Network modelling of multispecies systems. Ontological and epistemological implications

This project aims to contribute to the growing tradition of **philosophical studies of science**. Concretely, the project will pay attention to the scientific study of multispecies systems in contemporary biology, with the aim of uncovering some of the philosophical assumptions and implications of this type of research.

Multispecies systems (such as the microbiome) are sets of biological organisms that live together forming a biological community. Ground-breaking biological research has recently suggested that these multispecies communities exhibit very sophisticated forms of collective behaviour, and even in some fascinating cases they may evolve as a single unit. Biological have developed sophisticated tools to explore the empirical validity of that hypothesis. These tools include sophisticated **techniques of mathematical modelling** (**network analysis**), that despite having been applied in the past to other research domains (such climate modelling), had not been applied in biological research before.

The use of these new modelling techniques in biological research is far from being philosophically irrelevant. Biological research had traditionally been based **on the use mechanistic (interventionist) modelling techniques**. A key feature of these techniques is that the system needs to be de-composed so that the interactions among its component-parts can be studied, and each component-part of the system can be attributed a highly specific role in the system. The study of pathogenic interactions, for instance, is guided by this type of modelling strategy: pathogens must be grown separately, following the strict requirements of the Koch postulates, so that their specific role on the biological system can be understood. Mechanistic modelling techniques are especially important in the biological and biomedical sciences because they allow to perform specific interventions in the system (e.g. to develop antibiotics), as **they serve to uncover causal connections between its components**.

Ground-breaking philosophical research has recently suggested that **network modelling, however, differs radically from mechanistic modelling**. Rather than de-composing the system in its component-parts to discover how they interact with each other, network modelling strategies are used to study **global properties of the system** that cannot be studied independently of the system where they are manifested. In other words, these properties cannot be studied by breaking down the system in its component-parts, for they are only present globally, and thus the specific role of each component-part cannot be determined. For instance, some multispecies systems show a high degree of stability in the number of species that compose them, and their relative abundances. To uncover the reasons why this is so, the system (and its properties) have to be studied globally, for de-composing it in its component-parts denaturalizes it, and thus is makes impossible to carry out any significant investigation on it.

This raises a substantial philosophical question: if network modelling can be systematically used to study some properties of biological systems, which is the metaphysical basis that makes this type of research possible? Or, in other words, **what are the philosophical grounds for this type of research?** Is it justified to use these modelling techniques? What kind of consequences can be brought up from their use? And, more importantly, how do biological systems that con only be studied by network modelling techniques differ from those that can be studied mechanistically? Answering these questions will be the main goal of the project. To do so, the project will rely on **two philosophical methods**: (1) analysis of scientific practise and (2) conceptual analysis.

The results of the project will substantially **increase our understanding of scientific modelling and of its use in the biological sciences**, thus supposing a fundamental contribution to contemporary philosophy of science and biology.