Abundance and α-diversity

October 30, 2020

Count Data

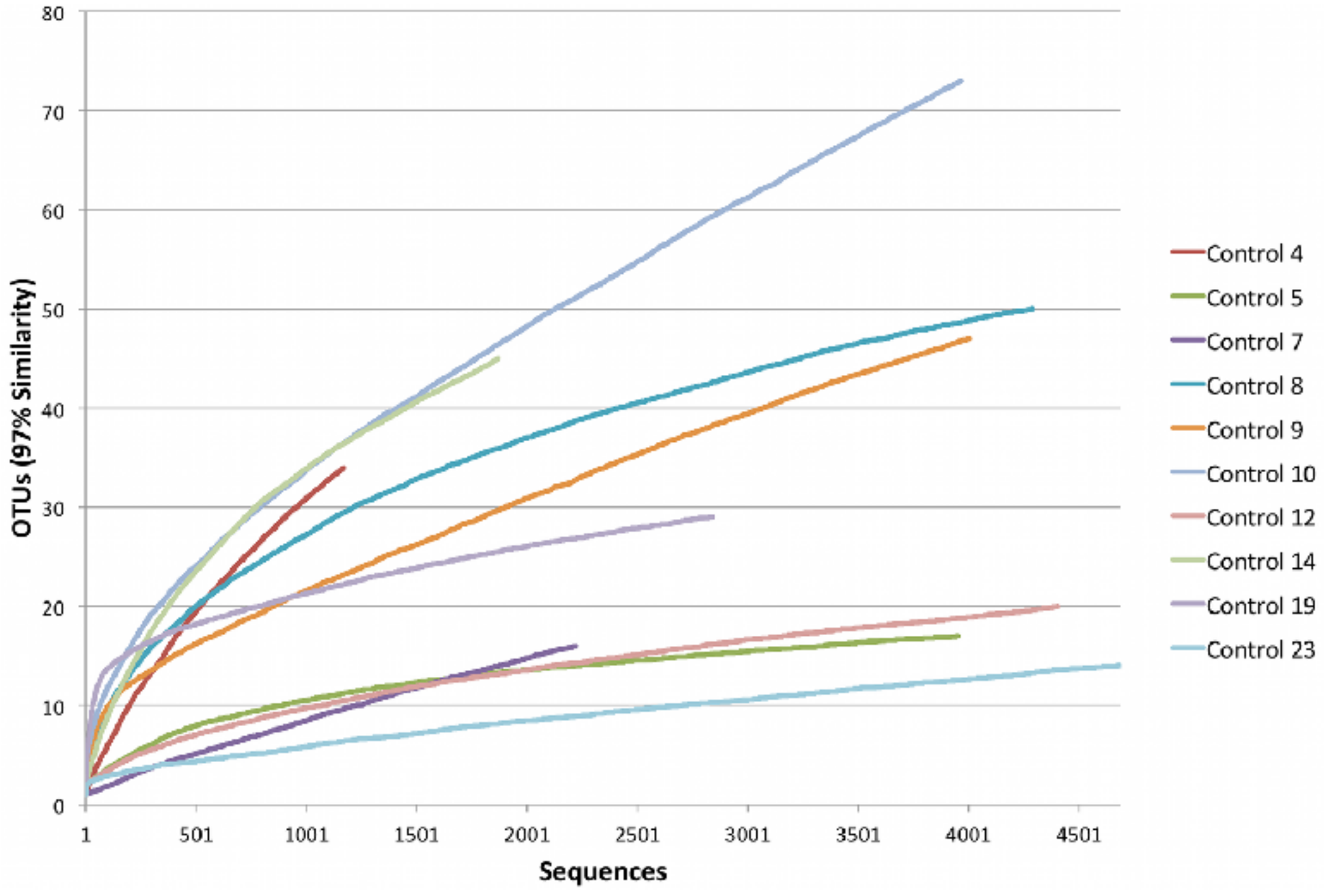
	OTU 1	OTU 2	…	Meta 1	Meta 2	…
Sample 1						
Sample 2						
…						
Sample N						

N

P

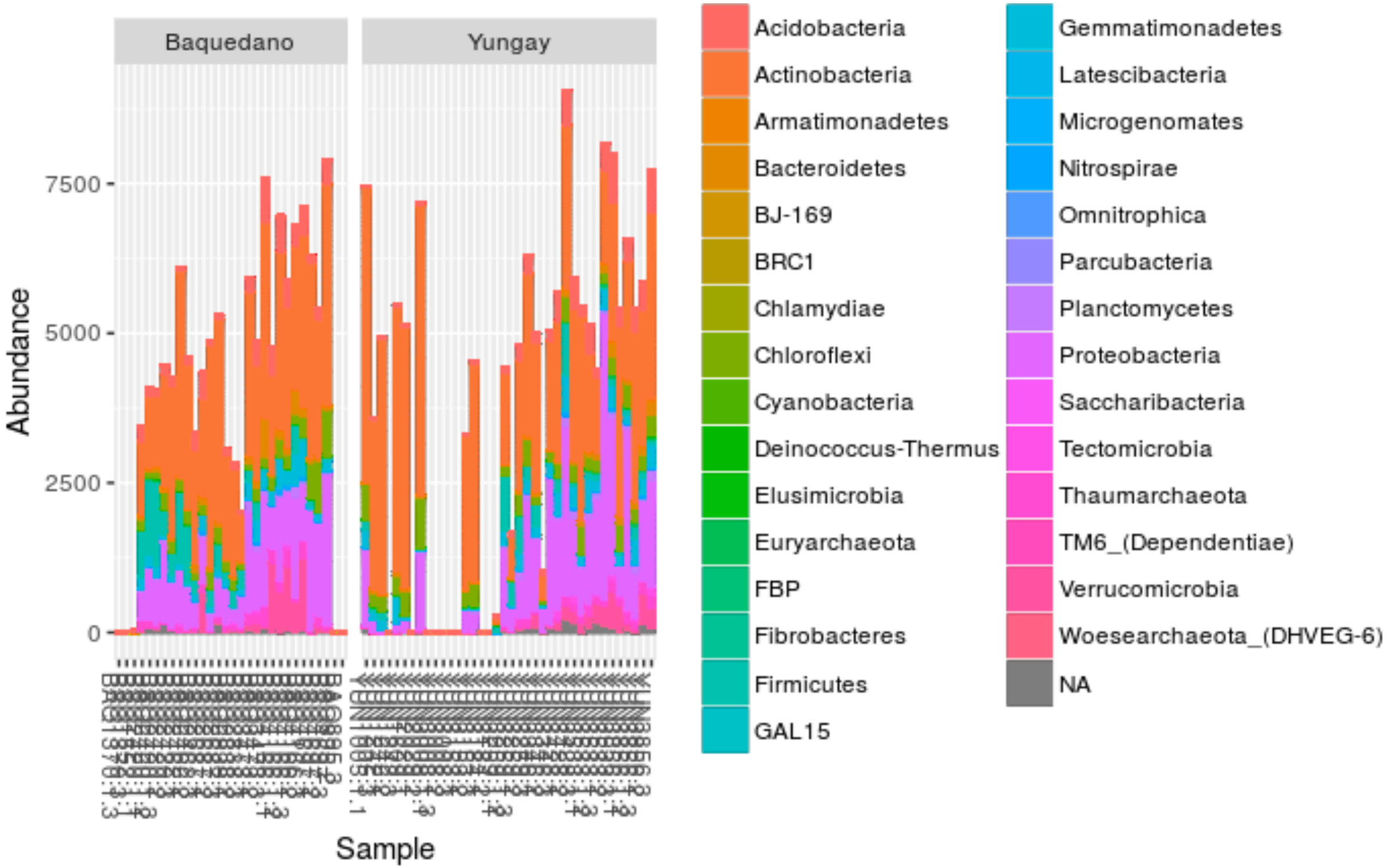
Exploratory Analysis and Quality Control

Collector's Curves (aka rarefaction)



https://doi.org/10.1371/journal.pone.0047305

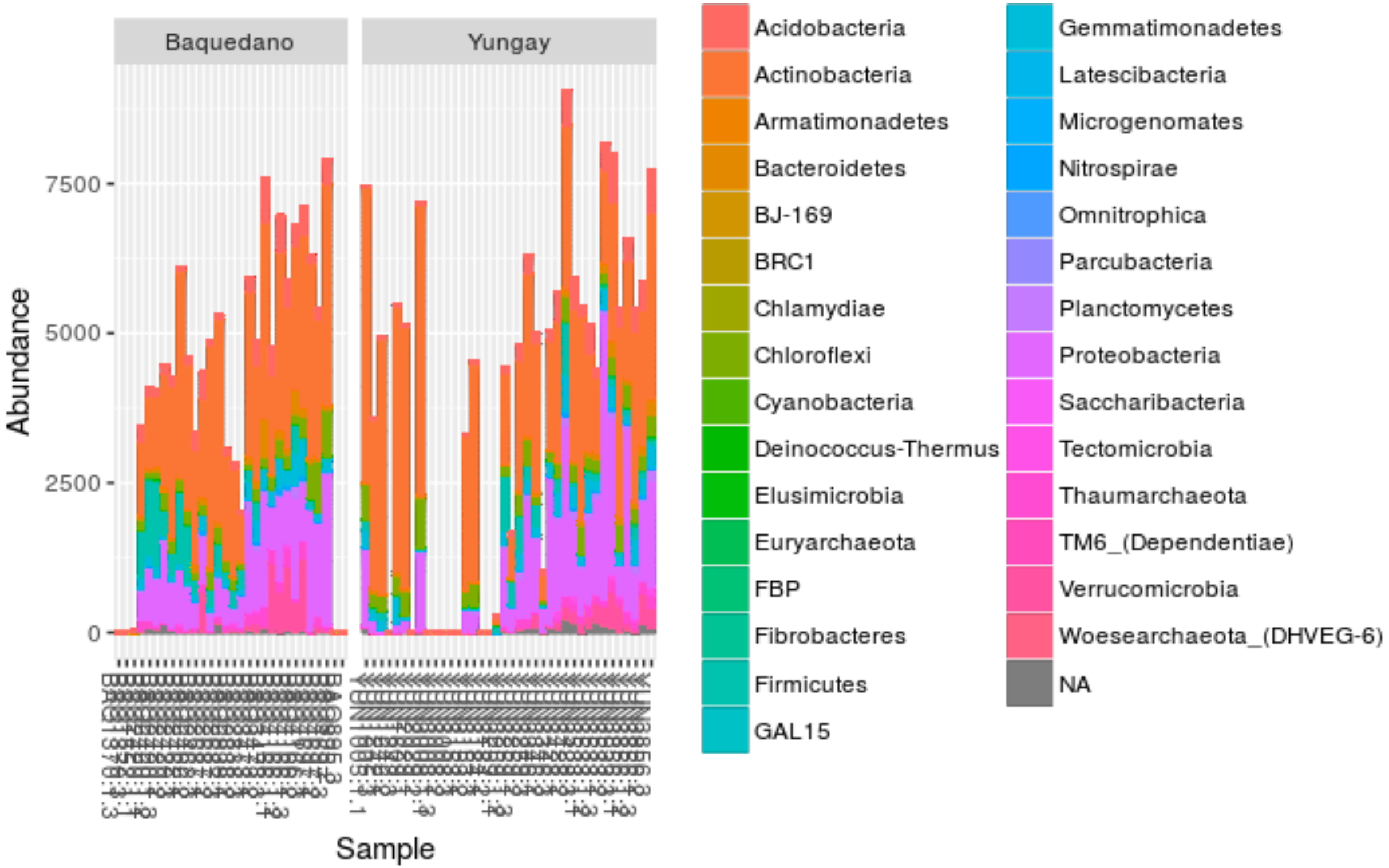
Absolute Abundance



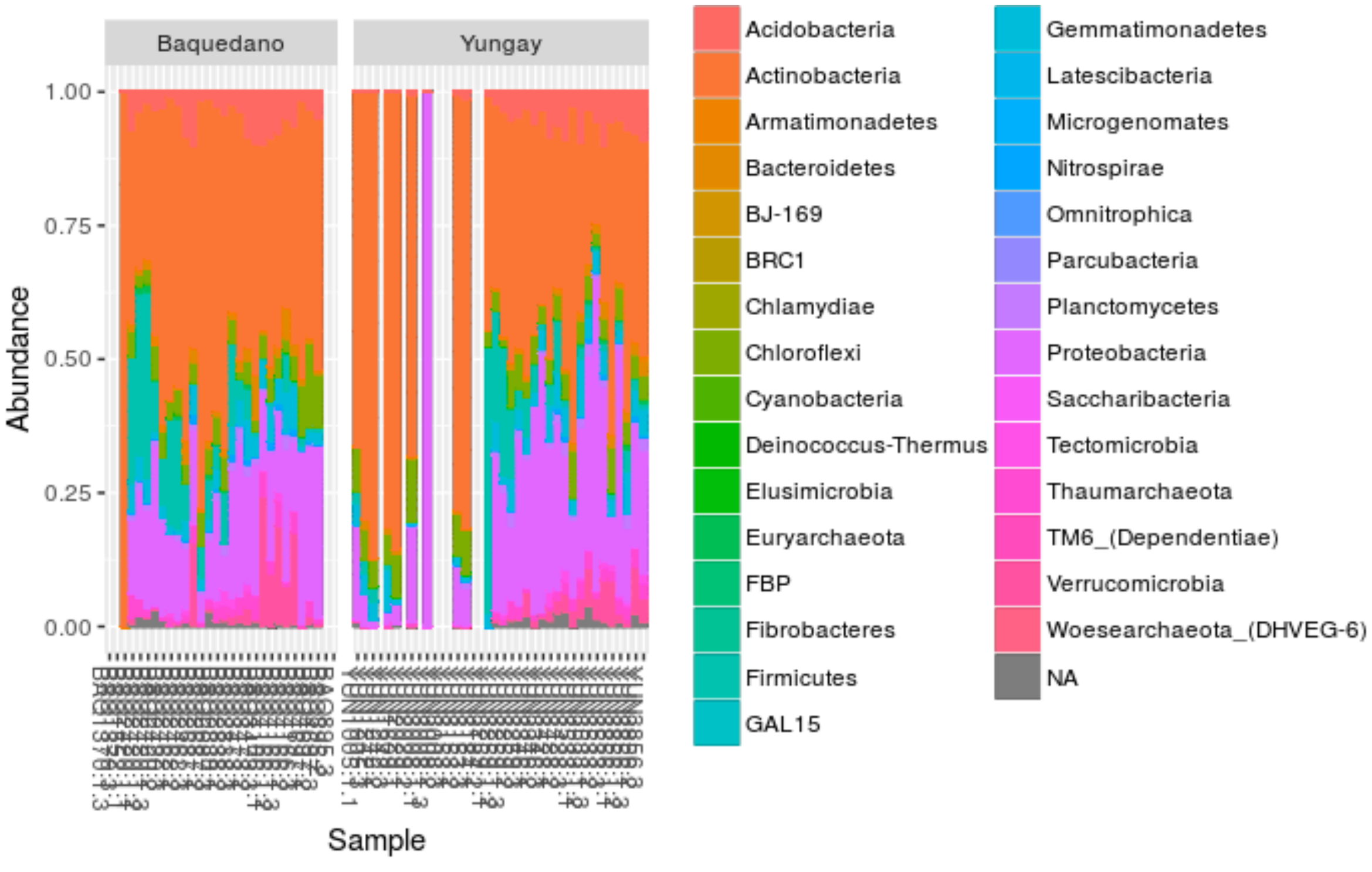
Caveat

http://www.lebleu.com

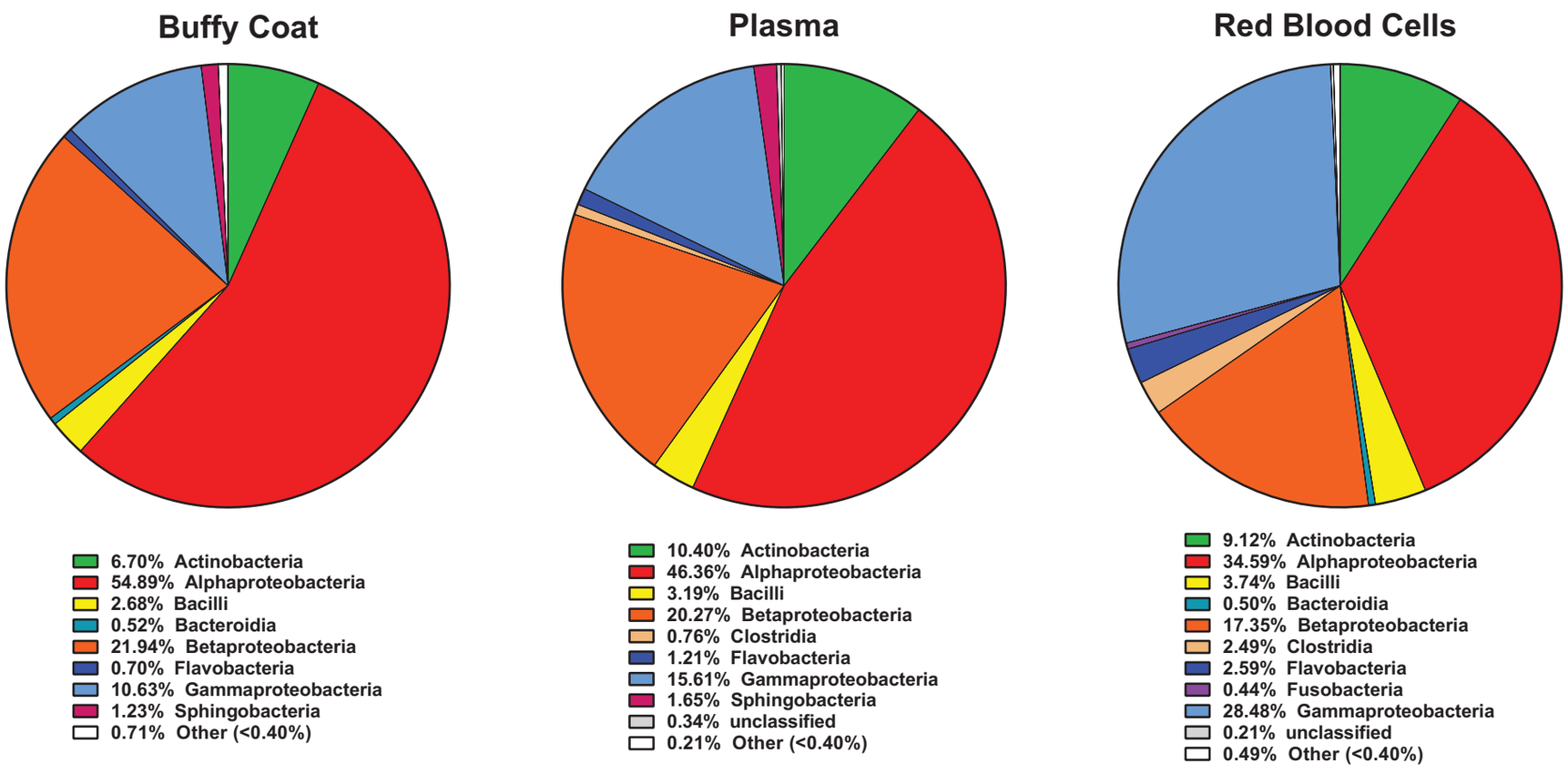
Absolute Abundance

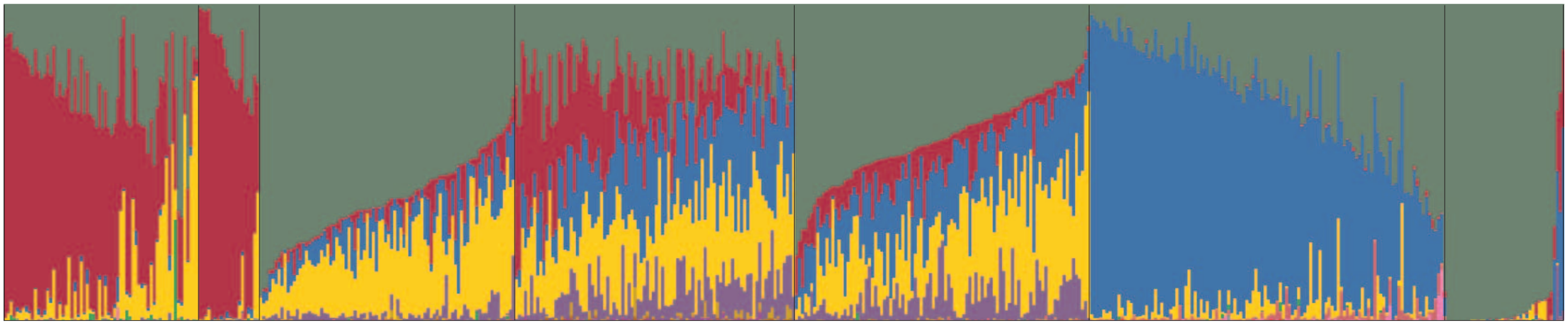


Relative Abundance



Bad Figures: Pie Charts





https://doi.org/10.1111/trf.13477
https://doi.org/10.1038/nature11234

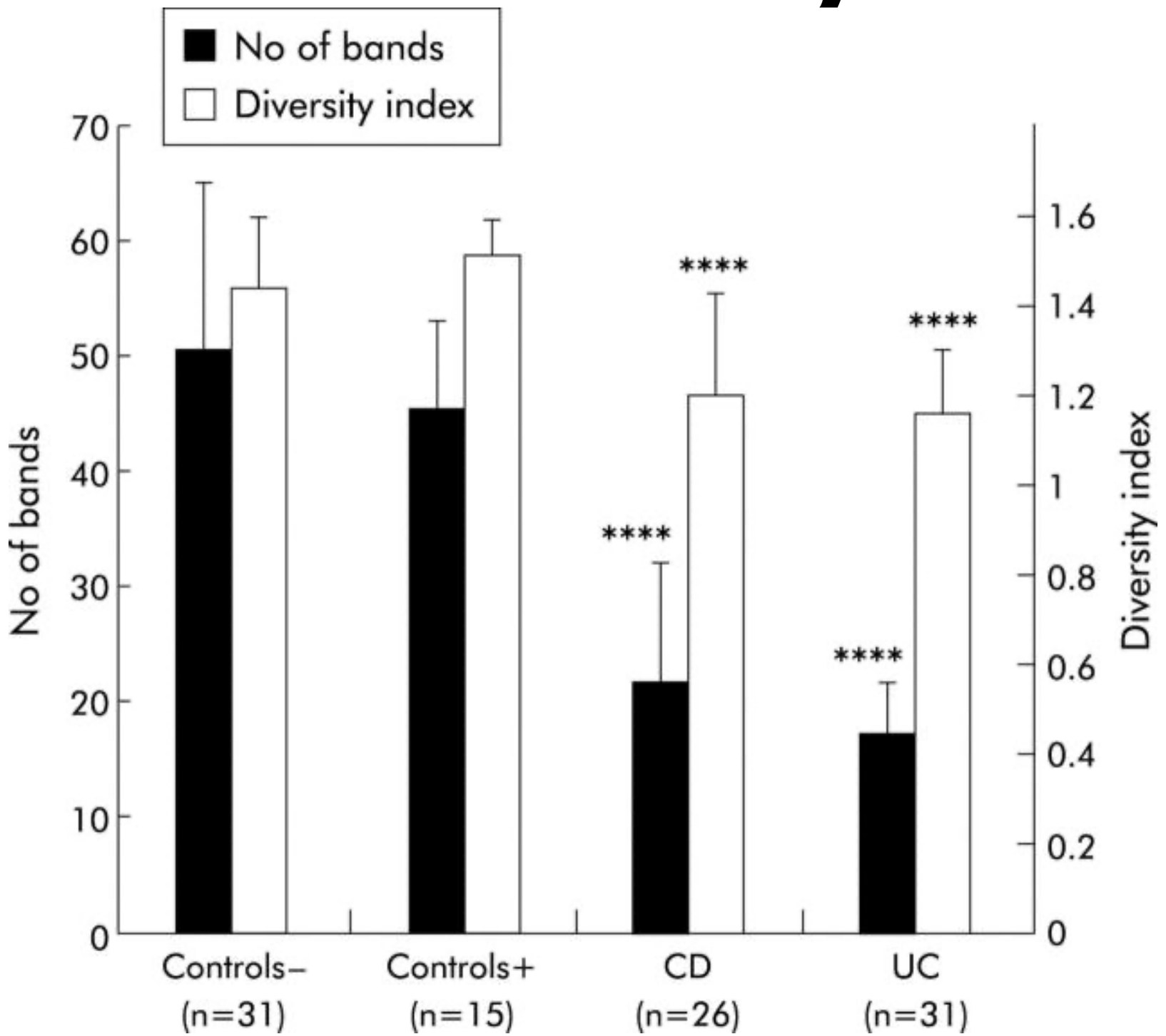
Diversity

Diversity

Diversity

https://upload.wikimedia.org/wikipedia/commons/4/4b/Amazon_Manaus_forest.jpg
https://en.wikipedia.org/wiki/File:Clearcutting-Oregon.jpg
https://upload.wikimedia.org/wikipedia/commons/a/a0/Tractors_in_Potato_Field.jpg

Diversity



https://dx.doi.org/10.1136%2Fgut.2003.025403

Alpha Diversity

- Diversity within a sample
  - Richness: number of different species
  - Evenness: distribution of species (i.e. relative abundance of species)

Richness

Richness: 5

Richness: 10

http://www.coastalwiki.org/w/images/d/d4/Richness.jpg

Evenness

Richness: 5

Evenness: 1

Richness: 5

Evenness: 0.48

http://www.coastalwiki.org/w/images/d/dd/Evenness.jpg

Alpha Diversity Metrics

- Observed Richness

Counting

- Shannon (entropy)
- Simpson

Gambling

- Chao1
- ACE (abundance-based coverage estimators)

Richness Estimators (Weirdos)

Gambling Metrics

- Jar with 8 balls
  - Shannon: How much would you bet that a randomly selected ball is red?

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

  - Simpson: How much would you bet that two randomly selected balls are the same color?

$$\lambda = \sum_{i=1}^{R} p_i^2$$

where p_i is the proportion of individuals belonging to the ith species

	Jar 1	Jar 2	Jar 3	Jar 4
Red	8	5	2	1
Yellow	0	1	2	2
Green	0	1	2	2
Blue	0	1	2	3
Total	8	8	8	8

shannon	0.00	1.07	1.39	1.32
simpson	0.00	0.56	0.75	0.72

Richness Estimators (Weirdo Metrics)

- Chao1: How many species are present, and how many are observed only once or twice?

- ACE: How many species are present, and how many are observed less than 10 times?

Richness Estimators (Weirdo Metrics)

- Chao1: How many species are present, and how many are observed only once or twice?

$$S_p = S_o + \frac{a_1(a_1 - 1)}{2(a_2 + 1)}$$

where *So* is the observed richness, a_1 is the number of species observed once, and a_2 is the number of species observed once

- ACE: How many species are present, and how many are observed less than 10 times?

$$S_p = S_{\text{abund}} + \frac{S_{\text{rare}}}{C_{\text{ACE}}} + \frac{a_1}{C_{\text{ACE}}}\gamma^2\,, \quad \text{where}$$

$$C_{\text{ACE}} = 1 - \frac{a_1}{N_{\text{rare}}}$$

$$\gamma^2 = \frac{S_{\text{rare}}}{C_{\text{ACE}}} \sum_{i=1}^{10} i(i-1)a_1 \frac{N_{\text{rare}} - 1}{N_{\text{rare}}}\,.$$

S_{abund} and S_{rare} are the numbers of species of abundant and rare species, with an arbitrary upper limit of 10 individuals for a rare species, and N_{rare} is the total number of individuals in rare species

Vegan: ecological diversity

Calculating Diversity

Richness	5	10	5
Shannon	1.60	2.30	0.78
Simpson	0.8	0.9	0.35
Evenness	1	1	0.48
Chao1	5	10	11
ACE	5	10	NaN

http://www.coastalwiki.org/w/images/d/d4/Richness.jpg

Alpha Diversity Metrics