The Effects of Oil on Orientation and Vertical Position in Early Life Stage Mahi-mahi (*Coryphaena hippurus*) and its Implications for UV Exposure

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Introduction

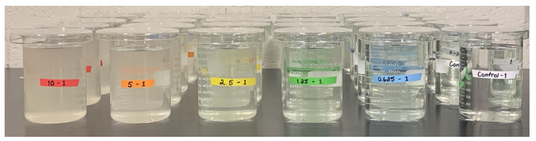
The *Deepwater Horizon* (*DWH*) oil spill resulted in the release of almost 5 million barrels of crude oil into the Gulf of Mexico (GoM) during the spring and summer of 2010 and coincided spatially and temporally with the early life stages of many economically important fish species, including Mahi-mahi (*Coryphaena hippurus*).

Mahi embryos are positively buoyant in the laboratory and are assumed to float near the surface in the wild. Environmental stressors such as UV radiation occur at higher intensities in surface waters, so ELS (early life-stage) mahi may be especially vulnerable and sensitive to stressors due to their transparency, limited mobility, incomplete development, and proximity to the surface after hatching. The survival of ELS fish is important to adult populations because high ELS mortality affects recruitment to later life stages.

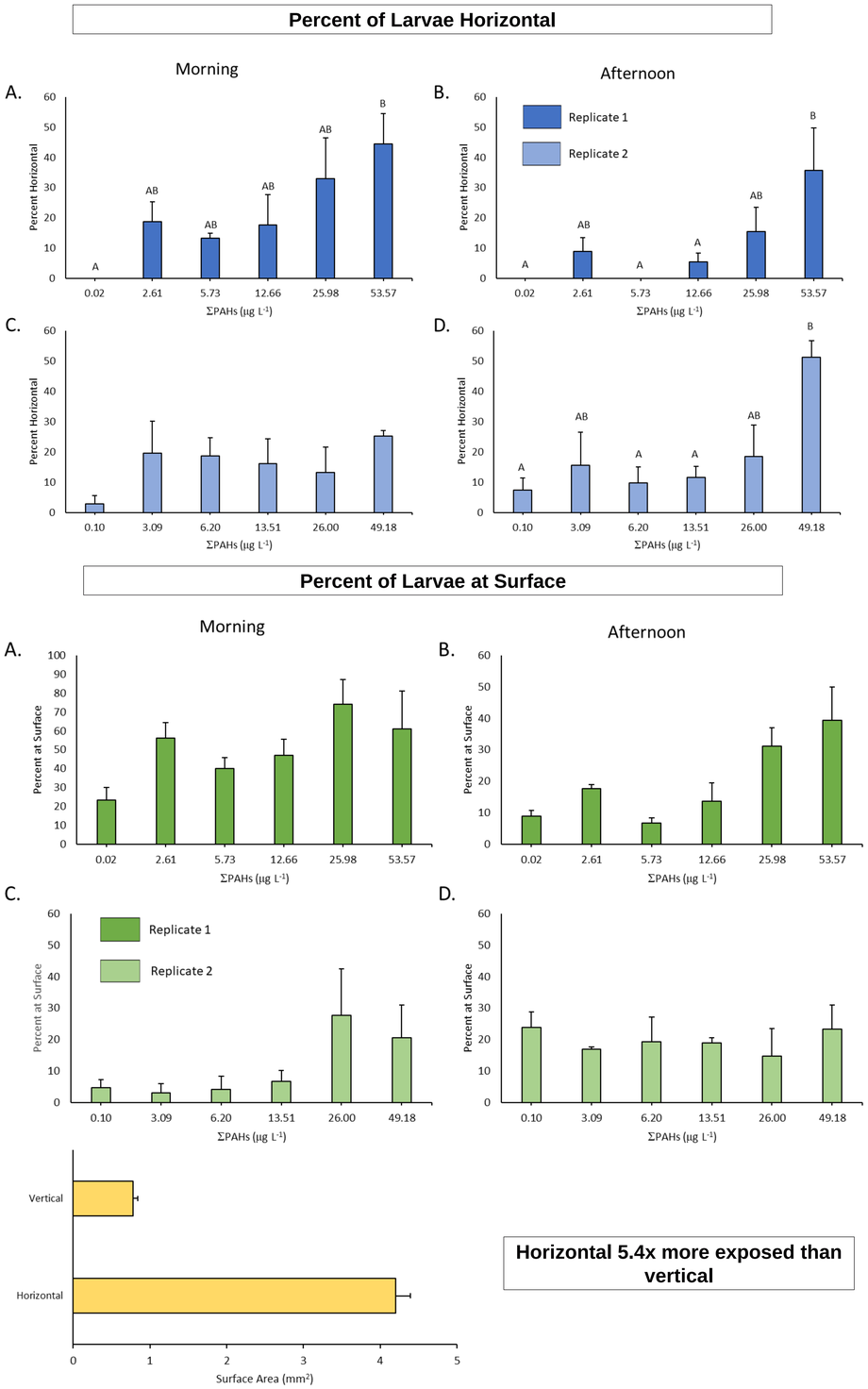
The orientation and position in the water column of ELS fish are critical to their survival as they affect dispersal potentials, hatching environment, and extent and duration of exposure to stressors. Unquantified observations suggest that, in the laboratory, oil-exposed larvae float horizontally and at the surface in comparison to control larvae which tend to float vertically and deeper in the water column. This study aimed to examine if these observations could be repeated and further hypothesized that changes in orientation and position in the water column due to oil exposure would lead to increased UV exposure.

Methods

- **Experimental Animals-** Mahi embryos were obtained from naturally spawning adult broodstock at the University of Miami Experimental Hatchery (UMEH).
- **Exposure Treatments-** Embryos were exposed to oil for 48-h. Oil exposures were prepared as high energy water accommodated fractions (HEWAFs) of surface oil collected during the *DWH* spill and diluted to 0.625%, 1.25%, 2.5%, 5%, and 10% using UV-sterilized seawater for test exposures.
- **Data Collection-** Post-hatch, and approximately 48 hrs after initial oil exposure, the first count of orientation and position in the water column were recorded. The second count was recorded ~5-6 hrs later. Only completely horizontal larvae were considered in the data. Those considered as on the surface were at least one larvae length from the surface. The surface area exposed to UV radiation was calculated by averaging the surface areas of four larvae microscopically imaged in the lab.



Results



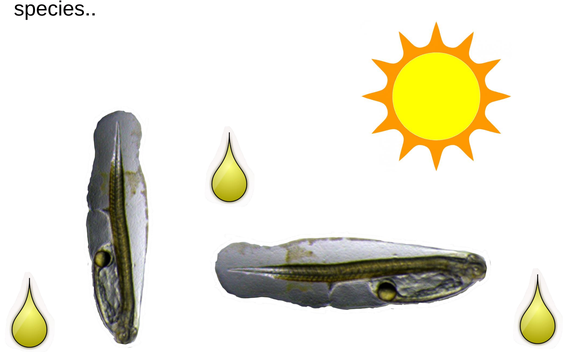
Conclusions

Main Findings

- Change in orientation, from vertical to horizontal, due to oil exposure was significant in several data sets.
- Change in position in the water column was not statistically significant in any data set though a trend of increasing number of larvae at the surface was noted with increasing oil exposure.
- Horizontal larvae had 5.4x more surface area exposed to potential UV radiation than vertical larvae.

Conclusions and Implications

- Behavioral modifications in mahi larvae induced by oil exposure result in a 5.4-fold increase in UV exposure.
- Increase in UV radiation can cause an increase in phototoxicity even when the oil concentration remains the same (reciprocity).
- This increase in UV exposure to a significant portion of the ELS group demonstrates that larval behavior may be an important component of UV enhanced oil toxicity in mahi. It remains to be seen if this phenomenon applies to other species..



Acknowledgements

This research was made possible by a grant from the Gulf of Mexico Research Initiative (GoMRI) and could not have been completed without the support of the University of Miami Experimental Hatchery.
The author would also like to thank the members of the Grosell Toxicology and Physiology lab at the Rosenstiel School of Marine and Atmospheric Science and her thesis committee, Dr. Martin Grosell, Dr. John Stieglitz, and Dr. Christina Pasparakis.