Cladoceran zooplankton are an important component of freshwater ecosystems. They are effective filter feeders that remove microscopic algae, bacteria, and organic material from the water column leading to increases in lake water clarity. Cladocerans also transfer matter and energy from primary producers to upper trophic levels (fish) that are exploited by humans. In particular, cladocerans transfer important elements that are needed for animal growth, such as phosphorus and nitrogen and, more significantly, essential polyunsaturated fatty acids (PUFA), which cannot be synthesized by animals, and have to be provided in food. Therefore, cladoceran community structure and dynamics are crucial for the well-being of all the animals that exploit freshwater food resources.

The goal of our project is to determine the mechanisms responsible for structuring cladoceran communities. In particular, we are interested in understanding how differences in competitive performance of cladoceran species vary as a function of body size, which is one of the most important trait, influencing several attributes of their biology and ecology. Large species of cladocerans are particularly efficient filter-feeders, thus they "purify" water more effectively than small species, and they are also a more valuable resource for fish because per capita they contain more energy, PUFA, and phosphorus which can be transferred further via fish to terrestrial animals and humans. Therefore, an important goal of our project is to identify the environmental conditions that promote the dominance of large species in cladoceran communities.

We propose to conduct a series of experiments and develop a simulation model to better understand how algal food quantity, food quality in terms of PUFA and phosphorus content, and temperature affect the size structure of cladoceran communities. We will conduct (1) experiments to establish individual threshold food concentrations (i.e. lowest food concentration at which the individuals can still grow) for different sized cladoceran species that are fed algal food of different quantity and quality (PUFA and phosphorus contents), at several temperatures. The species with lower TFCs under a given set of environmental conditions should be competitively superior and dominate cladoceran communities; (2) life-table experiments to establish cladoceran population TFCs (i.e. lowest food concentration at which the population can still increase in numbers) for different sized cladoceran species that are fed algal food of different quantity and quality, at several temperatures; and (3) outdoor mesocosm experiment with multi-species cladoceran communities, to determine how algal quality (PUFA and phosphorus) and temperature affect shifts in domination between small and large cladoceran species. We will also develop models using data collected in the experiments to predict cladoceran species structure and community dynamics under different algal resource and temperature scenarios.

Our proposed research is important in the context of global warming and increased human impacts in freshwater ecosystems. Our results will provide essential information that can be used to develop methods for the biological manipulation of plankton communities in freshwater ecosystems to achieve the greatest efficiency in matter and energy transfer to higher trophic levels if the proportion of large species increases. Zooplankton are also important as a sink of phosphorus in the aquatic ecosystems. Large species of cladocerans accumulate more phosphorus than small species. Excess phosphorus facilitates eutrophication and the development of harmful cyanobacteria blooms. Our proposal is a new step in the development of biomanipulation approaches that will help to improve the quality of freshwater ecosystems.