README: this is an unorganized document of papers to remember to cite, analyses to remember to do, and random bs that might be worth thinking about during manuscript authorship.

Analysis ideas:

* Try to estimate how many endophytes in Wy, same for epiphytes. Do a phylogeny of them all.
* For each taxon compare its absolute abundances across plant taxa. The evenness of this is a way to look at its host specificity (sensu Ryoko Oono and Austin’s chapter) this could be a paper by itself.
* Do we see any vert. Transmitted endophytes in leaves or soil. Would be interesting to scour all studies for vert. Transmission to get the sequences, then see if they show up in the data anywhere.
* Could I approxiamate flavonoids and anthocyanins via contrasting red and visible absorbance as per that Gonzalez J o E paper I reviewed?!!
* look for outliers in data and doublecheck the its/16s shows they are the correct taxon. For instance, 3\_1\_1\_1- may be P. flexilis?
* DOUBLECHECK id of spruce, fir, and pine with ITS
* 3\_1\_4 has a few plants with slightly bigger leaves, dble check the ITS of those.
* Compare cooccurrance patterns with a nullmodel to see if co-occurrence is more likely for certain mirobes. E.g. Fungal-Fungal Associations Affect the Assembly of Endophyte Communities in Maize (Zea mays)
* Doublecheck that the Wind River samples from Big Sandy Lake are not outliers because these were impossible to keep on ice very well due to the difficulty of hiking them out. Also doublecheck the samples from deep in the N winds as those were not frozen as quickly either. All other samples were frozen within 5 hours of collection and mostly stored on ice in the field. In the future, for backcountry would be better to have a goat with lots of ice, or figure out some sort of buffer to use like DMSO.
* Figure out dates of sample parsing and make sure that is not predictive of anything. For instance, doublecheck second round of parsing does not have elevated contaminants, it shouldn’t but is worth doublechecking.
* For endophytes that are widespread genera (e.g. pseudomonas, alternaria) see how many OTUs are widespread. Is it just one strain that occurs across the state with any abundance? Compare and contrast the breadth of strain colonization within plants. E.g. does PICO have 10 strains of pseudomonas, but PIPO only 5? Does Alternaria have lots of abundant taxa but pseudomonas onlyhve a few abundant taxa. See <https://www.sciencedirect.com/science/article/pii/S1931312818303238>
* Are there more endophytes in glacial refugia? Do we have refugia?
* <https://www-pnas-org.libproxy.uwyo.edu/content/117/4/2043.short>
* The above citation suggests modularity increases in nutrient poor locations, do we see this with endophytes? How to determine nutrient poor...I guess by both taxon and location

To cite:

# **Fungal communities living within leaves of native Hawaiian dicots are structured by landscape‐scale variables as well as by host plants - Darcy et al. with Amend**

<https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.15544>

Fig. 2 in this is a nice way to show environmental variation

<https://apsjournals.apsnet.org/doi/pdfplus/10.1094/PBIOMES-01-20-0006-R>

Leveau’s paper with replicast leaves, shows importance of leaf microtopography.

Tons of good shit in :**A brief from the leaf: latest research to inform our understanding of the phyllosphere microbiome**

[Johan HJLeveau](https://www.sciencedirect.com/science/article/pii/S1369527419300566#!)

# **Relationships between endophyte diversity and leaf optical properties**

* [Arturo Sanchez-Azofeifa](https://link.springer.com/article/10.1007/s00468-011-0591-5#auth-1),
* [Yumi Oki](https://link.springer.com/article/10.1007/s00468-011-0591-5#auth-2),
* [G. Wilson Fernandes](https://link.springer.com/article/10.1007/s00468-011-0591-5#auth-3),
* [Ronald Aaron Ball](https://link.springer.com/article/10.1007/s00468-011-0591-5#auth-4) &
* [John Gamon](https://link.springer.com/article/10.1007/s00468-011-0591-5#auth-5)

# Co-occurring Fungal Functional Groups Respond Differently to Tree Neighborhoods and Soil Properties Across Three Tropical Rainforests in Panama

Worth looking into for any soil work

Ef in bark - cite for influence of traits

<https://onlinelibrary.wiley.com/doi/full/10.1111/mec.15237>

Possible order of papers:

1. Ultradeep sequencing reveals unexpected biodiversity in the phyllosphere

-biodiv characterization, blah blah, talk about how it could change Hawksworth, what is a taxon, compare epiphytes and endophytes and 16s and its, acknowledge limtiations of primers

1. Link Otus, diversity, etc, to traits.
2. Diversity versus elevation.
3. Host breadth

https://www.nature.com/articles/s41396-019-0470-4?utm\_source=ismej\_etoc&utm\_medium=email&utm\_campaign=toc\_41396\_13\_11&utm\_content=20191016&WT.ec\_id=ISMEJ-201910&sap-outbound-id=9DAA0F525CB54BCA4ABAADA7497C1DADC7FEC848&mkt-key=005056B0331B1ED8B3CF6BFF11CF0BF2

# **Fungal communities living within leaves of native Hawaiian dicots are structured by landscape-scale variables as well as by host plants**

Cite in evidence that biomass is what drives ecosystem functoni

<https://besjournals-onlinelibrary-wiley-com.libproxy.uwyo.edu/doi/full/10.1111/1365-2745.13169>

The cobain and amend paper from Hawaii

Arnold AE, Engelbrecht BMJ. Fungal endophytes nearly double minimum leaf conductance 444 in seedlings of a neotropical tree species. J Trop Ecol 2007; 23: 369–372.

Plant Identity Influences Foliar Fungal Symbionts More Than Elevation in the Colorado Rocky Mountains

Liu, X., Ma, Z., Cadotte, M. W., Chen, F., He, J. S., & Zhou, S. (2018). Warming affects foliar fungal diseases more than precipitation in a Tibetan alpine meadow. New Phytologist.

Van Bael, S., Estrada, C., & Arnold, A. E. (2017). 6 CHAPTER Foliar Endophyte Communities and Leaf Traits in Tropical Trees. The Fungal Community: Its Organization and Role in the Ecosystem, 79.

Larger plants promote a greater diversity of symbiotic nitrogen-fixing soil bacteria associated with an Australian endemic legume

-Evidence that long-lived large plants are reservoirs

Paper to cite regarding the influence of light exposure:

Fahimipour, A. K., Hartmann, E. M., Siemens, A., Kline, J., Levin, D. A., Wilson, H., ... & Siemens, K. N. (2018). Daylight exposure modulates bacterial communities associated with household dust. *Microbiome*, *6*(1), 175.

Laforest Lapointe Nat: We obtained data on host plant functional traits including maximum photosynthetic capacity (Amass), leaf longevity (LL), leaf mass per area (LMA), leaf nitrogen content (Nmass), and wood density (WD) from global databases ([Extended Data Table 1](https://www.nature.com/articles/nature22399#t3)). To estimate total plant community productivity, we measured the diameter and height of each 13,824 trees at the end of the sixth growth year (2014) since planting and then estimated the aboveground stem volume (Vplot) with the following formula:

From Nillsons Nat Rev paper: “Across fungi, the abun- dance of pathogens declined with decreasing anthro- pogenic influence on habitats126 and soil dryness109. “

Should look and see if we find decline in pathogens with elevation or soil moisture

From Worldwide leaf econ. Spectrum: <https://www.nature.com/articles/nature02403>

“This spectrum runs from species with potential for quick returns on investments of nutrients and dry mass in leaves to species with a slower potential rate of return. At the quick-return end are species with high leaf nutrient concentrations, high rates of photosynthesis and respiration, short leaf lifetimes and low dry-mass investment per leaf area. At the slow-return end are species with long leaf lifetimes, expensive high-LMA leaf construction, low nutrient concentrations, and low rates of photosynthesis and respiration.”

Table 1 in ths paper shows more correlations. THis means that we can use %N and photosynthetic rate as a proxy of leaf age, and these two former traits should go a long way towards placing a leaf on the economic spectrum. Leaf thickness and area may help too as I can imagine larger, thicker leaves require more investment.

We could imagine microbes of different life histories would prefer one type of leaf over another. Lets think fungi, bc bacteria reproduce so fast that maybe they dont care as much (hypothesis to test). Fungi may like the nutrients in quick to live and quick to die leaves, they may also like that they can get access to the senescing cells quicker and dont have to wait as long for the goods, if they are latent saprotrophs. ON the other hand, longer lived leaves that persist give fungi more of an opportunity to colonize the leaf and could achieve longer lives...perhaps the longer lifespan and more stable habitat would allow for the development of sexual structures? If you only have a little time, then you would want to reproduce asexually and spread quickly. If you have more time, then perhaps battles with pathogens/competitors become more important and you need the genetic variation begat by sex. Hypothesis to test. Can we determine if an organism reproduces mostly sexually or asexually from 16s data, from metagenomics data? Maybe by looking for heterozygosity within a sample?