The molecular basis of circadian rhythms in echinoderm larvae

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Project Summary

Timing mechanisms influence physiology and behavior of most living organisms on Earth and are crucial for optimal adaptation to the environment. In the marine environment, possibly more than in the terrestrial, marine organisms are influenced by fluctuations following not only diurnal, but also monthly and semi-monthly period lengths, all potentially affecting growth, propagation and temporal distribution of marine communities in the Oceans. These factors impact the global biogeochemical cycles that are ultimately linked to climate regulation. Thus, understanding how and to what extent physiology and behavior of marine organisms are influenced by environmental factors is one of the most important challenges in the light of climate change and increasing photo-pollution.

A great deal of attention has been dedicated in the last years to circadian rhythms, molecular adaptation systems that synchronize cellular processes to the diurnal environmental periodicities. A number of studies, carried out mainly in terrestrial model systems, led to the reconstruction of the core circadian clocks in animals, plants, fungi and bacteria. These studies highlighted the importance of an efficient synchronization to the environment for organismal health and fitness.

Echinoderms are benthic organisms as adults, but have free-swimming planktonic larvae, representing a crucial life cycle stage for individual dispersion. The anatomical complexity and the wide repertoire of neuronal cell types discovered in echinoderm larvae points at a complex regulation of larval behavior in response to environmental stimuli (e.g., the regulation of ciliary beating for swimming and/or to catch food). Also, due to their phylogenetic position (non-chordate deuterostomes), echinoderms are ideal model systems to explore gene family evolution in animals.

Daily rhythms of vertical migration in echinoderm larvae are known since decades and experiments investigating the influence of light on sea urchin larvae revealed that plutei utilize light to direct their swimming behavior. However, a detailed study of the effect of light-dark alternation on echinoderm larval physiology and behavior and of the mechanistic basis underlining these responses is missing. The aim of this project is to explore the molecular basis of diel rhythms in echinoderm larvae using multidisciplinary approaches including transcriptomics, mathematical modeling, gene perturbation and behavioral analyses. The representatives of the two main echinoderm groups presenting different larval types (the Echinozoa sea urchin *Strongylocentrotus purpuratus* and the Asterozoa sea star *Patiria miniata*) will be exploited to explore the ability of larvae with different morphologies to adapt and cope with periodicities in the marine environment.