Monitoring of phytoplankton species and associated bacterial populations in the coastal water of United Arab Emirates


¹Department of Natural Science and Public Health, College of Sustainability Sciences& Humanities Zayed University, Dubai, UAE. E-mail: Munawwar.Khan@zu.ac.ae

**Emirates Authority for Standardization & Metrology, P.O.Box: 48666, Dubai, UAE.

International Conference on Desalination Environment and Marine Outfall System Sultan Qaboos University, Muscat, Sultanate of OMAN April 13-16th, 2014
Background

- Harmful algal blooms (HABs) commonly known as ‘red tides’ are caused by single-celled microscopic protists or dinoflagellates (phytoplankton).

- The rapid growth and proliferation of HABs cause
  - fish mortality, disruptions to microbial ecosystems, coral reef ecosystems and seafood contamination, affect desalination plants, recreational activities.

- HABs can occur naturally, but exacerbated by anthropogenic activity.
HAB events

The HABs have been reported in several countries and are increasing in frequency and magnitude worldwide as a result of changes in

- oceanic climate
- increased coastal eutrophication
- enhanced long-distance dispersal in ballast water

In recent years, a high incidence rate of red tide has been reported in the United Arab Emirates (UAE).

- In Dubai, several man-made coastal lagoons, bays, palm jumeirah, including Dubai festival city on Dubai creek were affected by red tide (Arnold 2009; Landais, 2008).
- The Environmental agency Abu Dhabi (EAD) has reported an increasing occurrence of HABs in Abu Dhabi waters (Al Qubaisi 2006).
## Major HAB event in the UAE

<table>
<thead>
<tr>
<th>Date</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/8/2008</td>
<td>Kalba</td>
</tr>
<tr>
<td>8/9/2008</td>
<td>Dibbah Al Hesen</td>
</tr>
<tr>
<td>Dec. 2008</td>
<td>Ras Al-Khaimah</td>
</tr>
<tr>
<td>23/12/2008</td>
<td>Umm Al Quwain, Ajman and Sharjah and reached ocean</td>
</tr>
<tr>
<td>Sep. 2009</td>
<td>spread throughout most of the UAE coastal area</td>
</tr>
<tr>
<td>15/9/2009</td>
<td>red tide started to retreat and disappeared except for some areas in</td>
</tr>
<tr>
<td></td>
<td>Dibbah AlHesen</td>
</tr>
<tr>
<td>14/10/2009</td>
<td>Appearance of red tide was last seen</td>
</tr>
</tbody>
</table>
HAB events in the UAE
HABs and Bacterial community

In order to manage and mitigate the adverse impact of HABs, basic research is required; For example:

- understanding the types of algae or phytoplankton (both toxic and non-toxic) present in the sea water samples before or after the HAB event
- their interactions with each other and other biological organism like bacteria, viruses, protozoan
Significance of bacterial community

- Bacteria play an important role
  - in nutrient regeneration and energy transformation in aquatic ecosystems
  - as potentially important regulators of algal growth and toxin production
Objective

The aim of this study was to monitor the bacterial communities associated with the phytoplankton (both toxic and non-toxic) present in selected coastal areas in the UAE.
METHODOLOGY

SAMPLES

PROCESSING

ISOLATION

CULTIVATION

CHARACTERIZATION
- Morphological
- Physiological, Biochemical

Analysis

Physical parameters
pH, temp., DO, depth etc.

Microscopic observation
- Phytoplankton
Species & abundance

FIXATION

HYBRIDIZATION WITH PROBES

FISH
Identification
Quantification
Analysis
SAMPLING SITE
### Oligonucleotide probes used

<table>
<thead>
<tr>
<th>Probe</th>
<th>Sequence (5’-3’)</th>
<th>Specificity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eub338</td>
<td>GCTGCTCCCGTAGGAGT</td>
<td>Domain bacteria</td>
<td>Amann et al. 1990</td>
</tr>
<tr>
<td>Eub338II</td>
<td>GCAGCCACCCGTAGGTGT</td>
<td>Domain bacteria (Planctomycetales)</td>
<td>Daims et al. 1999</td>
</tr>
<tr>
<td>Eub338III</td>
<td>GCTGCCACCCGTAGGTGT</td>
<td>Domain bacteria (Verrucomicrobiales)</td>
<td>Daims et al. 1999</td>
</tr>
<tr>
<td>Alpha 1b</td>
<td>CGTTCGYTCTGAGCAG</td>
<td>alpha-Proteobacteria</td>
<td>Manz et al. 1992</td>
</tr>
<tr>
<td>Beta42a</td>
<td>GCCTTTCCACCTTCGTTT</td>
<td>beta-proteobacteria</td>
<td>Manz et al. 1992</td>
</tr>
<tr>
<td>Gamma42a</td>
<td>GCCTTTCCACATCGTTT</td>
<td>gamma-Proteobacteria</td>
<td>Manz et al. 1992</td>
</tr>
<tr>
<td>HGC 69a</td>
<td>TATAGTTACCACCGCCGT</td>
<td>gram positive high G+C content</td>
<td>Schuppler et al. 1998</td>
</tr>
<tr>
<td>LGC354A</td>
<td>TGGAAGATTCCCTACTGC</td>
<td>gram positive low G+C content</td>
<td>Meier et al. 1999</td>
</tr>
<tr>
<td>LGC354B</td>
<td>CGGAAGATTCCCTACTGC</td>
<td>gram positive low G+C content</td>
<td>Meier et al. 1999</td>
</tr>
<tr>
<td>LGC354C</td>
<td>CCGAAGATTCCCTACTGC</td>
<td>gram positive low G+C content</td>
<td>Meier et al. 1999</td>
</tr>
</tbody>
</table>
## RESULTS

### Table 1. Hydrographic data of the samples

<table>
<thead>
<tr>
<th>Date/sample #</th>
<th>Station location</th>
<th>Depth (km)</th>
<th>Temp (° C)</th>
<th>DO (mg/L)</th>
<th>Salinity (ppt)</th>
<th>pH</th>
<th>Fluorescence (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/3/2011/ sample 1</td>
<td>UAQ</td>
<td>1.29</td>
<td>24.08</td>
<td>6.99</td>
<td>40.52</td>
<td>8.07</td>
<td>0.51</td>
</tr>
<tr>
<td>4/17/2011/ sample 2</td>
<td>UAQ</td>
<td>1.86</td>
<td>24.38</td>
<td>6.71</td>
<td>42.24</td>
<td>7.88</td>
<td>0.72</td>
</tr>
<tr>
<td>4/20/2011/ sample 3</td>
<td>Dibba</td>
<td>1.56</td>
<td>25.83</td>
<td>7.52</td>
<td>38.81</td>
<td>8.08</td>
<td>2.86</td>
</tr>
<tr>
<td>5/1/2011/ sample 4</td>
<td>UAQ</td>
<td>1.23</td>
<td>27.54</td>
<td>6.54</td>
<td>41.12</td>
<td>7.82</td>
<td>0.72</td>
</tr>
</tbody>
</table>
RESULTS

Dominant Harmful marine dinoflagellates species found in the samples (a) *Cochlodinium polykrikoides* (b) *Dinophysis caudata* (c) *Prorocentrum arenarium* (d) *Protoperidinium spp.*
<table>
<thead>
<tr>
<th>Samples</th>
<th>Phytoplankton species number</th>
<th>Phytoplankton abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>
| S 1     | NC*                         | Diatoms (dominant): Asterionellopsis glacialis, Chaetoceros, Guinardia flaccida, Eucampia zodiacus  
Dinoflagellates: Dinophysis caudata, Prorocentrum micans, Prorocentrum balticum |
| S 2     | Diatoms: 3                  | Diatoms: Pseudo-nitzschia pungens, Pseudo-nitzschia seriata, Skeletonema costatum  
Dinoflagellates (dominant): Cochlodinium polykrikoides, Dinophysis caudata, Prorocentrum minimum |
| Sub-2a  | Diatoms: 3                  | Diatoms: Pseudo-nitzschia pungens, Pseudo-nitzschia seriata, Skeletonema costatum  
Dinoflagellates (dominant): Cochlodinium polykrikoides, Dinophysis caudata, Prorocentrum minimum |
| Sub-2b  | Diatoms: 3                  | Diatoms: Pseudo-nitzschia pungens, Pseudo-nitzschia seriata, Skeletonema costatum  
Dinoflagellates (dominant): Cochlodinium polykrikoides, Dinophysis caudata, Prorocentrum minimum |
| S 3     | Diatoms: 2                  | Diatoms (dominant): Guinardia striata, Thalassiosira |
| S 4     | NC*                         | Diatoms (dominant): Guinardia flaccida, Guinardia striata, Navicula  
Dinoflagellates: Ceratium fusus, Protoperidinium |
Whole cell rRNA targeted fluorescence *in situ* hybridization of bacterial community members belonging to: 

a) Alpha sub-class of proteobacteria  
b) Beta sub-class of proteobacteria
RESULTS

Whole cell rRNA targeted fluorescence *in situ* hybridization of bacterial community members belonging to: c) Gamma sub-class of proteobacteria d) Enterobacteriaceae family
Whole cell rRNA targeted fluorescence *in situ* hybridization of bacterial community members belonging to: e) High G+C sub-class f) Low G+C sub-class.
Culture dependent study

- A few bacterial species were successfully isolated and purified on thiosulfate-citrate-bile-sucrose (TCBS) agar (a specific culture media for the isolation of Vibrio spp.)

V. Cholera or Vibrio alginolyticus?
Conclusions

- In this study, 13 toxic dinoflagellates and 6 non-toxic dinoflagellates species were observed in a total of eight coastal water samples.

- This study showed a highly diverse bacterial community belonging to five different sub-groups (Alpha, Beta and Gamma sub-class of proteobacteria, High and Low G+C sub-group) and one family (Enterobacteriaceae) associated with the phytoplankton species present in the UAE coastal water.
Further Work

- The specific role of a few isolated bacteria, whether algicidal or favorable against harmful or nontoxic phytoplankton species need to be established.

- In order to improve our understanding of phytoplankton–bacterial interactions in the UAE coastal waters a long term monitoring study on bacterial populations is highly recommended.
Acknowledgements

- Ministry of Environment and Water (MOEW), Dubai, UAE.

- Dr. Rashid Mohammed AlShihi and Dr. Jaishinimol Santhamma, The Marine resources research centre laboratory, Umm Al Quwain, UAE.
Thank you for your attention