Analytical report of plant-pollinator networks from Cantavieja and Ejea de los Caballeros

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Objectives

Some text here

Field sampling

Two distinct locations are being monitored with different historical land-use and management in the region of Aragón (Spain): Cantavieja (40º 30' 44", N 0º 22' 59" W) at 1450m above sea level with a total of 30 plots and Ejea de los Caballeros (42º 01' 06" N, 1º 08' 53" W) at 350m with a total of 21 plots. Plot size is 2m by 2m and they are randomly distributed within each location (see **Figure 1**). Importantly, since the start of the project vegetation has remained undisturbed without grazing or clearing.

Figure 1. Cantavieja (left) and Ejea de los Caballeros (right) locations with the different sampling plots indicated with an orange square plus the plot identifier. The position of the bee hives are shown with a white cross for both locations.

Data visualization

Location 1 'Cantavieja'

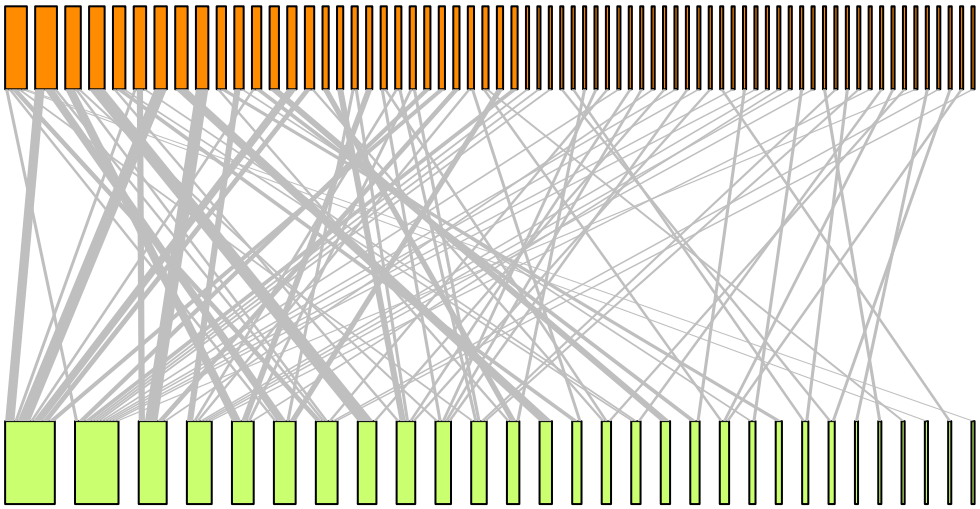

Figure 2. Bipartie plant-pollinator network from Cantavieja location. Pollinators are coloured in orange and plants in green. The width of the conection between plants and pollinators represent the strength of the interaction (number of links) and the width of the different nodes corresponds to the total number of links.

Location 2 'Ejea caballeros'

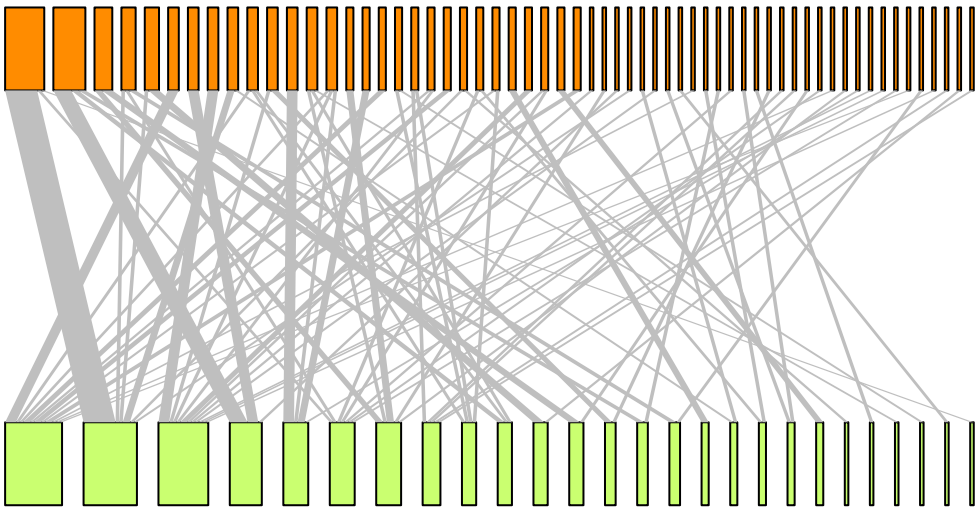

Figure 3. Bipartie plant-pollinator network from Ejea de los Caballeros location. Pollinators are coloured in orange and plants in green. The width of the conection between plants and pollinators represent the strength of the interaction (number of links) and the width of the different nodes corresponds to the total number of links.

Analysis of network structure

Two main aspects of network structure are going to be analyzed for each location: weighted nestedness (NODF) implemented in Almeida-Neto et al. (2008) and the quantitative version of modularity (Dormann and Strauss 2014). To understand how nested or modular are these two networks, the resulting values are compared with nestedness and modularity values of the same networks after randomization (N=1000). In addition, the overall specialization or 'selectiveness' as estimated in Blüthgen, Menzel, and Blüthgen (2006) is also going to be explored. All analysis are conducted in R Core Team (2021) version *4.0.5*.

Location 1 'Cantavieja'

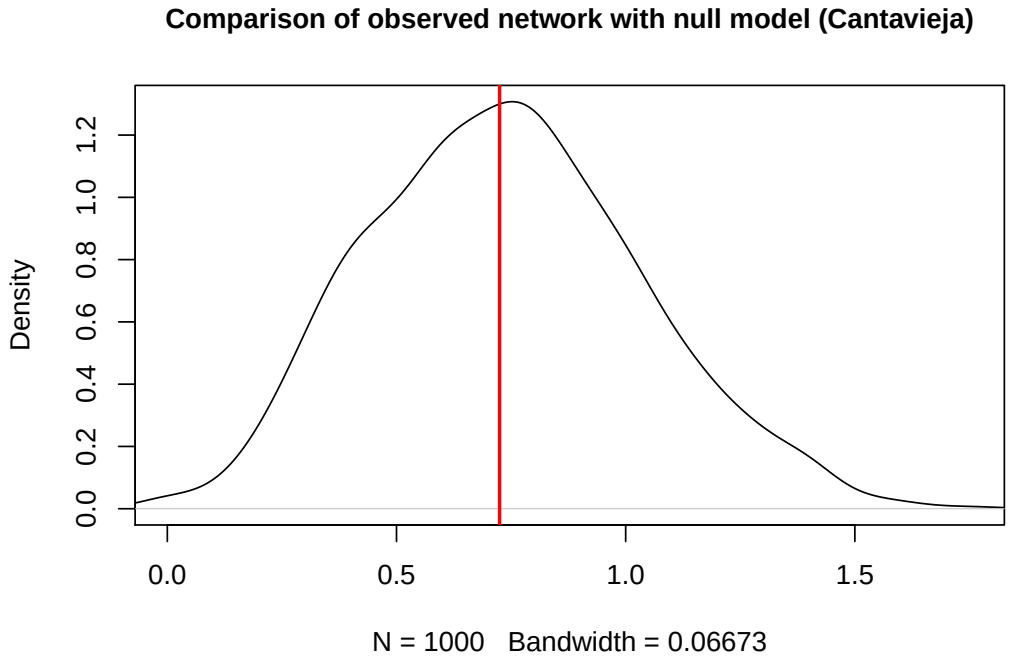

Figure 4. Density plot of the nestedness values for the different random networks (N=1000). The red vertical line indicates the observed nestedness in Cantavieja.

Nestedness of the plant-pollinator network from Cantavieja is similar to the one that is expected by chance (P value = 0.506). This indicates that smaller subsets of interacting species are not contained in larger subsets of interacting ones.

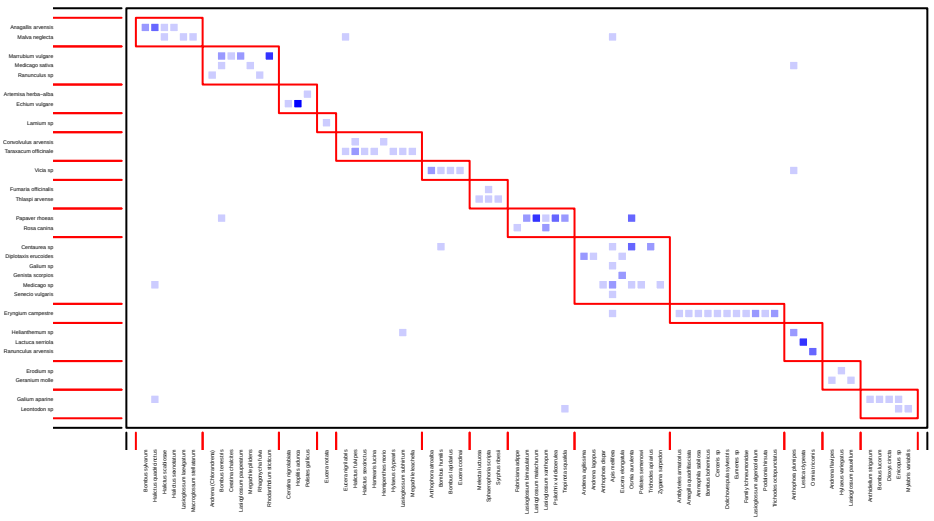

Figure 5. Interaction modules of the plant-pollinator network from Cantavieja.

Cantavieja plant-pollinator network is more modular than expected by chance (P-value = 0). This suggest that the are subgroups or modules of species with strong connections but these modules are weakly connected. This also supports the lack of nestedness found previously.

The overall network specialization (H2) is 0.56.

Location 2 'Ejea de los Caballeros'

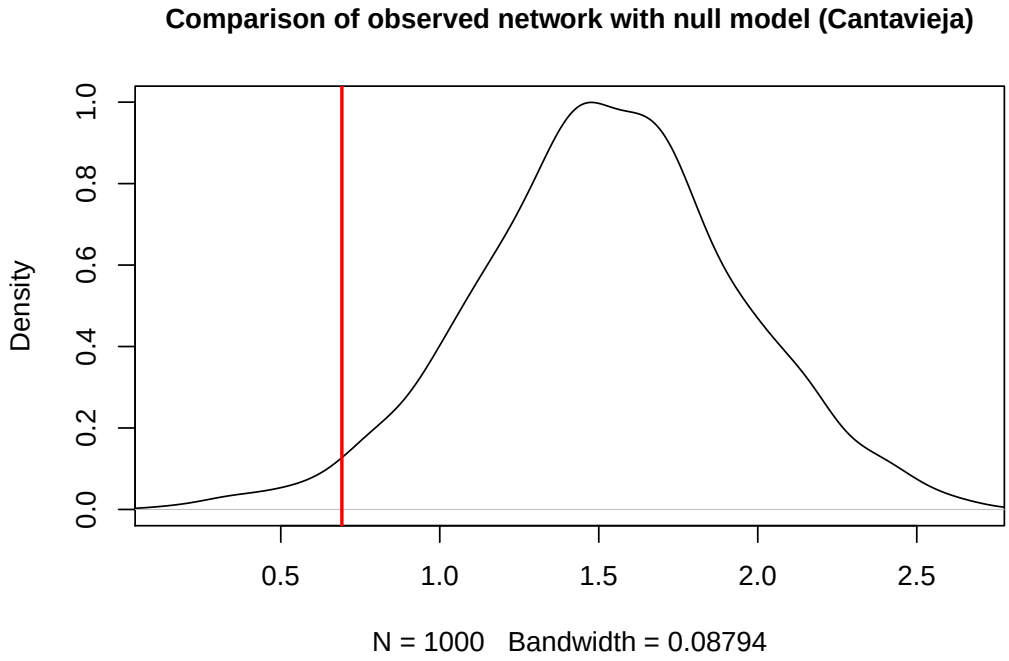

Figure 6. Density plot of the nestedness values for the different random networks (N=1000). The red vertical line indicates the observed nestedness in Ejea de los Caballeros

The plant-pollinator network from Ejea de los Caballeros is also non-nested (P-value = 0.975).

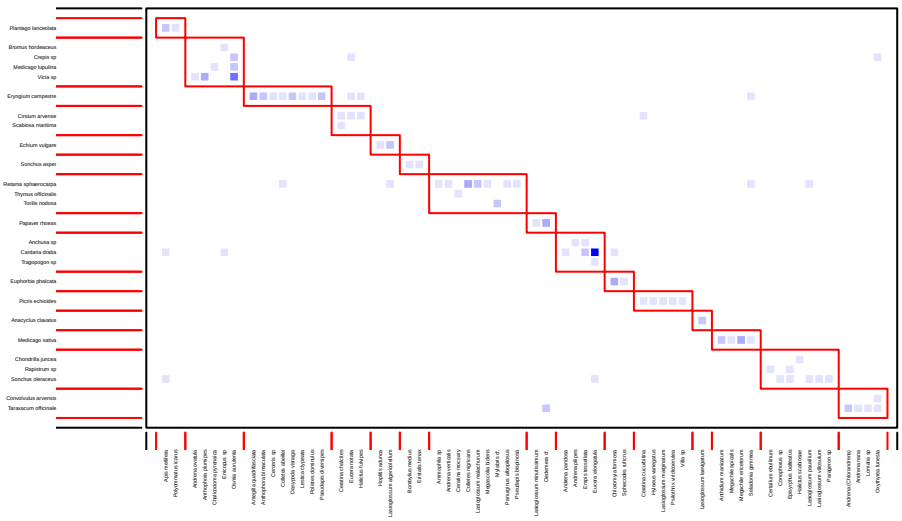

Figure 7. Interaction modules of the plant-pollinator network from Ejea de los Caballeros

Similar to Cantavieja, the plant-pollinator of Ejea de los Caballeros is also more modular than expected by chance (P-value = 0). Again, this indicates the presence of subgroups of species with strong connections but weakly connected between these subgroups or modules.

The overall network specialization (H2) is 0.58.

References

Almeida-Neto, Mário, Paulo Guimaraes, Paulo R Guimaraes Jr, Rafael D Loyola, and Werner Ulrich. 2008. "A Consistent Metric for Nestedness Analysis in Ecological Systems: Reconciling Concept and Measurement." *Oikos* 117 (8): 1227–39. https://doi.org/10.1111/j.0030-1299.2008.16644.x.

Blüthgen, Nico, Florian Menzel, and Nils Blüthgen. 2006. "Measuring Specialization in Species Interaction Networks." *BMC Ecology* 6 (1): 1–12. https://doi.org/10.1186/1472-6785-6-9.

Dormann, Carsten F, and Rouven Strauss. 2014. "A Method for Detecting Modules in Quantitative Bipartite Networks." *Methods in Ecology and Evolution* 5 (1): 90–98. https://doi.org/10.1111/2041-210X.12139.

R Core Team. 2021. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.