Statistical Analysis of Amplicon Data

Part 2
February 22, 2019

Useful Reference

- GUide to STatistical Analysis in Microbial Ecology (GUSTA ME)!: https://mb3is.megx.net/gustame

Beta Diversity:
How different are sites?

http://www.webpages.uidaho.edu/veg_measure/Modules/Lessons/Module%209(Composition&Diversity)/9_2_Biodiversity.htm

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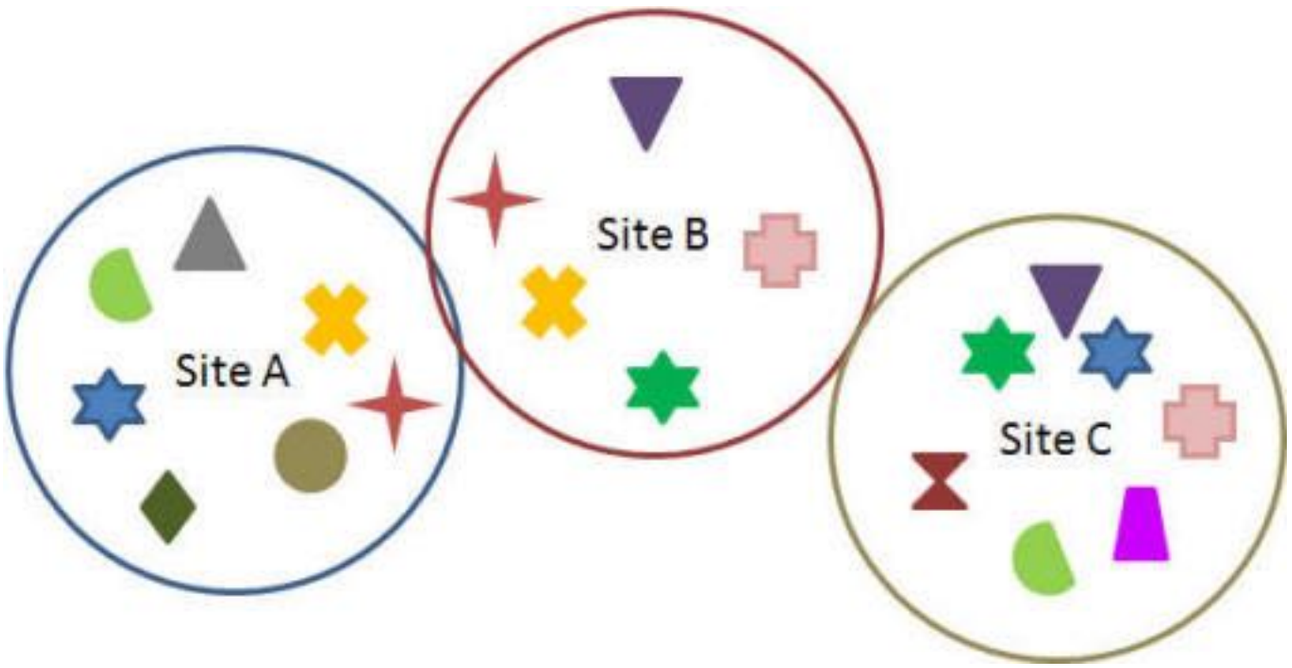

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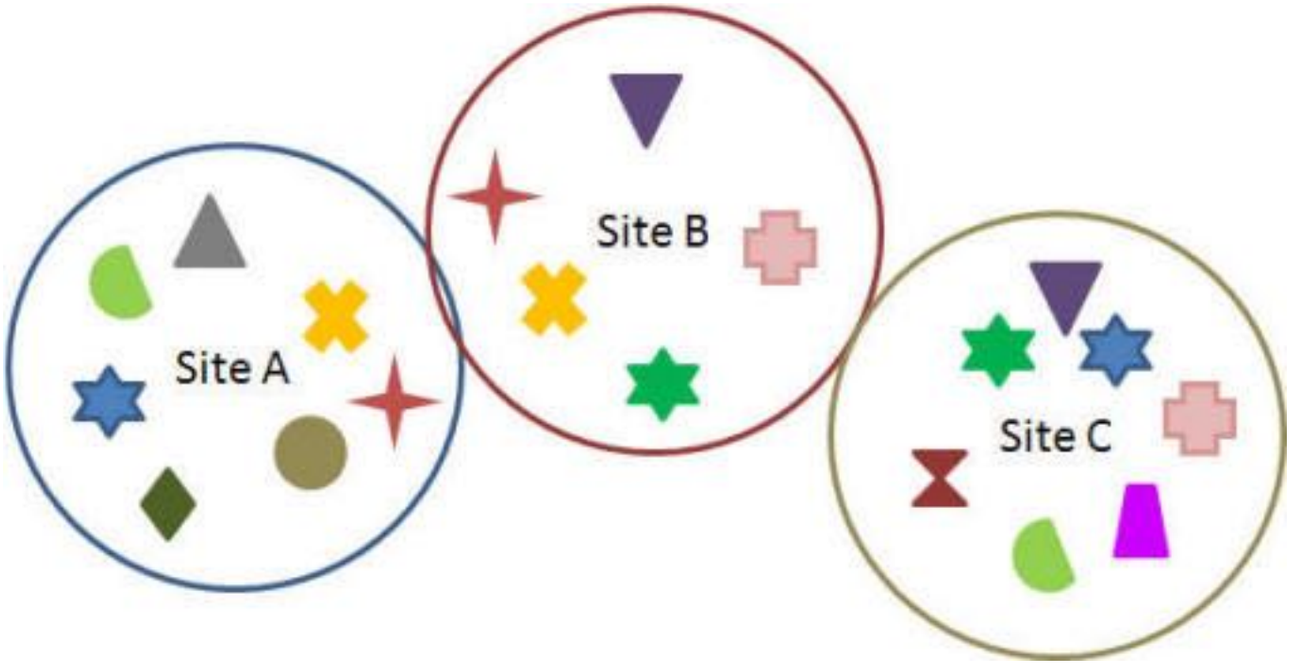

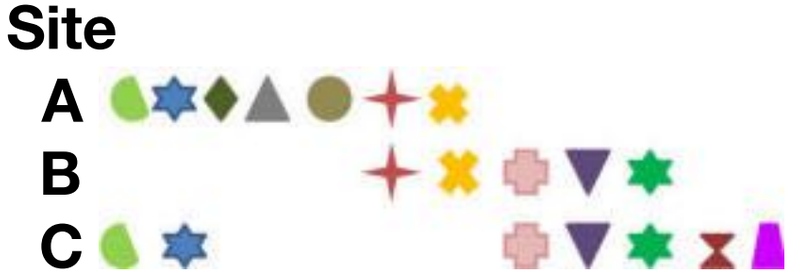

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Beta Diversity:
How different are sites?

	Species		
	1	2	3
A	1	1	0
B	5	5	0
C	0	0	1

Tree diversity analysis, Kindt and Coe <http://www.worldagroforestry.org/downloads/Publications/PDFS/b13695.pdf>

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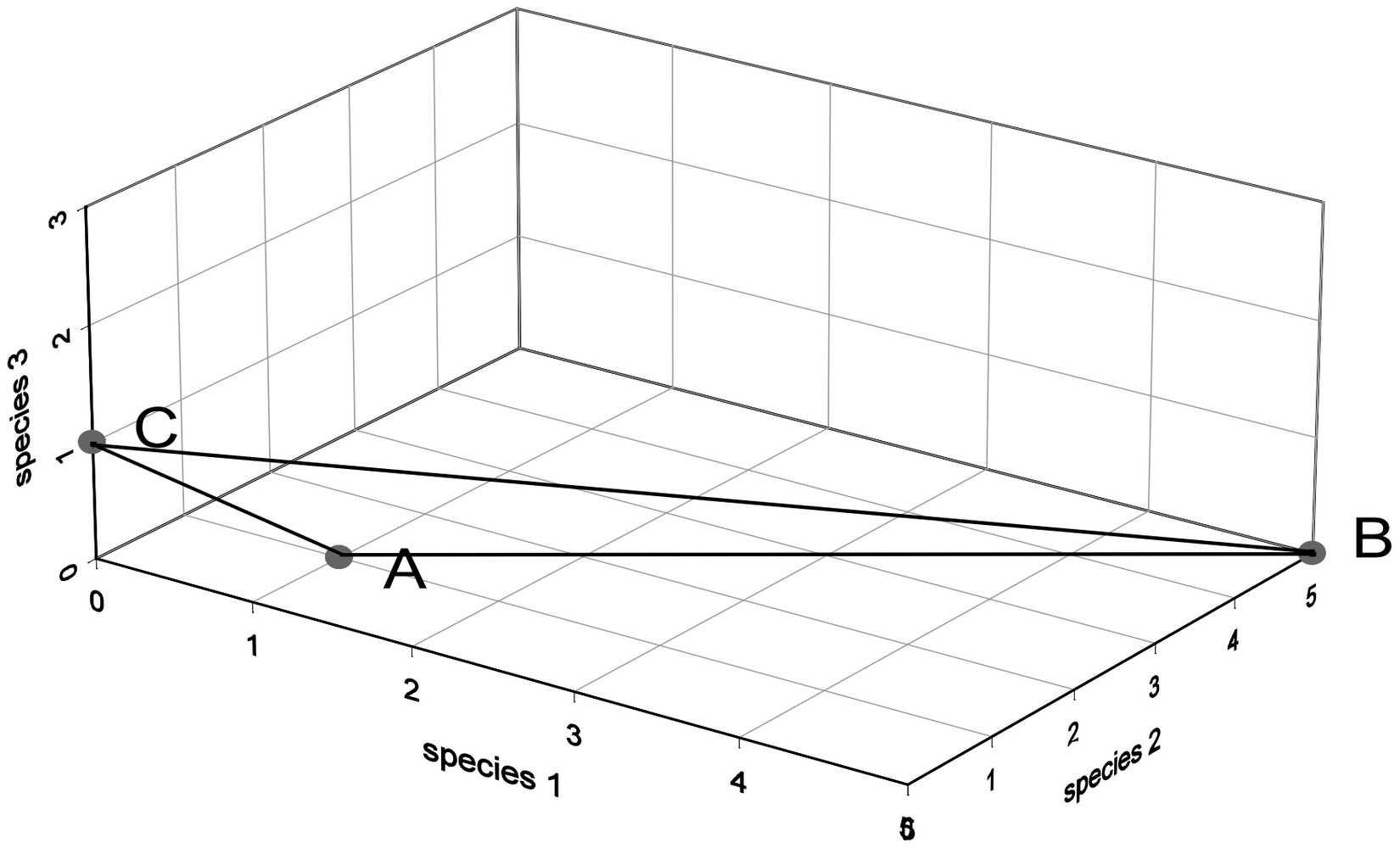

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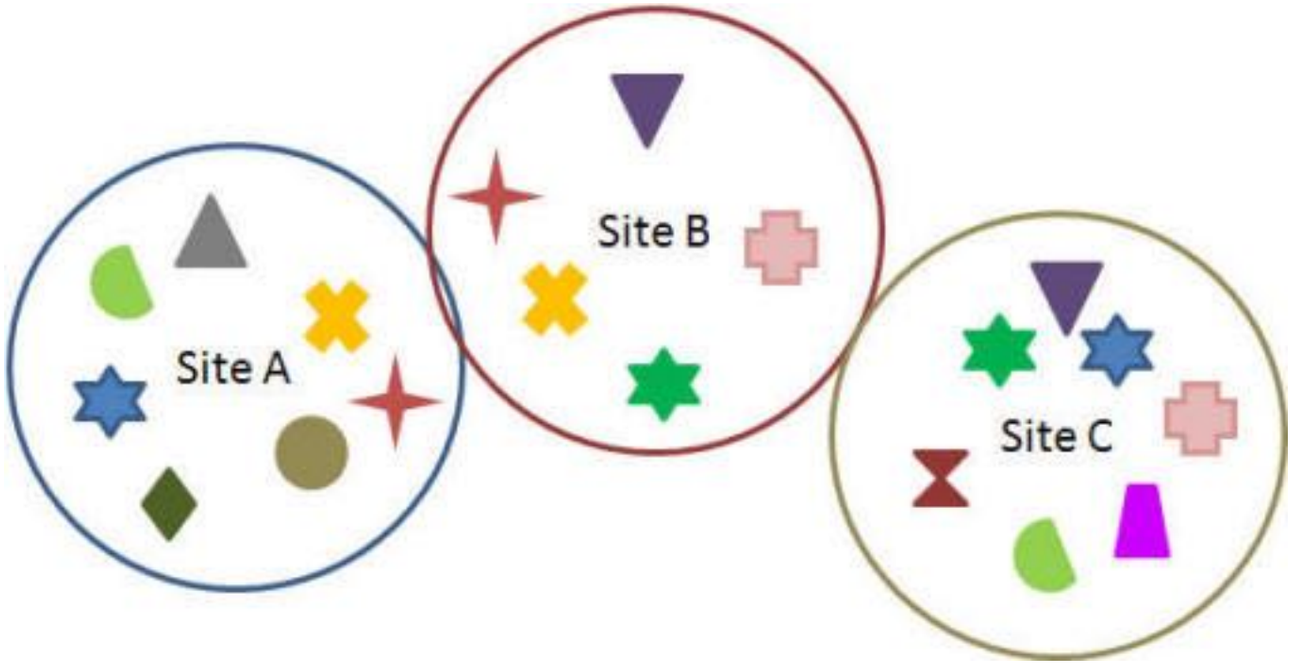
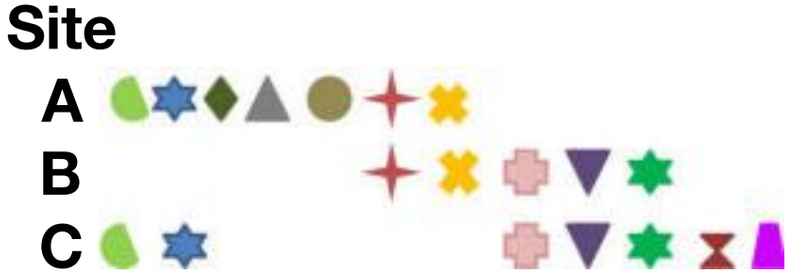
Beta Diversity Metrics

- Number of Taxa
- Bray-Curtis Dissimilarity
- UniFrac
- etc

Number of Taxa

- How different are samples?





	Species Differences
A vs B	8
B vs C	4
A vs C	10

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Bray-Curtis Dissimilarity

$$D_{BC} = 1 - 2\frac{\sum_{i=1}^{S} min\left(a_i,\, b_i\right)}{\sum_{i=1}^{S} a_i + b_i}$$

Where x_i is the abundance of species *i* in sample *X*

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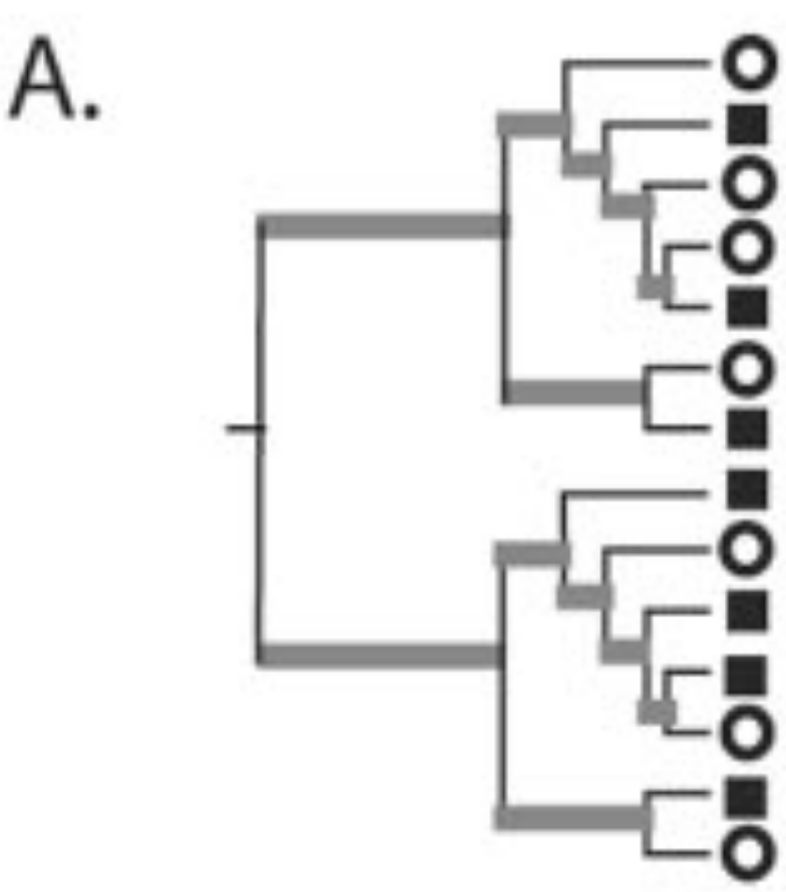
Bray-Curtis Dissimilarity

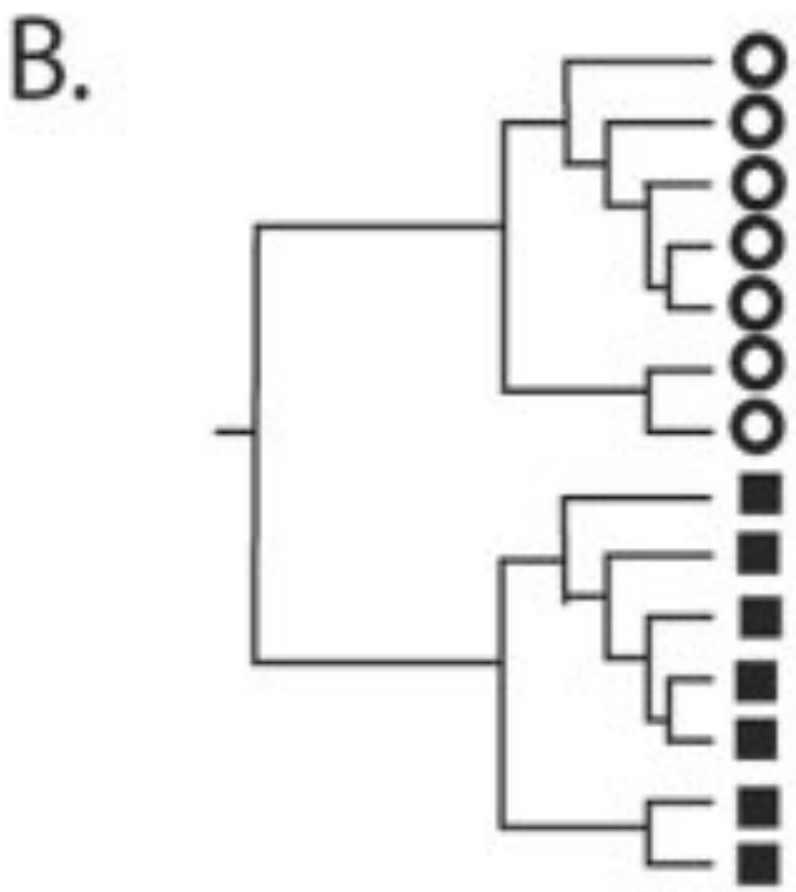
```
> y
  housing foodstuffs alcohol other services
1     640         328     147   169      196
2    1800         484     515  2291      912
3     640         328     147   169      196
4    6400        3280    1470  1690     1960
```

```
> vegdist(y, method="bray")
             1         2         3
2 0.6043839
3 0.0000000 0.6043839
4 0.8181818 0.4807230 0.8181818
```

UniFrac

- The phylogenetic distance between sets of taxa in a phylogenetic tree as the fraction of the branch length of the tree that leads to descendants from either one environment or the other, but not both.





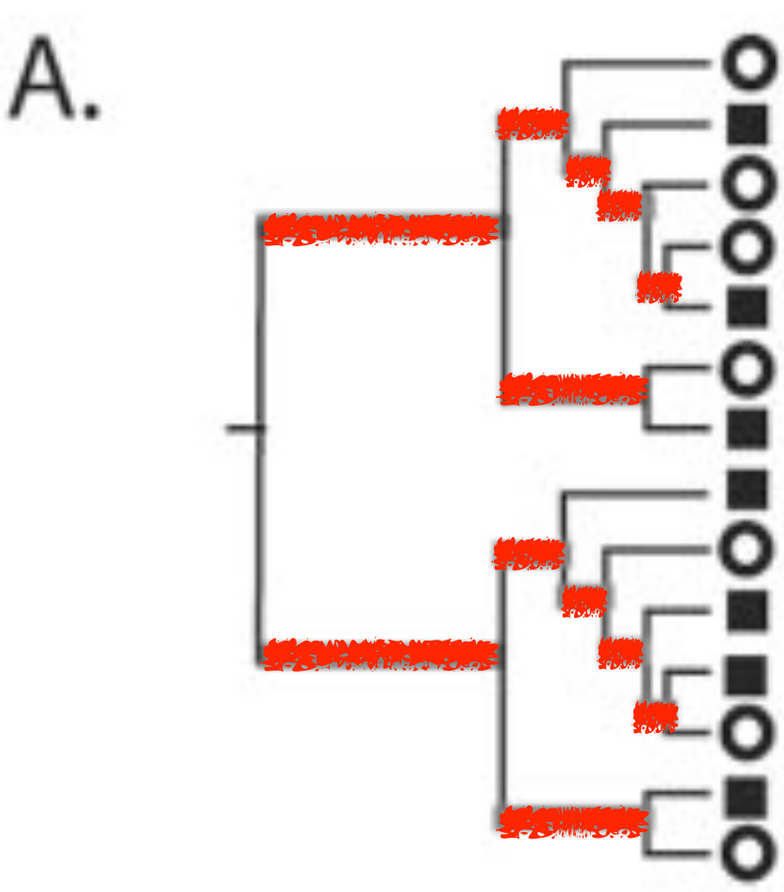
https://doi.org/10.1128/AEM.71.12.8228-8235.2005

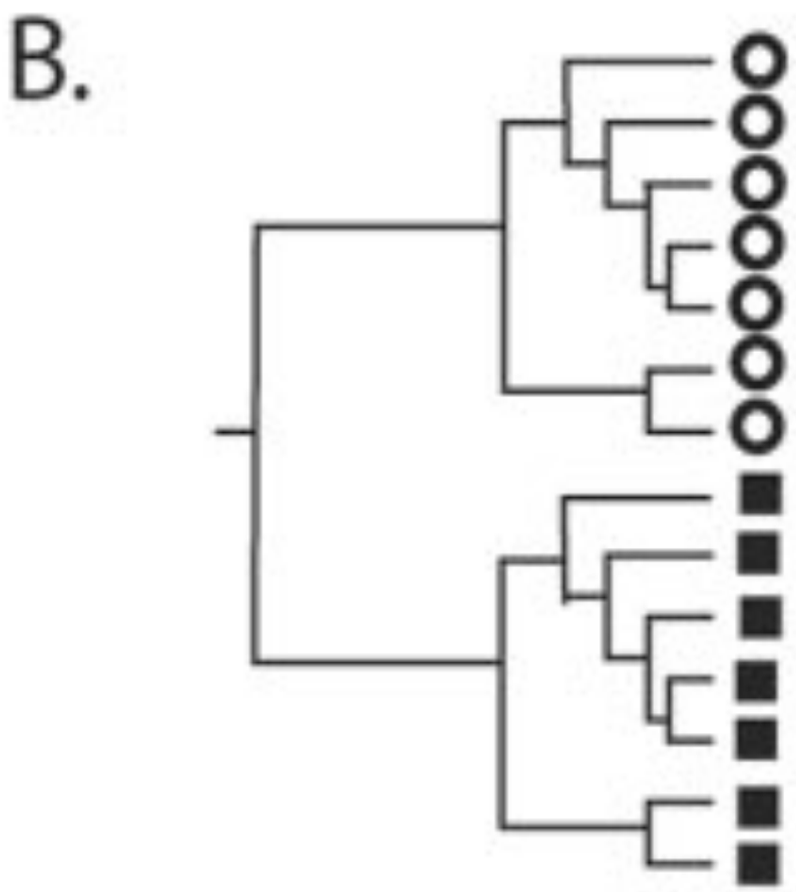
UniFrac

1. Label branches leading to taxa from both samples "shared"

2. Label branches leading to taxa which appears only in one sample "unshared".

3. Unifrac is the fraction of total branch length which is unshared. Alternatively, (the sum of "unshared" branch lengths)/(the sum of all tree branch lengths





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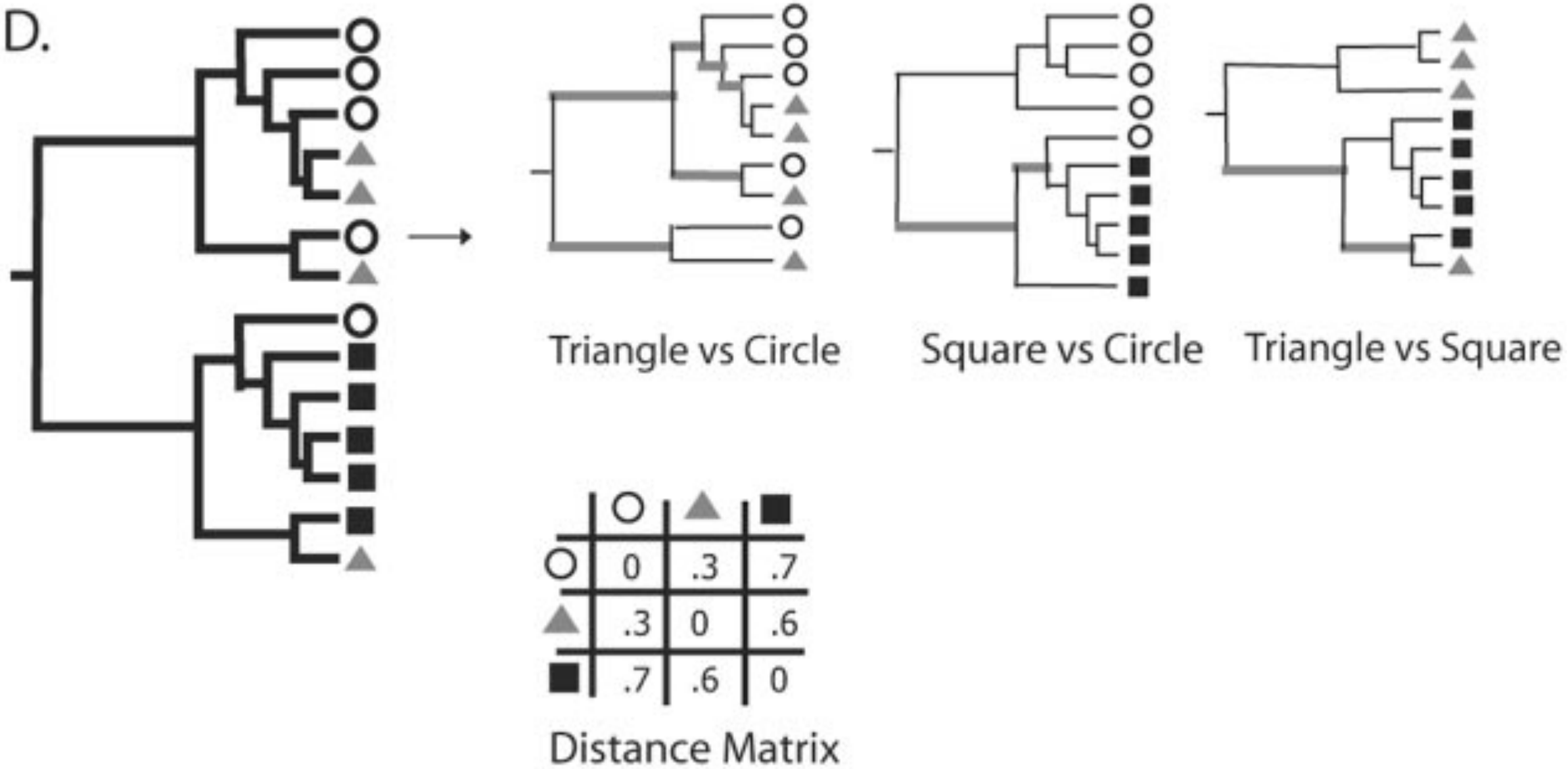

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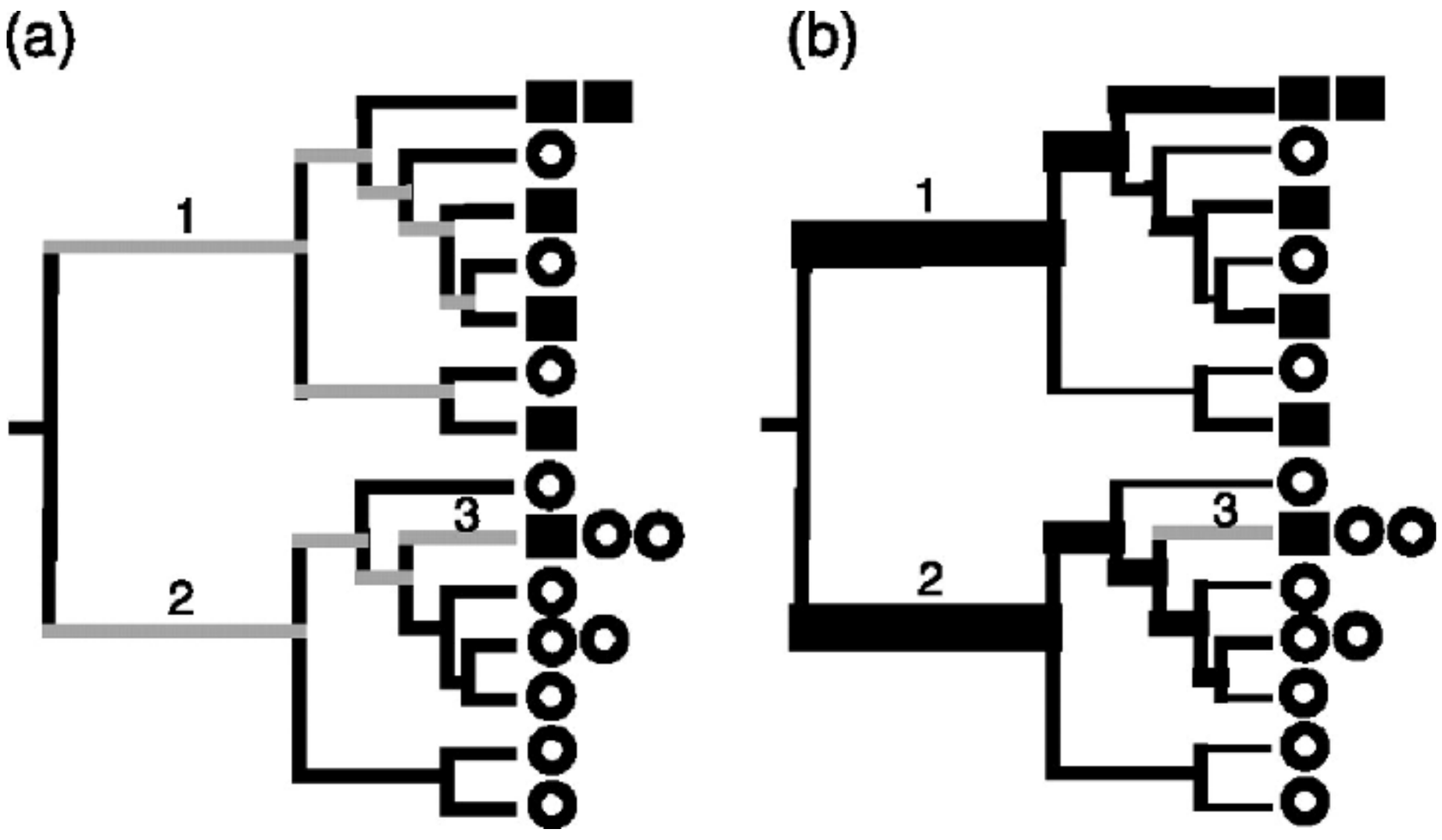
Weighted UniFrac



https://dx.doi.org/10.1128%2FAEM.01996-06

UniFrac:
Unweighted vs Weighted

- Unweighted UniFrac
  - Qualitative
  - Sensitive to differences in overall community structure
    - Strongly influenced by differences in rare (low abundance) taxa
- Weighted UniFrac
  - Quantitative
  - Sensitive to differences in high abundance taxa

Generalized UniFrac

- Sensitive to differences in moderately abundant taxa

- Maintains ability to detect differences in high and low abundance taxa

https://dx.doi.org/10.1093%2Fbioinformatics%2Fbts342