Topic 2: Data Analysis

When diversity means richness
How to measure biodiversity

Is it possible to measure biodiversity?

"The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

Convention on Biological Diversity, 1993

Life on earth developed approximately 3.5 billion years ago, and since then it has grown and diversified enormously. The quantification of this diversification is important for many reasons, and it is normally referred to as Biological diversity or biodiversity. Biologists have tried to understand the processes that drive biodiversity and to quantify it since ancient times, and today, we know that higher biological diversity is positive for the continuity of life on earth.

Biological diversity increases the **resilience** and **productivity** of ecosystems. A broader number of responses against a particular event will always be more effective than a smaller number of responses, in the long run. The effect of biodiversity on ecosystem functioning was initially studied by Darwin and Wallace, who claimed that a diverse mixture of plants should be more productive than a monoculture since the environmental resources would be broadly utilized.

In Biology, biodiversity is highly valued, and ecologists have a special interest in studying the relationships between biodiversity distribution and many other variables. But is this concept easy to measure? At first sight, the concept is simple: the sum of all biotic variation from the level of genes to ecosystems.

The concept somehow tries to put together the different forms of dissimilarity: from morphological traits to physiological or even genetic differences. But is there any way to summarize all diversity into a single measurement? The truth is that **biodiversity is a fundamentally multidimensional concept**, which implies that it cannot be reduced to a single number.

BIODIVERSITY DIMENSIONS:

This figure illustrates two of the many different measures of diversity. Sample A has a higher **species richness** since 3 species can be observed. However, **evenness** is higher in Sample B, because there are no clear dominant species (there is less chance in sample B than in sample A. Which sample is more diverse? It depends on the diversity criteria considered.

Biological diversity measurements

Species richness indices: The most **basic way of reporting biodiversity** is by counting the number of species of a sample. However, this index is **highly dependent on the sampling effort**, and in trying to correct this bias, some specific indices have been described (i.e. Margalef's index). Another way of correcting this is by standardizing the number of species per unit of effort (although there are also many different ways of measuring effort!).

Heterogeneity measures: To solve the problem in the insect figure, some measurements **combine evenness and species richness** (i.e. Shannon-Wiener index, Simpson's index, Pielou's evenness index). These indices are a very popular choice among scientists because they do not make any assumptions on the distribution of the species populations.

Taxonomic indices: It could be the case that the richness and evenness of two samples were exactly the same, but the taxonomic groups were different. In this case, a way of comparison would be to quantify the taxonomic distance across the different groups of a sample, which is what the taxonomic indices try to do (i.e. Clarke and Warwick's taxonomic distinctness index).

Functional diversity: Another solution to the previous scenario would be to consider how functionally diverse our sample is. In this case, what can be normally found in the literature is a grouping of the organisms into functional groups (i.e. feeding habitats) to posterior use them as the input for a heterogeneity measure.

Randomness or determination?

After sampling and calculating a specific biodiversity index, we get some results that differ for each sample. How can we be sure that the differences are due to real differences between the populations that we are studying, and not from the random factor of the sampling? Unfortunately, we cannot. There is no way to be absolutely sure of anything, in the world of science and statistics. However, it is possible to approach conviction through the concept of **statistical tests**. These tests (i.e. t-test, ANOVA, Kruskal-Wallis) are mathematical approaches to calculate the probability of our results coming from a specific population.

Once the user selected a measure of biodiversity, it is possible to look for correlations and trends. Some variables which are traditionally linked to changes in biodiversity are habitat complexity, stability, and environmental variables such as pH, temperature, salinity, etc.

REFERENCES

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