Alpha diversity variability

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04 December, 2017

Alpha diversity analyses in our healthy population. Alpha diversity of food and microbiome have been calculated in QIIME.

```
##
##  Paired t-test
##
## data:  alpha_test$Post and alpha_test$Pre
## t = 1.274, df = 33, p-value = 0.2116
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.425979  6.203238
## sample estimates:
## mean of the differences
##                 2.38863
```

```
##
##  Paired t-test
##
## data:  alpha_test_EVOO$Post and alpha_test_EVOO$Pre
## t = 1.7812, df = 16, p-value = 0.09387
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.8024787  9.2429116
## sample estimates:
## mean of the differences
##                4.220216
```

```
##
##  Paired t-test
##
## data:  alpha_test_MCT$Post and alpha_test_MCT$Pre
## t = 0.19142, df = 16, p-value = 0.8506
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -5.611920  6.726006
## sample estimates:
## mean of the differences
##               0.5570432
```

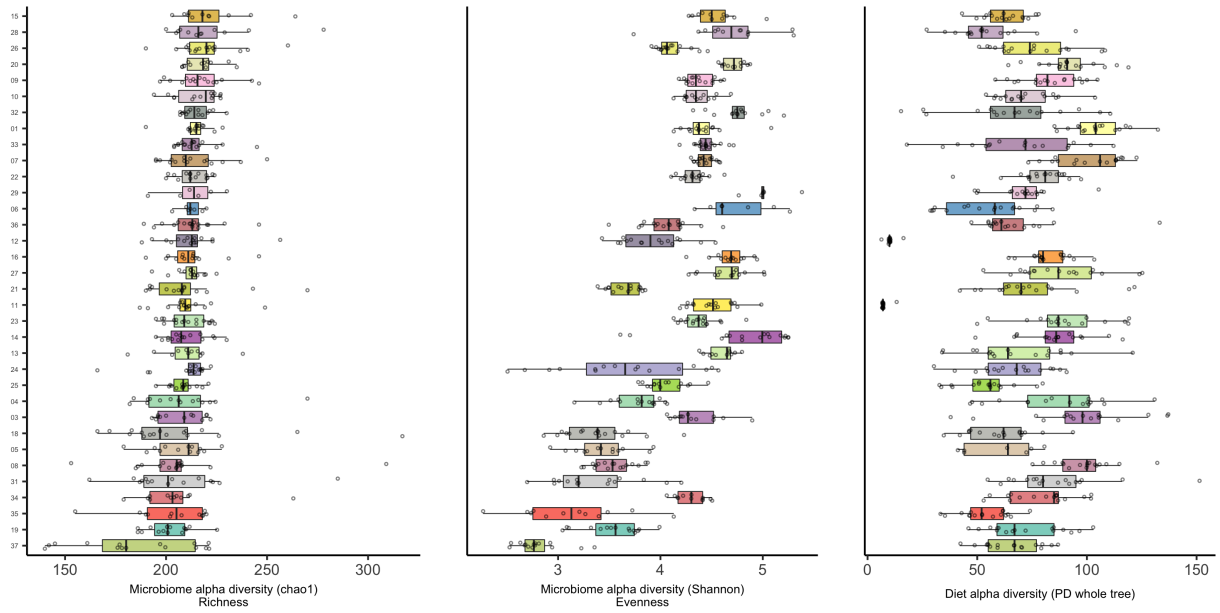
```
##
##  Paired t-test
##
## data:  alpha_test$Post and alpha_test$Pre
## t = -1.0886, df = 32, p-value = 0.2845
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.8925574  0.5742313
## sample estimates:
## mean of the differences
```

```
##              -0.6591631
```

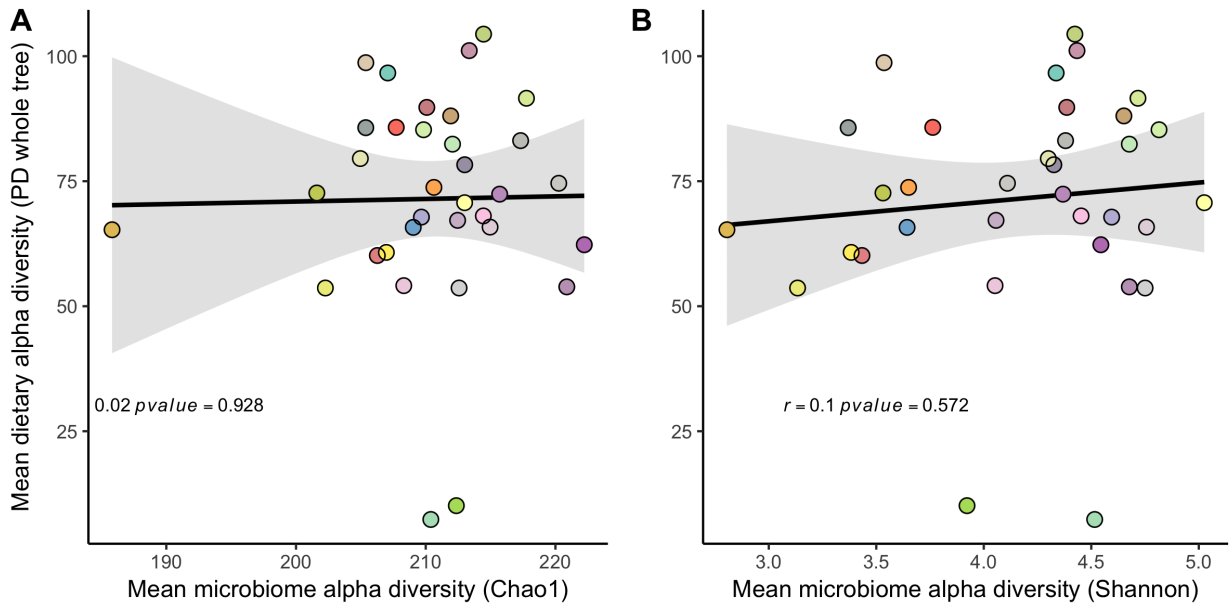
```
##
##  Paired t-test
##
## data:  alpha_test_EVOO$Post and alpha_test_EVOO$Pre
## t = -1.2664, df = 15, p-value = 0.2247
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.0991212  0.7890021
## sample estimates:
## mean of the differences
##                -1.15506
```

```
##
##  Paired t-test
##
## data:  alpha_test_MCT$Post and alpha_test_MCT$Pre
## t = -0.23663, df = 16, p-value = 0.8159
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.916420  1.531546
## sample estimates:
## mean of the differences
##               -0.192437
```

1. Is there a relationship between mean alpha diveristy of the microbiome and mean alpha diveristy of the diet?



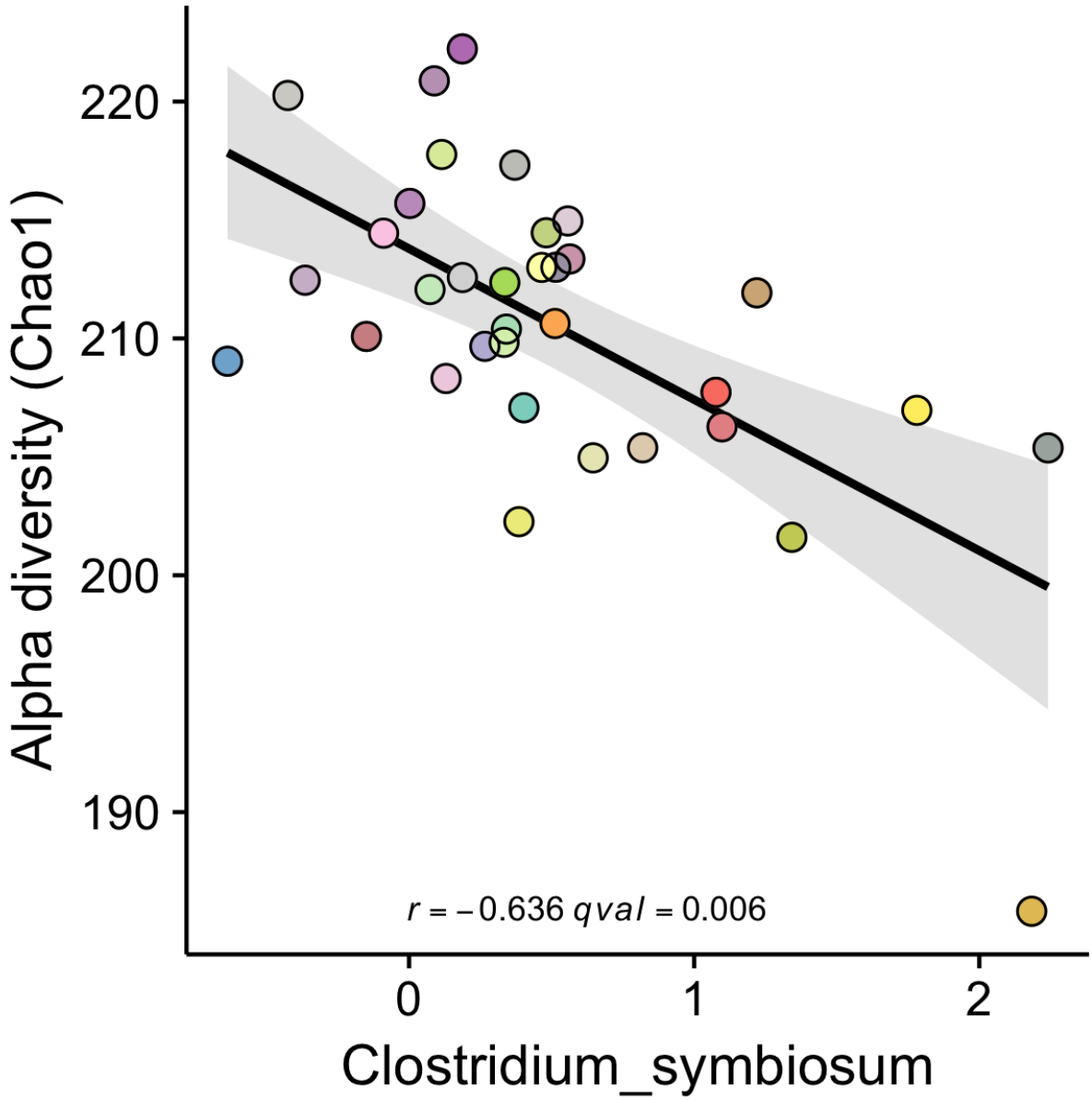
TODO: Also need to consider what happens if we look at the alpha diversity of diet at a higher level. Can't use PD-whole tree for this, but if we collapse at level 3 first, then look at overall diversity metrics, like shannon or chao1 do we see relationships?

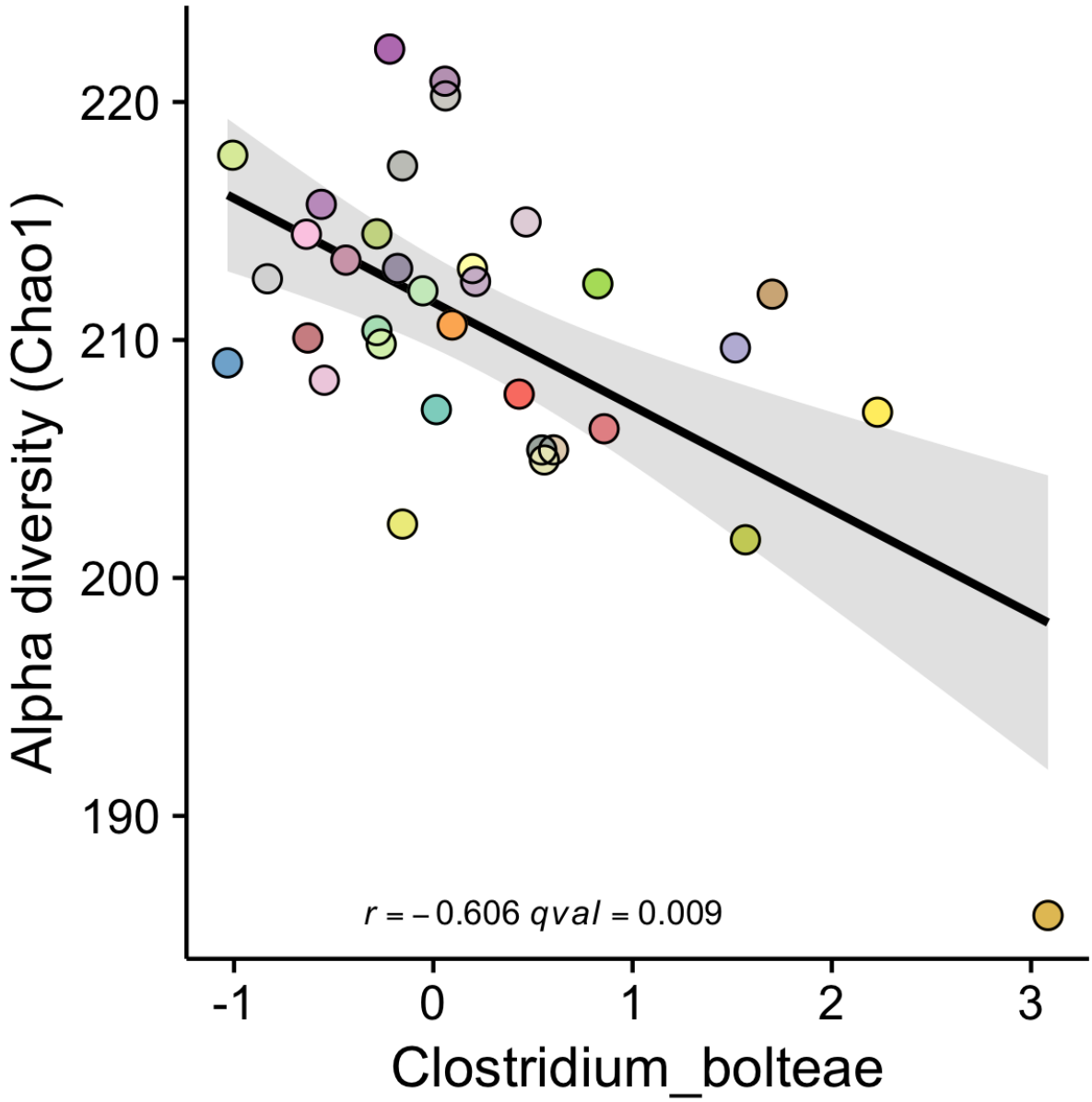


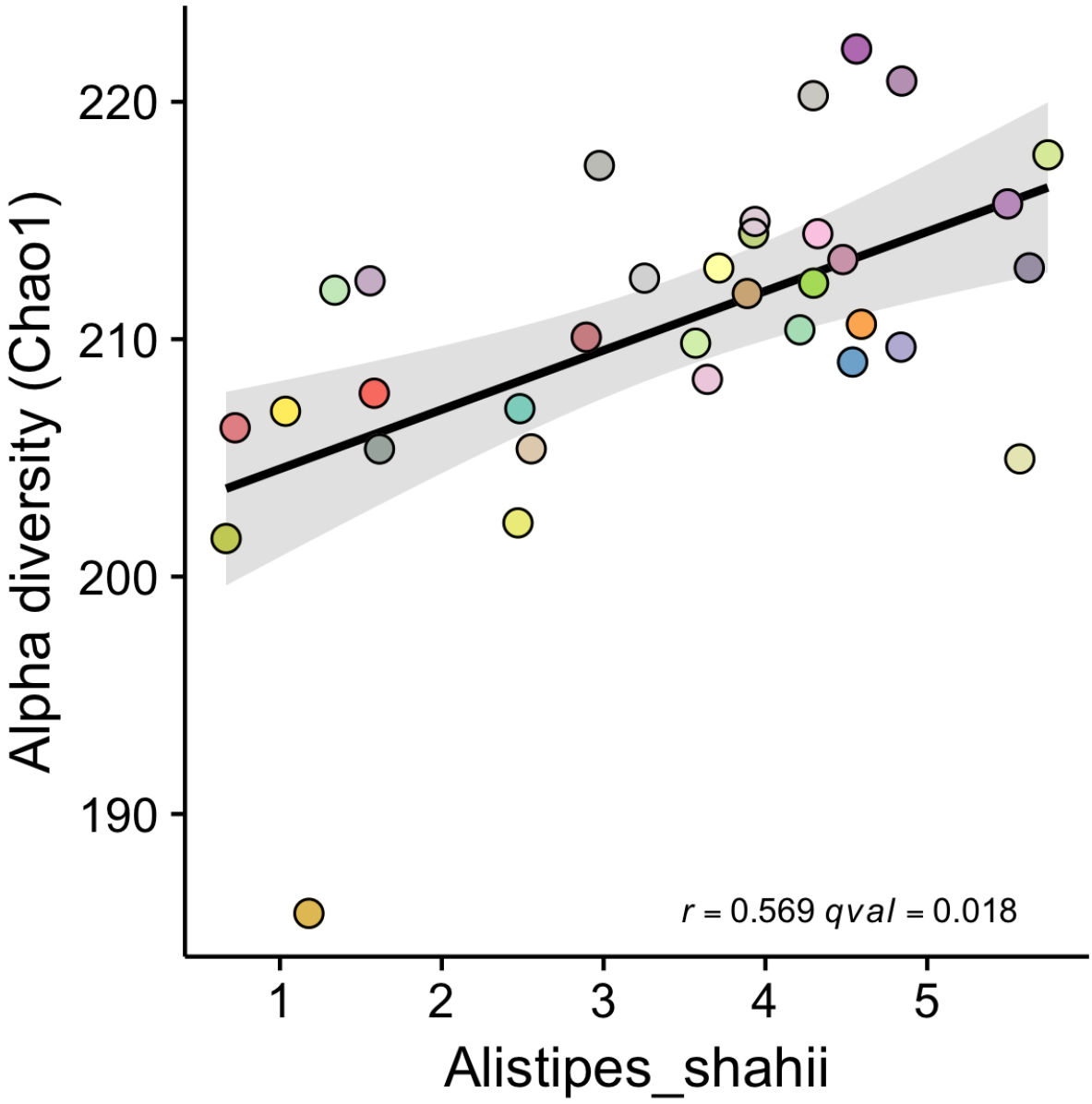
2. Are any taxa associated with microbiome alpha diversity?

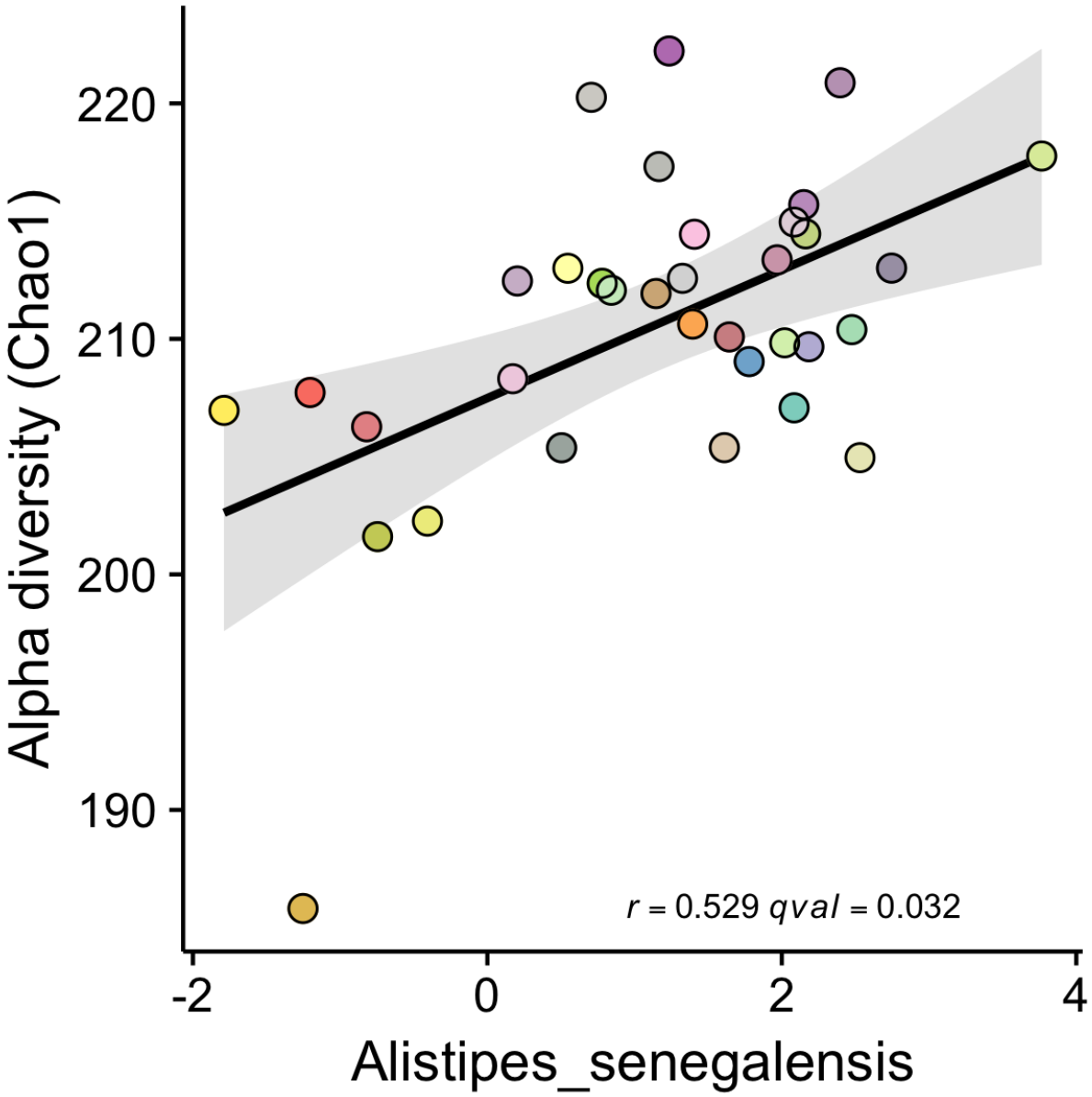
```
##
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnoclostridium;s__
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnoclostridium;s__
## k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Rikenellaceae;g__Alistipes;s__Alisti
## k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Rikenellaceae;g__Alistipes;s__Alisti
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__;g__Flavonifractor;s__Flavonifractor_plau
##
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnoclostridium;s__
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnoclostridium;s__
## k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Rikenellaceae;g__Alistipes;s__Alisti
## k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Rikenellaceae;g__Alistipes;s__Alisti
## k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__;g__Flavonifractor;s__Flavonifractor_plau
```

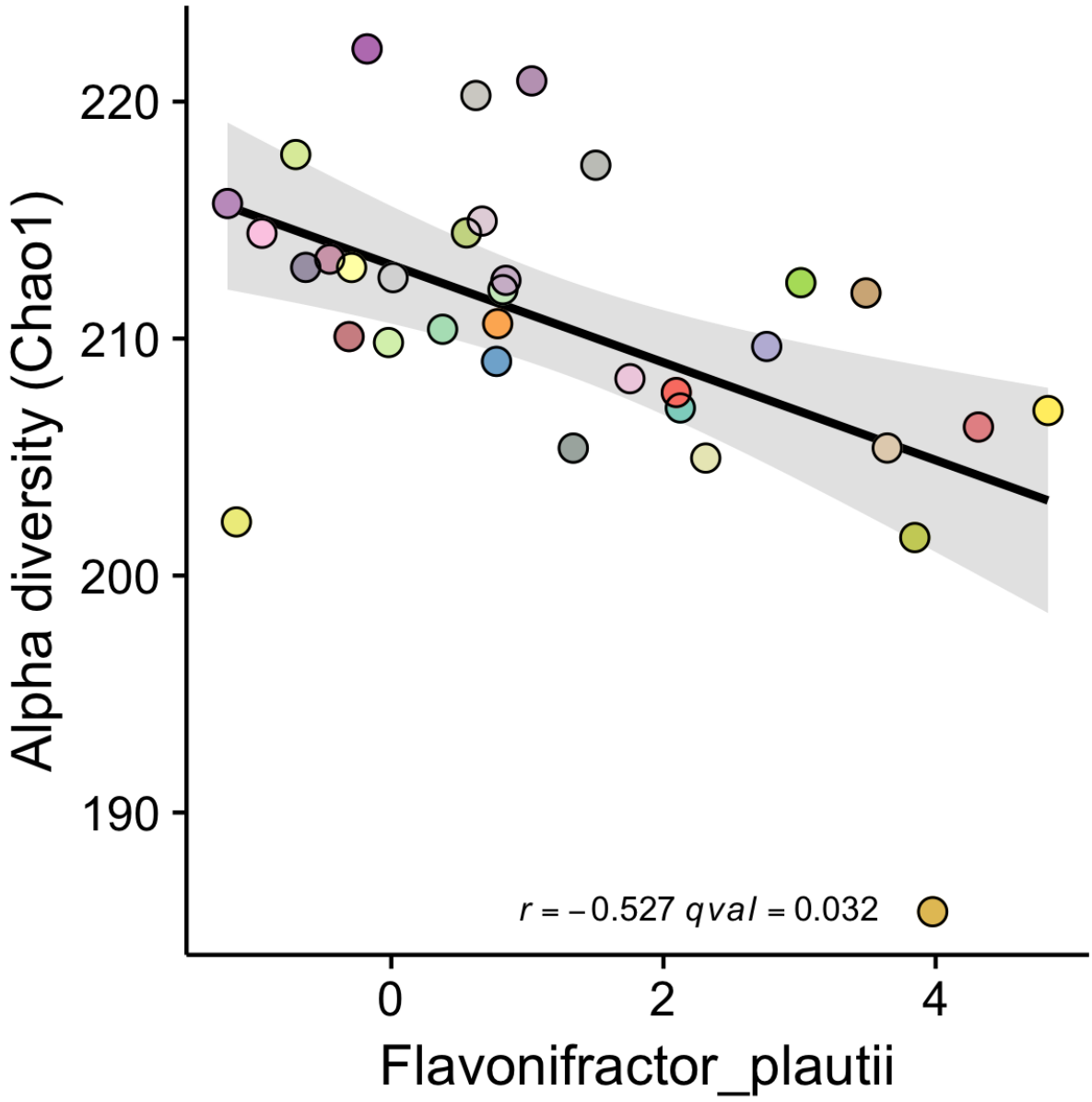
Plots of significantly correlated taxa:


Alpha diversity (Chao1)
220
210
200
190
r = −0.636 qval = 0.006
0
1
2
Clostridium_symbiosum


Alpha diversity (Chao1)
220
210
200
190
r = – 0.606 qval = 0.009
-1
0
1
2
3
Clostridium_bolteae

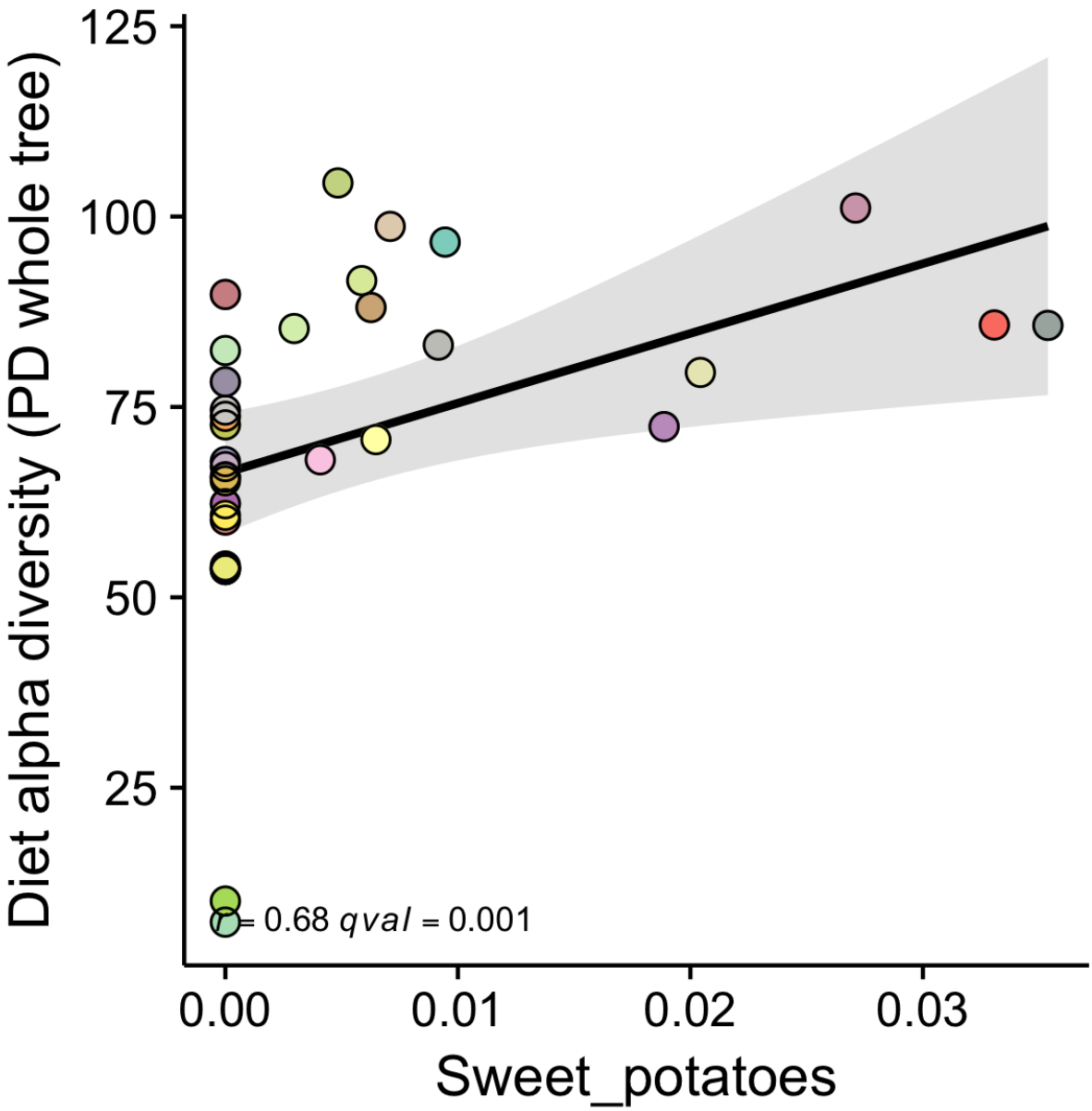

Alpha diversity (Chao1)
220
210
200
190
1
2
3
4
5
Alistipes_shahii
r = 0.569 qval = 0.018

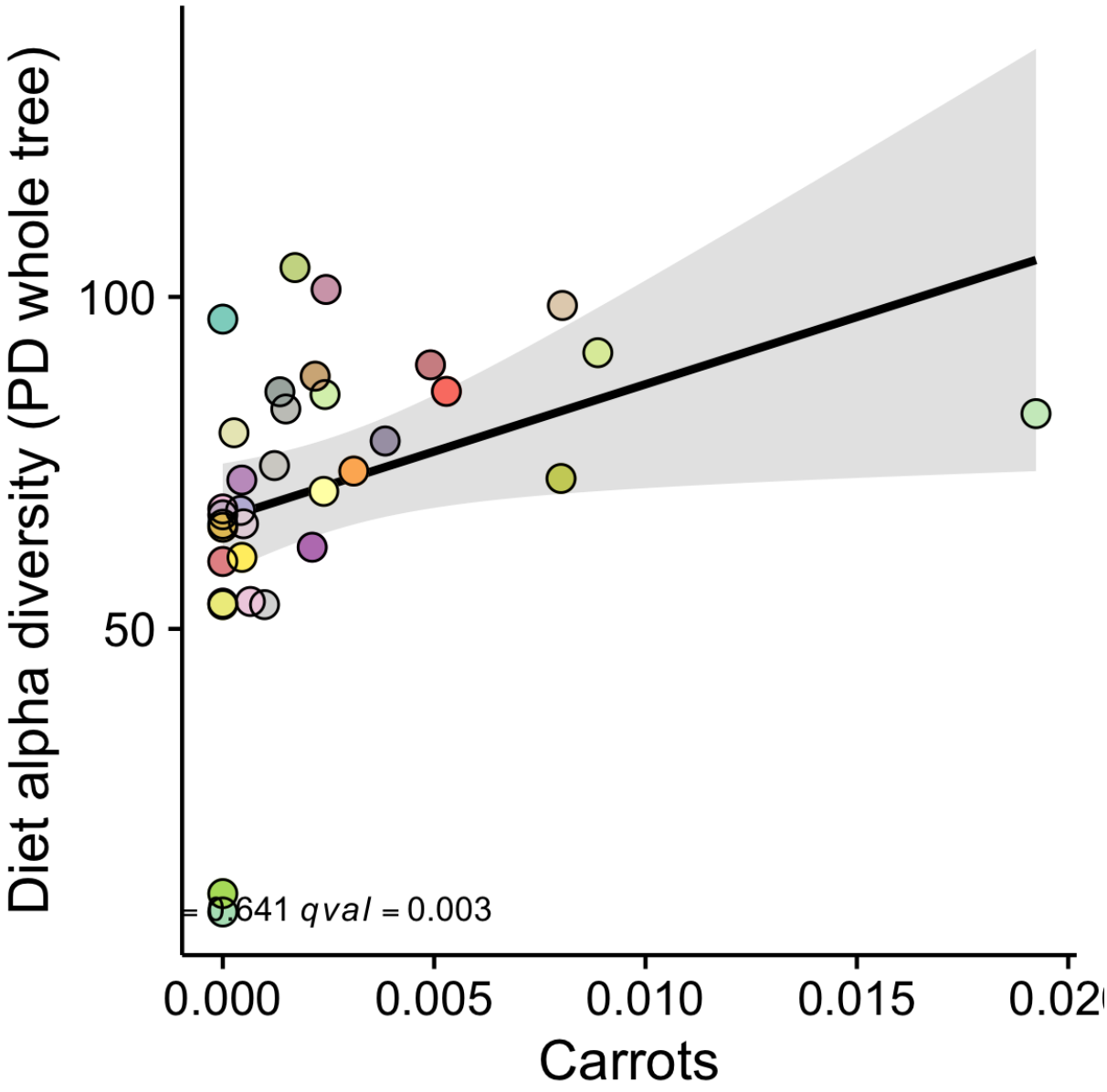

Alpha diversity (Chao1)
220
210
200
190
-2
0
2
4
Alistipes_senegalensis
r = 0.529 qval = 0.032

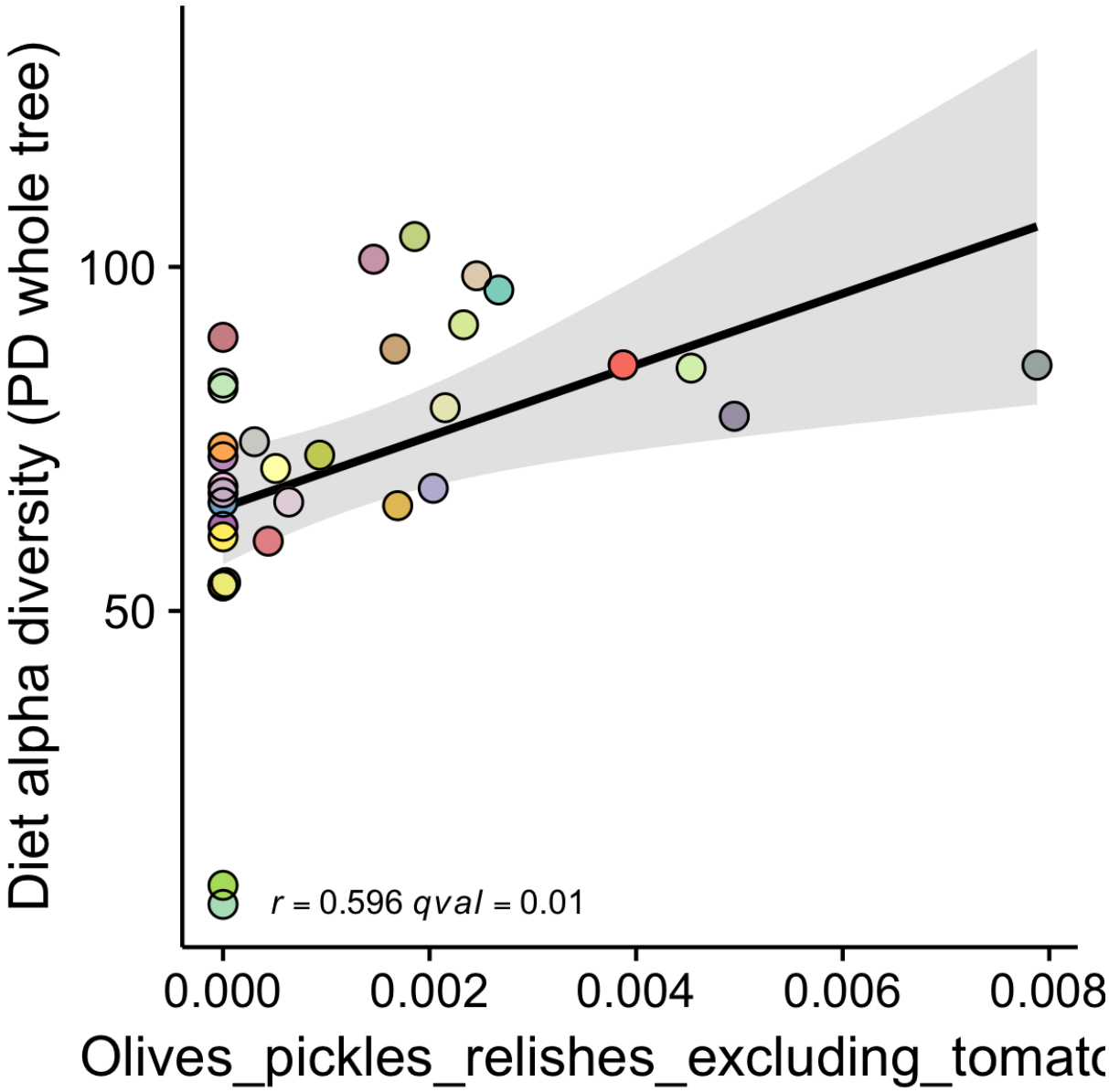


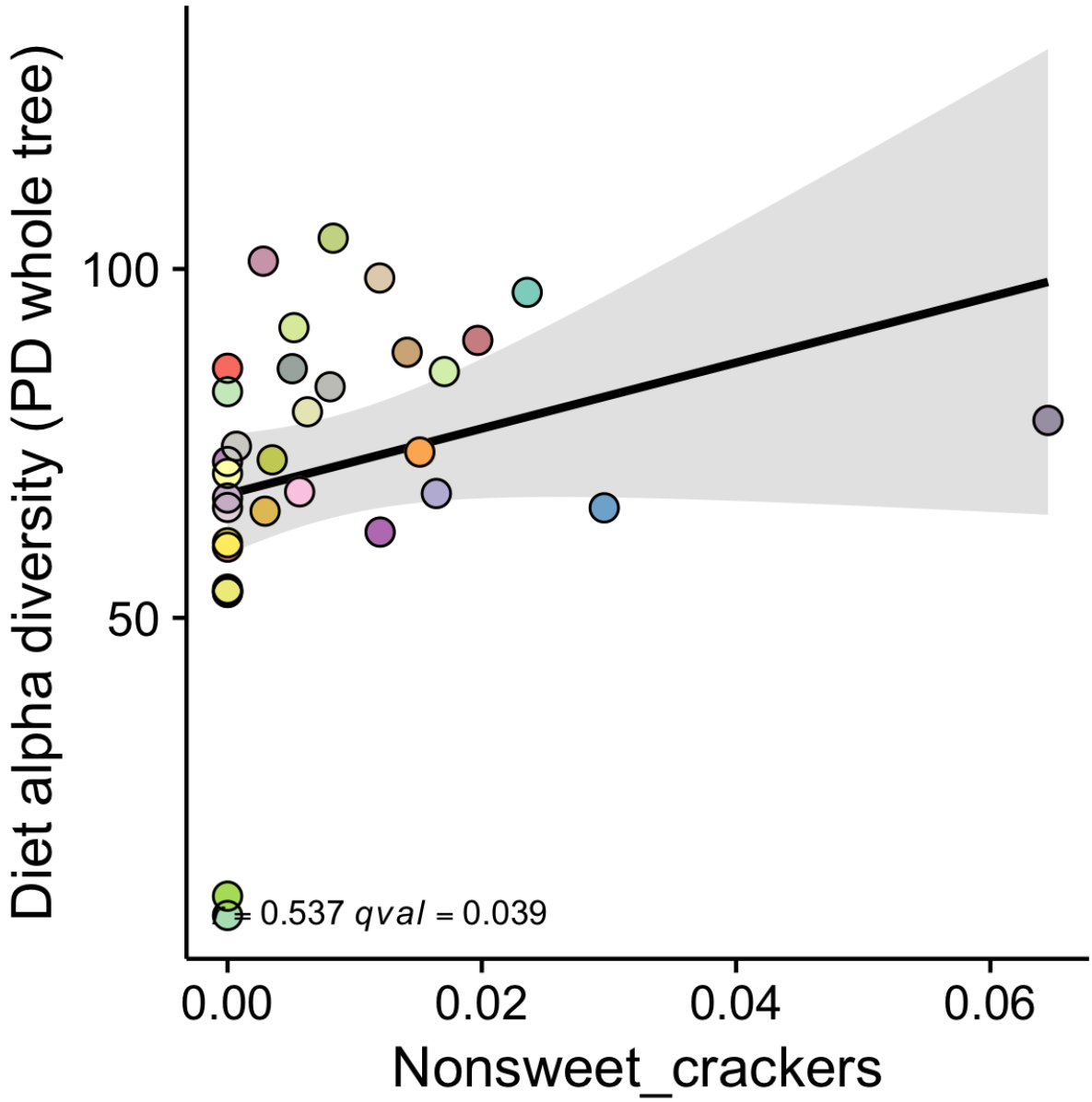

```
##                              qvals       cors
## Clostridium_symbiosum  0.006133703 -0.6364942
## Clostridium_bolteae    0.008597843 -0.6059984
## Alistipes_shahii       0.017643311  0.5687593
## Alistipes_senegalensis 0.032144842  0.5286524
## Flavonifractor_plautii 0.032144842 -0.5270454
```

3. Are any foods correlated with alpha diveristy of diet?


Diet alpha diversity (PD whole tree)
125
100
75
50
25
0.00
0.01
0.02
0.03
Sweet_potatoes
r = 0.68 qval = 0.001


Diet alpha diversity (PD whole tree)
100
50
= 0.641 qval = 0.003
0.000
0.005
0.010
0.015
0.02
Carrots


Diet alpha diversity (PD whole tree)
100
50
r = 0.596 qval = 0.01
0.000
0.002
0.004
0.006
0.008
Olives_pickles_relishes_excluding_tomato

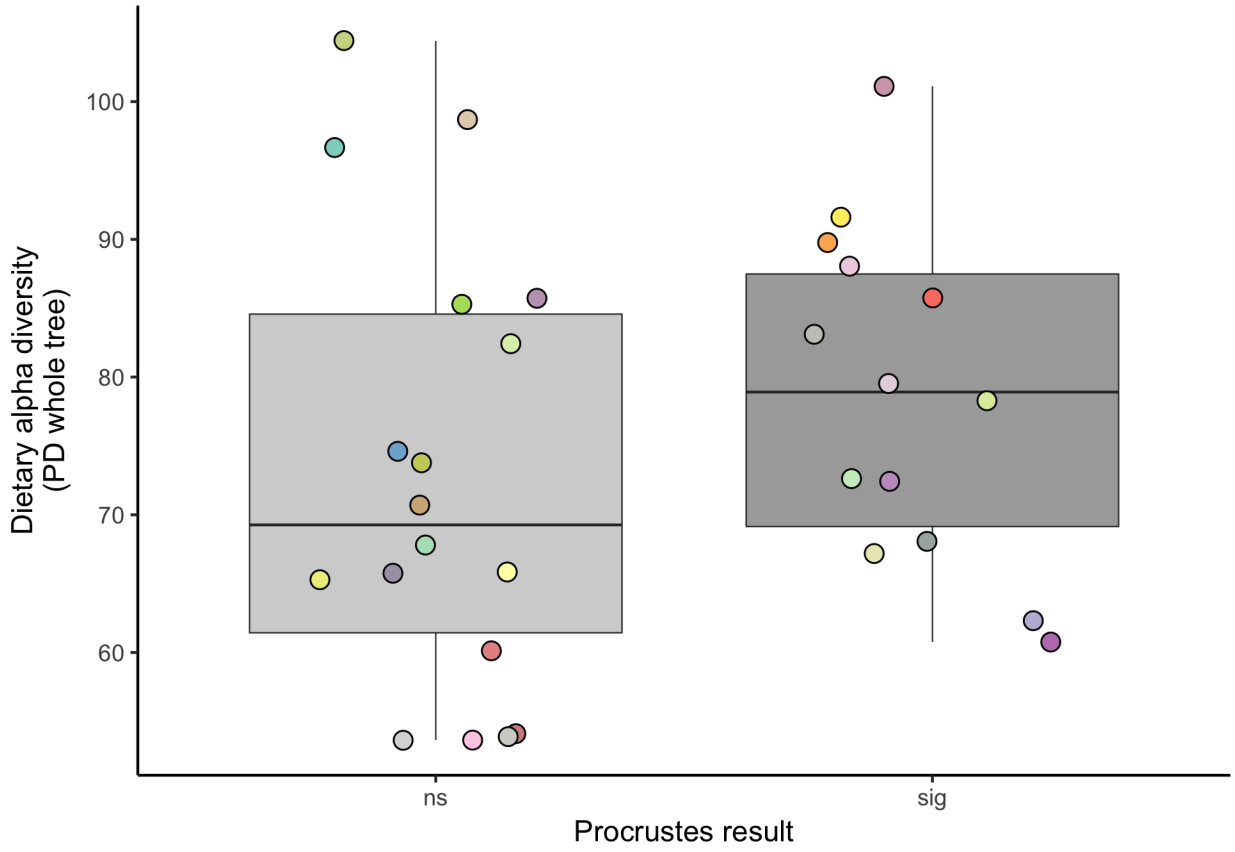



```
##                                                 qvals      cors
## Sweet_potatoes                              0.001440912 0.6799241
## Carrots                                     0.003277677 0.6409523
## Olives_pickles_relishes_excluding_tomatoes  0.009803110 0.5961719
## Nonsweet_crackers                           0.038694557 0.5374692
```

2. Is dietary alpha diveristy is associated with the ability to successfully match diet with microbiome using procrustes?

```
##
##  Welch Two Sample t-test
##
## data:  procrustes$`mean(PD_whole_tree)` by as.factor(procrustes$Procrustes)
## t = -1.1466, df = 29.951, p-value = 0.2606
## alternative hypothesis: true difference in means is not equal to 0
```

```
## 95 percent confidence interval:
##  -15.864621   4.456707
## sample estimates:
##  mean in group ns mean in group sig
##          72.90949          78.61345

##
##  Pearson's product-moment correlation
##
## data:  procrustes$`mean(PD_whole_tree)` and procrustes$Monte.Carlo.p.value
## t = 0.075376, df = 30, p-value = 0.9404
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.3365484  0.3607235
## sample estimates:
##       cor
## 0.01376034

## Joining, by = "UserName"

## Warning: Column `UserName` joining factors with different levels, coercing
## to character vector

##
##  Welch Two Sample t-test
##
## data:  procrustes$`mean(chao1)` by as.factor(procrustes$Procrustes)
## t = -1.1971, df = 29.862, p-value = 0.2407
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -7.536041  1.966988
## sample estimates:
##  mean in group ns mean in group sig
##          209.3245          212.1090

##
##  Pearson's product-moment correlation
##
## data:  procrustes$`mean(chao1)` and procrustes$Monte.Carlo.p.value
## t = -1.5262, df = 30, p-value = 0.1374
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.56429690  0.08856436
## sample estimates:
##       cor
## -0.2684189
```



Also did a check for foods correalted with alpha diversity (both chao1 and shannon) but didn't find any foods assocaited. May need to re-check this with the dry beans/peas and alpha diversity

Are any foods correlated with the short list of microbes that correlate with alpha diversity?

```
## Warning in cor.test.default(a, b, method = "spearman"): Cannot compute
## exact p-value with ties

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```
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```
## exact p-value with ties

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## exact p-value with ties

## Warning in cor.test.default(a, b, method = "spearman"): Cannot compute
## exact p-value with ties

## Warning in cor.test.default(a, b, method = "spearman"): Cannot compute
## exact p-value with ties
##                                              Food
## 1 L1_Dry_Beans_Peas_Other_Legumes_Nuts_and_Seeds
##
## 1 k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnoclostridium;s
##   Correlation      Pvalue   fdr_pval Significance
## 1   0.5225762 0.001521558 0.06847011            *
```
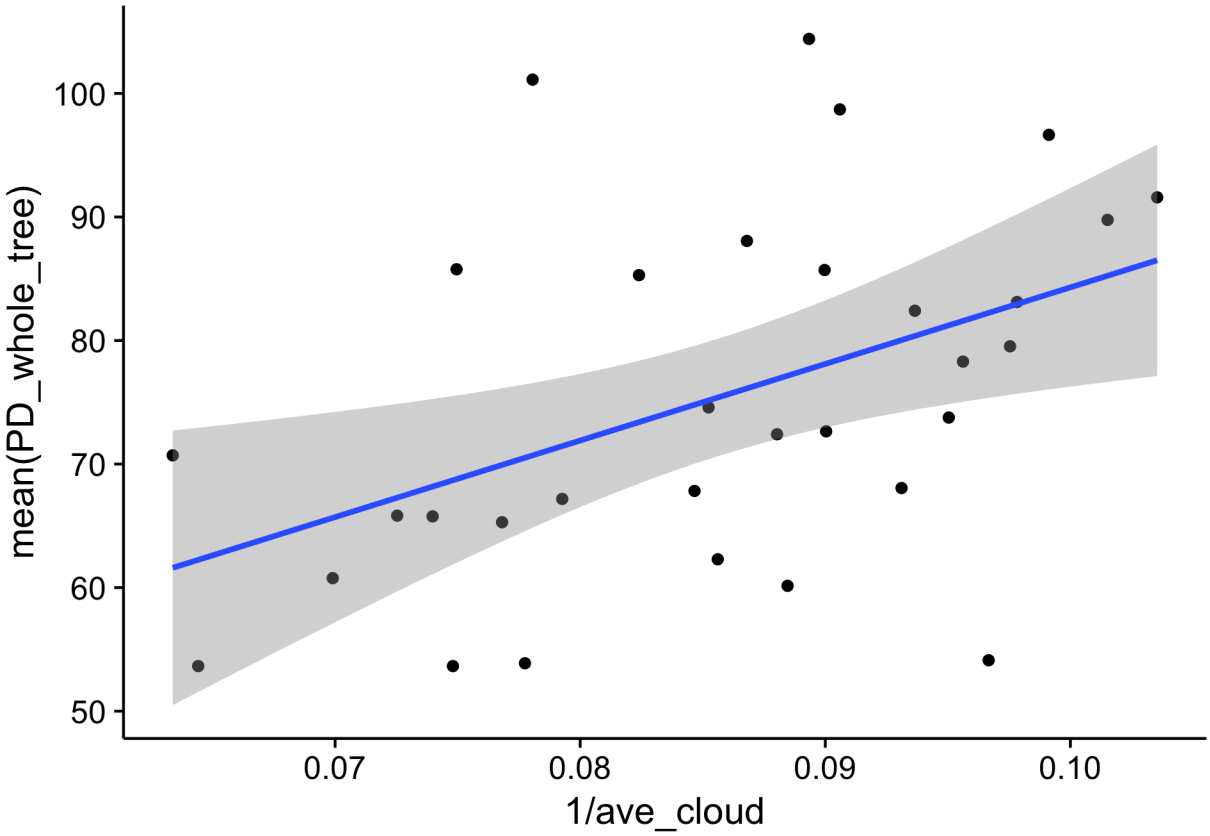
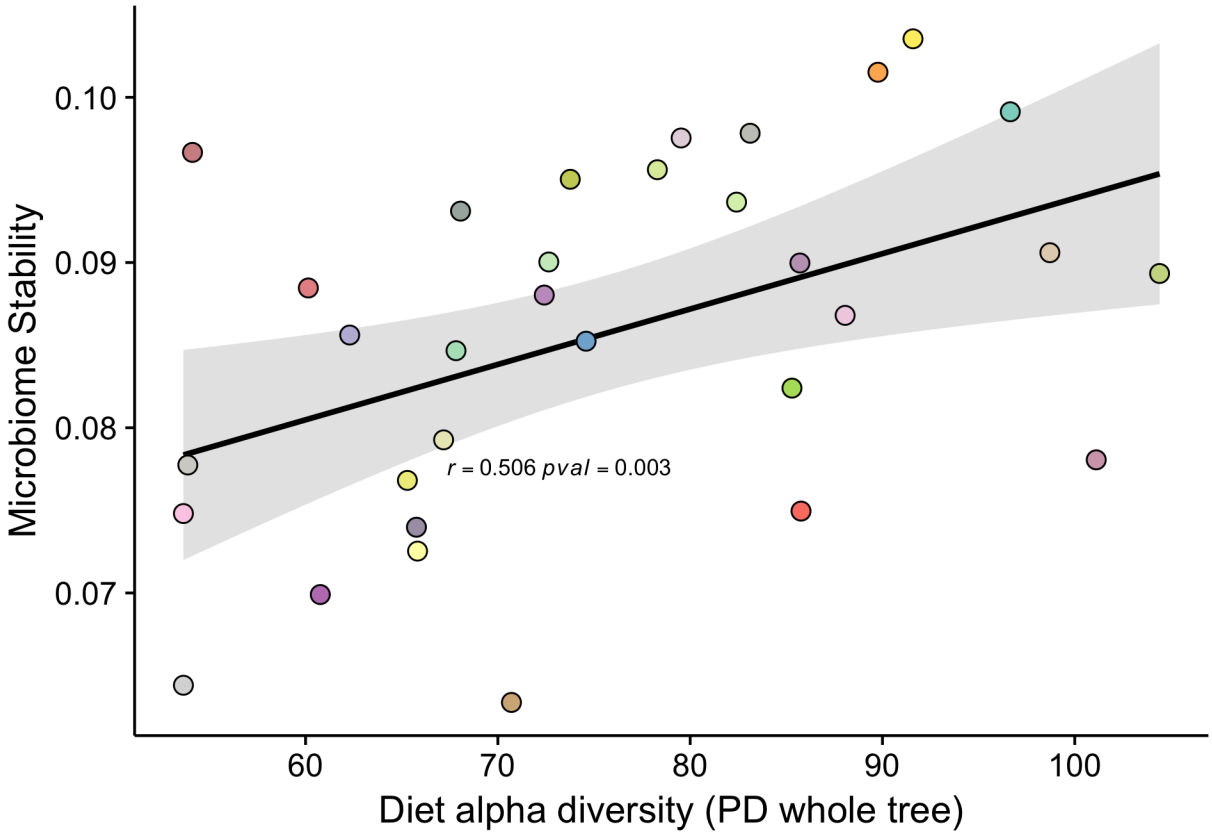


mean(PD_whole_tree)
100
90
80
70
60
50
0.07
0.08
0.09
0.10
1/ave_cloud


Microbiome Stability
0.10
0.09
0.08
0.07
r = 0.506 pval = 0.003
60
70
80
90
100
Diet alpha diversity (PD whole tree)