Experiment details for invertebrate larvae electrophysiology

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Project

» Vision-mediated influence of low oxygen on the physiology and ecology of marine larvae (Vision under hypoxia)

Contributors	Affiliation	Role
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Abstract

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Dataset Description

Details on the timescale, pH, and temperature of the time series experiments from McCormick et al., 2019

Please see additional datasets for this paper, including the “TimeSeries” and the “OxygenMetrics_Vision” datasets.

Acquisition Description

Detailed methods can be found in McCormick, *et al.,* 2019.

Briefly, the time series test recorded electroretinogram (ERG) responses to a 1 s square step of light at a constant irradiance of 3.56 μmol photons m−2 s−1 repeated every 20 s, providing a nearly continuous measure of ERG response in a tethered, live larva during the experimental manipulation of partial pressure of oxygen (pO2). There was a constant flow of pH-buffered sterile seawater in the chamber where the larva was held, and after a brief period in “normoxia” (surface-ocean oxygen levels), the pO2 was decreased, and then held at a low pO2 before re-oxygenating the solution. This dataset shows additional experimental details for the “TimeSeries” and “OxygenMetrics_Vision” datasets, including the original experiment name (that can be matched with the experiment name from the other datasets), the time periods for each oxygen exposure, and the pH and temperature of the experiments.

Oxygen was measured using a Microx4 (PreSens) oxygen meter and a Pst-7 oxygen optode probe.

Processing Description

All electrophysiology data was recorded and analyzed using Igor Pro 7 Software (Wavemetrics) using custom code. Oxygen data was analyzed using PreSens Measurement Studio 2. Post-processing analysis was completed in R Studio (version 3.3.3).

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Related Publications

McCormick, L. R., Levin, L. A., & Oesch, N. W. (2019). Vision is highly sensitive to oxygen availability in marine invertebrate larvae. The Journal of Experimental Biology, 222(10), jeb200899. doi:10.1242/jeb.200899

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Parameters

Parameter	Description	Units
Species	Species name	unitless
Experiment_Name	Original experiment name that can be linked back to raw datafile collected in Igor.	unitless
Normoxia_Time	Total time (in minutes) that was spend at 100-105% saturation oxygen before oxygen decline. NA indicates there were no visual recordings in normoxia.	minute (min)
O2_Decay	Total time during which the animal was exposed to a decrease in oxygen (in minutes)	minute (min)
Normoxia_O2	The average oxygen concentration of the normoxia (~100-105% saturation) period	micromole per liter (umol/L)
Low_O2	The average oxygen concentration of the lowest oxygen period	micromole per liter (umol/L)
O2_Change	Subtracted value between the average in normoxia and the average in the low oxygen period	micromole per liter (umol/L)
O2_Change_Time	The rate of decline in oxygen (see above) over the total time when the animal was exposed to a decline in oxygen	micromole per liter per minute (umol/l per min)
Low_O2_Min	Total time (in minutes) the animal was exposed to Low oxygen	minute (min)
Total_Exp_Time	Total experiment duration in hours	hour (hr)
pH	pH of the seawater during the experiment. No buffer indicates the solution was not buffered and the pH might have varied during the experiment	unitless
Temp_Max	Maximum temperature of the experiment	degrees Celsius (C
Temp_Min	Minimum temperature of the experiment	degrees Celsius (C
Temp_Avg	Mean temperature of the experiment	degrees Celsius (C

Stimulus_Irradiance	Irradiance of the light stimulus (LED 525 nm)	mol photons per second and square meter (mol m-2s-1)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Oxygen Microelectrode Sensor
Dataset-specific Description	Oxygen was measured using a Microx4 (PreSens) oxygen meter and a Pst-7 oxygen optode probe.
Generic Instrument Description	A miniaturized Clark-type dissolved oxygen instrument, including glass micro-sensors with minute tips (diameters ranging from 1 to 800 um). A gold or platinum sensing cathode is polarized against an internal reference and, driven by external partial pressure, oxygen from the environment penetrates through the sensor tip membrane and is reduced at the sensing cathode surface. A picoammeter converts the resulting reduction current to a signal. The size of the signal generated by the electrode is proportional to the flux of oxygen molecules to the cathode.The sensor also includes a polarized guard cathode, which scavenges oxygen in the electrolyte, thus minimizing zero-current and pre-polarization time.With the addition of a meter and a sample chamber, the respiration of a small specimen can be measured. Example: Strathkelvin Inst. http://www.strathkelvin.com

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Project Information

Vision-mediated influence of low oxygen on the physiology and ecology of marine

larvae (Vision under hypoxia)

Coverage: Souther California Bight, Northeast Pacific Ocean

NSF abstract: Oxygen is being lost in the ocean worldwide as a result of ocean warming and the input of nutrients from land. Vision requires a large amount of oxygen, and may be less effective or require more light when oxygen is in short supply. This is especially true for active marine animals with complex eyes and visual capabilities, including active arthropods (crabs), cephalopods (squid), and fish. The California coastal waters exhibit a sharp drop in oxygen and light with increasing water depth. This project examines how visual physiology and ecology in young (larval) highly visual marine animals respond to oxygen loss, with a focus on key fisheries and aquaculture species. Experiments and observations will test the hypothesis that oxygen stress will change the light required for these organisms to see effectively, influencing the water depths where they can live and survive. The project will provide interdisciplinary experiences to students and an early career scientist and inform both the public (through outreach at the Birch Aquarium at Scripps Institution of Oceanography) and policy makers about the effects of oxygen decline in the ocean. Negative effects of oxygen loss on vision have been described for humans and other terrestrial organisms, but never in the marine environment, despite the large changes in oxygen that can occur with depth and over time in the ocean, and the high metabolic demand of visual systems. This project will test the effects of low oxygen on vision in 3 combinations of eye design and photo-transduction mechanisms: compound eye with rhabdomeric photoreceptors (arthropods), simple eye with rhabdomeric photoreceptors (cephalopods), and simple eye with ciliary photoreceptors (fish). A series of oxygen- and light-controlled laboratory experiments will be conducted on representative taxa of each group including the tuna crab, Pleuroncodes planipes; the market squid, Doryteuthis opalescens, and the white sea bass, Atractoscion nobilis. In vivo electrophysiology and behavioral phototaxis experiments will identify new oxygen metrics for visual physiology and function, and will be compared to metabolic thresholds determined in respiration experiments. Hydrographic data collected over 3 decades by the CalCOFI program in the Southern California Bight will be evaluated with respect to visual and metabolic limits to determine the consequences of oxygen variation on the critical luminoxyscape (range of oxygen and light conditions required for visual physiology and function in target species) boundary in each species. Findings for the three vision-based functional groups may test whether oxygen-limited visual responses offer an additional explanation for the shoaling of species distributions among highly visual pelagic taxa in low oxygen, and will help to focus future research efforts and better understand the stressors contributing to habitat compression with expanding oxygen loss in the ocean. This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829623

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