ARC '16

مؤتمر مؤسسة قطر
السنوي للبحوث

QATAR FOUNDATION
ANNUAL RESEARCH
CONFERENCE

Towards World-class
Research and Innovation

Energy and Environment Pillar

http://dx.doi.org/10.5339/qfarc.2016.EEPP2749

First Impact Assessment of Genotoxic Components in the Qatari Marine Environment

Alexandra Leitão-Ben Hamadou[1], Ismail Al-Shaikh[1], Ibrahim Al-Maslamani[1], Ebrahim Al-Ansari[1], Hassan Hassan[1], Radhouan Ben Hamadou[1], Steffen Bach[2]

[1]Qatar University, QA
[2]Maersk Oil Qatar, QA

Email: alexandra.hamadou@qu.edu.qa

The Arabian Gulf is a semi-enclosed sea with very high evaporation and low discharge rates resulting in extreme saline and thermal conditions. Additionally the system is characterized by a weak hydrodynamic flushing resulting in pollutant build-up over time. As a result, compared to open marine systems, added stress imposed by pollutants is likely to have severe consequences.

Qatar has witnessed a rapid expansion in coastal development, linked to its industrial and population growth in recent decades. While economically and socially valuable, the growth comes with an associated environmental cost and Qatar's marine environment now faces many pressures including eutrophication, inputs of domestic sewage, discharge of industrial waste and the resuspension of sediment due to coastal construction. Although the threats pose to biota inhabiting Qatar's marine environment are evident, their extent has yet to be fully assessed.

A large percentage of contaminants in the aquatic environment consist of potentially (directly or indirectly) genotoxic, carcinogenic and mutagenic substances. A genotoxin can modify the genetic material at non lethal and non cytotoxic concentrations and has often belated effects which are significantly important at the population and community levels. Genotoxins have particularly high ecotoxicological relevance in situations of chronic exposure to low doses and to multiple contaminants (e.g. in case of PAHs rich tarballs arriving in the shorelines), raising he need to establish genotoxicological profiles of the ecosystems.

Indeed several regulatory developments such as: EU – Marine Strategy Framework Directive, the or US – Environmental Protection Agency - Integrated Risk Information System have stressed explicitly on the need of the detection and assessment of potential carcinogenic and mutagenic toxicants using genotoxicity endpoints.

Cite this article as: Hamadou AL-B, Al-Shaikh I, Al-Maslamani I, Al-Ansari E, Hassan H, Ben Hamadou R, Bach S. (2016). First Impact Assessment of Genotoxic Components in the Qatari Marine Environment. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP2749 http://dx.doi.org/10.5339/qfarc.2016.EEPP2749.

The analysis of cytogenetic endpoints in organisms exposed to contaminants in their natural environment contributes significantly to the early detection of genotoxic damage. The relevance of cytogenetic parameters and atypical cytogenetic features, such as numerical chromosomal abnormalities, i.e. aneuploidy, have largely proven their relevance as alerting indicators of poor environmental health and relevant biomarkers for the early detection of environmental stressors.

The use of marine invertebrates for in situ environmental assessment is a widely accepted method for identifying risks to the ecosystems. Moreover, at the DNA and chromosome levels they express qualitatively similar types of induced damage to that found in higher organism (e.g. numerical and structural chromosomal aberrations).

In this study, we aimed to take a step towards Qatar's marine sustainability by assessing the health status of the marine environment, and providing early alerting symptoms of degradation, by having as specific objectives: i) to measure the levels, in abiotic (water, sediments) and a marine invertebrate model species, of various anthropogenic contaminants (metals, polycyclic aromatic hydrocarbons, (PAHs) and Total polyaromatic hydrocarbons (TPH) at 3 selected sites around the Qatari coast, ii) measure the biological response at the chromosome level, and iii) determine the main drivers of genotoxicity through a multivariate analysis in order to establish a first partial genotoxicological profile of the Qatar Marine Zone.

The 3 selected sampling sites, with expected different levels and sources of pollution were: South of Al Khor, Al Wakra harbor and South of Doha harbor. Two sampling campaigns were performed, one in summer and one in winter, to evaluate the role of the abiotic parameters, among others, on the bioavailability of the studied contaminants.

The native pearl oyster Pinctada radiata was selected as model and surrogate species due to, its wide distribution along the Qatari coast, filter feeder and sessile mode of life and to its ability as a bivalve to bioaccumulate pollutants. Chemical analyses of the main trace metals and hydrocarbons were performed in water, sediment and P. radiata samples.

The evaluation of the aneuploidy levels in P. radiata was estimated in 25–30 animals from each sampling site and season, by counting the total number of aneuploid metaphases over 30 metaphases counted per individual.

The evaluation of the aneuploidy level on Pinctada radiata from the three sampling sites revealed an occurrence of significantly higher levels in Al-Wakra harbor (17% in summer and 20% in winter) and South of Doha harbor (19% in summer and 17% in winter), when compared to Al Khor (5% in summer cand 7% in winter). No statistically significant differences were observed between seasons in each location.

In order to investigate the discrepancy between sampling sites and seasons with respect to all estimated descriptors and to evaluate the relationship between all the studied parameters, a principal component analysis (PCA) was performed. Aneuploidy levels were highly correlated to mercury and PAHs levels in the bivalve tissue. Moreover, the higher aneuploidy levels registered at Al Wakra harbor (both seasons) and Doha harbor (summer) showed a high correlation with the contaminants levels in P. radiata tissues. South of Al Khor (in both sampling seasons) was highly positively correlated with Cadmium (Cd), although this contamination was not responsible for a significant increase of the aneuploidy levels.

The studied genotoxic contaminants were found to be highly variable among considered locations and between sampling seasons. Indeed, the 6 observations (contaminants levels among three sampling sites at two sampling seasons) differ substantially, no site or sampling season grouping being observed, which suggests an important spatial and temporal variability of the bioaccumulation of pollutants into P. radiata tissues.

The aneuploidy levels, however, were consistently different among sampled locations, but did not differ between the two sampling seasons, suggesting that aneuploidy is the consequence of a local chronic contamination, and not a direct response to the temporal variability of the contaminants in P. radiata tissues.

The results of this study confirm the suitability of the cytogenetic endpoints to discriminate, categorize the studied sites as regards to their level of contamination, underlining the added value of the detection of the genotoxicity levels in the marine environment to environmental health assessment and mitigation research programs. Further studies should be developed, under the specific hydrological and toxicological conditions of the Qatar Marine Zone (QMZ), to better explain the underlining mechanisms of such genotoxicity in the local filter feeders.

The establishment of a Genotoxicological profile of the QMZ would be a valuable contribution to a wider approach on environmental diagnosis or prognosis, contributing to the protection and sustainability of the QMZ natural habitats and resources.