QCL WATER SCIENCE

PyroScience AquapHOx

Metabolic Strategies of Bivalves Residing in Oligotrophic Seas

Bivalves are the principal suspension feeders in many benthic habitats, and for over a century, their nutrition and eco-physiology have been intensively studied, mostly under laboratory conditions, and in temperate, eutrophic, or mesotrophic habitats. However, the vast majority of the ocean is oligotrophic, where organic particulate matter is scarce and is dominated by minute picoplanktonic cells (<2µm).

Israel is located on the shores of one of the most oligotrophic marine basins, the Eastern Mediterranean, where bivalve populations thrive and flourish despite the extreme oligotrophic conditions. As the filtration efficiency of most bivalves studied to date sharply diminish for particles smaller than 4µm, bivalve survival in oligotrophic environments requires special adaptions to cope with both the paucity of food and its small size.

Our group is studying the filtration, metabolism, and ecophysiology of bivalves residing in oligotrophic waters, and most of our work is carried in-situ, in the natural environment, with minimal disturbance to the studies animal. In the past we have been using custom-made underwater optode systems, so we were happy to test the new AquapHOx-Logger (PyroScience) to quantify the amount of oxygen consumed by individual bivalves as a measure of their in-situ metabolic rate.

Set-Up and Study Site

The AquapHOx-LX is a long-term logger for stand-alone underwater monitoring of pH, temperature, or dissolved oxygen with optical sensors from PyroScience. The internal battery and data storage allows deployments of up to one year. In this case study, we tested the application of this device to monitor dissolved oxygen removal by individual bivalves at the coast of Israel.

To measure bivalve respiration rate we continuously measured the differences in the dissolved oxygen (DO) concentration between the water inhaled and exhaled by the bivalves (ΔCDO) over prolonged periods during June-July 2020. Two devices were equipped with robust DO optodes (tip diameter, 3 mm, each with a 4 m cable).

After a two-point laboratory calibration, that was quick and efficient, the devices were set to record every 10 seconds. We deployed the system at ~8 m depth on the rocky reef in front of the Faculty for Marine Science in Michmoret (Israel). Optodes were carefully positioned using custom-made manipulators, within the exhale jet of the bivalve (as close as possible to the siphon opening) and near its inhalant siphon (Fig. 1) to continuously record the difference between the dissolved oxygen concentrations in the water inhaled and exhaled by the bivalves that were otherwise undisturbed. Every 24 hours the two optodes were cross-calibrated in the ambient water, before relocation to another specimen.

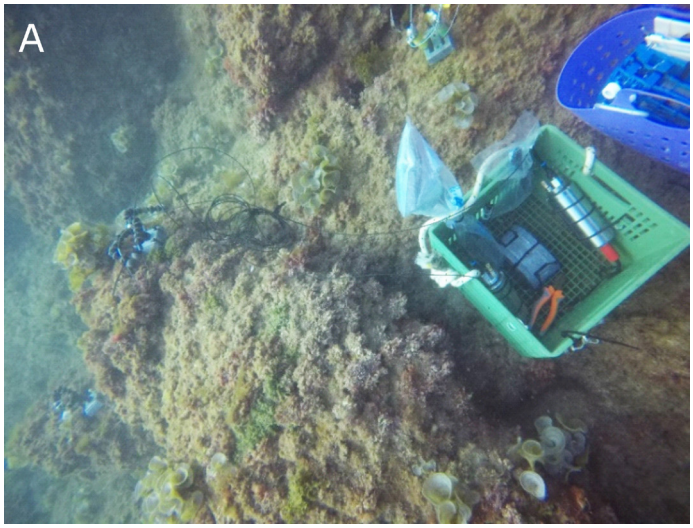

Figure 1A. The underwater set-up of the AquapHOx-Logger. The instruments were very easy to carry and deploy. We secured the AquapHOx-LX in a milk crate for protection

Figure 1B. To minimize the disturbance to the studied specimens, the devices were positioned coupled of meters away and we used the four meter cables to carefully position the optode tip within the inhaled and exhaled siphons of the studied bivalves.

Conclusion and Outlook

The new AquapHOx underwater loggers were remarkably easy to calibrate, operate, deploy, and retrieve, and generated high quality in-situ data demonstrating high oxygen removal

by bivalves during nighttime. Here we present an example for one diel cycle; however, the loggers have successfully acquired similar data over several days – and the logger can operate for weeks to months. The ability to deploy the instruments for prolonged period, along with high-resolution measurements (~ every 10 sec), yielded a comprehensive database with minimum human power. Handling the data obtained was also easy as the included Workbench software is user-friendly. The AquapHOX underwater loggers are ideal tools for the study of the in-situ metabolism of even minute invertebrates with minimal to null disturbance to the studied organisms.

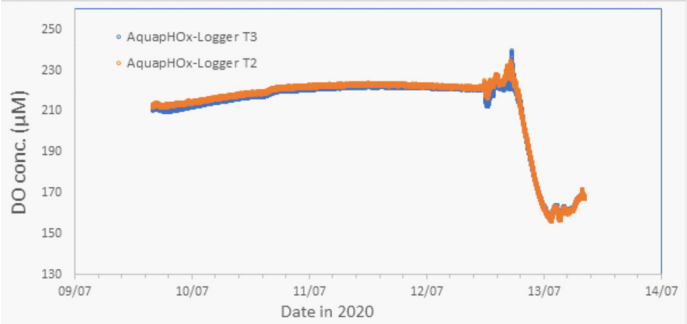

Figure 3. Cross-calibration of the two AquapHOx-Loggers in the Michmoret running seawater facility. Blue and orange dots are the DO concentrations measured by the two AquapHOx-Loggers, respectively, recorded every 10 seconds.

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