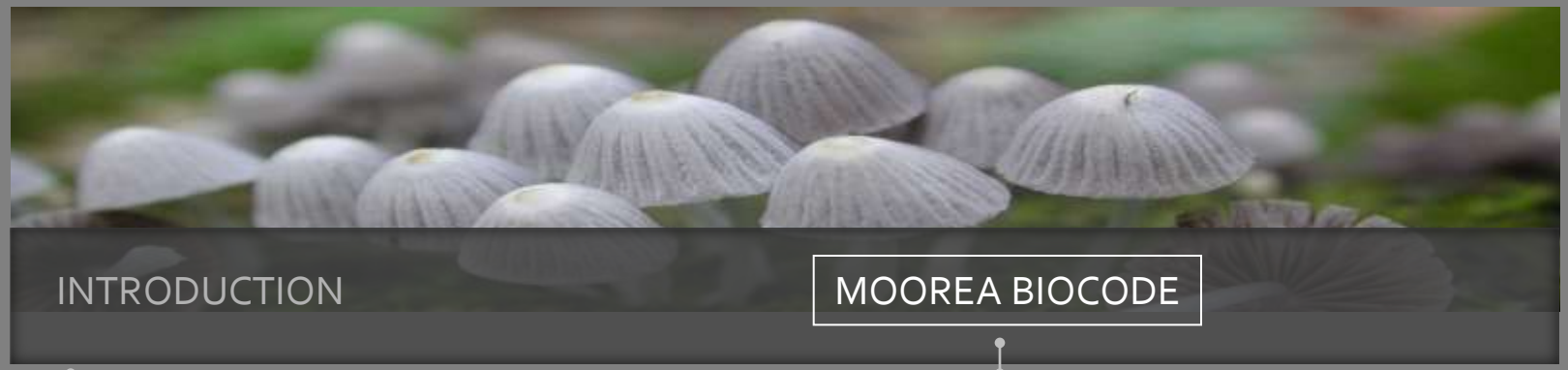
MOOREA BIOCODE

Sampling Approach:

- Field collections
- Voucher information, DNA sequence lin made public
- Collaboration with BioMatters, Inc.– Geneious Moorea Biocode workbench/ data pipeline

BIOCODE moorea

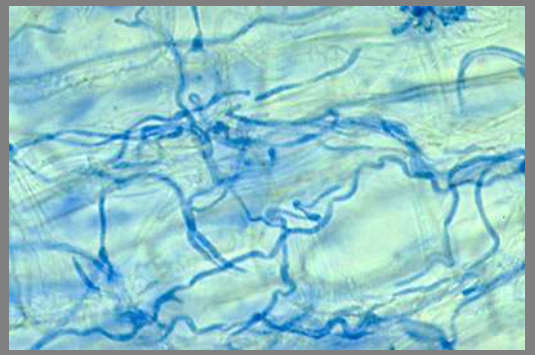
geneious



INTRODUCTION

MOOREA BIOCODE

macrofungi



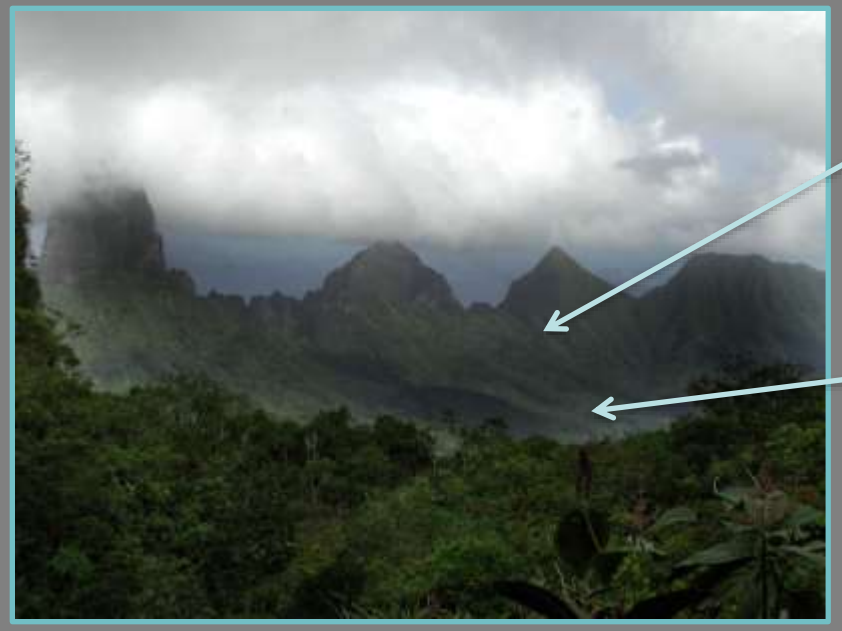
Leaf endophytes

Foliar pathogens

Fungal competitors (enemies) will affect outcome of invasive fungus

Miconia calvescens:
One of the most aggressive invasives in the South Pacific

Colletotrichum gleosporoides:
Introduced as a biological control from Brazil, but…



Works in highlands

Does <u>not</u> work in lowlands

How to test for effect of competitors? Experimental design:

- Able to artificially inoculate plants at all elevations with *Colletotrichum* (no climatic barrier)

- Endophytes from lowlands (n=20 isolates) were significantly more antagonistic *in vitro* to *Colletotrichum* than those from highlands (Irene Chen's thesis)

Interactions between endophytes and pathogen (biological control) change with elevation

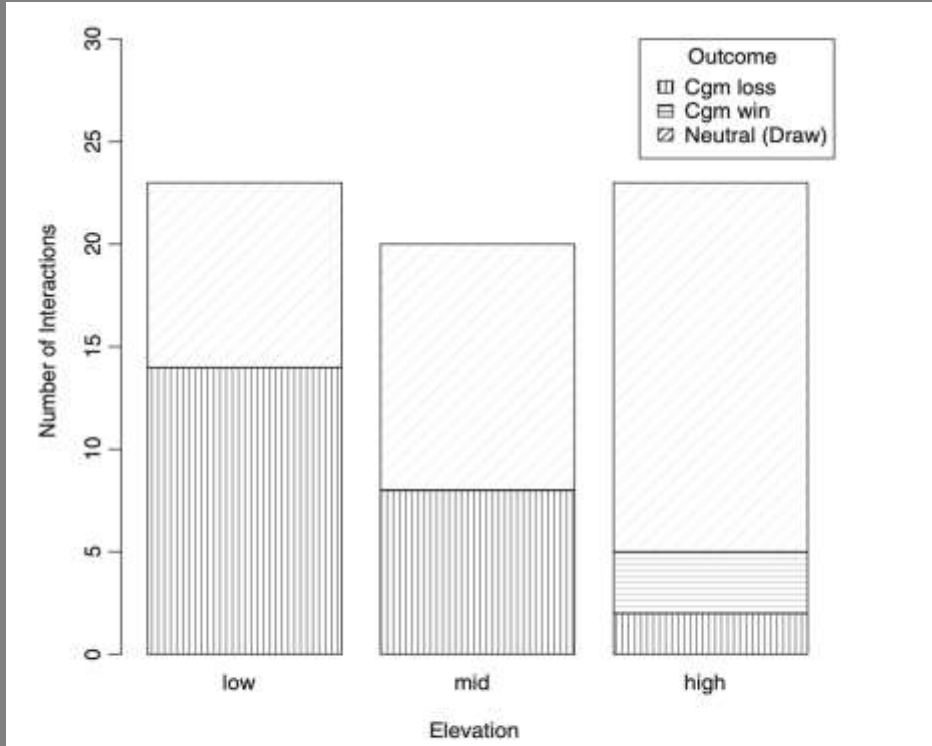


Fig. 5 Frequency of competitive interactions between the *Colletotrichum gloeosporioides* f. sp. *miconiae* biocontrol fungus and randomly-selected endophytic fungi obtained from *Miconia calvescens* plants from low, mid, and high elevations

So, are there differences in community composition of *Miconia* endophytes?

Generated clone libraries at three elevations (19 sites) and…

- 51 fungal taxa detected
- Endophtic communities showed **no overlap** between lowlands and highlands

CONCLUSIONS:

Endophytic community composition has an effect on spread of invasive biological control fungus *Colletotrichum*

Evidence for inhibition of a fungal biocontrol agent by a plant microbiome

Matteo Garbelotto[1] · Natalie Lowell[1] · Irene Y. Chen[1] · Todd W. Osmundson[1,2]