Influence of *Alliaria petiolata* on plant community ecology

Amelie Mahrt-Smith, Queen's University

Data and supporting documents available on Github (https://github.com/ameliems99/Metabarcoding).

Garlic mustard, *Alliaria petiolata*, is an invasive species in North America. It was purportedly introduced by European settlers in the 1800s. Current research in the Colautti Lab (https://www.ecoevogeno.org/research.html) at Queen's University seeks to identify the effect of this species on native soil ecology, and whether the introduced populations of *A. petiolata* are more vigorous than in its native range. To learn more about garlic mustard, visit the Opinicon Natural History Blog (https://opinicon.wordpress.com/2020/06/09/garlic-mustard-alliaria-petiolata-brassicaceae/).

This analysis seeks to determine the effect of garlic mustard on plant communities, based on a floristic survey at the Queen's University Biological Station. More specifically, does the presence of garlic mustard affect plant community composition?

```
Dat <- read.csv("./Input/FloristicSurvey.csv", header = TRUE)
Dat$Location <- recode(Dat$Location, "i" = "Present", "o" = "Absent")  #is A. petiolata present/absent?
PlDat <- select(Dat, Claytonia_virginiana:maianthenum_racemosum) %>%  #keep plants present in sample
  mutate(Alliaria_petiolata = recode(Dat$Location, "Present" = 1, "Absent" = 0))
row.names(PlDat) <- Dat$ï..Quadrate  #sample IDs

Pl_binary <- PlDat
Pl_binary[Pl_binary > 0] <- 1  #reformat data as presence/absence of a plant species in community
Pl_dist<- dist(Pl_binary, method = 'binary')  #distances btwn communities by species composition
Pl_tree <- nj(Pl_dist)  #neighbour-joining tree
ggtree(Pl_tree, layout = 'rectangular') %<+% Dat +
  geom_tiplab(aes(colour = Location), size = 3) +
  guides(colour = guide_legend(title = expression(italic("A. petiolata"))))
```

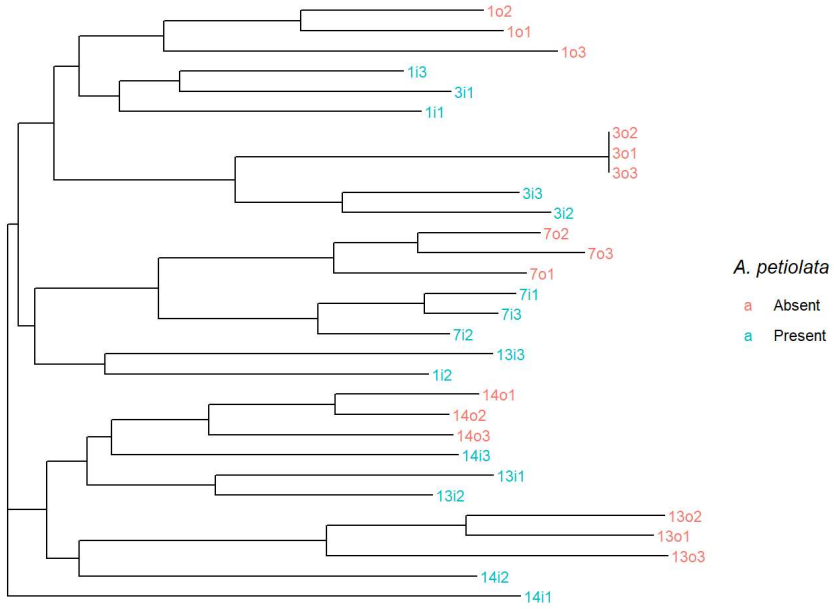

Figure 1. Clustering of plant communities based on the species present.

Garlic mustard has a weak effect on plant community composition. Fig. 1 shows that there is some clustering of communities by presence/absence of *A. petiolata*. This suggests that for groups of plant communities that are broadly similar, the presence of *A. petiolata* can be used to differentiate between them. However, if *A. petiolata* had a biologically relevant impact on plant community composition—i.e., significantly affected the presence/absence of other species—we would expect to see just two distinct clusters of plant communities: an *A. petiolata* present group and an *A. petiolata* absent group.

The floristic survey included abundance of plant species in addition to the community composition, which allows for a more in-depth analysis of the factors affecting plant community structure. For example, what has a stronger effect on plant community: the presence/absence of garlic mustard or the sampling population?

```
Ab_dist <- vegdist(PlDat, method = 'bray', binary = FALSE)  #distance btwn communities, by abundance
NMDS <- metaMDS(Ab_dist, k = 2)  #non-metric multi-dimensional scaling, 2 dimensions
PDat <- data.frame(NMDS1 = NMDS$points[, 1],
                   NMDS2 = NMDS$points[, 2],
                   SampleID = Dat$ï..Quadrate,
                   Location = Dat$Location,
                   Population = as.character(Dat$Population))

P1 <- qplot(x = NMDS1, y = NMDS2, colour = Population, data = PDat) +  #colour by sampling pop
  coord_fixed(ratio = 1.5) +  #keep plots square
  theme(legend.position = "bottom") +
  geom_mark_ellipse(aes(color = Population), expand = 0.01) +  #encircle points by population
  theme(legend.justification = "right")

P2 <- qplot(x = NMDS1, y = NMDS2, colour = Location, data = PDat) +  #colour by garlic mustard
  guides(colour = guide_legend(title = expression(italic("A. petiolata")))) +
  coord_fixed(ratio = 1.5) +
  theme(legend.position = "bottom")
plot_grid(P1, P2, labels = c("a", "b"))  #arrange plots in same figure
```

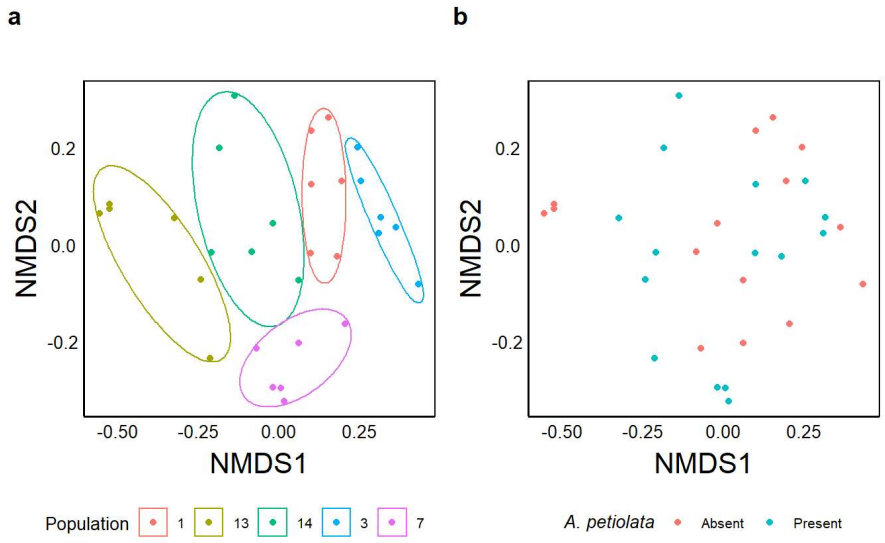

Figure 2. (a) The influence of sampling population on the similarity of plant communities. (b) The influence of *A. petiolata* on the similarity of plant communities.

The sampling population has a stronger influence on plant community structure (i.e., which species are present, and in what relative amounts) than the presence or absence of garlic mustard. The communities sampled from the same population, as shown in Fig. 1a, tend to cluster together. In general, communitites are more likely to be similar to other communitites from the same sampling population than to those from a different population. In contrast, there is no discernable clustering of communities based on presence or absence of *A. petiolata* (Fig. 1b). Community structure is not significantly affected by the presence of garlic mustard.