Dedicated to my late father

Shri. Krishna P. Naik and sister Deepa
Contents

Statement

Certificate

Acknowledgements

Chapter 1 General introduction

Chapter 2 Spatio-temporal variation in surface water dinoflagellates in the Bay of Bengal

2.1. Introduction

2.2. Materials and methods
2.2.1. Study area and sampling
2.2.2. Microscopic analysis
2.2.3. Data analyses

2.3. Results
2.3.1. Dinoflagellate assemblages
2.3.2. Spatial and temporal variation in dinoflagellate assemblages
2.3.3. Seasonal variation in HAB species

2.4. Discussion

Chapter 3 Primary description of surface water phytoplankton pigment patterns in the Bay of Bengal

3.1. Introduction

3.2. Materials and methods
3.2.1. Sampling strategy
3.2.2. Pigment analysis
3.2.3. Pigment calibration and estimation of the analytical detection limit
3.2.4. Data analysis

3.3. Results
3.3.1. The analytical detection limit, total chlorophyll $a$ concentrations
3.3.2. Photo-pigment indices
3.3.3. Diagnostic pigment indices
3.3.4. Changes in pigment patterns in different regions

3.4. Discussion
Chapter 4  Micro-phytoplankton community structure at Mormugao and Visakhapatnam ports

4A.1. Introduction 58

4A.2. Materials and methods 60
4A.2.1. Study areas 60
4A.2.2. Sampling strategy 62
4A.2.3. Analysis of environmental variables 63
4A.2.4. Analysis of phytoplankton 64
4A.2.5. Data analyses 64

4A.3. Results 65
4A.3.1. Mormugao Port (MPT) 65
4A.3.1.a Environmental variables 65
4A.3.1.b Phytoplankton community 66
4A.3.1.c Diatom community 78
4A.3.1.d Effect of environmental variables on the diatom community in surface and near bottom waters 81
4A.3.1.e Dinoflagellate community 83
4A.3.1.f Effect of environmental variables on the dinoflagellate community in surface and near bottom waters 85
4A.3.2. Visakhapatnam Port (VPT) 87
4A.3.2.a Environmental variables 87
4A.3.2.b Phytoplankton community 88
4A.3.2.c Diatom community 96
4A.3.2.d Effect of environmental variables on the diatom community in surface and near bottom waters 98
4A.3.2.e Dinoflagellate community 100
4A.3.2.f Effect of environmental variables on the dinoflagellate community in surface and near bottom waters 103

4A.4. Discussion 103

4B. Diversity of Skeletonema

4B.1. Introduction 113

4B.2. Materials and methods 115
4B.2.1. Culture strain 115
4B.2.2. Preserved samples 115
4B.2.3. Light microscopy (LM), Scanning Electron microscopy and Transmission Electron Microscopy (TEM) 115
4B.2.4. Molecular analysis of the culture strain 116
<table>
<thead>
<tr>
<th>4B.3.</th>
<th>Results</th>
<th>116</th>
</tr>
</thead>
<tbody>
<tr>
<td>4B.3.1.</td>
<td>Microscopic identification of the culture strain and preserved samples</td>
<td>116</td>
</tr>
<tr>
<td>4B.3.2.</td>
<td>Molecular analysis</td>
<td>121</td>
</tr>
</tbody>
</table>

| 4B.4. | Discussion | 121 |

**Chapter 5**  
Effect of preservation on the morphology of *Karlodinium veneficum*, a non-thecate, potentially harmful dinoflagellate and allelopathy in relation to *Skeletonema costatum*

| 5.1. | Introduction | 123 |

<table>
<thead>
<tr>
<th>5.2.</th>
<th>Materials and methods</th>
<th>125</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.1.</td>
<td>Dinoflagellate culture</td>
<td>125</td>
</tr>
<tr>
<td>5.2.2.</td>
<td>Morphological characterization</td>
<td>125</td>
</tr>
<tr>
<td>5.2.3.</td>
<td>Effect of preservatives/fixatives</td>
<td>126</td>
</tr>
<tr>
<td>5.2.4.</td>
<td>Allelopathy experimental set-up</td>
<td>126</td>
</tr>
<tr>
<td>5.2.5.</td>
<td>Data analyses</td>
<td>127</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.3.</th>
<th>Results</th>
<th>128</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3.1.</td>
<td>Morphological characterization</td>
<td>128</td>
</tr>
<tr>
<td>5.3.2.</td>
<td>Light Microscopy (LM)</td>
<td>128</td>
</tr>
<tr>
<td>5.3.3.</td>
<td>Scanning Electron Microscopy (SEM)</td>
<td>128</td>
</tr>
<tr>
<td>5.3.4.</td>
<td>Effect of preservatives/fixatives</td>
<td>130</td>
</tr>
<tr>
<td>5.3.5.</td>
<td>Allelopathic effect of Culture Filtrate (CF)</td>
<td>133</td>
</tr>
<tr>
<td>5.3.6.</td>
<td>Allelopathic effect of Cell Extract (CE)</td>
<td>134</td>
</tr>
</tbody>
</table>

| 5.4. | Discussion | 135 |

**Chapter 6**  
Summary

Bibliography

Publication

Appendices