A metric to measure ecosystems: the Viralization, Microbialization dichotomy

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Abstract

Measurements are critical for the practice of science. Testing hypotheses or rigorously classifying entities into categories require the ability of making precise measurements. In biological sciences, classifications are often subjective, precisely because they are not based in objective measurements. The classification of ecosystems is an example of this phenomenon. Here, we propose a new metric to classify ecosystems in two different categories: viralized or microbialized ecosystems. The balance of viruses to microbes is correlated to the dominant metabolism in the ecosystem and it can be measured in the lab or in the field. We tested our metric on different datasets and the results were consistent with our expectations.

Introduction

Hypothesis and background

Our hypothesis is that all ecosystems can be classified into two categories: viralized or microbiolized ecosystems. Unlike other ecosytem classifications, this viral-bacterial dichotomy is an objective measurement in the sense that it is possible to measure the concentration of virus and bacteria in any given ecosystem. Our metric is based on microbiologic activity, because microbes (bacteria, particularly), and viruses are the most abundant biological entities on Earth. They have a big impact on upper levels of the trophic chain and also on abiotic factors, effectively shaping entire ecosystems.

Knowledge gap

Unlike commonly called hard sciences, there is a lack of objective metrics in biology. For instance, the concept of biological species was questioned by Darwin in The Origin of Species (Darwin, 1859).

However, here have been several attempts to propose objective classifications in several problems of biology. A well known example is the Daisyworld (WATSON a LOVELOCK, 1983) . More recently, and specifically to viruses, other dichotomies have been proposed such as the Kill-the-Winner/Piggyback-the-Winner dynamics (Knowles et al., 2016).

How to fill the knowledge gap

Here, we propose viralized-microbialized dicthomy: an objective, scale-free and binary metric to classify ecosystems. In our classification, viralized ecosystems are characterized by the dominance of bacteriophages with lytic activity and a catabolic metabolism, whereas in microbialized systems, phages are temperate, microbes are thus dominant, and there is an anaerobic metabolism. Whether an ecosystem belongs to one category or the other can be determined by sampling the ecosystem and determining the Virus to Microbe Ratio (VMR), for instance.

Methods

Results

Discussion

Conclusions

We have proposed a metric to classify ecosystems based on microbiolical factors.

Caveats

Binary classifications are easily interpretable, but they are also arbitrary (where do we put the line?)

We have not considered other factors that could influence ecosystems. In other words, two ecosystems that are equally viralized or microbialized can be very different

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