



Microbes in vernal pools

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Microbes?

“Not very little to the naked eye”



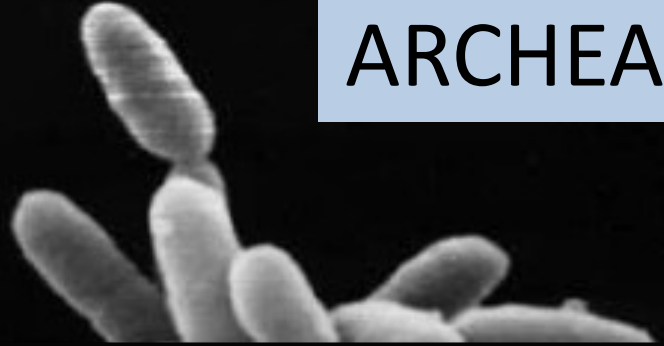


PROTOZOOA

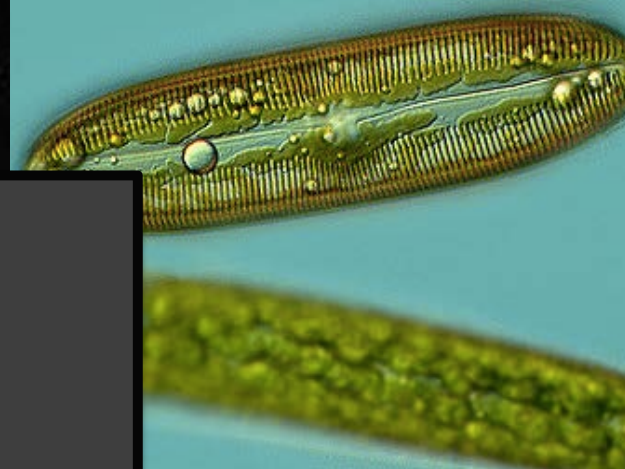


5
μm

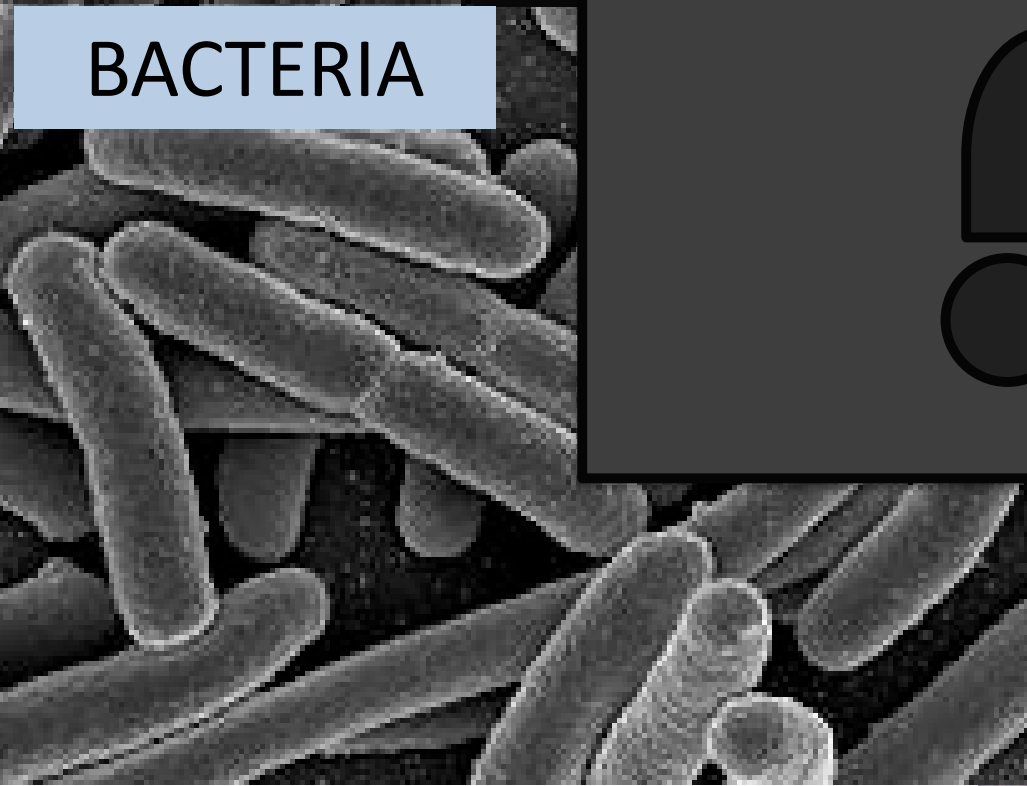
ARCHAEA



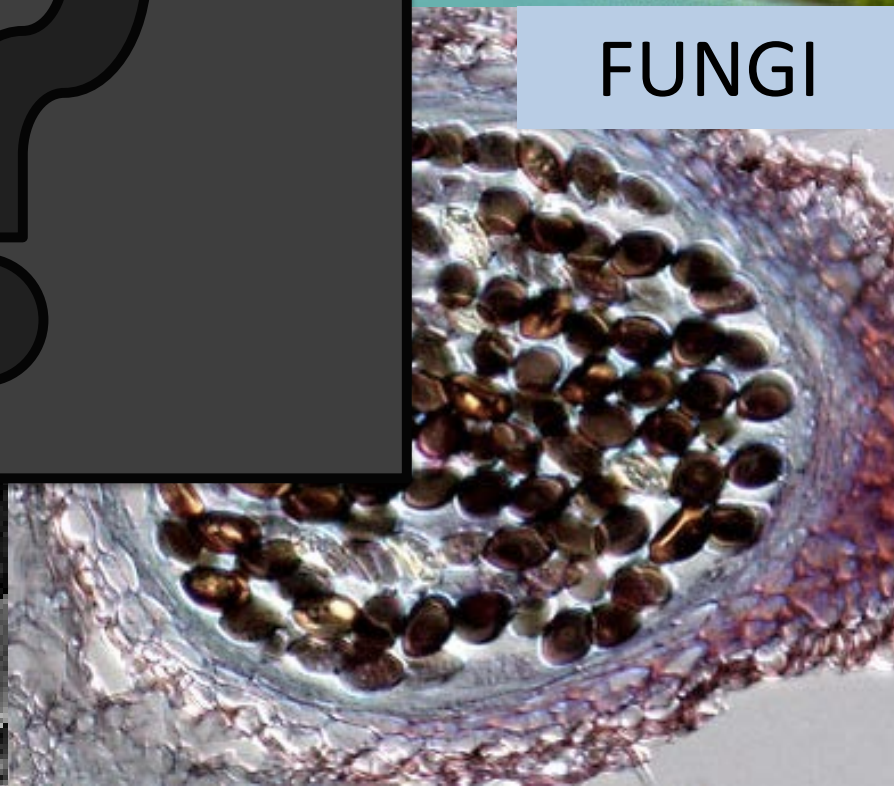
ALGAE



BACTERIA



FUNGI



Why they are important?

Microbial group	Process	Ecosystem service	Ecosystem service category
Heterotrophic bacteria/ archaea	Organic matter breakdown, mineralization	Decomposition, nutrient recycling, climate regulation, water purification	Supporting and regulating
Photoautotrophic bacteria	Photosynthesis	Primary production, carbon sequestration	Supporting and regulating
Chemo(litho)autotrophic	Specific elemental transformations (e.g., NH_4^+ , S_2^- , Fe_2^+ , CH_4 oxidation)	Nutrient recycling, climate regulation, water purification	Supporting and regulating
Unicellular phytoplankton	Photosynthesis	Primary production, carbon sequestration	Supporting and regulating
Archaea	Specific elemental transformation (e.g., metals, CH_4 formation, NH_4^+ oxidation), often in extreme habitats.	Nutrient recycling, climate regulation, carbon sequestration	Supporting and regulating
Protozoa	Mineralization of other microbes	Decomposition, nutrient recycling, soil formation	Supporting
Fungi	Organic matter breakdown and mineralization	Decomposition, nutrient recycling, soil formation, primary production (i.e., mycorrhizal fungi)	Supporting
Viruses	Lysis of hosts	Nutrient recycling	Supporting
All	Production of metabolites (e.g., antibiotics, polymers), degradation of xenobiotics, genetic transformation, and rearrangement	Production of precursors to industrial and pharmaceutical products	Provisional
All	Huge diversity, versatility, environmental and biotechnological applications	Educational purposes, getting students interested in science	Cultural

(Bodelier, 2011. *Frontiers in microbiology*)

MICROORGANISM IN VERNAL POOLS :

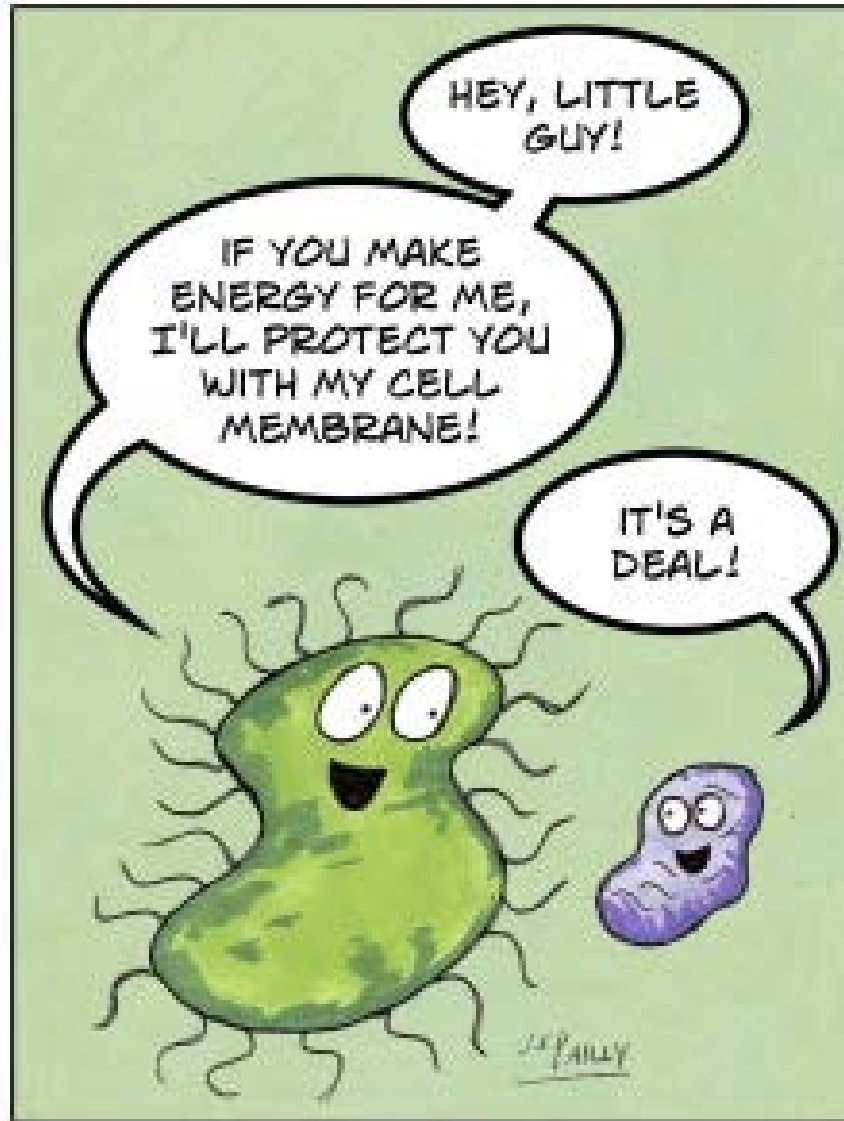
- PLANT SYMBIOSIS**
- DISTRIBUTIONAL PATTERN**



Microorganisms as symbionts

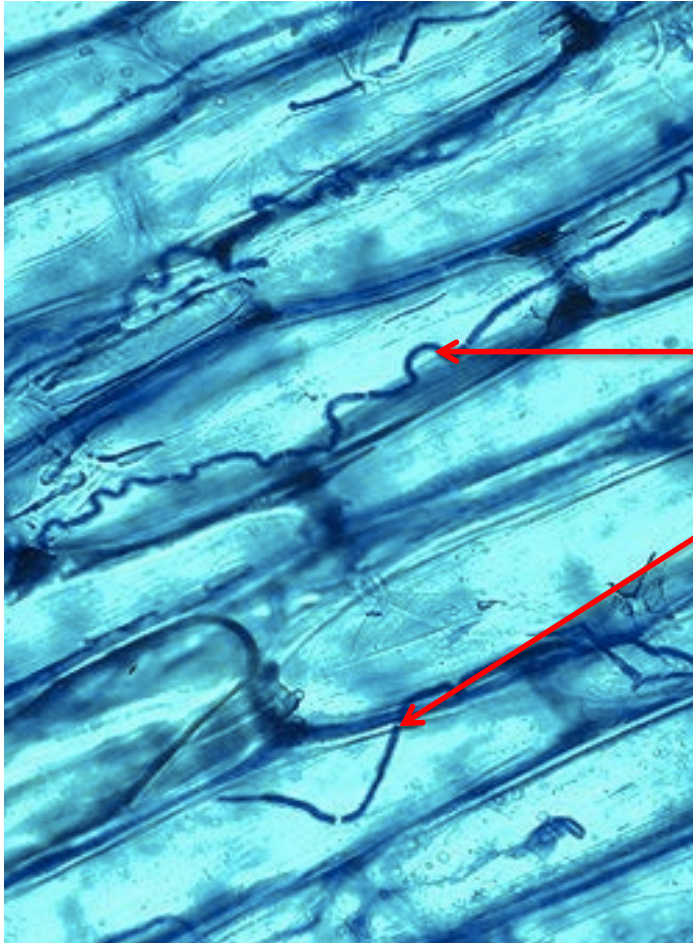
**DO FUNGAL ENDOPHYTES CONTRIBUTE TO
PLANT ADAPTATION IN VERNAL POOLS?**

Symbiosis



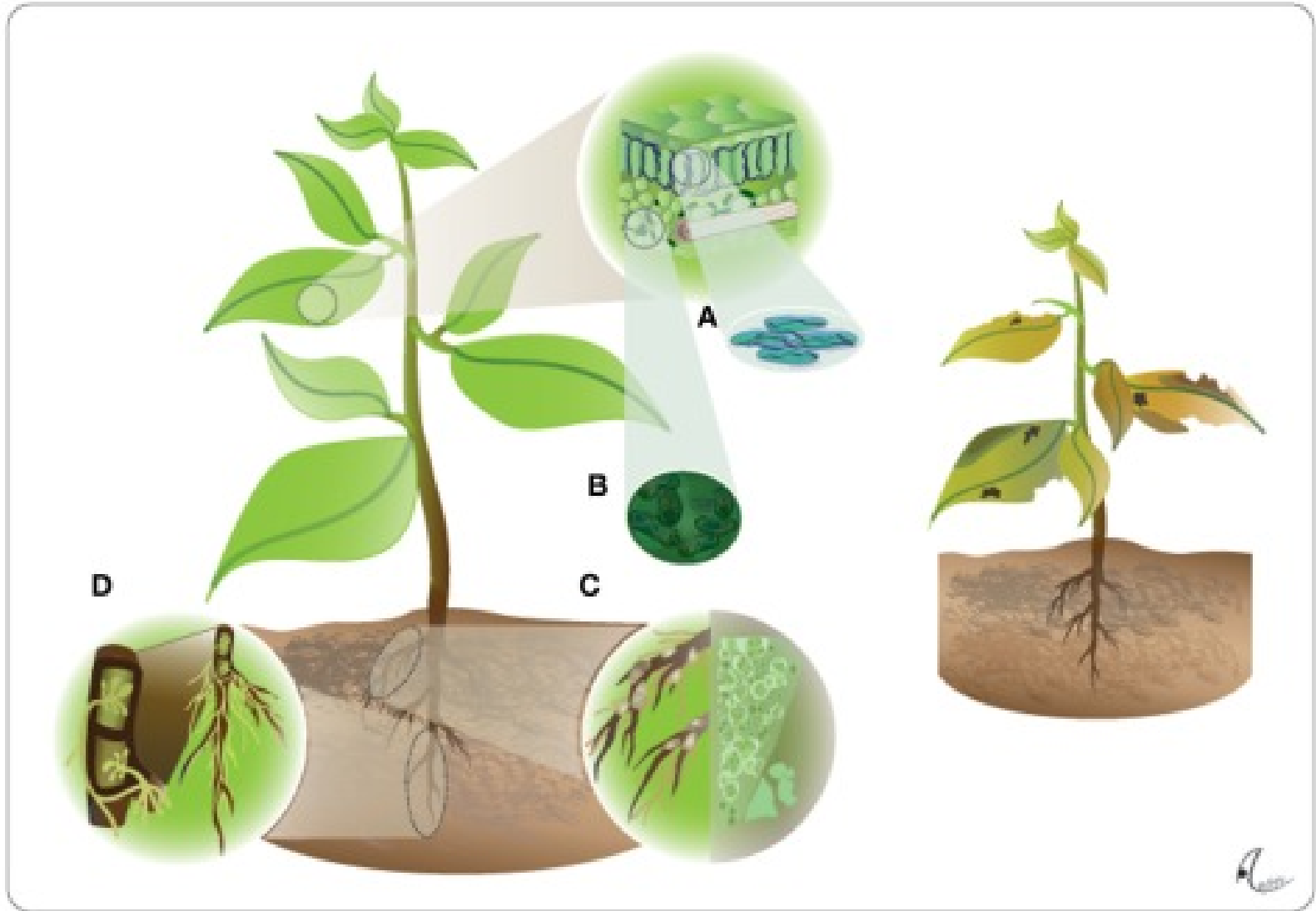
Fungal Endophytes

- Live inside plant tissues
- No diseases to the host



Fungal
endophytes
hyphae

environmental adaptation -> plant fitness



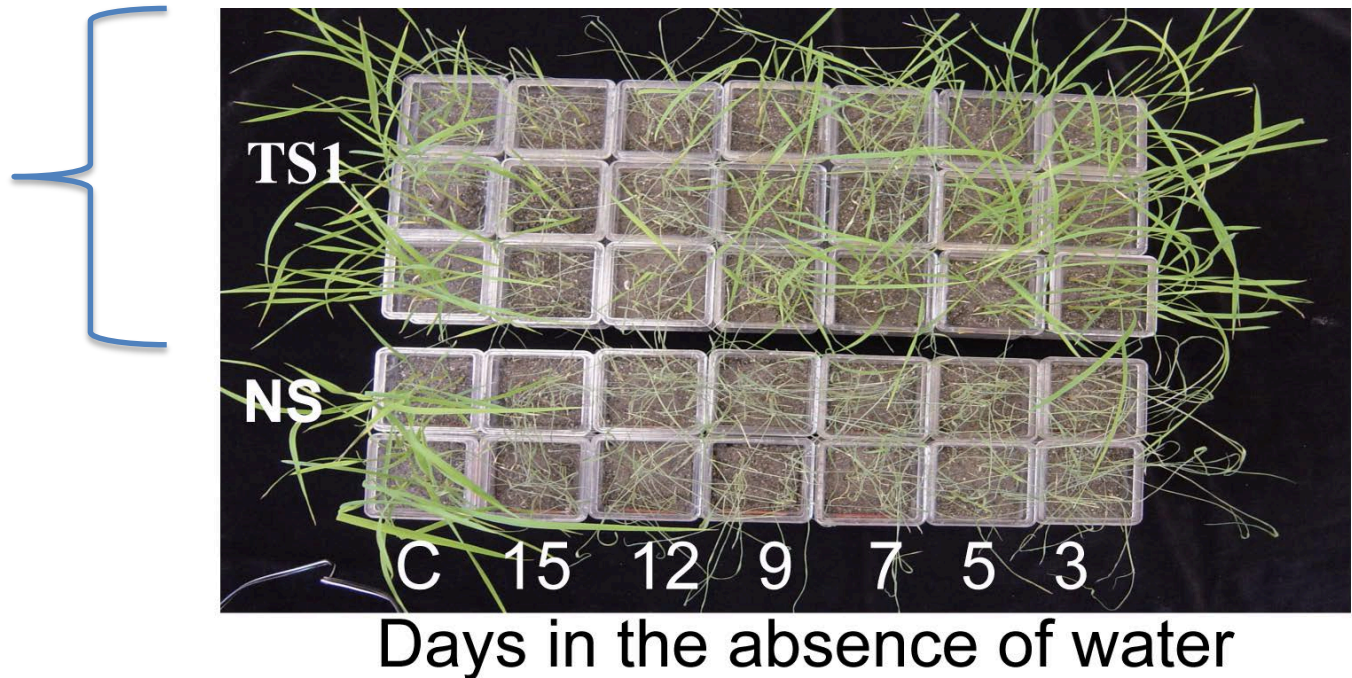
Fungal symbionts evidence

- Fungal endophyte confers heat tolerance to plants growing in geothermal soils in Yellowstone National Park (Rodriguez *et al.*, 2008)



- Tolerance via fungal endophyte symbiosis to drought stress has been reported (Rudgers & Swafford, 2008; Rodriguez *et al.*, 2009; Shi *et al.*, 2012).

Endophyte
drought
tolerant



What is happening in vernal pools?



Psylocarphus brevissimus



Amphibious plant



Evolution of Amphibious Vernal Pool Specialist Annuals: Putative Vernal Pool Adaptive Traits in *Navarretia* (Polemoniaceae)

STANLEY C. SPENCER

Rancho Santa Ana Botanic Garden, Claremont, CA 91711

CURRENT ADDRESS: Laboratory of Molecular Systematics, Smithsonian Institution

...some traits are perhaps advantageous for the vernal pools plants specialist, but are not likely evolutionary adaptations in the strict sense.

tunity to study adaptive evolution for two reasons. First, most of these plants exhibit a major shift in habitat preference from that of their terrestrial ancestors. Second, in most cases, this shift apparently has occurred recently. Because this adaptive evolution has been dramatic and recent, obligate vernal pool species may be compared with relatives of other habitats to determine what developmental, morphological, and reproductive traits may have been important for vernal pool adaptation. A number of traits have been proposed by various authors as adaptive in vernal pool specialists. We test whether these traits are strictly correlated with the vernal pool habitat in *Navarretia*, a genus with closely related vernal pool specialists and terrestrial species. All vernal pool specialist taxa and their closest terrestrial relatives of the California Floristic Province were observed in their native habitats and under uniform cultivation. Adaptive hypotheses are supported for non-shattering inflorescences, outcrossing, and isoetid juvenile growth form. Contrary to prediction, spininess is reduced in the vernal pool taxa compared with their terrestrial relatives. Indehiscent fruits, small seeds, and absence of glandular hairs are perhaps advantageous traits for the vernal pool *navarretias*, but are not likely evolutionary adaptations in the strict sense.

CITATION. Pages 76-85 in: C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (Editors). Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA. 1998.

Hypothesis

Fungal endophyte
associations influence plant
adaptation to environmental
stress in vernal pools.

Evidence of fungal advantageous associations

“*Orcuttia tenuis* need fungal interactions in order for germination to be activated”
(Griggs, 1981).

“Fungi play an important role in seed germination for *Orcuttia californica*”
(Keeley, 1988).

What is the role of fungal endophytes ?
Are they related to the amphibious behavior
of vernal pool plants?



Potential distribution patterns

**MICROBIAL COMMUNITIES IN VERNAL
POOLS**

DO MICROBIAL COMMUNITIES IN VERNAL POOLS SHOW SPATIAL STRUCTURE?





Because of its size, they are thought to be everywhere:


- “The lower the organization of the body is, the more generally it is distributed” (De Candolle, 1821)




- “Everything is everywhere: but the environment selects” (Baas-Becking, 1934)

☆ ●  **Biogeography of anaerobic ammonia-oxidizing (anammox) bacteria**
Puntipar Sonthiphand; MW Hall; JD Neu... - 2014 - Frontiers in Microbiology
...ciated with a greater overall **microbial** diversity (Table 1). The diversity of anammox ...

☆ ●  **Spatial and seasonal changes in species diversity of epilithic fungi along environmental gradients of a river**
Aya Miura; J Urabe - 2015 - Freshwater Biology
...York. Findlay S. (2010) Stream **microbial** ecology. Journal of the North American Benthological ...


☆ ●  **Annual periodicity in planktonic bacterial and archaeal community composition of eutrophic Lake Taihu**
Junfeng Li; J Zhang; L Liu; Y Fan; L ... - 2015 - Scientific Reports
Abstract: ...that temporal variation of the **microbial** community was significantly greater than ...
...that temporal variation of the **microbial** community was significantly greater than ...

Microorganisms show distributional patterns...

☆ ●  **Distance decay of similarity in freshwater communities: Do macro- and microorganisms follow the same rules?**
Anna Astorga; J Oksanen; M Luoto; J S... - 2012 - Global Ecology and Biogeography
Abstract: ...beta diversity, that is, do **microbial** organisms exhibit distance-decay patterns similar ...
...beta diversity, that is, do **microbial** organisms exhibit distance-decay patterns similar ...

☆ ● **Microbial**1. J. B. Martiny et al., **Microbial biogeography: putting microorganisms on the map**, Nat Rev Microbiol 4, 102–112 (2006). bio
J B Martiny; BJ Bohannan; JH Brown; R... - 2006 - Nat Rev Microbiol
Abstract: ...the idea that free-living **microbial** taxa exhibit biogeographic patterns. Current ...

☆ ●  **Microbial eukaryote communities exhibit robust biogeographical patterns along a gradient of Patagonian and Antarctic lakes**
M. Romina Schiaffino; E Lara; LD Fern... - 2016 - Environmental Microbiology
Abstract: **Microbial** eukaryotes play important roles in aquatic ecosystem functioning. Unravelling...
...10.1111/1462-2920.13566 **Microbial** eukaryote communities exhibit robust biogeographical ...

☆ ●  **Effects of increasing precipitation on soil microbial community composition and soil respiration in a temperate desert, Northwestern C**
Gang Huang; Y Li; YG Su - 2015 - Soil Biology and Biochemistry
Abstract: Soil **microbial** communities play a critical role in soil carbon cycling and influence...
Author Keywords: Desert ecosystem, **Microbial** community composition, Precipitation increasing, Soil...
...of increasing precipitation on soil **microbial** community composition and soil respiration ...

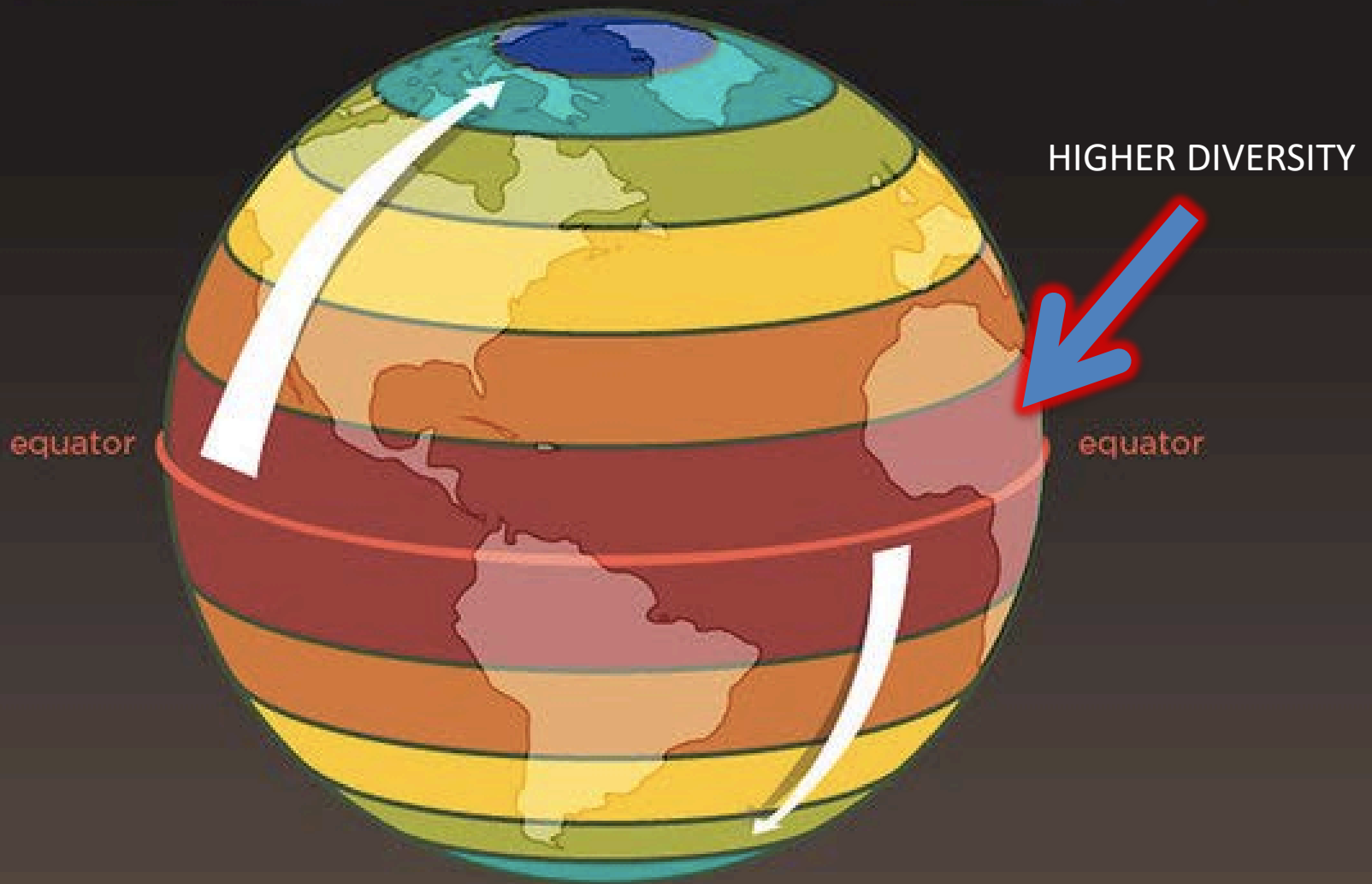
☆ ● **Microbial biogeography?**
John R. Dolan - 2006 - Journal of Biogeography
Abstract: ...matters, how researchers can determine **microbial** diversity, whether microbes can be ...
Author Keywords: ...00500], [organism], habitat type, intermed, **microbial** bi, **microbial** diversity pattern, recognition,...



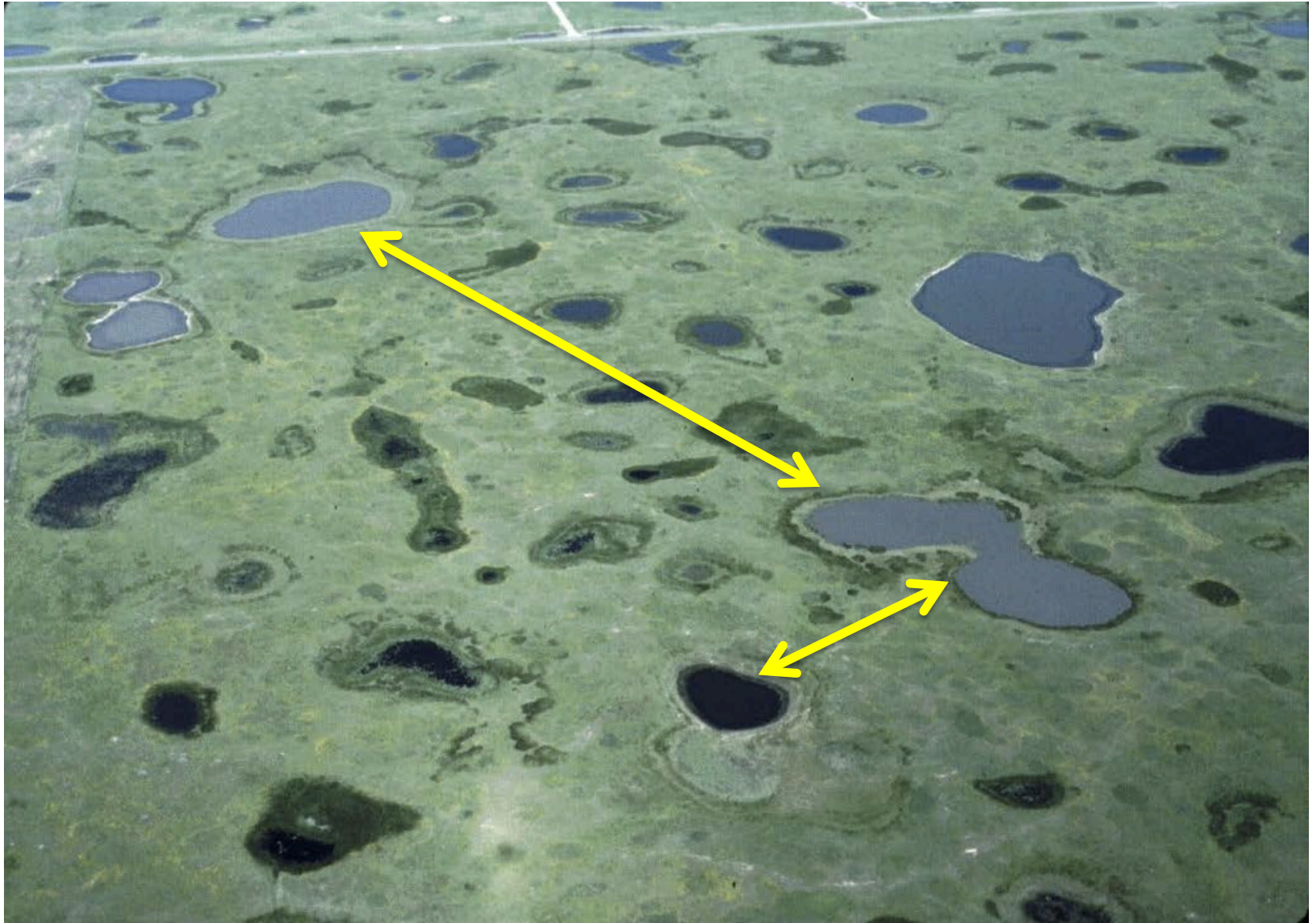
SIMILAR TO
MACROORGANISMS



Latitudinal Diversity Gradient



Variation by distance (distance-decay)



Vernal pools as a good system to study spatial distributions

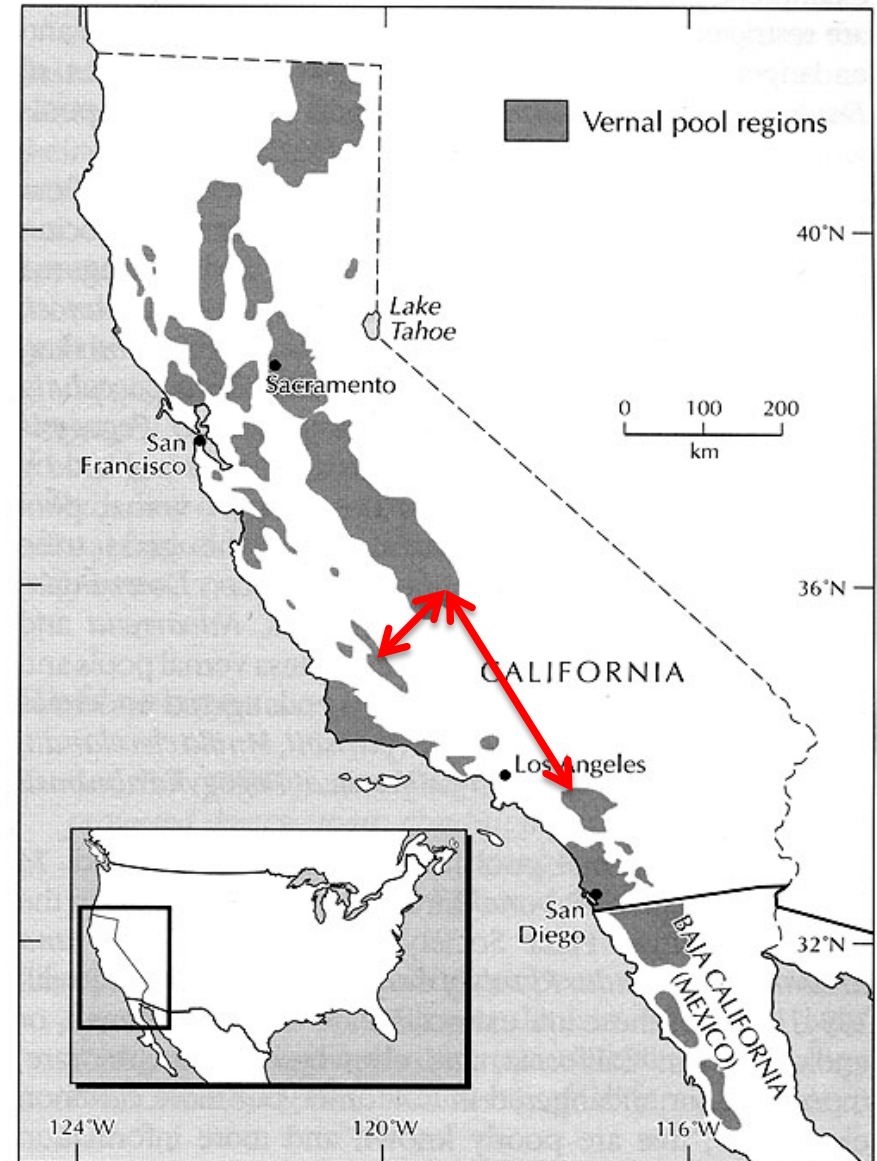
- Latitudinal gradient? 

- precipitation

- Distance-decay? 

- Dispersal

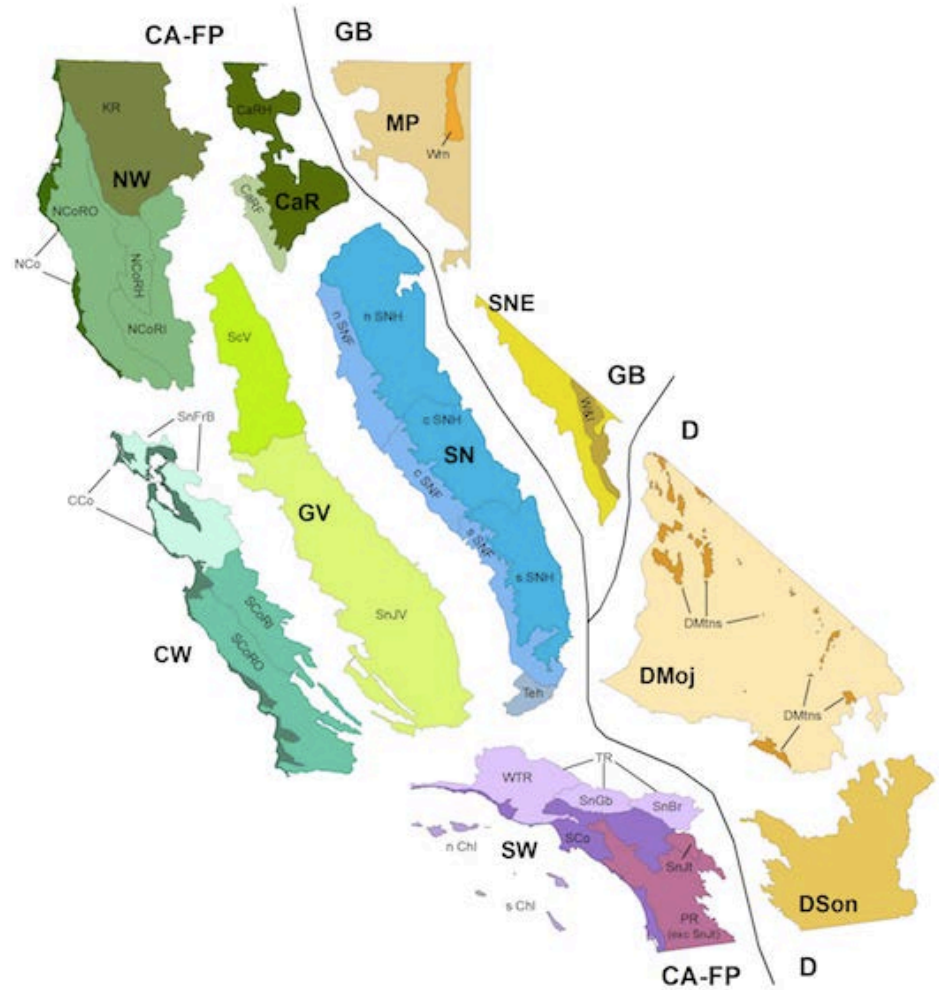
- Vernal pool environment



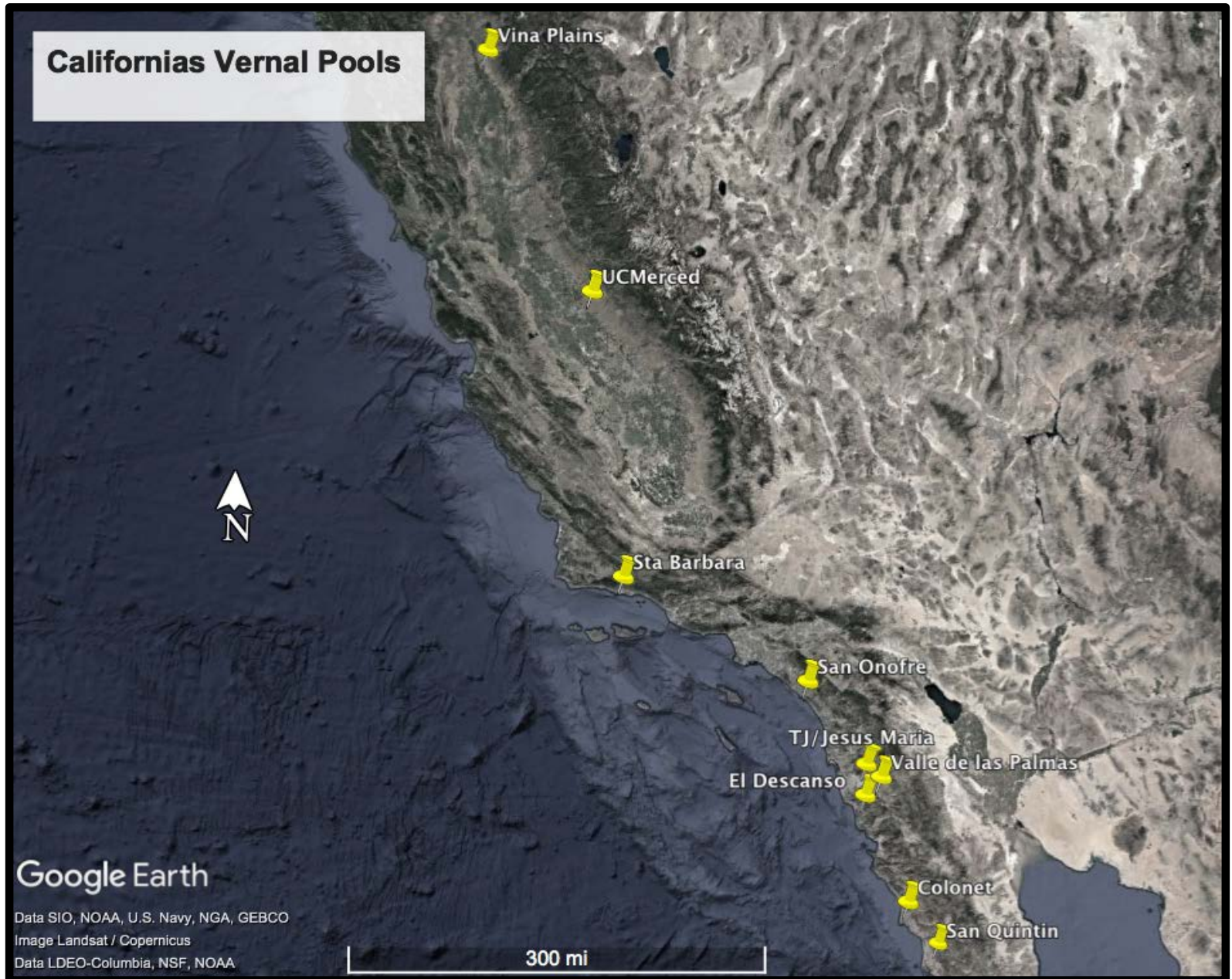


Biogeography

Provinces?
Regions?



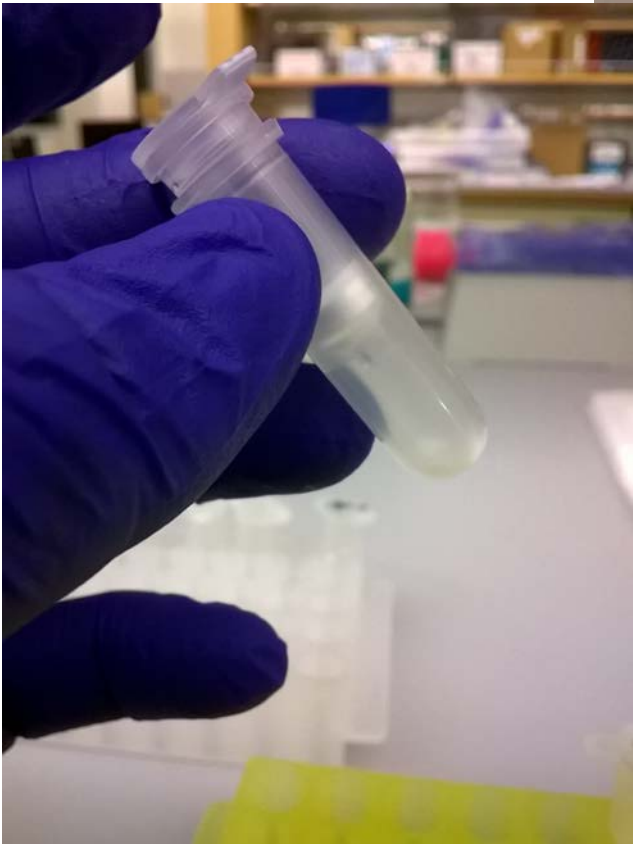
Sampling sites







Sequencing DNA



RESULTS

PRÓXIMAMENTE

GRACIAS.





CENTRO DE INVESTIGACIÓN CIENTÍFICA Y DE EDUCACIÓN
SUPERIOR DE ENSENADA



Programa de posgrado en Ciencias de la Vida con orientación en Biología
Ambiental

Distribución de flora rara y endémica de charcas vernaes en relación a las
propiedades fisicoquímicas del suelo.

Tesis
para cubrir parcialmente los requisitos necesarios para obtener el grado de
Maestro en Ciencias

Presenta:
Jorge Armando Montiel Molina

Ensenada, Baja California, México, 2013