Microbial Ecology from the Ecologist point of view (3 credit)

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Weekly Lecture Hours	Exercise	Laboratory	Field Trip
3			

Course description and objective:
Explaining biodiversity is a central problem in ecology. Recent advances in genomics are offering fresh perspectives on the previously underappreciated microbial world. Microbial Ecology—the current merger between Microbiology, Ecology, and Molecular Biology—has proven very powerful for describing niche differentiation and habitat and functional diversities of microbes. However, the full potential of Microbial Ecology, which aims to understand how microorganisms interact with each other and with their environment to generate and to maintain such diversities, is still far from being used. Moreover, even today, most studies in Microbial Ecology are descriptive rather than hypothesis-driven. Thus, it is not clear whether the same ecological mechanisms operate in macro- and in microorganisms. The course is aimed to:

(1) Explore the range of ecological hypotheses which are being explored in the field of Microbial Ecology
(2) Reveal similarities and dissimilarities between patterns and mechanisms underlying macro- versus microorganisms
(3) Highlight future directions that Microbial Ecology needs to take, including testing ecological hypotheses that could, but have not, been tested in microbes.
(4) To practice literature search, reading, criticizing, and presenting papers, as a bonus of the course.

Detailed description of course units:
The course is divided to three parts: (i) The ecology of microbes in the different habitats (#3–6 below), (ii) Testing ecological theories by microbes (#7–10 below), and (iii) applied aspects of microbial ecology (#11–12 below).

1. **Introduction:** Course goals and description; introduction to the field of microbial ecology and its history; the unique features of microbes.
2. **Searching, reading, and presenting papers:** Providing tips and tools that will assist the students throughout the course (and career) to read and criticize papers, search in the literature, and present their review.
3. **Microbes of arthropods:** Introduction and characterization of arthropod symbionts; ecological aspects investigated in respect to arthropod symbionts; main trends in research and future directions.
4. **Microbes of vertebrates:** Coevolution between microbes and their vertebrates; the role of microbes in their hosts; ecological and evolutionary

processes shaping microbial communities within the vertebrate host including succession, community assembly, dispersal, diversification, natural selection, drift, multitropic interactions, response to disturbance, and metacommunity dynamics; implications for human health.

5. **Microbes in plants:** The roles that microbes play in plant ecology; different habitats within and near the plants; the relevant microbial groups, factors affecting the microbiome; microbial interactions within the plant and with the plants; main trends in research and future directions.

   Microbes in the soil: Importance of the soil microbiome and biological crust; main relevant microbial groups; factors affecting the soil microbiomes; applied aspects of the soil microbiome; main trends in research and future directions.
6. **Marine microbes**: different habitats and constraints; factors affecting the community composition; microbial interactions; interactions between microplastic and marine microbes; main trends in research and future directions.
7. **Coexistence mechanisms between microbes:** Was the Chesson's framework for coexistence mechanisms tested in microbes; evidence for coexistence between microbes in nature; evaluation of specific coexistence mechanisms in microbes, including resource partitioning, competition-enemy trade-off, density-dependent selection by specialized enemies, frequency-dependent functional responses of generalist enemies, and fluctuating-dependent mechanisms.
8. **Microbial diversity at local and global scales:** terminology; are local and global patterns common to microbes and macroorganisms. The patterns that will be discussed are species abundance distributions, species-area relationship, distance-decay relationship, and latitudinal gradients in richness and mechanisms underlying these patterns.
9. **Microbial biogeography:** what is included in this field, differences between micro-and macroorganisms in respect to biodiversity, patterns and processes in microbes that vary in their lifestyle.
10. **Metacommunities of microbes:** definitions**;** local versus regional processes; the main four paradigms and their relevance to microbes.
11. **Disease ecology:** Introduction to the field; different complexity levels of host-parasite interactions; methodology that faces with the challenges of high complexity; examples from case studies.
12. **Other applied aspects of microbial ecology:** Uses of microbial ecology concepts in medicine, industry, agriculture, and biotechnology.
13. **Course summary:** Integration: similarities and dissimilarities between microbes and macroorganisms; knowledge gaps and future directions.

Assessment of students and structure of final grade:

The grades will be given based on a written assignment or a presentation (depending on the student choice). The students will be asked to read key and review articles and to provide critical summary for a chosen subject presenting the tested theories, supportive evidence in microbes, and ideas for future research and challenges in the field (100% of the grade).

Recommended Readings: A list of relevant papers will be provided during the course.