We've Got Bigger Fish to Spy:
Tracking Vision Structures of Marine Amphipods

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Introduction

Hyperiids, a suborder of marine amphipod, possess a range of complex and unique vision systems. I worked at a lab to help identify the components of their eyes and adapt a machine learning system for NMNH use.

Left: A specimen from genus Hyperia *located at the Smithsonian Museum Support Center.*
Middle: A photograph of species Paraphronima gracilis*. Image taken from the Scripps Institute of Oceanography (http://sio-legacy.ucsd.edu/zooplanktonguide/species/paraphronima-gracilis).*
Right: A collection of Themisto compressa *located at the Smithsonian Museum Support Center.*

Site Location

National Museum of Natural History, Smithsonian Institution. https://naturalhistory.si.edu/

10th Street & Constitution Avenue, Washington DC, 20560

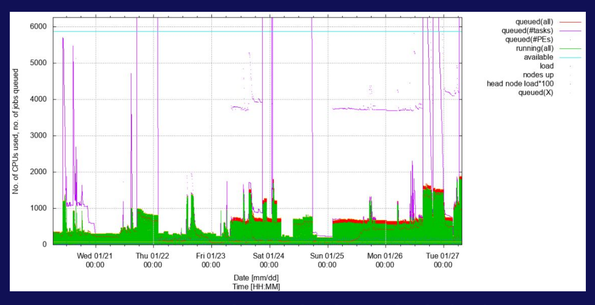
I worked with Dr. Karen Osborn in the Department of Invertebrate Zoology, which researches and archives extant non-vertebrate species.

The Osborn lab in particular focused on research centered on the evolutionary biology of polychaetes and peracarids.

The exterior of the Smithsonian Museum Support Center, where the majority of wet specimens are stored.

My Role

- Manual plotting of corneas and rhabdoms for *Vibilia*, *Eusceliotes*, and *Brachyscelus* specimens
- Adaption of deep heatmap regression model for use on the Smithsonian's High Performance Computing Cluster (Hydra)
- Training of DHR model on *Vibilia* and *Paraphronima* specimens

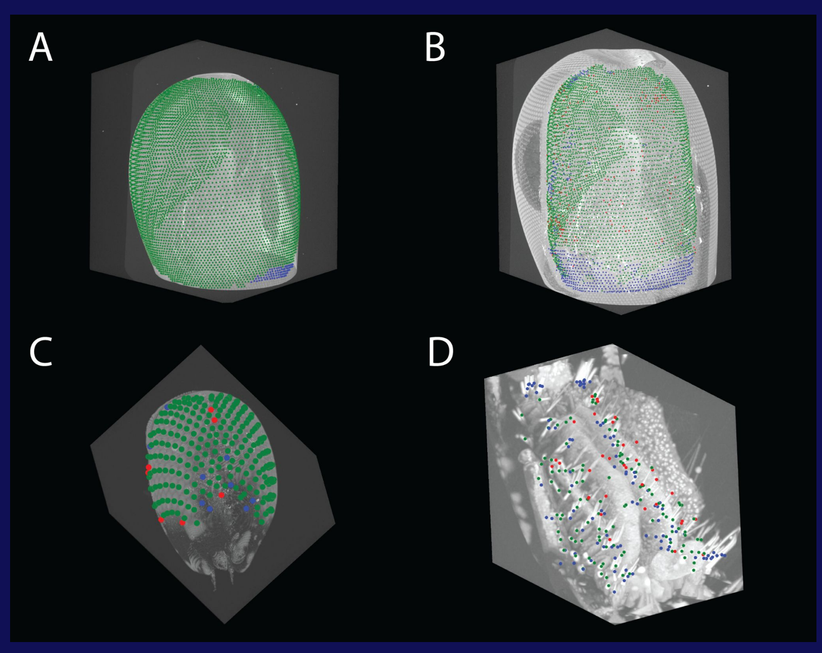


Statistics on Hydra use for the week of 1/21/26 (https://lweb.cfa.harvard.edu/~sylvain/hpc/status/)

- Modifying instructions for the DHR and MCTV models to make them more accessible to outside users; adding information about the use of DHR on Hydra

Overview

- Three dimensional scans of hyperiids (NIFTI format) are loaded
- A Matlab program developed by Jan Hemmi is used to individually plot points of interest
  → Eye points of interest for hyperiids are their corneas and rhabdoms
- These points, along with the scans, are then used to train a deep heatmap regression model
- This model can produce largely correct localisations, which can then be corrected and used to train the model further.



Example heatmap regression results for fiddler crab corneas (A), fiddler crab rhabdoms (B), hyperrid corneas (C), and hyperiid rhabdoms (D). Performance is best for cornea modelling; performance is by far the worst for the hyperiid rhabdom. Image taken from part of Jake Manger's PhD thesis (https://github.com/jakemanger/dhr)

Results/Discussion

- Completed plotting for *Eusceliotes* and the majority of *Brachyscelus* scans
- Directions for MCTV and DHR were updated and implemented without major difficulty
- Training on *Vibilia* and *Paraphronima* was limited due to constraints with time and the movement of the Hydra servers
- Further mapping of the eyes is easier, as Hydra allows for a large number of simultaneous trainings and modellings.
- Currently, the model is prepared to work on hyperiids with eye structures similar to *Paraphronima*/*Vibilia*. In the future, it hopefully can be trained for more complex structures.

I had the opportunity to meet some of the specimens held at the Museum Support Center!

Acknowledgements

Special thanks to Dr. Karen Osborn, my incredible site supervisor; Dr. Jan Hemmi and Jake Manger, who provided the MCTV and DHR systems; Matt Kweskin, for his help with the Hydra servers; and of course Dr. Tom Holtz and Dr. John Merck for all that they've done to support the program.