Geophysical Research Abstracts
Vol. 18, EGU2016-3030-1, 2016
EGU General Assembly 2016

The environmental impacts of oil platforms in the Persian (Arabian) Gulf: the conservation paleobiology approach

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The Persian (Arabian) Gulf is a semi-enclosed basin that currently hosts the highest concentration of infrastructures for oil and gas extraction in the world. Moreover, major oil spills have occurred here due to accidents and conflicts. The disjunction between recent environmental monitoring programmes and industry-scale oil exploration and extraction dating back to the mid-20th century means a lack of data on pre-impact ecosystem conditions. This shortcoming hampers quantifying disturbance and ecosystem shifts and calls for novel approaches to reconstruct baselines.

Conservation palaeobiology is such a new research field. It uses the accumulations of hard skeletal parts left by organisms in the sediments after death (e.g., mollusk shells) to gain information on past community states. These so-called “death assemblages” contain skeletons produced over tens to thousands of years and change very slowly in comparison to living assemblages. Accordingly, under anthropogenic pressures, living assemblages change their structure and composition faster than their corresponding death assemblages. This increases the differences between the two beyond those caused by purely natural processes. When coupled with dating of dead shells (using radiocarbon calibrated amino acid racemization), such live-dead comparisons help assess the magnitude and timing of environmental impacts and ecosystem change when baseline data are not available.

We applied these approaches to two major oil platforms off the United Arab Emirates coastline. We found a mismatch between living and death assemblages, with death assemblages dominated by a single bivalve species, the semelid Ervilia purpurea. However, the frequency distributions of post-mortem shell ages of this bivalve show that the mismatch can be mainly attributed to natural extreme demographic fluctuations in its population.

We conclude that, at the field scale, decadal and century-level changes in the molluscan community composition were weak or too brief to leave any signatures in the death assemblages. At the regional scale, there was a weak shift towards trophic groups more tolerant to eutrophic conditions. Shell age dating is crucial in understanding the sources of the live-dead mismatch and enables exploring bivalve population dynamics in the past. Combining live-dead comparison with geochronology can shed light on community shifts in other oilfields and more broadly in areas where disturbance-related changes are expected and pre-impact conditions need to be reconstructed.