Lobster Larvae Growth and Mortality Data

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Project
» RUI: Collaborative Research: Linking physiological thermal thresholds to the distribution of lobster settlers and juveniles (Lobster Thermal Thresholds)

Contributors	Affiliation	Role
Annis, Eric R.	Hood College	Principal Investigator
Frederich, Markus	University of New England - Marine Science Center (UNE-MSC)	Co-Principal Investigator
Rasher, Douglas B.	Bigelow Laboratory for Ocean Sciences	Co-Principal Investigator

Abstract
We used the American lobster (Homarus americanus) in the Gulf of Maine as a model system to define thermal tolerance in larvae and establish mechanistic linkages between thermal tolerance of the individual larva and the patterns of settlement in the field. We assessed and compared the thermal tolerances of larvae reared in the laboratory using conventional methods with larvae captured in the wild, and examined ontogenetic changes in thermal tolerance. The upper and lower thermal thresholds larval stages I-IV and the first juvenile stage were defined in part by growth and mortality when subjected to chronic exposure to different treatment temperatures until they either molted to the next developmental stage or died. This data set includes individuals dying, the size after molting and the amount of time elapsed between the start of the treatment and either molting or death. These data were collected between 2021-2022 at Bigelow Laboratory for Ocean Sciences, led by Eric Annis.

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Coverage

Location: Bigelow Laboratory for Ocean Sciences
Temporal Extent: 2021-06-01 - 2022-12-31

Methods & Sampling

Larvae were reared to the appropriate stage in lab under several different conditions. Most larvae were reared individually in an environmental control room at 18°C in 400 ml glass jars in 0.45 µm filtered seawater and fed fresh hatched brine shrimp ad libitum. Water changes were made every 2-3 days. Alternative rearing conditions included 14°C and fed fresh hatched brine shrimp, ambient seawater temperature (jars were held in a water bath of flow through seawater) fed fresh hatched brine shrimp, and 18°C and fed a diet of live freshly collected zooplankton from local waters. We also conducted trials on wild caught stage IV larvae. Larvae were collected using a neuston net (0-0.5 m depth) in the vicinity of Boothbay, Maine, USA. Wild larvae were held in individual jars at ambient sea water temperature until trials could be conducted.

To assess growth and mortality larvae were transferred from their rearing condition to the treatment temperature and maintained at the treatment temperature until they either molted to the next developmental stage or died. Larvae were transferred in their jar at the rearing temperature to the treatment temperature without exchanging the water which allowed for a gradual temperature change. Feeding and water changes continued as described for rearing conditions. When larvae molted to the next developmental stage they were photographed for carapace length measurements and frozen individually. Measurements of carapace length were made from the posterior edge of the ocular cavity to the the midline of the posterior edge of the carapace using ImageJ. Frozen larvae were subsequently dried for 24 hours at 60 °C and weighed. Larvae dying during the experiment were not measured or weighed.

BCO-DMO Processing Description

- Separate data tables containing data from 2021 and 2022 were merged into one data table for the published primary data file
- Removed units from column names
- Replaced blank spaces in column names with underscores ("_")

Problem Description

Data have been checked and potentially problematic readings have been deleted.

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Parameters

Parameters for this dataset have not yet been identified

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Project Information

RUI: Collaborative Research: Linking physiological thermal thresholds to the distribution of lobster settlers and juveniles (Lobster Thermal Thresholds)

Coverage: Gulf of Maine

NSF Award Abstract:
Temperature is one critical factor that determines the distribution of marine organisms. However, in many cases temperature ranges (thermal tolerances) are only known for adults, but not for the immature stages that transition from the plankton to the bottom. This study is testing how temperature affects where larvae are settling. The American lobster (Homarus americanus) in the Gulf of Maine is serving as a model system to measure the thermal tolerance of the larvae and link this to the distribution of young lobsters in the field. Presently, lobster larvae are more likely to experience relatively cold temperatures than heat stress and larval settlement appears to be restricted to warmer shallow waters by a sensitivity to temperatures below 12°C. As water temperature has increased, settlement and juvenile distribution have expanded into deeper waters suggesting a release from cold stress. This project is advancing the understanding of shifting species distributions in response to increasing ocean temperatures by exploring thermal sensitivity in wild-caught larvae for the first time. This information is providing thermal thresholds for modeling larval viability in response to climate change scenarios. Understanding the larvae?s responses to temperature is fundamental to predicting the impact of climate change on one of the most valuable commercial fisheries in North America. The project is supporting training of undergraduate interns and a master?s student from small colleges (Hood College and University of New England) and connecting them with a research institution (Bigelow Laboratory for Ocean Sciences). Teacher training is occurring in collaboration with the Marine Science Center at the University of New England. Results from this study are being shared with stakeholders and contributing to science-based management of the lobster fishery.

This project is the first to examine how thermal stress on a larval stage determines juvenile distributions using a combination of correlative and experimental approaches that includes measuring biochemical stress indicators in larvae deployed in natural field habitats. The central hypothesis is that the physiology of individual planktonic larvae controls meso-scale settlement patterns in the field. The goal is to ascertain if there is a causal relationship between the underlying physiology and thermal sensitivity of the organism and the distribution of early life stages. Larval supply, settlement and juvenile abundances will be assessed at different depths with temperatures above and below the proposed minimum temperature threshold of 12°C for larvae. Laboratory experiments using conventional methods are determining thermal tolerances in wild-caught larvae and how they change with ontogeny. The upper and lower thermal optima are being resolved using multiple physiological parameters such as measurements of oxygen consumption and aerobic scope, and biochemical assays of thermal stress (HSP70, AMPK, and SIRT). To link physiology to settlement patterns, caged stage IV larvae and V juveniles are being deployed in the field at sites with temperatures above and below 12°C. Lethal and sub-lethal effects on caged lobsters are being evaluated through measures of growth, mortality and biochemical markers of thermal stress. This is the first study to focus on the thermal tolerance of wild larvae, which has broad implications for understanding settling in marine invertebrate larvae.

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NSF Division of Ocean Sciences (NSF OCE)	OCE-1948146
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