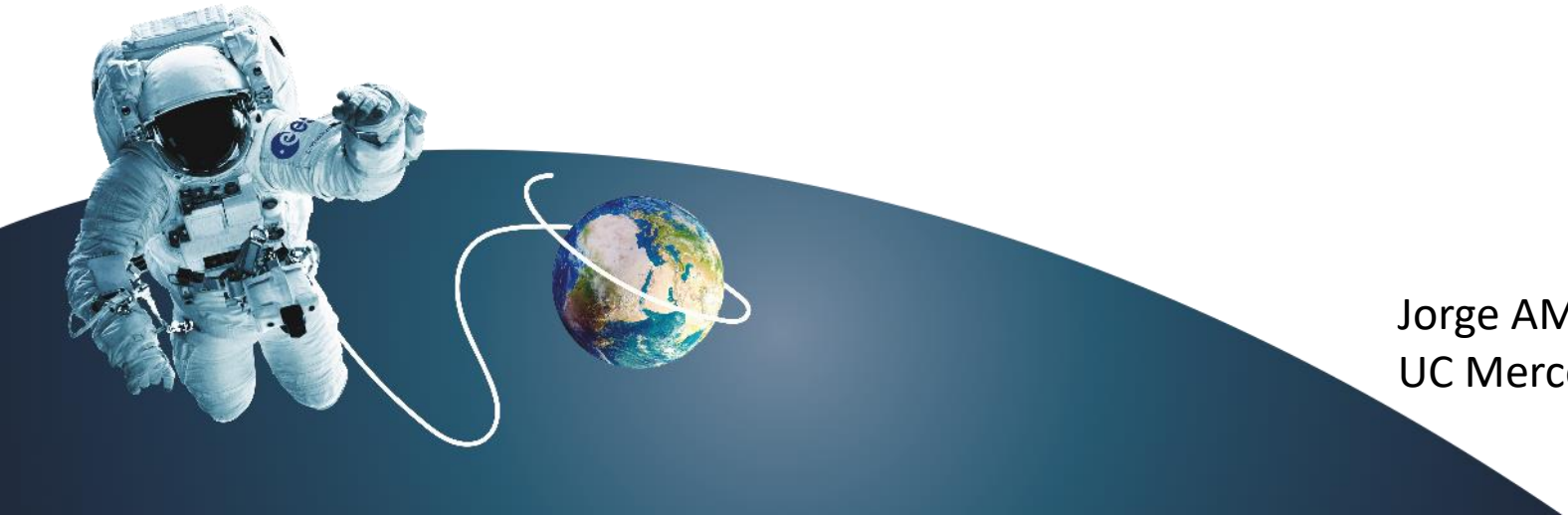
MELISSA
MICRO-ECOLOGICAL
LIFE SUPPORT SYSTEM
ALTERNATIVE

CREATING
A CIRCULAR
FUTURE

Amphibious plants present a shift in root microbiome community across life cycles.



Jorge AM Montiel-Molina
UC Merced

Amphibious plants

Microbial symbionts

Endophytes

Vernal pools

Ephemeral ecosystems

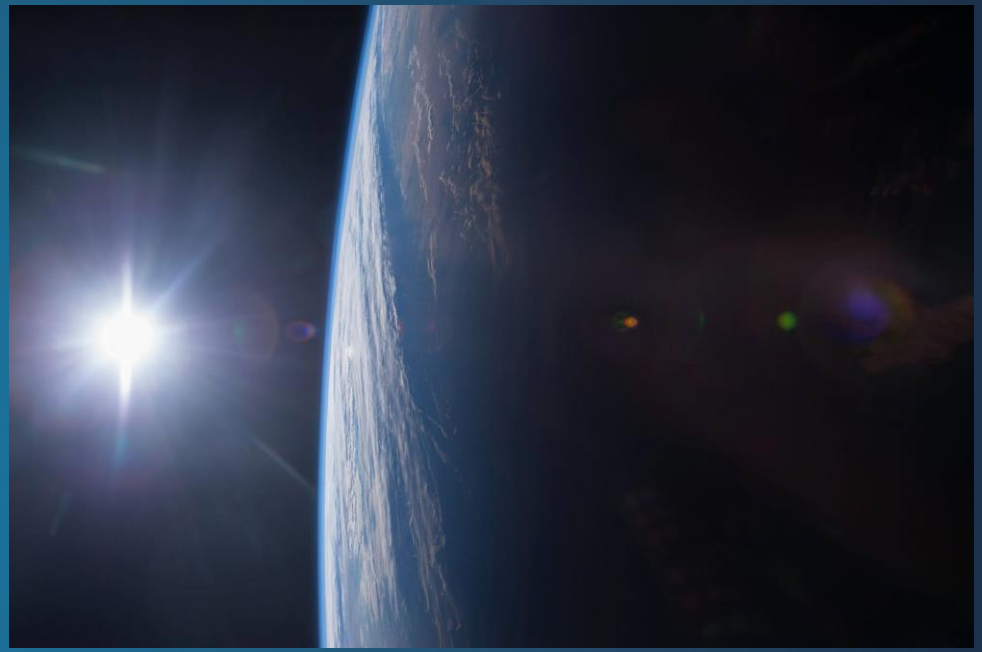
Community ecology

Microbial communities have an important role across ecosystems.

Primary producers

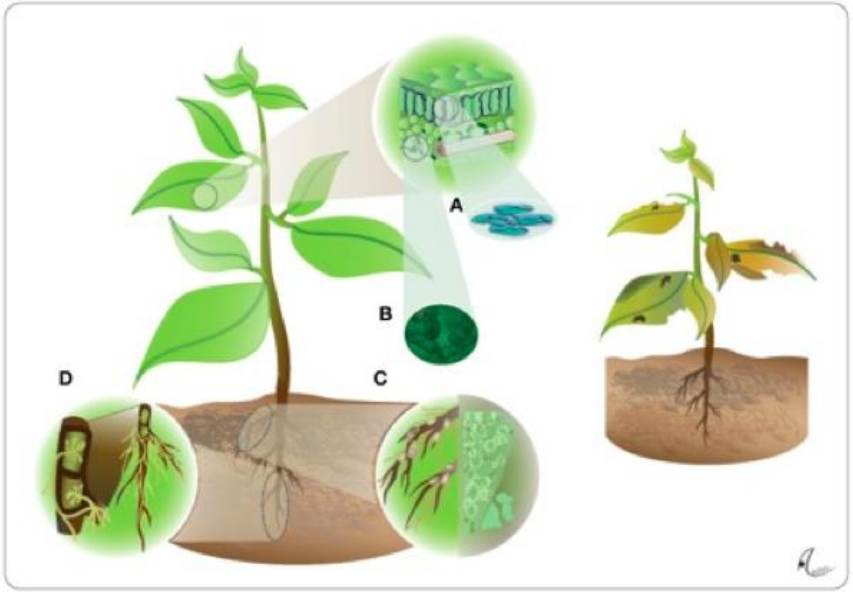
Decomposers

Drivers for evolution



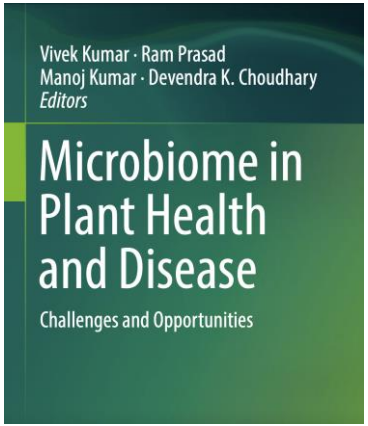
Terry W. Virts

As symbionts, they form strong relationships with larger organisms



(Chadha, et al. 2015;Fouda et al, 2015)

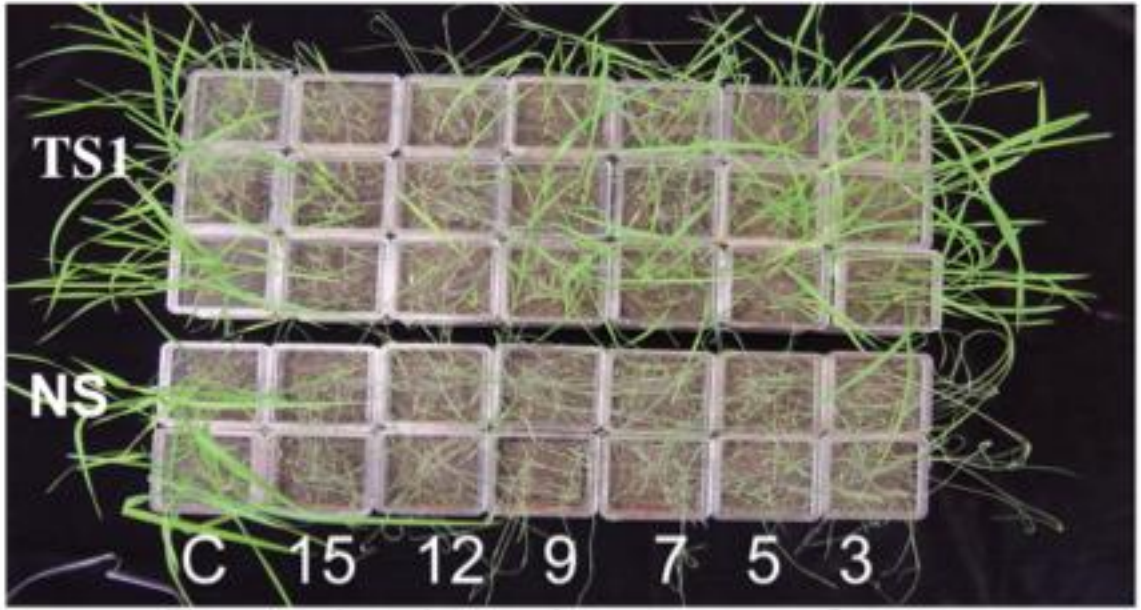
A epiphytes
B endophytes
C ectomycorrhizas
D endomycorrhizas



ENDOPHYTES
- Live inside the plant tissues
- No harm to the plant host

Stress tolerance transplanting symbionts in grasses

Endophyte
drought
tolerant



Redman et al. 2011

High temperature tolerance

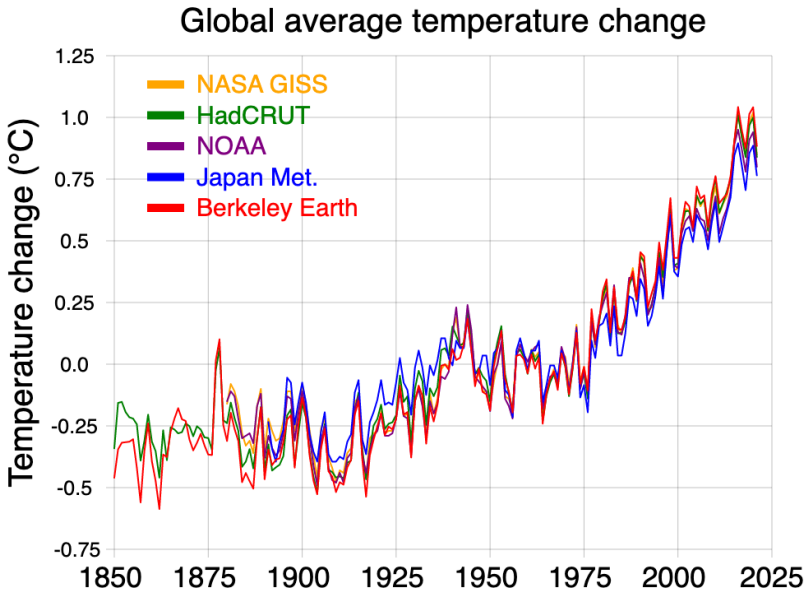
204°F / 95.6°C

High salinity tolerance

Redman et al. 2011

The study of extreme ecosystems holds important lessons for human applications.

Extreme scenarios caused by global change



Prolonged droughts

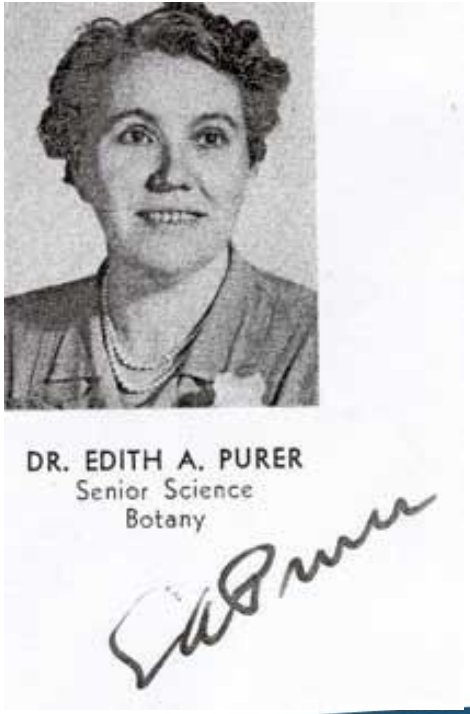
Soil salinity

Flash floods

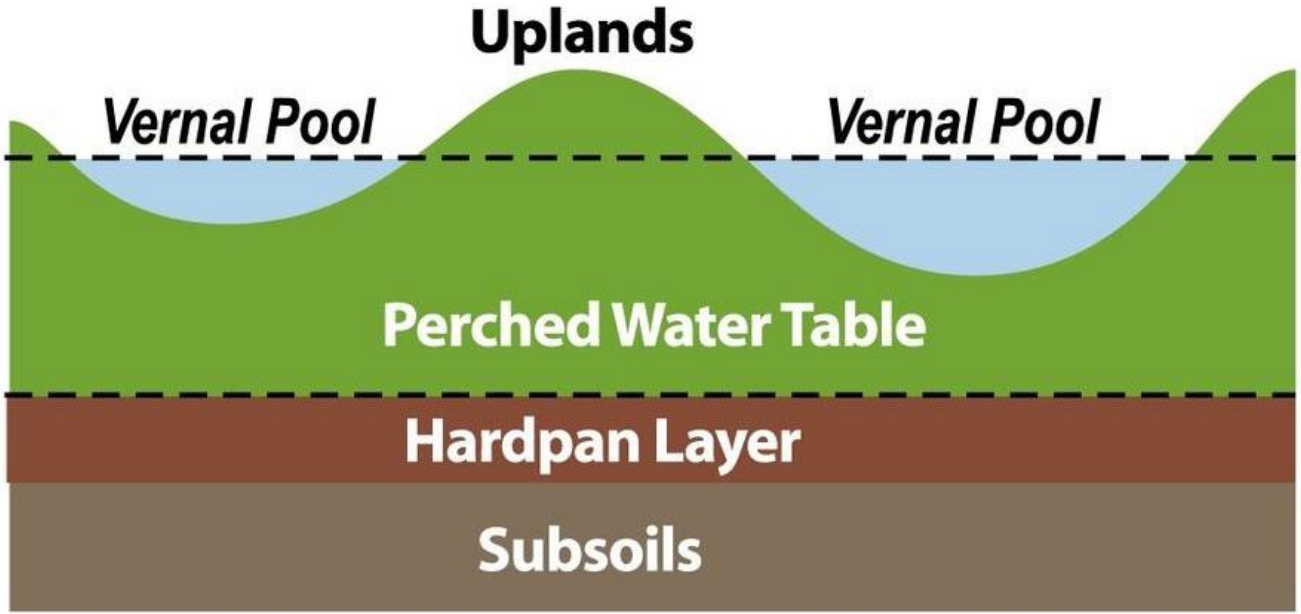
Ephemeral wetlands: Vernal Pools

Vernal Pools

1937



The habitat of endemic plants


Uplands
Vernal Pool
Vernal Pool
Perched Water Table
Hardpan Layer
Subsoils

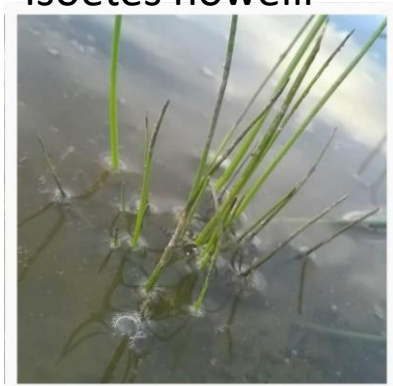
IN COOPERATION WITH

esa

European Space Agency

Plants inhabiting vernal pools are subject of strong environmental swings

Isoetes howelli



Psilocaphus brevissimus

amphibious plants

Eryngium castrense

Eryngium castrense

Functional Ecology 1999
13, 106–118

Photosynthetic pathway diversity in a seasonal pool community

J. E. KEELEY

USGS Biological Resources Division, Western Ecological Research Center, Sequoia–Kings Canyon Field Station, Three Rivers, CA 93271–9700, USA

Summary

1. Photosynthetic pathway diversity was evaluated for the dominant species in a seasonally aquatic community in the south-western USA using ^{14}C pulse-chase techniques.

2. Under submerged conditions, only about half of the species were clearly C_3, three of the 15 dominants were CAM, one species was C_4 and three were potentially assimilating carbon with both C_3 and C_4 fixation.

3. During the brief terrestrial stage in the life history of these amphibious plants, both the CAM and the $C_3 + C_4$ species switched to C_3, whereas the C_4 species did not switch.

4. Numerous variations were apparent; for example, the C_4 species, while exhibiting a biochemical pathway indistinguishable from terrestrial C_4 plants, lacked Kranz anatomy in the aquatic foliage. Also, despite well-developed CAM in several species, others exhibited low-level diel changes in acidity, apparently not indicative of CAM.

5. Species with C_4 or CAM CO_2 concentrating mechanisms lacked the capacity for bicarbonate uptake, an alternative CO_2 concentrating mechanism found in certain C_3 species in this community.

6. Rubisco/PEPC in aquatic foliage was higher in C_3 species than in C_4, CAM or putative $C_3 + C_4$ species. In the terrestrial phase, as expected, the switch from CAM or $C_3 + C_4$ to strictly C_3 assimilation was associated with a substantial increase in Rubisco/PEPC. Quite unexpected, however, was the substantial increase in this ratio in terrestrial C_3 foliage. It is hypothesized that submerged C_3 plants utilize PEPC for recycling of respiratory CO_2 and/or C_4 phototrophism under field conditions of limited CO_2 and O_2 saturation, and this is lost in the terrestrial foliage.

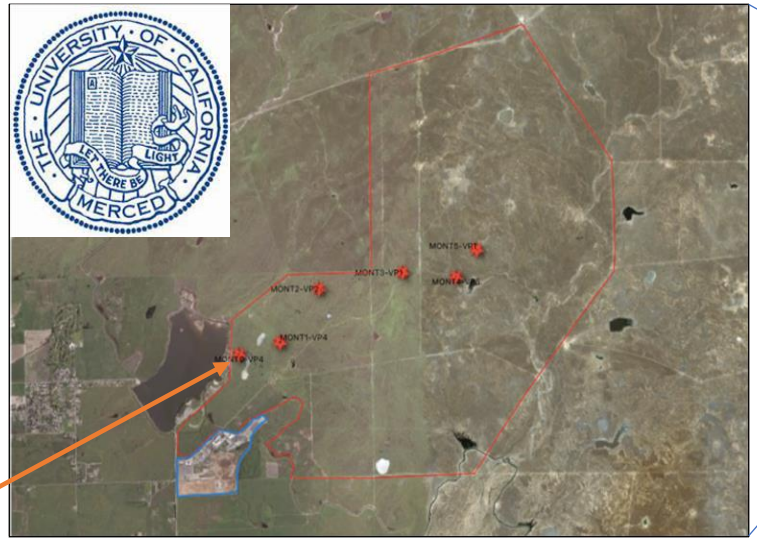
How the endophytes–composed by Fungi and prokaryotes, react to the aquatic and terrestrial contrasting phases in amphibious plants?

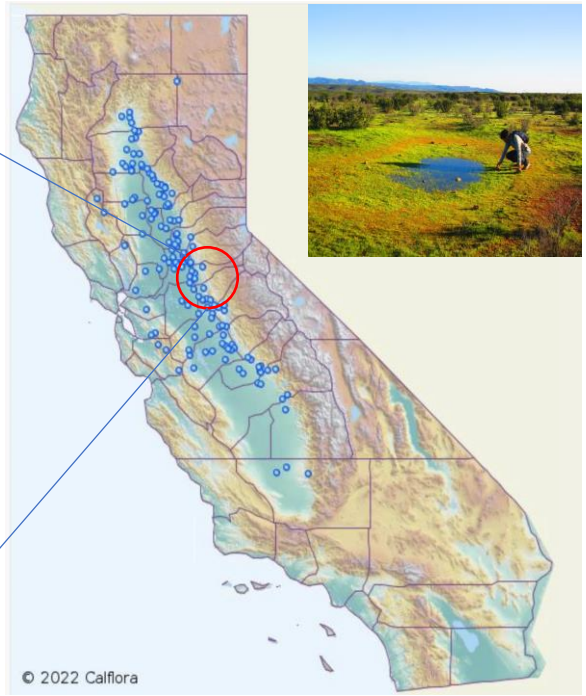
Specific objective:

Assess the community dynamics of microbial endophytes inhabiting roots and shoots of the amphibious plant species *Eryngium castrense (carrot family), across aquatic and terrestrial stages.*

E. castrense is distributed in California Central Valley

Vernal pools and Grasslands Reserve





5 specimens
per site

MELISSA

Surface sterilized plants

Wet season

Dry season

Shoots

Roots

Liquid nitrogen

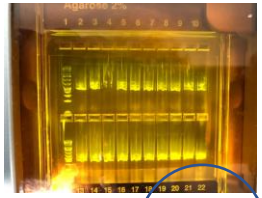
Tissue Powder

DNA

PowerSoilDNA®

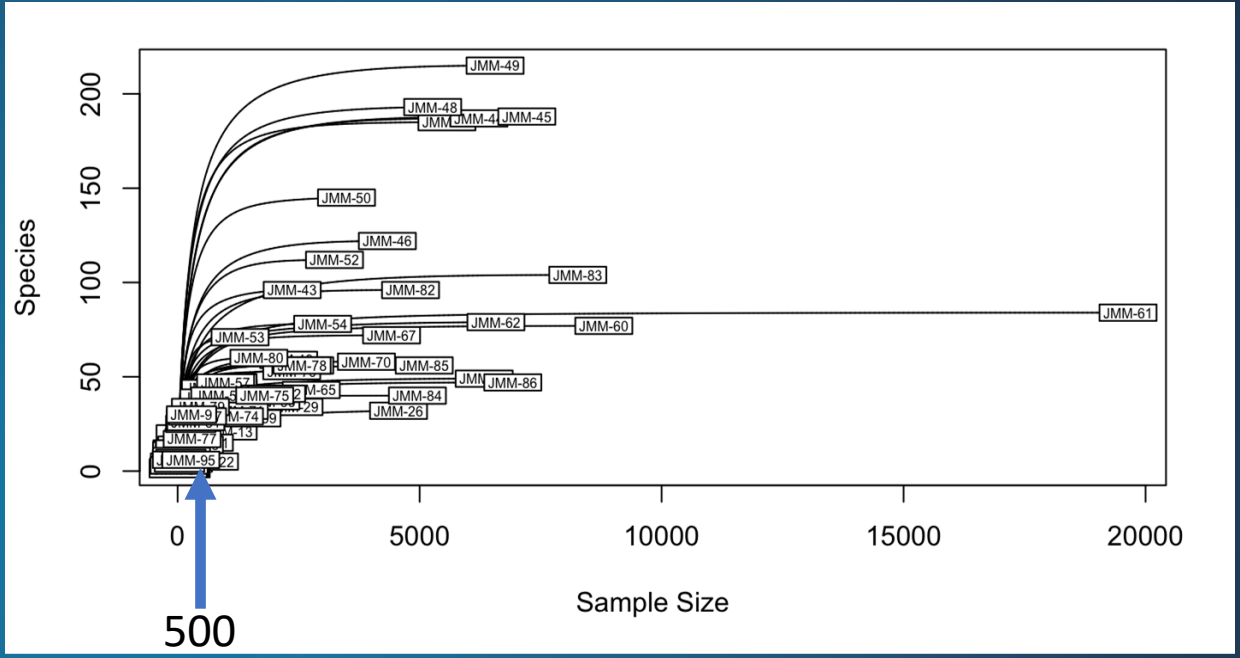
DNA Sequencing IlluminaMiseq®

Prokaryotes, V4-V5



Fungi, ITS 2

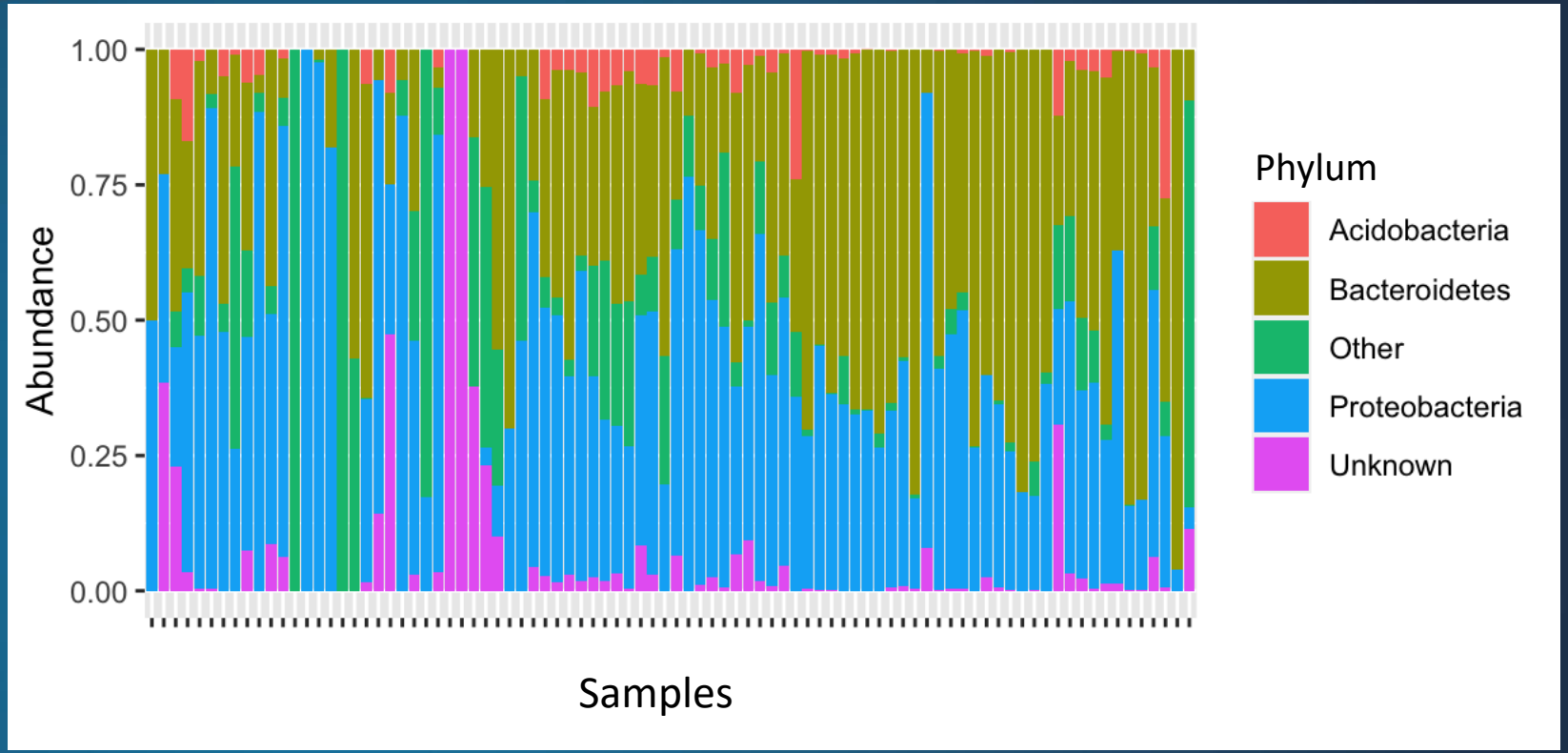
Sequences reads



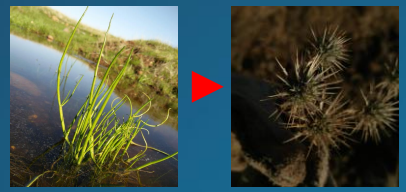
This is the first research study about amphibious plants microbiome Fungi/Bacteria

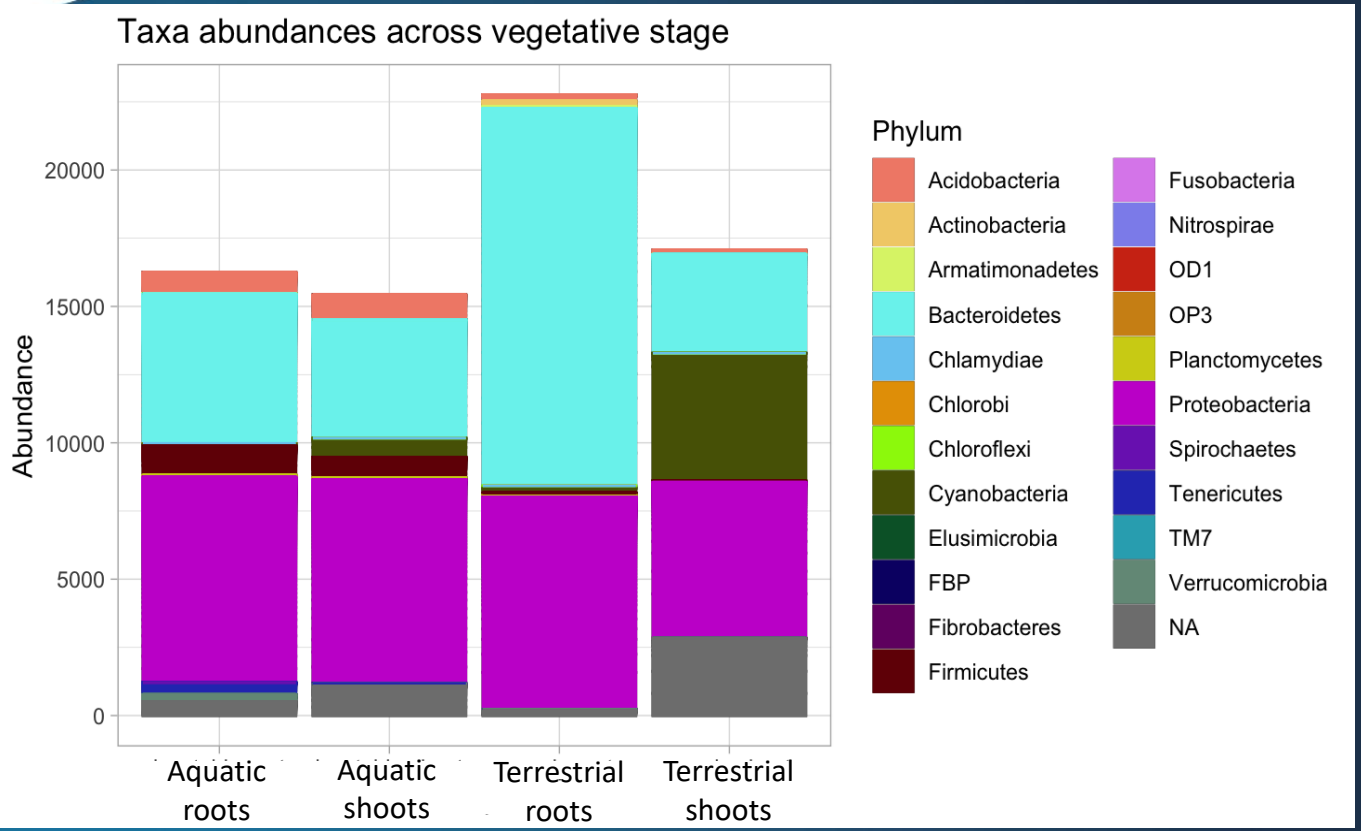
Preliminary Results

Prokaryotes



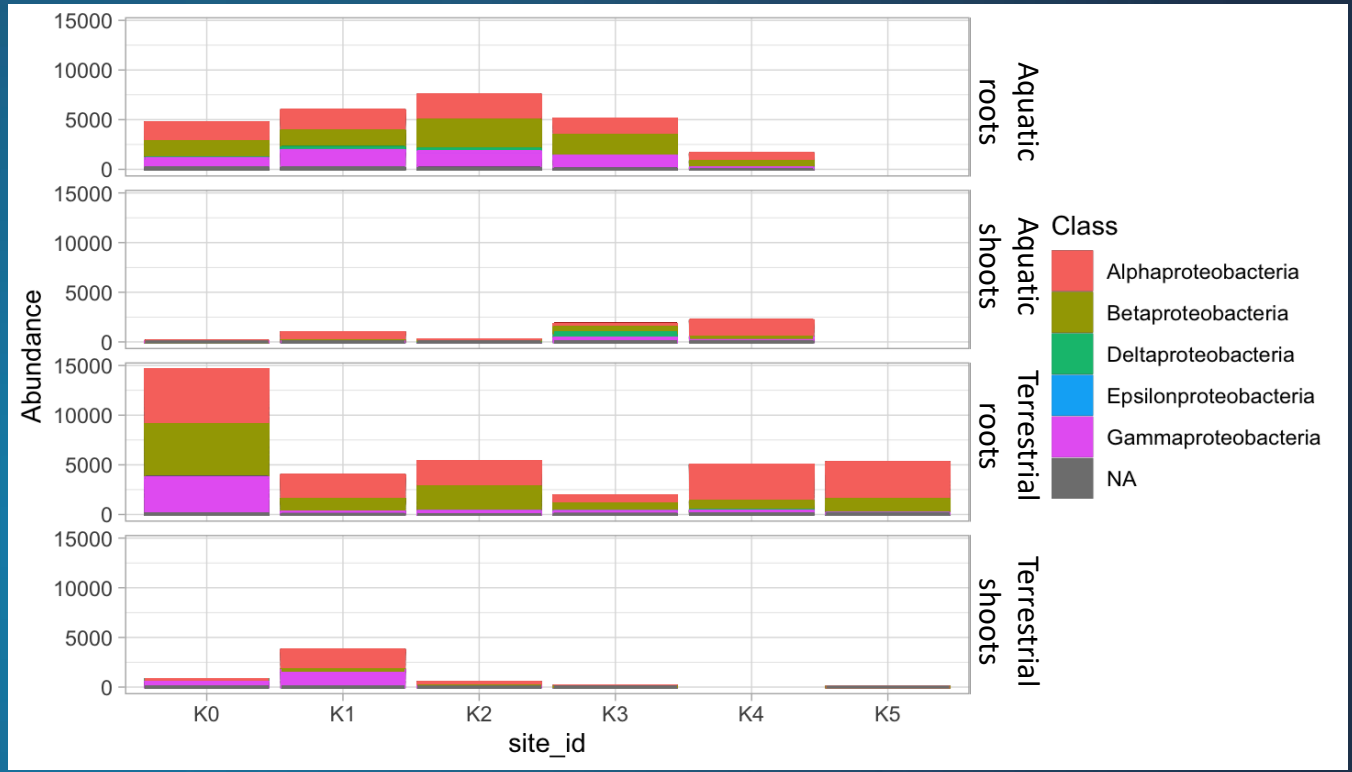
Prokaryotes





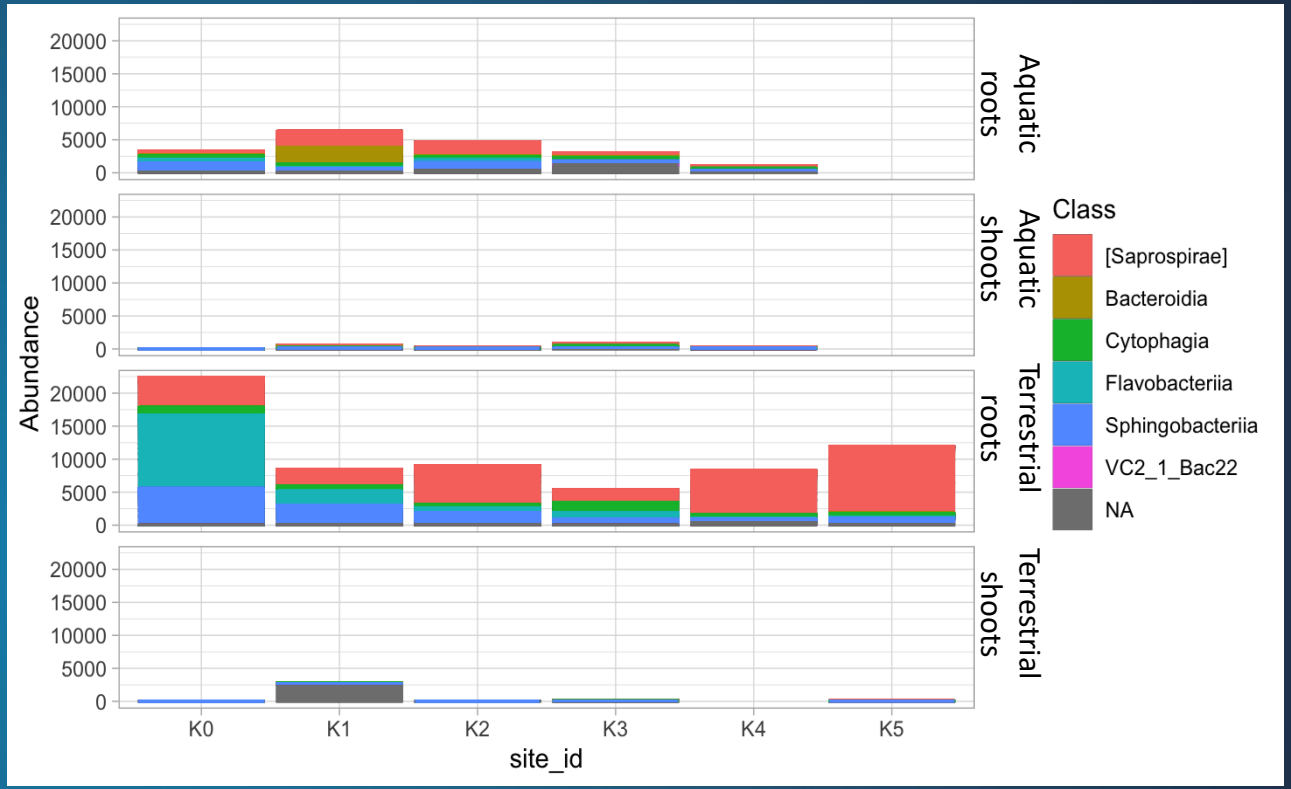
Prokaryotes

Proteobacteria

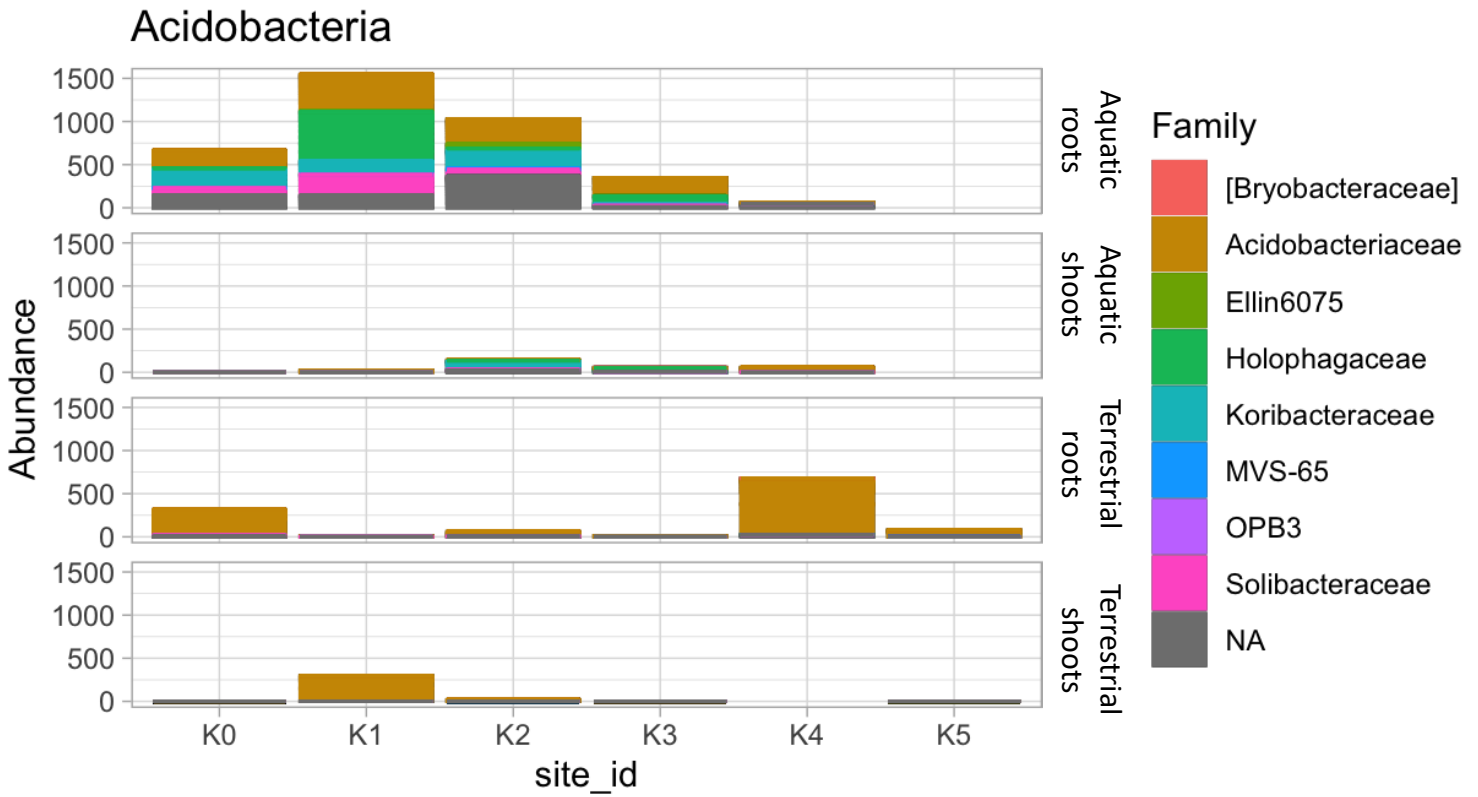


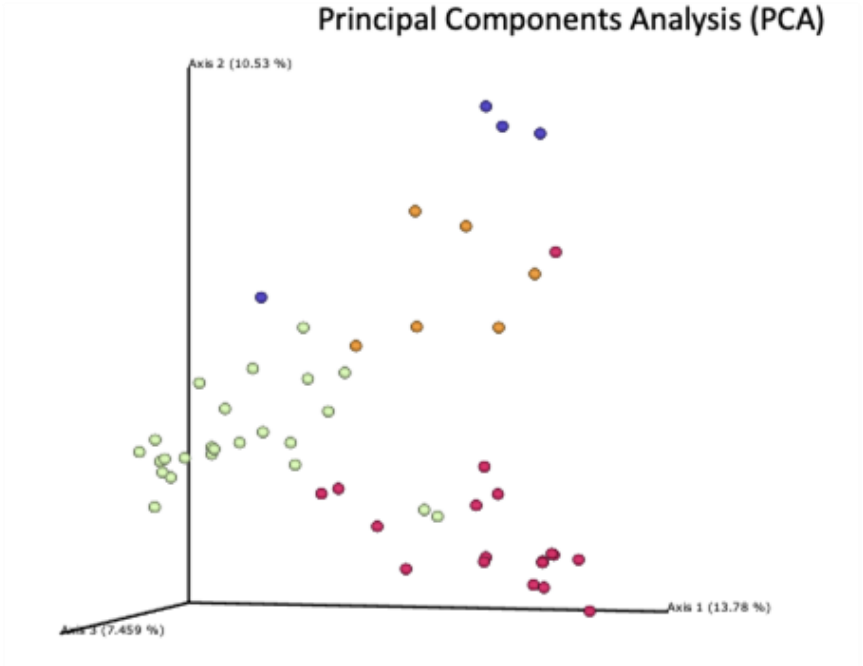
Prokaryotes

Bacteroidetes

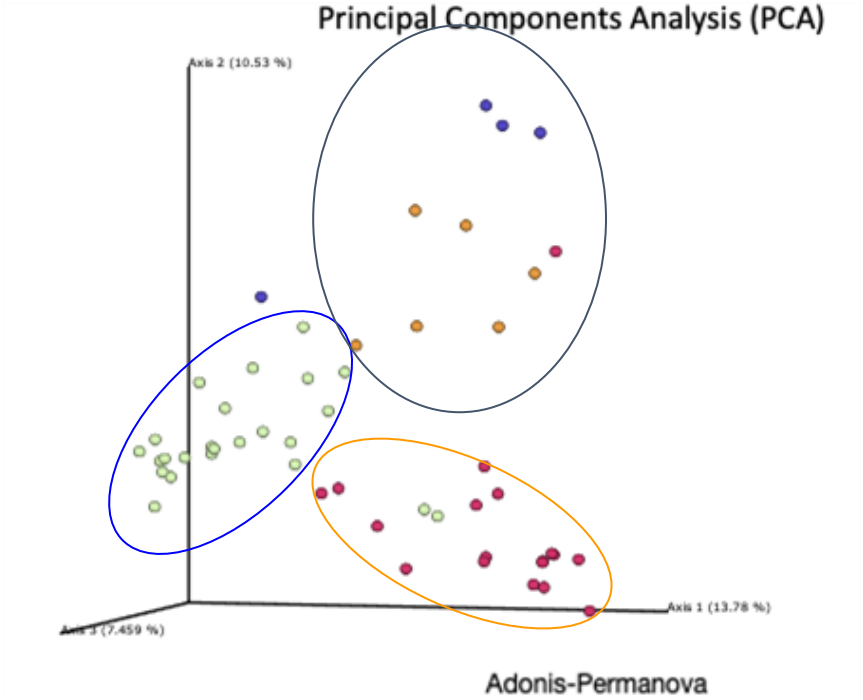


Prokaryotes





Weighted-UNIFRAC

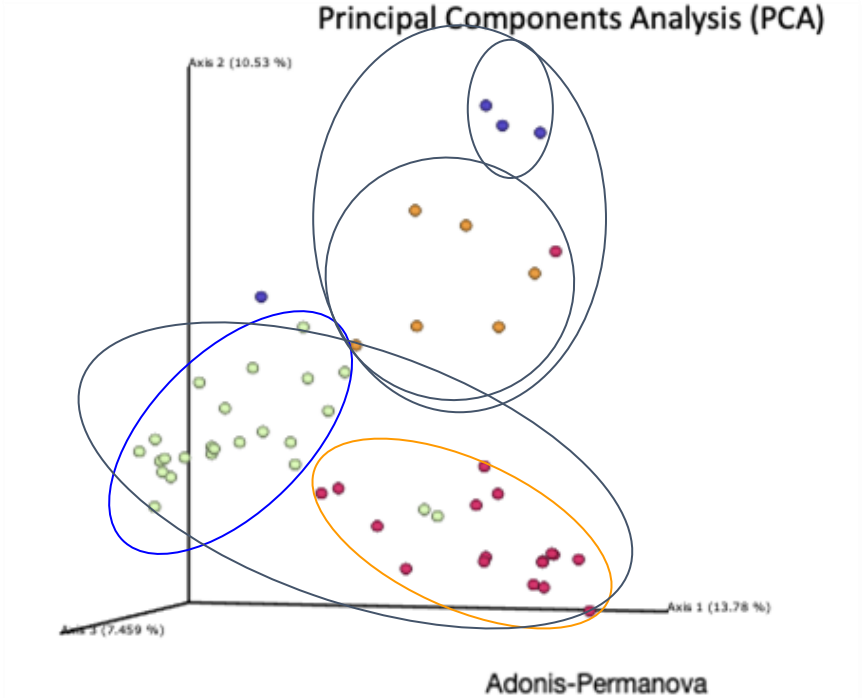


Aquatic stage - root

Aquatic stage - shoot

Terrestrial stage - root

Terrestrial stage - shoot



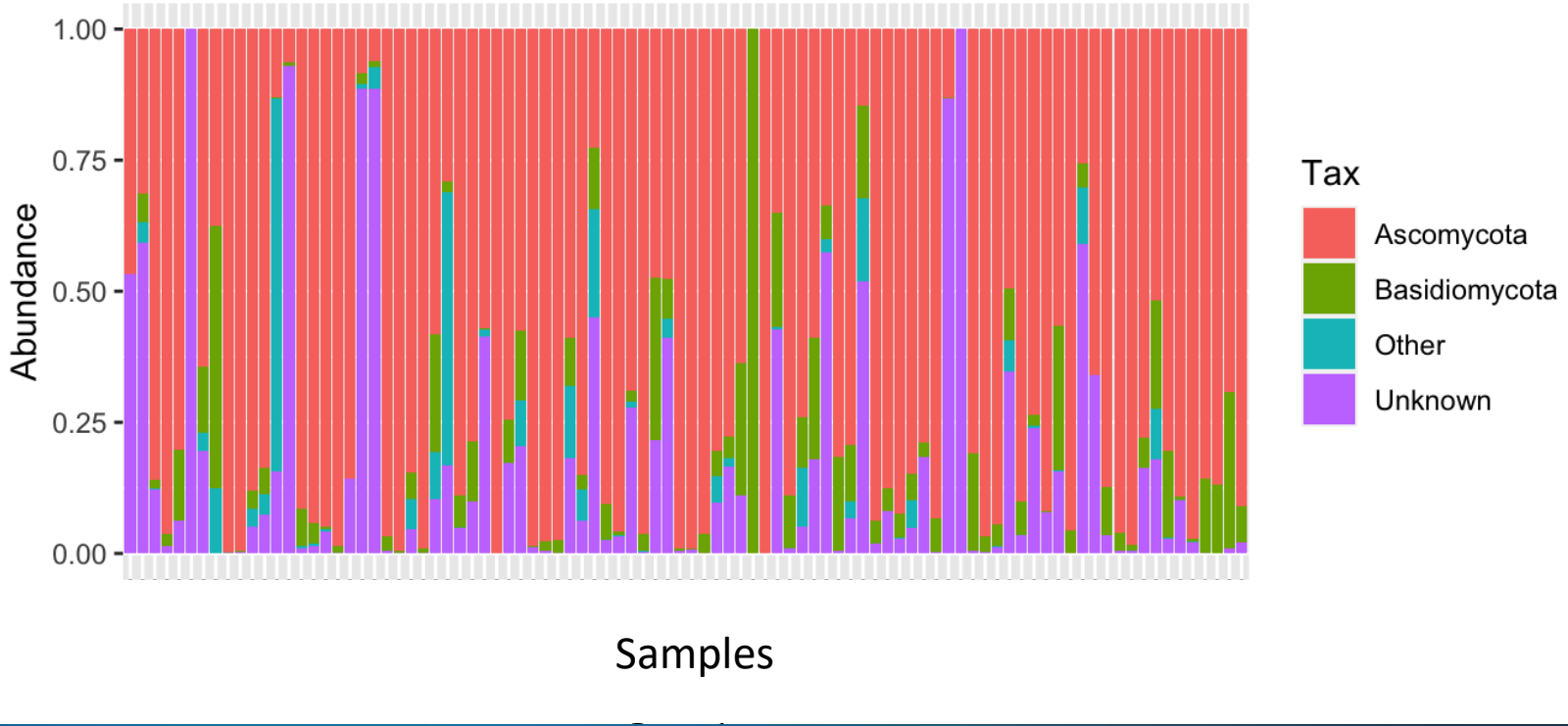
Aquatic stage - root

Aquatic stage - shoot

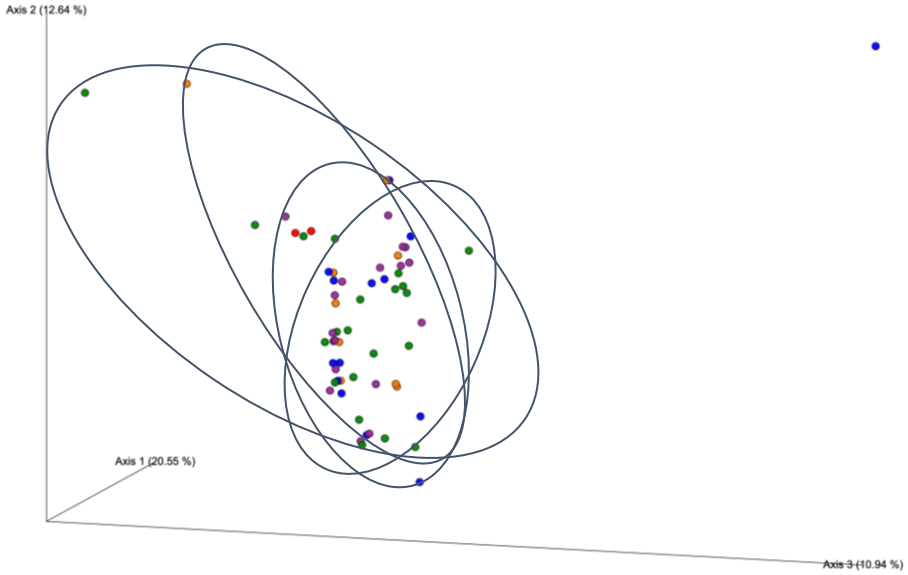
Terrestrial stage - root

Terrestrial stage - shoot

Fungi


1.00
0.75
0.50
0.25
0.00
Abundance
Samples
Tax
Ascomycota
Basidiomycota
Other
Unknown

Principal Components Analysis (PCA)



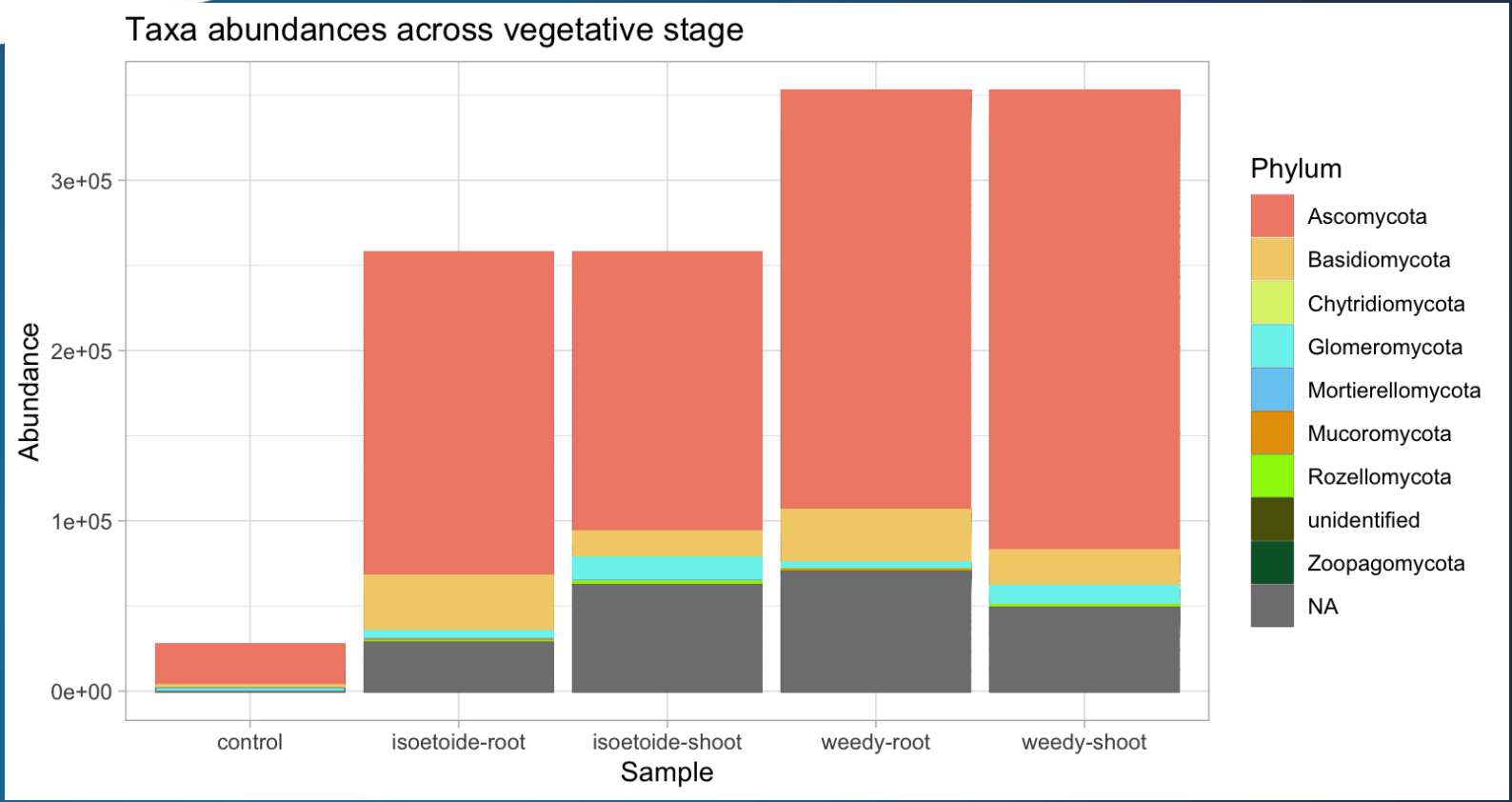
isoetoide-root

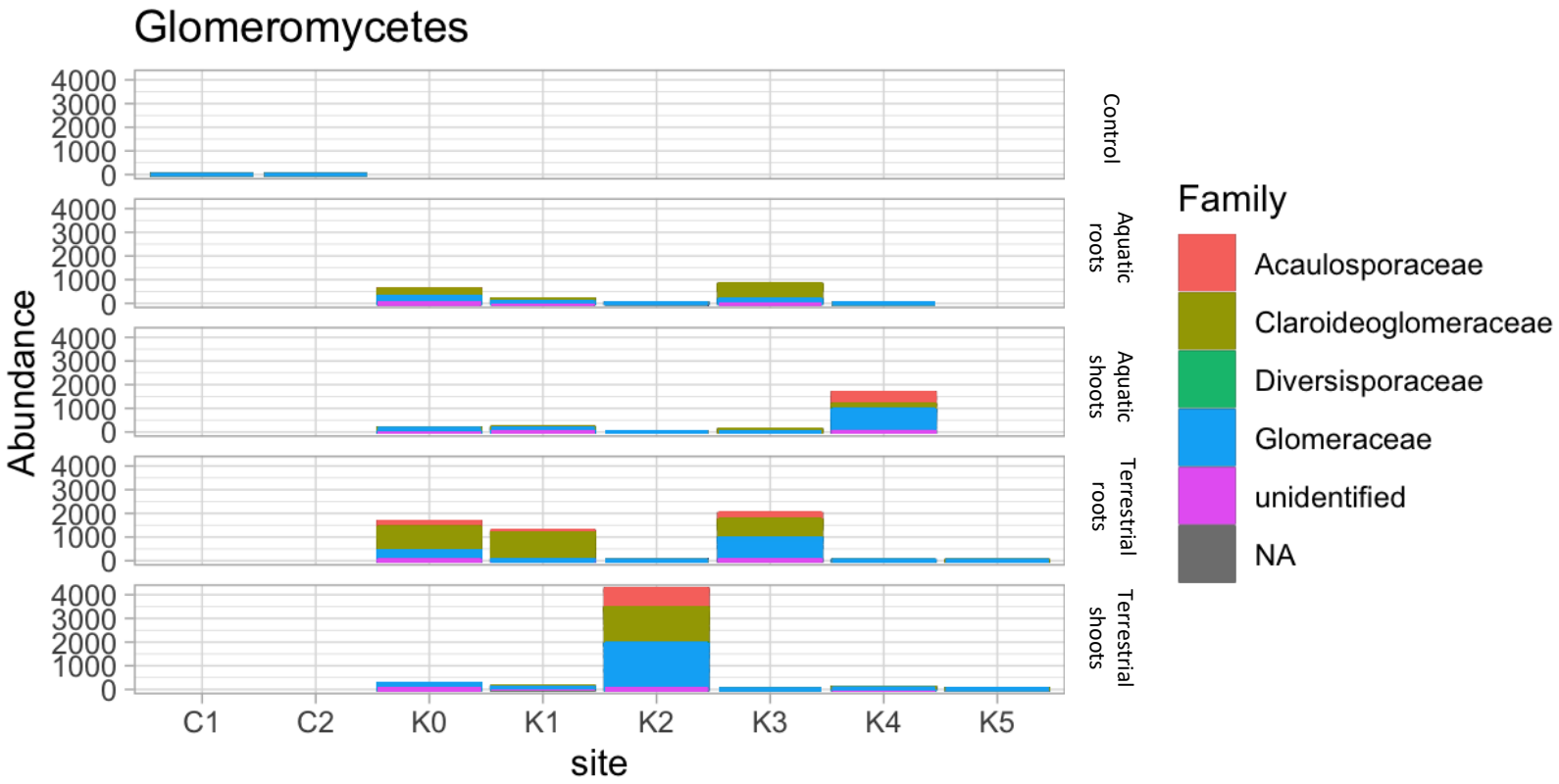
isoetoide-shoot

weedy-root

weedy-shoot

Fungi


Taxa abundances across vegetative stage
Abundance
3e+05
2e+05
1e+05
0e+00
control
isoetoide-root
isoetoide-shoot
weedy-root
weedy-shoot
Sample
Phylum
Ascomycota
Basidiomycota
Chytridiomycota
Glomeromycota
Mortierellomycota
Mucoromycota
Rozellomycota
unidentified
Zoopagomycota
NA


Glomeromycetes
Abundance
4000
3000
2000
1000
0
Control
Aquatic roots
Aquatic shoots
Terrestrial roots
Terrestrial shoots
C1
C2
K0
K1
K2
K3
K4
K5
site
Family
Acaulosporaceae
Claroideoglomeraceae
Diversisporaceae
Glomeraceae
unidentified
NA

Summary

- Aquatic roots and terrestrial roots microbiomes are differentiated
- Plant compartment is an important driver for community composition
- An experiment and microscopy required to address the role of microbial endophytes living within amphibious plants

Springer Link

Microbiology of Aquatic Systems | Open Access | Published: 31 December 2021

Archaeal and Bacterial Diversity and Distribution Patterns in Mediterranean-Climate Vernal Pools of Mexico and the Western USA

Jorge A. Mandussí Montiel-Molina, Jason P. Sexton, A. Carolin Frank & J. Michael Beman

Microbial Ecology (2021) | Cite this article

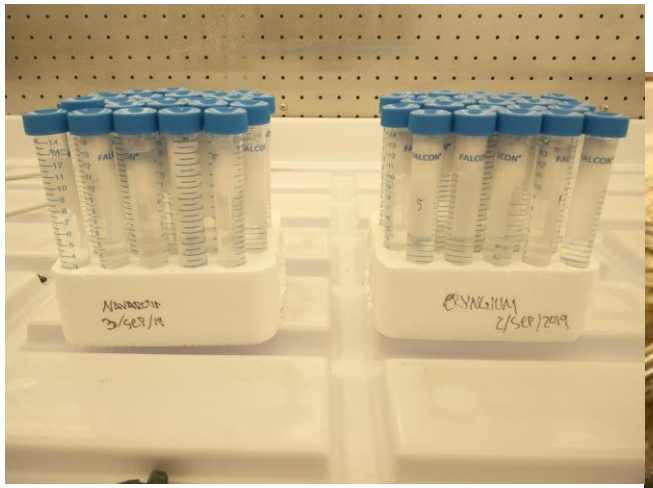
Abstract

Biogeographic patterns in microorganisms are poorly understood, despite the importance of microbial communities for a range of ecosystem processes. Our knowledge of microbial ecology and biogeography is particularly deficient in rare and threatened ecosystems. We tested for three ecological patterns in microbial community composition within ephemeral wetlands—vernal pools—located across Baja California (Mexico) and California (USA): (1) habitat filtering; (2) a latitudinal diversity gradient; and (3) a distance-decay relationship in community composition.

Future directions

Manipulative experiment

Plants with symbionts vs Plants without symbionts



General hypothesis:

Plants' ability to live in vernal pools environment is linked to fungal endophytes.

MELiSSA
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UNIVERSITY OF CALIFORNIA
UCMERCED
School of Engineering

CONACYT

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Dr. Michael Beman
Dr. Jon Keeley

THANK YOU.

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