Does morphology of *Penicillus* affect its usage as invertebrate habitat?

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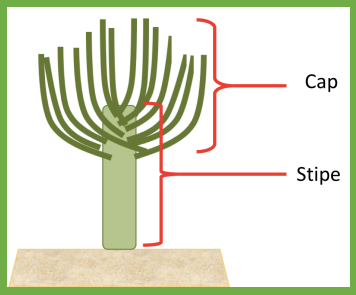
Penicillus as a contributor to habitat complexity

- Macroalgae has been well known to contribute to habitat complexity in shallow marine ecosystems, particularly seagrass beds (Schneider et al., 1991; Norkko et al., 2000)
- *Penicillus* spp. is an abundant and one of many macroalga that can be habitat or food for very small invertebrate epifauna.
- Previous studies have shown that increased *Penicillus* cap size contribute more to invertebrate diversity (Stoner 1985).
- In south Florida, there are at least three recorded *Penicillus* species found in seagrass beds: *P. capitatus*, *P. dumetosus*, and *P. lamorouxii* (Littler and Littler 2000, Dawes and Mathieson, 2008)
- South Florida also has varying degrees of anthropogenic influences, such as changes in salinity and nutrient, which have been shown to change macroalgal community composition (Collado-vides et al., 2011; Lirman et al., 2014). These changes can also potentially affect associated invertebrate epifauna
- The purpose of this **preliminary pilot study** is to discern whether the morphology of *Penicillus* spp. affects the diversity of invertebrates that live on that algae in south Florida.



Conceptual model of *Penicillus*

Questions and Hypotheses

1. **Is there a difference in *Penicillus* spp. present between sites?**

   Hypothesis: We expect that a site that is less affected by anthropogenic influences would have more *Penicillus* spp. than a more anthropogenically-influenced site.

2. **Is there a difference in *Penicillus* morphology between the two sites?**

   Hypothesis: We expect a difference in algal morphology (*Penicillus* cap size, dry weight, etc.) between our two study sites.

3. **How does algal morphology affect the diversity of invertebrates inhabiting it?**

   Hypothesis: We expect that *Penicillus* with larger morphological traits (e.g. larger cap size, heavier dry weight, etc.) would have more invertebrates living on *Penicillus*.

Methods

- **Study Sites**: The two sites selected are Sprigger Bank and Deering Estate (see map). Both sites are separate from each other and differed from levels of anthropogenic influences (Sprigger Bank has less while Deering Estate has more).
- **Field Collection**: From the two sites, we collected individual *Penicillus* thalli (and associated epifauna.) *Penicillus* was cleaned and sorted of invertebrates, while thalli was measured of cap and stipe, and dried for dry weight.
- **Statistical analyses**: T-test used to compare invertebrate abundances and *Penicillus* morphological traits between sites. Regression analysis used to determine a relationship between invertebrate abundances and *Penicillus* morphological traits.

Acknowledgements

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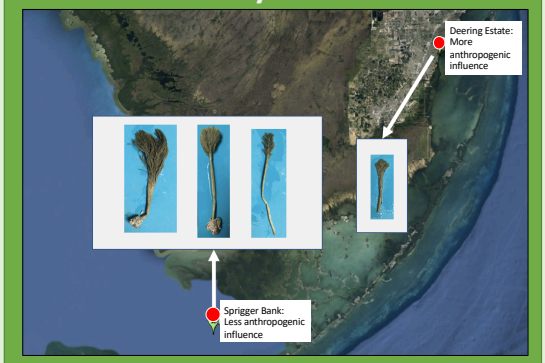
Morphologies of *Penicillus* found (so far)

Species	*Penicillus dumetosus*	*Penicillus capitatus*	
Morphology	Dumetosus	Bulbous	Elliptical ("pinecone")
Description	Cap siphons extend out vertically from the stipe, creating a sharp transition from stipe to cap. Cap siphons long and uncalcified	Common. Stipe in center of cap; cap siphons extending from stipe diagonally upward. Cap siphon density often dense (though not as much as Deering's)	Uncommon. Cap siphons extending horizontally from stipe short in length. Cap siphon density much less than bulbous form.
Example Pictures			

Study Sites



Selected Invertebrate Inventory as of March 2017
(Input on Identification welcome! ☺)


Carpias spp. (Isopod)


Sphaeromatid isopod spp.

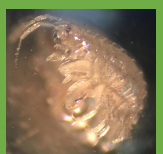

Unk. Amphipod spp. 1

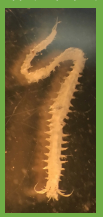

Dulichiella spp. (Amphipod)


Maera spp. (Amphipod)


Caprellid spp. (Amphipod)


Unk. Amphipod spp. 2


Unk. Amphipod spp. 3


Nereid worm spp. (polychaete)


Leptochiela spp. (Tanaid)


Spirorbis spp. (Polychaete)

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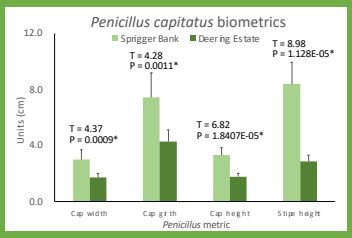
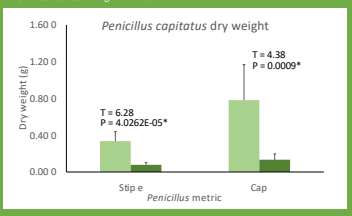
There are differences in *Penicillus* morphological traits between sites...

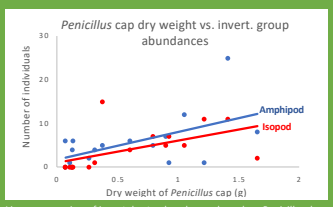


Comparative analysis of *Penicillus* morphological traits between the two sites. Values above are results of T-Test. Asterisk next to P-value denotes statistical significance



Comparative analysis of *Penicillus* dry weight between the two sites. Values above are results of T-Test. Asterisk next to P-value denotes statistical significance

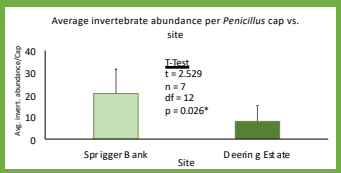
... And some invertebrates (e.g. Amphipods and Isopods) are more abundant in Sprigger Bank (with larger *Penicillus*) than at Deering Estate



Linear regression of invertebrate abundances based on *Penicillus* dry weight. Note that both Sprigger Bank and Deering Estate data are being used.

	Penicillus biometric		
Invert.	Cap height	Cap girth	Cap dry weight
Amphipod	0.30	1.17	6.47
	0.592	0.297	0.022*
Isopod	3.75	5.37	6.50
	0.072	0.035*	0.022*

Regression analysis results of varied *Penicillus* biometrics on invertebrate group abundances. Top number is F-value, while bottom number is P-value. Asterisk notes statistical significance.



Comparison of average total invertebrate abundance per *Penicillus* cap between sites. Asterisk next to P-value denotes statistical significance

n = 7 df = 12	Amphipods	Isopods	Tanaids	Sabellids	Phyllo-docids	Mytiloids	Caeno-gastropods
T-stat	2.15	3.86	1.76	-1.25	2.71	1.15	-1.55
P-value	0.03*	0.001*	0.05	0.12	0.01*	0.14	0.07

T-test results of abundances of invertebrate groups found between the two sites. Asterisk next to P-value denotes statistical significance.

Conclusion

- From the two sites, there are already differences shown in *Penicillus* species, morphology within species, and site, suggesting a clear need to further refine *Penicillus* taxonomy.
- From preliminary data collected for one month, there is already a difference in amphipod and isopod abundances based on morphology and site. There also seems to be higher abundance of invertebrates in Sprigger Bank overall as well.
- Data collected has suggested that *Penicillus* is an essential component of habitat for invertebrate epifauna in south Florida.
- While we have collected only one month's worth of data, we would like to further determine if there is a seasonality effect on *Penicillus* morphology and invertebrate diversity.