

## Feeding and food limitation in copepod nauplii, the neglected life stage

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The proposed research will investigate feeding by copepod nauplius larvae, the most abundant metazoans in the sea. This research will answer three questions: 1) How does food selection by adults and nauplii differ when they are fed multiple prey species in the laboratory? 2) How does food selection by adults and nauplii differ when they are feeding on natural prey assemblages? and, 3) How do growth, development, and survival differ between copepodites and nauplii when their growth is food limited?

Comparative experiments and field-based measurements will contrast the food consumed, and the effects of food limitation, between nauplii and later life stages. This contrast will include attributes of food such as size, taxon, and motility, and will include experiments with cultured prey offered singly or in a mixture, and natural prey, and apply genetic techniques to determine prey consumption by a predatory copepod. Copepods will be collected from the San Francisco Estuary, with four species selected for experiments to span taxonomic groups, sizes, salinity ranges, and general feeding behavior.

A variety of techniques will be applied to account for the inevitable biases and limitations of each; all but one have previously been applied in our laboratories. These will include laboratory feeding experiments using cultured prey individually and in mixtures, and experiments using natural prey. Consumption of prey in experimental bottles will be measured as chlorophyll concentration and through particle counts by microscopy and flow cytometry. Radioactively labeled prey will be used in short incubations to determine feeding on particular prey types. Samples from the field will be examined for gut fluorescence. Separate experiments will determine how nauplii and copepodites survive and grow at different concentrations of food.

Investigations of feeding by a predatory copepod (*Tortanus dextrilobatus*) will use molecular techniques to identify mitochondrial and nuclear DNA from diverse suspected prey species. Specific primers will be developed for common zooplankton species consumed by *T. dextrilobatus* in the laboratory. General primers and screening protocols developed here will be useful for identifying food web interactions in other estuarine communities.

**Intellectual merit:** Copepod nauplii are important both in their diverse trophic roles in ocean foodwebs and in the population dynamics of copepods. It is astonishing that, among the >2000 papers on feeding by copepods, only a handful deal with feeding by nauplii, and those of only a few genera. Fewer still compare quantitatively the food of nauplii with that of adults. Nauplii have a completely different feeding apparatus from later stages, and the first feeding stage can be very sensitive to starvation, making these life stages critical to population dynamics. Yet extant copepod population models treat nauplii as miniature adults. Just as the study of early lives of fishes has led to a much better understanding of fish populations, a more comprehensive view of the roles of nauplii is essential for understanding copepods. This view can best be obtained by a frontal assault on the problem for several different species, using several comparative techniques.

**Broader impacts:** An improved understanding of copepod population dynamics will have practical applications, particularly in estuaries where ecological problems have immediate

economic consequences. It will also provide valuable input to the growing efforts at modeling ocean ecosystems, e.g., for prediction of the effects of climate change. This research will also provide an opportunity for two Master's theses at San Francisco State University, a minority-serving institution. The project will provide continuing opportunities for training undergraduates, including URM students, in genetics and field ecology at the Romberg Tiburon Center for Environmental studies, an NSF FSML-supported field station on San Francisco Bay.