

## Libraries

```
library(spe)
library(ggplot2)
library(vgg)

## Loading required package: permute

## Loading required package: lattice

## This is vgg 2.6-4

library(dplyr)

## Attaching package: 'dplyr'

## The following object is masked from 'package:spe':
##   where

## The following objects are masked from 'package:stats':
##   filter, lag

## The following objects are masked from 'package:base':
##   intersect, setdiff, setequal, union

library(BiocManager)
library(ggtree)

## ggtree v3.6.2 For help: https://yulab-smu.top/treedata-book/
## If you use the ggtree package suite in published research, please cite
## the appropriate paper(s):
##
## Guangchuang Yu, David Smith, Huachen Zhu, Yi Guan, Tommy Tsan-Yuk Lam,
## ggtree: an R package for visualization and annotation of phylogenetic
## trees with their covariates and other associated data. Methods in
## Ecology and Evolution. 2017, 8(1):28-36. doi:10.1111/2041-210X.12620
##
## Guangchuang Yu. Data Integration, Manipulation and Visualization of
## Phylogenetic Trees (1st edition). Chapman and Hall/CRC. 2022,
## doi:10.1201/9781083279242
##
## Guangchuang Yu. Using ggtree to visualize data on tree-like structures.
## Current Protocols in Bioinformatics. 2020, 69:e66. doi:10.1002/cpbi.96

## Attaching package: 'ggtree'

## The following object is masked from 'package:spe':
##   rotate
```

## Exploring Dataset

```
Samples<-read.csv("C:/Users/egavvr/OneDrive/Documents/BIO1432/Csv files/FloristicSurvey.csv")
dim(Samples)

## [1] 30 44

head(Samples)

##      Quadrate Population Location Rosettes Bolting Budding Bud_Flw Flower Flw_Sil
## 1      703          7          0          0          0          0          0
## 2      701          7          0          0          0          0          0
## 3      702          7          0          0          0          0          0
## 4      713          7          1          14         8      157          0
## 5      712          7          1          3         18      184          0
## 6      711          7          0          0          3         122          0
##      Sillique Claytonia_virginiana Anemone_hepatica Grass_tuft
## 1          0          38          8          14
## 2          0          29          7          22
## 3          0          57          3          6
## 4          0          22          0          19
## 5          0          54          0          3
## 6          0          44          0          6
##      Trillium_grandifolium Erythronium_trout_lily Acer_saccharum
## 1          9          0          25          10
## 2          30          10          5
## 3          8          5          74
## 4          0          16          0
## 5          0          18          2
## 6          0          7          0
##      Dicentra_cucularia Bloodroot Gallium_aparine Ulmus_americana Unknown_1
## 1          0          0          0          0          0
## 2          22          4          27          3          1
## 3          23          0          8          0          0
## 4          0          0          17          88          0
## 5          0          1          0          22          159
## 6          0          0          21          133          0
##      Unknown_2 Unknown_3_ranunculaceae Unknown_4 Dryopteris_marginalis
## 1          0          0          0          0          0
## 2          0          0          0          0          0
## 3          0          0          0          0          0
## 4          5          0          0          0          0
## 5          4          0          0          0          0
## 6          0          0          0          0          0
##      Ostrich_fern Plantago_lanceolata Violet Rhamnus_frangula Raspberry Unknown_5
## 1          0          0          0          0          0
## 2          0          0          0          0          0
## 3          0          0          0          0          0
## 4          0          0          0          0          0
## 5          0          0          0          0          0
## 6          0          0          0          0          0
##      Unknown_6 Solidago_canadensis Unknown_7 Dandelion grass viccia_cracca
## 1          0          0          0          0          0
## 2          0          0          0          0          0
## 3          0          0          0          0          0
## 4          0          0          0          0          0
## 5          0          0          0          0          0
## 6          0          0          0          0          0
##      herb_robert thorny_ash rhamnus_cathartica rhubarb Unknown_8 Unknown_9
## 1          0          0          0          0          0
## 2          0          0          0          0          0
## 3          0          0          0          0          0
## 4          0          0          0          0          0
## 5          0          0          0          0          0
## 6          0          0          0          0          0
##      maianthemum_racemosum
## 1          0
## 2          0
## 3          0
## 4          0
## 5          0
## 6          0
```

```
tail(Samples)

##      Quadrate Population Location Rosettes Bolting Budding Bud_Flw Flower Flw_Sil
## 25      1402          14          0          0          0          0          0
## 26      1401          14          0          0          0          0          0
## 27      1403          14          0          0          0          0          0
## 28      1412          14          1          28         15          0
## 29      1411          14          1          0          34         12          0
## 30      1413          14          1          5          25         41          0
##      Sillique Claytonia_virginiana Anemone_hepatica Grass_tuft
## 25          0          5          0          0
## 26          0          0          0          0
## 27          0          1          0          0
## 28          0          0          0          0
## 29          0          7          0          0
## 30          0          37          0          0
##      Trillium_grandifolium Erythronium_trout_lily Acer_saccharum
## 25          0          0          7          16
## 26          0          12          13
## 27          0          0          19
## 28          0          0          2
## 29          0          0          0
## 30          0          1          1
##      Dicentra_cucularia Bloodroot Gallium_aparine Ulmus_americana Unknown_1
## 25          0          0          3          5          0
## 26          0          0          41          2          1
## 27          0          0          21          3          0
## 28          0          0          0          0          0
## 29          0          0          0          0          0
## 30          0          0          1          0          1
##      Unknown_2 Unknown_3_ranunculaceae Unknown_4 Dryopteris_marginalis
## 25          0          0          0          1          0
## 26          0          0          1          0
## 27          0          0          2          0
## 28          0          0          0          0
## 29          0          0          0          0
## 30          0          1          0          0
##      Ostrich_fern Plantago_lanceolata Violet Rhamnus_frangula Raspberry Unknown_5
## 25          0          0          0          0          0
## 26          0          0          0          0          0
## 27          0          0          0          0          4
## 28          0          0          0          0          0
## 29          0          0          1          0          0
## 30          0          0          0          0          1
##      Unknown_6 Solidago_canadensis Unknown_7 Dandelion grass viccia_cracca
## 25          0          0          0          0          14          0
## 26          0          0          0          0          39          0
## 27          0          0          0          0          0          0
## 28          0          2          0          0          14          0
## 29          0          4          0          0          0          0
## 30          0          0          0          0          30          0
##      herb_robert thorny_ash rhamnus_cathartica rhubarb Unknown_8 Unknown_9
## 25          10          0          0          0          0          0
## 26          5          0          0          0          0          0
## 27          18          1          0          0          0          0
## 28          0          1          0          0          0          0
## 29          0          0          0          0          0          3
## 30          5          4          0          0          0          0
##      maianthemum_racemosum
## 25          0
## 26          0
## 27          0
## 28          0
## 29          0
## 30          4
```

```
str(Samples)

## 'data.frame':   30 obs. of  44 variables:
## $ Quadrate      : chr "703" "701" "702" "713" ...
## $ Population    : int  7 7 7 7 7 3 3 3 3 ...
## $ Location      : chr "o" "o" "o" "o" "i" ...
## $ Rosettes      : int  0 0 0 14 3 0 14 0 0 ...
## $ Bolting       : int  0 0 0 8 18 3 3 12 26 0 ...
## $ Budding       : int  0 0 0 157 184 122 11 23 19 0 ...
## $ Bud_Flw       : int  0 0 0 0 0 0 0 0 0 ...
## $ Flower        : int  0 0 0 0 0 0 0 0 0 ...
## $ Flw_Sil       : int  0 0 0 0 0 0 0 0 0 ...
## $ Sillique      : int  0 0 0 0 0 0 0 0 0 ...
## $ Claytonia_virginiana : int  38 29 57 12 54 44 0 0 0 ...
## $ Anemone_hepatica : int  8 7 3 0 0 0 0 0 0 ...
## $ Grass_tuft    : int  14 22 16 10 3 0 0 0 0 ...
## $ Trillium_grandifolium : int  30 8 0 0 0 0 0 0 0 ...
## $ Erythronium_trout_lily : int  25 15 0 16 17 0 0 0 0 ...
## $ Acer_saccharum : int  5 10 74 0 2 0 66 60 26 71 ...
## $ Dicentra_cucularia : int  0 22 23 0 0 0 0 0 0 ...
## $ Bloodroot     : int  0 4 0 0 1 0 0 0 0 ...
## $ Gallium_aparine : int  25 15 0 17 22 21 2 0 0 ...
## $ Ulmus_americana : int  0 3 0 88 150 133 0 0 0 0 ...
## $ Unknown_1     : int  0 1 0 0 0 0 0 0 0 ...
## $ Unknown_2     : int  0 0 0 0 5 4 0 0 0 0 ...
## $ Unknown_3_ranunculaceae : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_4     : int  0 0 0 0 0 0 1 0 0 0 ...
## $ Dryopteris_marginalis : int  0 0 0 0 0 0 1 0 0 ...
## $ Ostrich_fern  : int  0 0 0 0 0 0 0 0 0 ...
## $ Plantago_lanceolata : int  0 0 0 0 0 0 0 0 0 ...
## $ Violet        : int  0 0 0 0 0 0 0 0 0 ...
## $ Rhamnus_frangula : int  0 0 0 0 0 0 0 0 0 ...
## $ Raspberry     : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_5     : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_6     : int  0 0 0 0 0 0 0 0 0 ...
## $ Solidago_canadensis : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_7     : int  0 0 0 0 0 0 0 0 0 ...
## $ Dandelion     : int  0 0 0 0 0 0 0 0 0 ...
## $ grass         : int  0 0 0 0 0 0 0 0 0 ...
## $ viccia_cracca : int  0 0 0 0 0 0 0 0 0 ...
## $ herb_robert   : int  0 0 0 0 0 0 0 0 0 ...
## $ thorny_ash    : int  0 0 0 0 0 0 0 0 0 ...
## $ rhamnus_cathartica : int  0 0 0 0 0 0 0 0 0 ...
## $ rhubarb       : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_8     : int  0 0 0 0 0 0 0 0 0 ...
## $ Unknown_9     : int  0 0 0 0 0 0 0 0 0 ...
## $ maianthemum_racemosum : int  0 0 0 0 0 0 0 0 0 ...
```

```
summary(Samples)

##      Quadrate      Population      Location      Rosettes
## Length:30      Min.   : 1.0      Length:30      Min.   : 0.000
## Class :character 1st Qu.: 3.0      Class :character 1st Qu.: 0.000
## Mode :character  Median : 7.0      Mode :character  Median : 0.000
##              Mean : 7.6              Mean : 2.733
##              3rd Qu.:13.0             3rd Qu.: 4.500
##              Max.   :14.0             Max.   :14.000
##      Bolting      Budding      Bud_Flw      Flower      Flw_Sil
## Min.   : 0.000      Min.   : 0.00      Min.   :0      Min.   :0
## 1st Qu.: 0.000      1st Qu.: 0.00      1st Qu.:0      1st Qu.:0
## Median : 1.500      Median : 5.50      Median :0      Median :0
## Mean   : 8.533      Mean   : 29.47      Mean :0.167      Mean :0
## 3rd Qu.:16.500      3rd Qu.: 36.00      3rd Qu.:0      3rd Qu.:0
## Max.   :134.000      Max.   :184.00      Max.   :0      Max.   :0
##      Sillique Claytonia_virginiana Anemone_hepatica Grass_tuft
## Min.   : 0.000      Min.   : 0.00      Min.   :0      Min.   : 0.000
## 1st Qu.: 0.000      1st Qu.: 0.000      1st Qu.: 0.000      1st Qu.: 0.000
## Median : 1.500      Median : 0.0000      Median : 1.500      Median : 0.000
## Mean   : 8.533      Mean   : 29.47      Mean : 0.167      Mean : 0
## 3rd Qu.:13.000      3rd Qu.: 0.0000      3rd Qu.: 7.233      3rd Qu.: 13.13
## Max.   :134.000      Max.   :184.00      Max.   :14.000      Max.   :159.00
##      Unknown_1 Unknown_2 Unknown_3_ranunculaceae Unknown_4
## Min.   :0.000      Min.   :0.0000      Min.   :0.0000      Min.   : 0.000
## 1st Qu.:0.000      1st Qu.:0.0000      1st Qu.:0.0000      1st Qu.: 0.000
## Median :0.000      Median :0.0000      Median :0.0000      Median : 0.000
## Mean   :0.1      Mean   :0.4333      Mean :0.0000      Mean : 1.267
## 3rd Qu.:0.000      3rd Qu.:0.0000      3rd Qu.:0.0000      3rd Qu.: 1.000
## Max.   :1.0      Max.   :5.0000      Max.   :4.0000      Max.   :15.000
##      Dryopteris_marginalis Ostrich_fern Plantago_lanceolata Violet
## Min.   :0.00000      Min.   :0.0      Min.   :0.00000      Min.   : 0.0
## 1st Qu.:0.00000      1st Qu.:0.0      1st Qu.: 0.0000      1st Qu.: 0.0
## Median :0.00000      Median :0.0      Median :0.0000      Median : 0.0
## Mean   :0.03333      Mean :0.5      Mean : 0.4333      Mean : 0.7
## 3rd Qu.:0.00000      3rd Qu.:0.0      3rd Qu.: 0.0000      3rd Qu.: 0.0
## Max.   :1.00000      Max.   :4.0      Max.   :13.0000      Max.   :17.0
##      Rhamnus_frangula Raspberry Unknown_5 Unknown_6
## Min.   :0.00000      Min.   :0.0      Min.   :0.0000      Min.   : 0.0000
## 1st Qu.:0.00000      1st Qu.:0.0000      1st Qu.: 0.0000      1st Qu.: 0.0000
## Median :0.00000      Median :0.0      Median :0.0000      Median : 0.0000
## Mean   :0.46667      Mean :0.3      Mean : 0.667      Mean : 0.7333
## 3rd Qu.:0.00000      3rd Qu.:0.0      3rd Qu.: 0.750      3rd Qu.: 0.0000
## Max.   :7.00000      Max.   :4.0      Max.   :12.0000      Max.   :22.0000
##      Solidago_canadensis Unknown_7 Dandelion grass
## Min.   : 0.000      Min.   :0.00000      Min.   :0.000      Min.   : 0.0
## 1st Qu.: 0.000      1st Qu.:0.00000      1st Qu.: 0.000      1st Qu.: 0.0
## Median : 0.000      Median :0.00000      Median : 0.000      Median : 0.0
## Mean   : 1.367      Mean :0.06667      Mean :1.233      Mean : 20.1
## 3rd Qu.: 0.000      3rd Qu.:0.00000      3rd Qu.: 0.000      3rd Qu.: 14.0
## Max.   :18.000      Max.   :2.00000      Max.   :14.000      Max.   :129.0
##      viccia_cracca herb_robert thorny_ash rhamnus_cathartica
## Min.   :0.00000      Min.   :0.0      Min.   :0.0000      Min.   :0.00000
## 1st Qu.:0.00000      1st Qu.:0.0      1st Qu.:0.0000      1st Qu.:0.00000
## Median :0.00000      Median :0.0      Median :0.0000      Median :0.00000
## Mean   :0.06667      Mean :1.0      Mean :0.4333      Mean :0.03333
## 3rd Qu.:0.00000      3rd Qu.:0.0      3rd Qu.:0.0000      3rd Qu.:0.00000
## Max.   :2.00000      Max.   :18.0      Max.   :18.0000      Max.   :1.00000
##      rhubarb Unknown_8 Unknown_9 maianthemum_racemosum
## Min.   :0.00000      Min.   :0.00000      Min.   :0.0      Min.   :0.0000
## 1st Qu.:0.00000      1st Qu.:0.00000      1st Qu.:0.0      1st Qu.:0.0000
## Median :0.00000      Median :0.00000      Median :0.0      Median :0.0000
## Mean   :0.03333      Mean :0.06667      Mean :0.1      Mean :0.0000
## 3rd Qu.:0.00000      3rd Qu.:0.00000      3rd Qu.:0.0      3rd Qu.:0.0000
## Max.   :1.00000      Max.   :12.00000      Max.   :3.0      Max.   :4.0000
```

## Converting Factors into Binary Data

```
Indat <- Samples %>%
  select(-c(Quadrate,Location))
Indat2 <- Samples %>%
  select(-c(Quadrate))
BinDat <- Indat2
BinDat <- Indat
for (row in 1:nrow(Indat)){
  for (col in 1:ncol(Indat)){
    if (BinDat[row,col] > 0){
      BinDat[row,col] <- 1
    }
  }
}
```

```
str(BinDat)

## 'data.frame':   30 obs. of  42 variables:
## $ Population    : num 1 1 1 1 1 1 1 1 1 ...
## $ Rosettes      : num 0 0 0 1 1 0 1 0 0 ...
## $ Bolting       : num 0 0 0 1 1 1 1 1 0 ...
## $ Budding       : num 0 0 0 1 1 1 1 1 0 ...
## $ Bud_Flw       : int 0 0 0 0 0 0 0 0 0 ...
## $ Flower        : int 0 0 0 0 0 0 0 0 0 ...
## $ Flw_Sil       : int 0 0 0 0 0 0 0 0 0 ...
## $ Sillique      : int 0 0 0 0 0 0 0 0 0 ...
## $ Claytonia_virginiana : num 1 1 1 1 1 1 0 0 0 ...
## $ Anemone_hepatica : num 1 1 1 0 0 0 0 0 0 ...
## $ Grass_tuft    : num 1 1 1 0 0 0 0 0 0 ...
## $ Trillium_grandifolium : num 1 1 0 0 0 0 0 0 0 ...
## $ Acer_saccharum : num 1 1 0 1 0 1 1 1 1 ...
## $ Dicentra_cucularia : num 0 1 0 0 0 0 0 0 0 ...
## $ Bloodroot     : num 0 1 0 0 1 0 0 0 0 ...
## $ Gallium_aparine : num 0 1 1 1 1 1 0 0 0 ...
## $ Ulmus_americana : num 0 1 0 1 1 0 0 0 0 ...
## $ Unknown_1     : num 0 1 0 0 0 0 0 0 0 ...
## $ Unknown_2     : num 0 0 0 0 1 1 0 0 0 ...
## $ Unknown_3_ranunculaceae : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_4     : num 0 0 0 0 0 0 1 0 0 ...
## $ Dryopteris_marginalis : num 0 0 0 0 0 0 0 0 0 ...
## $ Ostrich_fern  : num 0 0 0 0 0 0 0 0 0 ...
## $ Plantago_lanceolata : num 0 0 0 0 0 0 0 0 0 ...
## $ Violet        : num 0 0 0 0 0 0 0 0 0 ...
## $ Rhamnus_frangula : num 0 0 0 0 0 0 0 0 0 ...
## $ Raspberry     : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_5     : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_6     : num 0 0 0 0 0 0 0 0 0 ...
## $ Solidago_canadensis : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_7     : num 0 0 0 0 0 0 0 0 0 ...
## $ Dandelion     : num 0 0 0 0 0 0 0 0 0 ...
## $ grass         : num 0 0 0 0 0 0 0 0 0 ...
## $ viccia_cracca : num 0 0 0 0 0 0 0 0 0 ...
## $ herb_robert   : num 0 0 0 0 0 0 0 0 0 ...
## $ thorny_ash    : num 0 0 0 0 0 0 0 0 0 ...
## $ rhamnus_cathartica : num 0 0 0 0 0 0 0 0 0 ...
## $ rhubarb       : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_8     : num 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_9     : num 0 0 0 0 0 0 0 0 0 ...
## $ maianthemum_racemosum : num 0 0 0 0 0 0 0 0 0 ...
```

## Q1- Categorizing by Dissimilarity - Highlighting the samples that are taken in and out of mustard plant patches

```
OTU.dist<- vegdist(BinDat, method="bray",binary=F)
OTUtree<-nj(OTU.dist)
NMDSdat<-metaMDS(OTU.dist,k=2)
```

```
## Run 0 stress 0.1935574
## Run 1 stress 0.2030529
## Run 2 stress 0.2031668
## Run 3 stress 0.1976602
## Run 4 stress 0.2110444
## Run 5 stress 0.1976602
## Run 6 stress 0.2110444
## Run 7 stress 0.1976602
## Run 8 stress 0.2110444
## Run 9 stress 0.2030529
## Run 10 stress 0.2110444
## Run 11 stress 0.1932304
## ... New best solution
## ... Procrustes: rmse 0.01444141 max resid 0.06028253
## Run 12 stress 0.1935574
## ... Procrustes: rmse 0.01444086 max resid 0.06034636
## Run 13 stress 0.1932304
## ... New best solution
## ... Procrustes: rmse 5.089089e-06 max resid 1.753421e-05
## ... Similar to previous best
## Run 14 stress 0.2259137
## Run 15 stress 0.1976602
## Run 16 stress 0.2030526
## Run 17 stress 0.2408614
## Run 18 stress 0.1932304
## ... Procrustes: rmse 1.625149e-05 max resid 6.959699e-05
## ... Similar to previous best
## Run 19 stress 0.1935574
## ... Procrustes: rmse 0.01444046 max resid 0.06033852
## Run 20 stress 0.1976778
## *** Best solution repeated 2 times
```

```
ggtree(OTUtree,layout="rectangular") %>% BinDat2 +
  geom_tiplab(aes(colour=Location)) +
  theme(legend.position = "right")
```

## 1 The tree contained negative edge length. If you want to ignore the edge, you can set options(ignore.negative.edges=TRUE), then re-run ggtree.

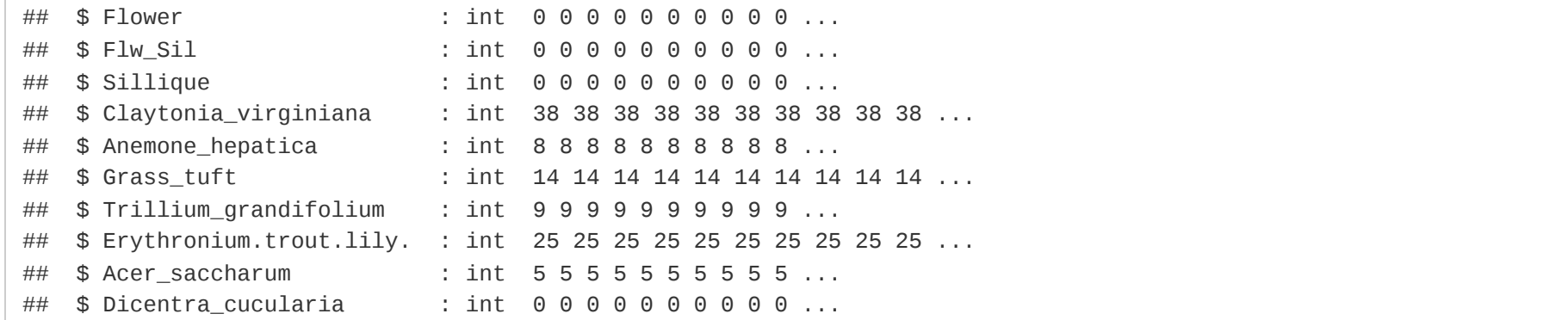


Fig. 1: Dissimilarity tree depicting the relationship between each sample. Red samples are samples that are taken from quadrants within mustard plant patches. Grey samples are taken from quadrants outside of mustard plant patches.

There is influence in plant samples from areas where mustard plants are present. The OUT tree determined the samples that are in the same patches as mustard plants to be the most similar to each other, while plants outside of the mustard patches are not as similar to those within.

## Q2

```
Pdat<-data.frame(NMDS1=NMDSdat$points[,1],
                 NMDS2=NMDSdat$points[,2],
                 SampleID=row.names(Samples))
Pdat<-merge(Pdat,Samples,all=TRUE,by=SampleID)
str(Pdat)
```

```
## 'data.frame':   900 obs. of  47 variables:
## $ NMDS1      : num -0.262 -0.511 -0.413 -0.689 -0.505 ...
## $ NMDS2      : num -0.7342 -0.6252 -0.6419 0.0100 -0.062 ...
## $ SampleID   : chr "a" "a" "a" "a" "a" ...
## $ Quadrate   : chr "703" "703" "703" "703" "703" ...
## $ Population : int 7 7 7 7 7 7 7 7 7 ...
## $ Location    : chr "a" "a" "a" "a" "a" ...
## $ Rosettes    : int 0 0 0 0 0 0 0 0 0 ...
## $ Bolting     : int 0 0 0 0 0 0 0 0 0 ...
## $ Budding     : int 0 0 0 0 0 0 0 0 0 ...
## $ Bud_Flw     : int 0 0 0 0 0 0 0 0 0 ...
## $ Flower      : int 0 0 0 0 0 0 0 0 0 ...
## $ Flw_Sil     : int 0 0 0 0 0 0 0 0 0 ...
## $ Sillique    : int 0 0 0 0 0 0 0 0 0 ...
## $ Claytonia_virginiana : int 38 38 38 38 38 38 38 38 38 ...
## $ Anemone_hepatica : int 8 8 8 8 8 8 8 8 8 ...
## $ Grass_tuft  : int 14 14 14 14 14 14 14 14 14 ...
## $ Trillium_grandifolium : int 9 9 9 9 9 9 9 9 9 ...
## $ Erythronium_trout_lily : int 25 25 25 25 25 25 25 25 25 ...
## $ Acer_saccharum : int 5 5 5 5 5 5 5 5 5 ...
## $ Dicentra_cucularia : int 0 0 0 0 0 0 0 0 0 ...
## $ Bloodroot   : int 0 0 0 0 0 0 0 0 0 ...
## $ Gallium_aparine : int 0 0 0 0 0 0 0 0 0 ...
## $ Ulmus_americana : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_1   : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_2   : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_3_ranunculaceae : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_4   : int 0 0 0 0 0 0 0 0 0 ...
## $ Dryopteris_marginalis : int 0 0 0 0 0 0 0 0 0 ...
## $ Ostrich_fern : int 0 0 0 0 0 0 0 0 0 ...
## $ Plantago_lanceolata : int 0 0 0 0 0 0 0 0 0 ...
## $ Violet      : int 0 0 0 0 0 0 0 0 0 ...
## $ Rhamnus_frangula : int 0 0 0 0 0 0 0 0 0 ...
## $ Raspberry   : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_5   : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_6   : int 0 0 0 0 0 0 0 0 0 ...
## $ Solidago_canadensis : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_7   : int 0 0 0 0 0 0 0 0 0 ...
## $ Dandelion   : int 0 0 0 0 0 0 0 0 0 ...
## $ grass       : int 0 0 0 0 0 0 0 0 0 ...
## $ viccia_cracca : int 0 0 0 0 0 0 0 0 0 ...
## $ herb_robert : int 0 0 0 0 0 0 0 0 0 ...
## $ thorny_ash  : int 0 0 0 0 0 0 0 0 0 ...
## $ rhamnus_cathartica : int 0 0 0 0 0 0 0 0 0 ...
## $ rhubarb     : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_8   : int 0 0 0 0 0 0 0 0 0 ...
## $ Unknown_9   : int 0 0 0 0 0 0 0 0 0 ...
## $ maianthemum_racemosum : int 0 0 0 0 0 0 0 0 0 ...
```

```
Pdat$Location <- factor(Pdat$Location)
ggplot(aes(x=NMDS1,y=NMDS2,colour=Location, alpha=(0.6)), data=Pdat)+
  geom_point()+
  geom_jitter()+
  scale_colour_gradient(limits = c(0,14))+
  theme_classic()+
  scale_color_manual(values = c("red", "green"))
```

## Scale for colour is already present.

## Adding another scale for colour, which will replace the existing scale.



Fig. 2: Plot of NMDS2 vs NMDS1. Red dots are where the samples in the presence of mustard. Green dots are where samples were recorded outside the presence of mustard.

```
ggplot(aes(x=NMDS1,y=NMDS2,colour=Population), data=Pdat)+
  geom_point()+
  geom_jitter()+
  theme_classic()
```



Fig. 3: Plot of NMDS2 vs NMDS1. Darker dots represent a lower population of mustard in the area that the sample was taken from. Lighter dots represent a higher population of mustard in the area that the sample was taken from.

The figures support that the population has a stronger impact on plant communities, because they are grouped together more tightly when categorized by population than by presence of mustard.