CMOP Undergraduate Intern Mentoring Opportunity

Deadline: **March 28, 2011**
Selections Announced: **April 1, 2011**

Name/Title/Institution(s) of senior mentor(s): Joe Needoba/Assistant Professor/OHSU

Name/Title/Institution(s) of frontline mentor(s): Leslie Slasor/M.S. Student/OHSU, Corey Koch/Scientist/Wet Labs

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Project Title: Preparing for future oil spills: towards detection and tracking of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment

Context for Project:

The 2010 Deepwater Horizon oil spill catastrophe in the Gulf of Mexico is a striking example of the threat caused by the accidental introduction of petroleum hydrocarbons to the environment. Ecosystem damage - for example dead wildlife or oiled marshes - was an obvious and well publicized effect of the spill. Equally devastating was the economic impact on Gulf coast residents who lost their livelihoods in the fishing and tourism industry. In addition to these 'front page' issues, the response to the oil spill included numerous attempts to quantify the fate of oil in the water column, because much of the released oil did not reach the surface or the shore but remained as an underwater plume moving with ocean currents. Compared to the surface slick, this subsurface contamination impacted the ecosystem very differently and remains a subject of intense research to understand its fate and longevity in the environment. Unfortunately the Deepwater Horizon oil spill is only the most recent of dozens of massive spills worldwide. The increased demand for oil and gas combined with the necessity of transport around the globe suggests that accidents will continue to occur and cause the acute or chronic pollution of lakes, rivers, and oceans.

Portland and Seattle are centers of shipping and petroleum transport - thus our region is not immune to the possibility of a catastrophic spill on the scale of the Deepwater Horizon or the Exxon Valdez events. The Columbia River estuary is the site of several smaller incidents, including the release of 170,000 gallons of oil when the *Mobiloil* tanker ran aground near St. Helens, OR and the Nestucca spill near Gray's Harbor, WA that killed an estimated 56000 seabirds. Because of the awareness of the threats posed by this type of accident, the regional response to a spill is likely to be swift and well-organized; entities including the U.S. Coast Guard and local government agencies have action plans for such an event, and many organizations are keenly aware of this important regional issue (e.g. see www.oilspilltaskforce.org). However, an emerging issue from research on the Deepwater Horizon spill

indicates that some fractions of crude oil will dissolve or form emulsions in the water column and thus be very difficult to contain or track with current technology. These fractions include polycyclic aromatic hydrocarbons (PAHs), which are toxic to organisms at many different trophic levels, including as carcinogens in humans when exposure occurs via the food chain. Examples of pathways to the human diet include food from sport or commercial fishing, and shellfish aquaculture. The importance of these industries in the Pacific Northwest underscores the added economic stress that a spill will have on the region.

Mitigation of the extent of environmental and economic damage from an accidental oil spill requires on-hand methods to track dissolved and emulsified oil, including PAHs. A promising technology for this purpose is fluorescence spectroscopy, which relies on the inherent optical fluorescence properties of the aromatic ring structure of PAHs. Fluorescence instrumentation that can be immersed underwater, and thus used as in situ tracking tools, are particularly suitable for tracking oil spills. In response to the Deepwater Horizon oil spill and through an NSF RAPID award (Koch and Barnard 2010) we undertook research to improve the fluorescence approach to detecting constituents of oil dissolved in seawater. This research has exposed an essential requirement to better understand the physical and biological weathering processes of PAHs in the environment, and in particular how fluorescence properties change as a result.

Brief Description.

Spectrofluorometric detection methods use ultraviolet (UV) light to generate fluorescence, a phenomenon caused when double bonds in the aromatic ring structure absorb and release electromagnetic energy. Although less specific than other methods (e.g. mass spectrometry), fluorescence techniques are highly sensitive and relatively easy to adapt to in situ instrumentation. The experimental component of the proposed research project will determine the optimal UV excitation/emission energy wavelengths required for in situ detection of dissolved PAHs in aquatic environments of the Pacific Northwest. This requires a multi-faceted laboratory-based experimental approach using precision optical instrumentation, in particular the Fluoromax-4 Spectrofluorometer.

Simple measurements of PAHs in water are not an adequate approach for the stated objective. Numerous factors influence the chemical nature of PAH fluorescence in the environment, including: pH, salinity, and photon-quenching interactions. Furthermore, biotic and abiotic processes that alter the chemical structures (thus their fluorescence characteristics) begin immediately after PAHs enter an ecosystem. Therefore, in order to understand the fate and persistence of spilled PAHs, we must also understand the weathering processes that alter the wavelength excitation/emission parameters of the compounds. The experimental approach will build upon our current research in order to conduct a series of laboratory experiments that address the dissolution and weathering of PAHs from crude oil. The laboratory-based experiments will investigate the fluorescence properties of PAHs dissolved in fresh and marine waters and determine how the properties change as a result of biological and chemical weathering. The outcome of these results will provide a clear path for instrument development that

incorporates a multiple excitation/emission detection system optimized for PAH detection. Such an instrument would be available for emergency response in the event of an oil spill, and would be specific to Pacific Northwest environments, although will likely be effective in many other coastal systems**.**

CMOP: Enabling technologies – towards the development of in situ sensors for oil spill mitigation and working with a CMOP industry partner. Coastal Margin Science – providing understanding of the influence of microbial processes on PAHs in the environment.

EBS: Supports an ongoing NSF funded research project with an important industry partner (WetLabs).

Proposed Outcomes/Broader Impact:

Until renewable energy replaces our society's requirement for petroleum hydrocarbons there will be oil spills. Developing the technology required to mitigate these disasters is currently 'front-and-center' as a result of the Deepwater Horizon oil spill. Past clean-up approaches that involve heavy equipment and oil recovery remains important to remove the contaminants from the surface of water bodies and before they reach sensitive shoreline environments. However, research by our group and others indicates that PAH compounds *dissolved* in the water column are more difficult to measure and track than the surface slick. These compounds are transported throughout the water column and pose a direct threat to many different trophic levels, ranging from invertebrate larvae to humans. There are still many unknowns about PAHs chemical behavior in the environment. The proposed research activities will make direct scientific advances to improve this knowledge.

Proposed timeline (within a 10 week span):

Week 1-2. Introduction to laboratory, background reading, and identification of specific project goals

Week 3-5. Microbial degradation experiments using Gulf of Mexico seawater

Week 6-8. Microbial degradation experiments using Columbia River freshwater

Week 9-10. Data analysis and paper writing

Intern academic experience and skill set should include: Experience in at least one of the following: Chemistry, environmental science, oceanography, geology. Laboratory experience will be an asset.