BOOK OF ABSTRACTS

First International Conference on Managing Ecosystem Health of Tropical Seas:
Environmental Management of Coastal Ecosystems

19 - 21 October 2010
Putrajaya Marriott Hotel, IOI Resort
Putrajaya, MALAYSIA
DISCLAIMER

The abstracts compiled in this CD of Abstracts appear exactly as they were submitted without editing. The Scientific Committee of ECOSEAS 2010 is not responsible for any errors in the abstracts or for the veracity of the information appearing therein.
# CONTENTS

## PLENARY LECTURES

1. **Sustainable management of the ocean – The IOC approach**  
   Wenxi Zhu  
   Pages 2

2. **Structural and functional indicators of ecosystem health: Sharing the inland seas - Great Lakes experience for global conservation**  
   M. Munawar, I.F. Munawar, M. Fitzpatrick and H. Niblock  
   Pages 7

## KEYNOTE ADDRESSES

1. **Sustaining aquatic ecosystem services through integrated management of river basins and the coastal seas**  
   Thia-Eng Chua  
   Pages 14

2. **Marine biodiversity and resource management – What is the link?**  
   Derek J. Staples and Rudolf Hermes  
   Pages 19

3. **Coral Triangle Initiative - Coral reefs, fisheries and food security (CTI-CFF)**  
   Nor Aieni Haji Mokhtar  
   Pages 23

4. **Coastal fisheries management in developing countries – Issues and policy concerns**  
   Dilip Kumar, P.S. Ananthan, Latha Shenoy and Nalini Ranjan  
   Pages 29

5. **Bioaccumulation of organotins by fish and rock shell**  
   Jiro Koyama, A. Takenouchi, S. Nigaya, M. Murakami, E. Kokushi and S. Uno  
   Pages 36

6. **Distributed network of environmental monitoring in the South China Sea and its implication for the regional collaborations**  
   Dong-Xiao Wang  
   Pages 40

7. **Marine pollution abatement through microbial bioremediation**  
   David J. W. Moriarty  
   Pages 43

8. **Responsible coastal fisheries and aquaculture for sustainable ecosystem health**  
   Meryl J. Williams  
   Pages 47

## ORAL PAPERS

### Session 1A - Coastal and Riverine Interactions

**OP01**  
**Water management achievement in tidal lowlands**  
Muhammad Yazid, Mad Nasir Shamsudin, Khalid Abdul Rahim, Alias Radam and Azizi Muda  
Pages 52
### Session 1B - Marine Biodiversity and Resource Management

**OP02**  Wave attenuation ability of *Rhizophora* species at Kemaman, Terengganu  
*Mohd Lokman Husain, P.C. Sinha and Isfarita Ismail*  
Page 56

**OP03**  Ecological capability evaluation for sustainable land use planning  
*Sara Kaffashi and Mandana Yavari*  
Page 60

**OP04**  Modelling sustainable development indicators for coastal cities - Case study of Mahshahr City in Iran  
Page 61

**OP05**  Conservation and management programmes for nesting habitats of sea turtles in Persian Gulf, Iran  
*Rouhollah Zare*  
Page 62

### Session 2A – Governance and Socio-Economics

**OP06**  The study of genetic diversity of *Eretmochelys imbricata* in the Persian Gulf using microsatellite analysis  
*Mohammad Ali Salari-Allabadi, Hossain Zolghamian and Somayeh Roshani*  
Page 68

**OP07**  Demographic composition of green turtle *Chelonia mydas* at foraging ground off Semporna Waters, Sabah  
*Juanita Joseph and Chong Yee Kuen*  
Page 73

**OP08**  Population biology and resilient features of mudskippers in mangrove ecosystem  
Page 77

**OP09**  Diversity of seaweeds in the vicinity of Johor: With emphasis on the east coast of Peninsular Malaysia Expedition II 2006  
*M.H. Gan, A. Siti Aishah, A. Nur Wahidah, K. Amyra Suryatie and M.P. Noraien*  
Page 81

**OP10**  Responsible small scale capture fisheries  
*Abdul Rahim Ibrahim and Saharuddin Abdul Hamid*  
Page 88

**OP11**  Co-management arrangements for Kota Marudu, Sabah  
*Illiiriyan Ismail, Fatimah Mohamed Arshad, Kusairi Mohd Noh, Tai Shzee Yew, Zahira Mohd. Ishan and Suryani Darham*  
Page 89

**OP12**  Sustainable fisheries of the east coast of Peninsular Malaysia: Is traditional fishing the "best hope" for it?  
*A. Azizi and A.H. Saharuddin*  
Page 93

**OP13**  Socio-economic profile of sea cucumber *Apostichopus japonicus* gatherers in the coastal areas of Bantayan Island, Cebu Province  
*Corazon P. Macachor and Noel Dierran*  
Page 97
OP14 Governance of mangrove rehabilitation in Carles, Central Philippines
Didi B. Baticados and Tsutomu Matsuura

OP15 Community-based tourism of mangrove ecosystem in Kota Marudu, Sabah
Awang Noor Abd. Ghani, Abdullah Mohd, Faridah Hanum Ibrahim, Mohamed Zakaria Hussin and Kamziah Abdul Kudus

Session 2B – The Straits of Malacca Special Session: Safety Navigation for Resource Protection

OP16 Ecosystem-based management of marine resources in the Straits of Malacca
H.M. Ibrahim

OP17 Maritime law enforcement for oil waste disposal in the Straits of Malacca
Sutarji Kasmin and Wan Nor Azmin Sulaiman

Session 2C – Environmental Stressors

OP18 Cooling of sea surface waters near Cheju Island responding to strong wind and positive geopotential tendency by a typhoon
Hyo Choi and Soo Min Choi

OP19 Persistent organochlorine pesticides (OCPs) residues in marine food chain
M. Maruf Hossain, Zubir Din and Sani Ibrahim

OP20 Assessment of anthropogenic influences of heavy metals from Klang River into the Straits of Malacca: An index analysis approach
Abolfazl Naji, Ahmad Ismail and Syaizwan Zahmir Zulkifli

OP21 Marine debris composition and abundance: A case study of selected beaches in Malaysia
A.K. Khairunnisa, S.H. Fauziah and P. Agamuthu

OP22 A preliminary study of zooplankton composition associated with thermal effluents from a power plant at Manjung, Perak, Malaysia
Jiang-Wei Chan, Omar Ahmad, W.O. Wan Mznah and Khairun Yahya

OP23 Utilization of locally isolated phototrophic bacterium for the treatment of palm oil mill effluent
Sujjat Al Azad and Sitti Reahanah Mohd. Shalleh

OP24 Effect of cold stress on three genera of hard corals in Persian Gulf with 70KDa protein as stress indicator
Fatemeh Nozhat
### Session 2D – South China Sea Special Session

<table>
<thead>
<tr>
<th>OP25</th>
<th>A numerical study of coupled estuary-shelf circulation around the Pearl River Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ting-Ting Zu, Jian-Ping Gan and Dong-Xiao Wang</td>
</tr>
<tr>
<td>OP26</td>
<td>Transportation and distribution of pollutant in Pearl River Estuary</td>
</tr>
<tr>
<td></td>
<td>Lin Luo, Wei Zhou and Dong-Xiao Wang</td>
</tr>
<tr>
<td>OP27</td>
<td>Seasonal water masses variation of the upper layer South China Sea</td>
</tr>
<tr>
<td></td>
<td>Abd Muhaimin Amiruddin and Zelina Zaiton Ibrahim</td>
</tr>
<tr>
<td>OP28</td>
<td>Environmental exposure and ecological risk of heavy metals from fishing harbours in</td>
</tr>
<tr>
<td></td>
<td>the Pearl River Delta (PRD), South China</td>
</tr>
<tr>
<td></td>
<td>Wei-Hai Xu, Xiang-Dong Li, Wen Yan, Tian Lin and Zhao-Hui Hu</td>
</tr>
<tr>
<td>OP29</td>
<td>Comparison and analysis of environmental constituents in the Pearl River Estuary</td>
</tr>
<tr>
<td></td>
<td>during summer of 1999 and 2009</td>
</tr>
<tr>
<td></td>
<td>Wei Yang, Lin Luo, Yong-Li Gao, Ting-Ting Zu, Wei Zhou and Dong-Xiao Wang</td>
</tr>
<tr>
<td>OP30</td>
<td>A theoretical frame for ecosystem health assessment and its application to the Tolo</td>
</tr>
<tr>
<td></td>
<td>Harbour, Hong Kong, China</td>
</tr>
<tr>
<td></td>
<td>Fu-Liu Xu</td>
</tr>
</tbody>
</table>

### Session 3A – Environmental Abatement Technologies

| OP31 | Reef restoration through coral transplantation in Malaysia                          |
|      | Mohamed Pauzi Abdullah and Ab Rahim Gor Yaman                                       |
| OP32 | Characterization of Cebu City port water and waterways: Clean-up strategies and     |
|      | technologies                                                                       |
|      | Cecilio S. Baga and Corazon P. Macachor                                              |
| OP33 | Macrobenthos as saline intrusion indicator upstream of Sungai Sarawak                |
|      | T.S. Leong, K.H. Khoo, S.H. Chong, A.R. Enchana and D. Law                           |
| OP34 | Simulation and prediction of seawater intrusion in a small island’s aquifer         |
|      | S.M. Praveena, M.H. Abdullah, A.Z. Aris and K. Bidin                               |
| OP35 | Application of AHP model for land-use suitability analysis in Malaysian coastal     |
|      | areas                                                                              |
|      | M. Bagheri, Z.Z. Ibrahim, W.N.A. Sulaiman and N. Vaghefi                            |
| OP36 | Three dimensional water quality modelling for Sungai Segget watershed                |
|      | Noor Baharim Hashim, Paul M. Craig, Dang Huu Chung, Nguyen Tat Thang and Maznah Ismail|
| OP37 | Usage of digital shoreline analysis system for coastal ecosystem management         |
|      | A. Moradi, Z.Z. Ibrahim, M.M. Ibrahim and M. Yamani                                |
### Session 3B – Fisheries

<table>
<thead>
<tr>
<th>OP38</th>
<th>Mapping fishing ground of yellowfin tuna (<em>Thunnus albacares</em>) with application of satellite multi-sensor and upwelling in Wakatobi National Park, Southeast Sulawesi Province, Indonesia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Muslim Tadjuddah, Ahmad Mustafa, Utama K Pangerang and Farid Yasidi</em></td>
</tr>
<tr>
<td>OP39</td>
<td>Population, stock status and management of sergestid shrimp <em>Acetes indicus</em> (Decapoda: Sergestidae) in the coastal waters of Malacca, Peninsular Malaysia</td>
</tr>
<tr>
<td></td>
<td><em>S.M. Nurul Amin, Aziz Arshad, Siti Shapor Siraj and Japar Sidik Bujang</em></td>
</tr>
<tr>
<td>OP40</td>
<td>Finfish fisheries and resources of Sarawak, Sabah and Labuan</td>
</tr>
<tr>
<td></td>
<td><em>Albert Chuan Gambang, Richard Rumpet and Nurridan Abdul Han</em></td>
</tr>
<tr>
<td>OP41</td>
<td>Recreational fisheries effort and values of Port Dickson, Negeri Sembilan, Malaysia</td>
</tr>
<tr>
<td></td>
<td><em>N. Gopinath, S.S. Puvanesuri and S. Norhayati</em></td>
</tr>
<tr>
<td>OP42</td>
<td>Impact of migratory birds on the production of fishery composition in Pongdam wetland in Himachal Pradesh, India</td>
</tr>
<tr>
<td></td>
<td><em>Ram Krishan Negi and Tarana Negi</em></td>
</tr>
<tr>
<td>OP43</td>
<td>Development of drawing ink from squid (<em>Thysanoteuthis rhombus</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Cecilio S. Baga and Corazon P. Macacho</em></td>
</tr>
<tr>
<td>OP44</td>
<td>Overview of the leiognathid species of Malaysia</td>
</tr>
<tr>
<td></td>
<td><em>Ying-Giat Seah, Gires Usup, Aziz Arshad and Mazlan Abd Ghafar</em></td>
</tr>
<tr>
<td>OP45</td>
<td>Research on season, places and gears for collection of grass eels migrating into estuaries in Quang Binh and Phu Yen, Vietnam and technical nursery in artificial conditions</td>
</tr>
<tr>
<td></td>
<td><em>Nguyen Quang Linh, Vo Duc Nghia, Tran Quang Khanh Van, Ha Thi Hue, Nguyen Duy Quyhn Tram, Tran Dinh Minh, Nguyen Duc Thanh, Kieu Thi Huyen and Ho Viet Lam</em></td>
</tr>
<tr>
<td>OP46</td>
<td>Coral associated fishes in St. Martin’s Island of the Bay of Bengal, Bangladesh</td>
</tr>
<tr>
<td></td>
<td><em>M. Maruf Hossain, D. Sultana and R. Ormond</em></td>
</tr>
</tbody>
</table>

### Session 3C – Aquaculture

| OP47 | Indicators for sustainability analysis of world shrimp aquaculture production                                 |
|      | *Md Arif Chowdhury and Khairun Yahya*                                                                       |
| OP48 | Integrated aquaculture system: Shrimp co-cultured with seaweed                                              |
|      | *M.H. Gan, M.K. Choy, Z.F. Chai, S. Faizah and A. Siti Aishah @ C.A. Orosco*                                |
| OP49 | Gametogenesis of green mussel *Perna viridis* in the coastal waters of Malacca, Malaysia                    |
|      | *Said Al-Barwani, Aziz Arshad, S.M. Nurul Amin and Siti Shapor Siraj*                                       |

---

vii
Absence of postzygotic isolating mechanisms: Evidence from experimental hybridization between two reef margin species of tropical sea urchins (genus Echinometra)
Md. Aminur Rahman and Tsuyoshi Uehara

Biofloc (BF) – The futuristic technology (BFT) for replacing animal protein in aquafeeds and improving the ecological sustainability of aquaculture systems
B. Madhusoodana Kurup and K.K. Prajith

POSTER PAPERS

Section 1 - Coastal and Riverine Interactions

PP01 Sedimentology of the Redang Island coral reefs environment
Nor Antonina Abdullah, Noor Azhar Mohamed Shazili, Norhayati Mohd. Tahir and Siti Zauyah Darus

PP02 Coastal water quality in near shore development area at Sepang coastline
Leow Wai Mun and Rozainah Mohamad Zakaria

PP03 A case of fish kill in cages related to dredging activity
Toh-Thye Chuah

Section 2 - Marine Biodiversity and Resource Management

PP04 Evaluation on the genetic relationship of Malaysian grouper using molecular marker
Abdul Muhaimin Ahmad, Mariana Nor Shamsudin and Noraznita Sharifuddin

PP05 Biodiversity and adaptability in artificial environment of two sea cucumber species
Abdoulie Ceesay and Mariana Nor Shamsudin

PP06 Biodiversity and cultivation of sea star, Astropecten indicus at Kuala Perlis, Perlis
Ahmad Fakhirrazzi Mokhtar and Mariana Nor Shamsudin

PP07 Zooplankton community structure in riverine coastal ecosystem, Kota Marudu, Sabah during dry season
Marinni Khir and Fatimah Md. Yusoff

PP08 Zooplankton abundance and distribution along Perak River estuary during northeast monsoon season
Nur Zulikha Zakaniya and Fatimah Md. Yusoff

PP09 Spatial and temporal distribution of phytoplankton along salinity gradient during northeast monsoon season in Perak River estuary, Malaysia
NurSuhayati Abu Seman and Fatimah Md. Yusoff
**Section 3 - Environmental Stressors**

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP10</td>
<td>The root profile of <em>Avicennia alba</em> in Carey Island, Selangor</td>
<td>Noraziera Mohd Fadhi, O. Normaniza and Rozainah Mohd Zakaria</td>
</tr>
<tr>
<td>PP11</td>
<td>Effect of elevated water temperature at a coastal power plant on</td>
<td>A.H. Muhammad Adlan, W.O. Wan Maznah and Khairun Yahya</td>
</tr>
<tr>
<td></td>
<td>phytoplankton assemblages</td>
<td></td>
</tr>
<tr>
<td>PP12</td>
<td>Heavy metal concentrations in the medaka fish (<em>Oryzias javanicus</em>) as</td>
<td>Dariosh Khodadoust and Ahmad Ismail</td>
</tr>
<tr>
<td></td>
<td>a new research organism collected from Linggi estuary in the west</td>
<td></td>
</tr>
<tr>
<td></td>
<td>coast of Peninsular Malaysia</td>
<td></td>
</tr>
<tr>
<td>PP13</td>
<td>Assessment of heavy metals in brown alga <em>Padina</em> sp. along the east</td>
<td>Siti Mashitah Mohammad and Nor Azhar Mohamed Shazili</td>
</tr>
<tr>
<td></td>
<td>coast of Peninsular Malaysia</td>
<td></td>
</tr>
<tr>
<td>PP14</td>
<td>Distributions of trace metals in rocky shore rock oyster <em>Saccostrea</em></td>
<td>Mohd Fuad Miskon and Noor Azhar Mohamed Shazili</td>
</tr>
<tr>
<td></td>
<td><em>cucullata</em> along the east coast of Peninsular Malaysia</td>
<td></td>
</tr>
<tr>
<td>PP15</td>
<td>Impacts of the 2010 severe coral reef bleaching event on a coral reef</td>
<td>Makamas Sutthacheep, Chaipichit Saenghaisuk, Sittiporn Pongsakun and Thamasak Yeemin</td>
</tr>
<tr>
<td></td>
<td>restoration site in Trat Province, the Gulf of Thailand</td>
<td></td>
</tr>
<tr>
<td>PP16</td>
<td>Particulate organic carbon and nitrogen in the Setiu estuary on the</td>
<td>Toshihiro Ichikawa, Lokman Husain, Rosnan Yaacob and Masanori Sato</td>
</tr>
<tr>
<td></td>
<td>east coast of Malaysia</td>
<td></td>
</tr>
<tr>
<td>PP17</td>
<td>Dissolved organic matter release by an axenic culture of <em>Emiliania</em></td>
<td>Suhaimi Suratman, Keith Weston, Tim Jickells, Rosie Chance and Tom Bell</td>
</tr>
<tr>
<td></td>
<td><em>huxleyi</em></td>
<td></td>
</tr>
<tr>
<td>PP18</td>
<td>Anthropogenic activities deteriorate the water quality of St. Martin’s</td>
<td>M. Maruf Hossain and D. Sultana</td>
</tr>
<tr>
<td></td>
<td>Coral Island, Bangladesh</td>
<td></td>
</tr>
<tr>
<td>PP19</td>
<td>Comparison of mitotic index in Nay Band and Asaloye coral reefs</td>
<td>M. Boloki, S.M.B. Nabavi and M. Haghighat</td>
</tr>
<tr>
<td></td>
<td>(Northern part of Persian Gulf, Iran)</td>
<td></td>
</tr>
<tr>
<td>PP20</td>
<td>Reclamation effects on meiofauna community: Case study - Fahaheel</td>
<td>Eiman Khalefa, Saied Al-Qadi, Aisha Al-Kandari, Jamila Al-Saffar and Mishari Al-Kandari</td>
</tr>
<tr>
<td></td>
<td>area, Kuwait</td>
<td></td>
</tr>
<tr>
<td>PP21</td>
<td>Hemolytic toxin in <em>Karlodinium</em> spp. from Kuwaiti waters</td>
<td>Muna M. Husain</td>
</tr>
</tbody>
</table>

ix
| PP22 | Analysis and control of pollution sources of aquaculture in Taihu Lake Basin in China | 302 |
|      | Yimin Zhang and Yue-Xiang Gao                                      |

**Section 4 - Fisheries and Aquaculture**

| PP23 | Improvement of grouper cultivation by domestication system | 304 |
|      | Ainatul Hakimah Zakaria                                      |

| PP24 | Contrasting marine and freshwater sea bass in promoting recreational fisheries: Muscle cellularity and flesh quality | 305 |
|      | C. Girish Palaniyappan, Mariana Nor Shamsudin, Norfarrah Mohamed Alipiah and Md. Shater Zakaria |

| PP25 | Growth of *Holothuria scabra* in nursery, fed with formulated feed and soft sediment | 309 |
|      | Zaidnuddin Ilias, Che Utama Che Musa, Zainoddin Jamari and Ong Chin Cheng |

| PP26 | Growth and survival rate of hatchery breed *Tridacna derasa* in an ocean nursery in Boheydulang Island, Semporna, Sabah, Malaysia | 310 |
|      | Nasrulhakim Maidin and Abdul Jalil Mapait |

| PP27 | Size, frequency, distribution and length-weight relationship of long-spined sea urchin, *Diadema setosum* in Malaysia | 312 |
|      | Md. Aminur Rahman, S.M. Nurul Amin, Perumal Kuppan, Aziz Arshad, Mariana Nor Shamsudin and Fatimah Md. Yusoff |

| PP28 | Microbial flora densities of *Perna viridis* distributed in the cities of Mandaue and Lapulapu Markets, Cebu Province | 316 |
|      | Corazon P. Macachor, Cecilio S. Baga and Bonifacio S. Villanueva |

| PP29 | Population dynamics of *Acetes serrulatus* (Krøyer 1859) from the coastal waters of Pontian, Johor, Peninsular Malaysia | 319 |
|      | Siew-Yong Oh, Aziz Arshad, Japar Sidik Bujang and Nor Azwady Abd Aziz |
PLENARY LECTURES
UNESCO and the international community recognized the importance of the ocean when they established the IOC (Intergovernmental Oceanographic Commission) in 1960. The United Nations then delegated to IOC, a unique and specialized agency, the mandate to act as the focal point for marine scientific research and to be the link between the Member States on conventions and agreements related to marine and coastal issues (Holland, 2006). As the only UN organization specialized in ocean sciences, IOC has the responsibility to promote basic marine scientific investigations on a global scale (Roll, 1979), and with that has played a major role in the progress and advances in ocean sciences.

IOC develops its competences through the promotion and intergovernmental coordination of programmes, projects and related activities in ocean sciences, services, observations and data management, and with due consideration to integrated ocean and coastal zone management in line with UNESCO’s priority for Africa. Scientific research and technological knowledge are vital to our understanding of the integrated ocean system, which depends on advances in science, technology and research and IOC is a driver for such advances and expects to be perceived as a benefactor of such scientific approach.

IOC, as the competent body and focal point for ocean matters in the UN system, is responding in its mandated areas of activity to the Johannesburg Plan of Action and the UN Millennium Development Goals, and acting in conformity with international law, including relevant UN conventions.

The IOC Mission is established in Article 2.1 of the IOC Statutes:

The purpose of the Commission is to promote international cooperation and to coordinate programmes in research, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States.

Thus, IOC has a key role to play as a global knowledge broker involving the promotion of science innovation, nurturing programmes, transferring, disseminating and sharing information, data and knowledge, best practices, assessment and scientific services related to oceanography and marine ecosystem management. This process is done in an inclusive and participatory way, including views of the scientific community, academia, Member States, scientific enterprises from the North and the South, scientific workers’ perspectives, including cultural diversity principles.

The current Medium Term Strategy is made operative through 4 High-level objectives (HLO) as follows:

HLO 1: Prevent and reduce the impacts of natural marine hazards
HLO 2: Mitigate the impacts and adaptation to climate change/variability
HLO 3: Safeguard the health of ocean ecosystems
HLO 4: Improve management procedures and policies leading to the sustainability of coastal and ocean environment and resources

The four objectives rely on solid science foundations, which are needed to produce credible and independent advice for societal purposes and for a better management and sustainability of marine ecosystems.

The functions to fulfil IOC Mission and to guide IOC within the HLO and successfully deliver outcomes and results include:

- **science innovation and management**: promotion, nurturing and coordination of scientific projects and programmes,
- **science synergy**: stimulating co-operation between researchers and organisations to explore new directions,
- **scientific services**: providing guidelines and scientific criteria for ecosystem and data management, and early warning systems
- **outreach**: publishing results, educating general public and giving visibility to OSS activities,
- **capacity building**: transferring knowledge and assisting policy makers.

As result, IOC is at the forefront of many important international developments and events and is responsible for the execution of many essential activities related with the promotion and coordination of best marine science and oceanographic research, and their application to ecosystem-based management.

The IOC Ocean Science Section (OSS) plays a lead role in creating the conditions for doing good science and building a network of scientific logistic facilities at global and regional scales. Current activities of the OSS are clustered around the IOC Mission, the high level objectives adopted for the period 2008-2013 and the priority areas of research determined by the ad hoc Advisory Group for the IOC Ocean Sciences Section: climate change, ocean health and coastal research and assessment and management (IOC, 2007; 2009).

OSS is also the forefront of many important international developments and events (guidelines, publications, symposia, etc.). All these take place in a wide range of scientific areas. These include:

**Oceans and climate-related research and assessment**
The IOC OSS catalyzes, promotes and coordinates marine scientific research in climate change through (i) contribution to increasing the understanding of the ocean’s role in climate variability and climate change (WCRP), including observations and models on carbon cycle and ocean acidification (IOOCP), (ii) anticipating and understanding the impacts of climate change and variability on marine ecosystems and their living resources, and (iii) promoting actions to increase the resilience of marine ecosystems, mitigating coastal erosion and protecting communities and economies, and exploring the potential of Earth System Engineering measures to enhance carbon sequestration by the ocean without causing new undesirable impacts in the ecological processes.

**Ocean health, marine ecosystem research, monitoring and modelling**
Ecological processes and biodiversity are essential pieces to maintain ecosystem resilience at local and global scale. In fact resilience is an essential characteristic to assure ecosystem recovery after adverse stresses and perturbations, and to minimise the effects of natural or induced variability. A better knowledge of ecosystem functioning is necessary for a sustainable management marine ecosystems and to maintain a healthy ocean environment.
Improve management procedures and policies leading to the sustainability of coastal and ocean environment and resources

Use of our coastal areas and our ocean wealth will continue if done in a sustainable manner, and if an integrated approach is taken when making decisions about how to best use these resources. The IOC OSS activities under this HLO provide guidance about how coastal and ocean areas are to be used and protected. These activities complement other processes overseen by OSS like the Regular Process and the development of MPAs beyond national Jurisdiction, and the development of methodological approach for Integrated Coastal Area Management and Marine Spatial Panning.

With regards to emerging scientific issues relating to ecosystem-based management (Valdes et al., 2010), IOC has identified a few key areas where future research investments are needed. These are:

a) Ecosystem resilience
One key research question is to evaluate the role conservation of biodiversity has on the resilience of ecosystems in the face of adverse natural and anthropogenic impacts like climate change and fisheries. This assessment will also help explain the role of some species, including top predators, in the sustainability and balance of marine ecosystems. Recent efforts to develop ecosystem-based approaches for the management of coastal areas and coastal biodiversity are also connected to the sustainability of the use of ocean living resources.

b) Biodiversity and ecosystem functioning
The wide-ranging decline in marine biodiversity is probably a consequence of habitat modifications and destruction, of increased rates of invasion by deliberately or accidentally introduced non-native species, and of the overexploitation of living resources, as well as other human-caused impacts. Species can vary dramatically in their contributions to ecosystem functioning. in fact, the loss of certain keystone organisms, which have high ecosystem value, can trigger a disproportionate impact on the community when compared to the loss of other species.

c) Discovering microbial diversity and functionality
Microorganisms are primary drivers of global element cycles and are essential for the functioning of all ecosystems. They contribute substantially to the productivity of oceanic and continental ecosystems. However, the interconnection between microbial diversity and distribution and the metabolism, productivity, and functionality of ecosystems remains largely unknown. Since microbial organisms may make up > 90% of the ocean’s biomass, and comprise a yet unknown diversity of genetic information and metabolic capacity that substantially exceeds that of animals and plants, discovering the diversity of marine microbes is the first step toward a better understanding of ocean life and is a high priority task.

d) Ecological consequences of invasive species
Lionfish, ctenophores, and crabs, among other dozens of invasive species, could be cited as examples of major ecological problems that need more attention (UNESCO, 2002; Sutherland et al., 2009). Until now, we have recorded many severe episodes of this serious ecological problem, but only a few have been properly monitored. We still need to evaluate the processes through which invasive species alter, stress, and reduce the resilience of marine ecosystems.

Controlling measures to limit the transference of species are not fully implemented or respected at the moment. Monitoring programs should incorporate control of ballast water and other vectors for transferring species, as recommended by the ballast water Convention and subsequent publications (Tamelander et al., 2010).
e) Deoxygenation of the ocean
The intermediate-depth, lowoxygen layers of 300–700 m (oxygen minimum zone) in the central and eastern tropical Atlantic and equatorial Pacific Oceans have expanded and become more anoxic since 1960. These zones have expanded and contracted in the past, with some periods exhibiting extensive areas of hypoxic conditions characterized by low levels of biodiversity. Models predict a further decline in the concentration of dissolved oxygen in the ocean as the climate continues to warm. Deoxygenation of the ocean is likely to have substantial effects on ocean ecosystem structure and productivity, making it essential to investigate the causes and consequences of this phenomenon.

f) Scales of ecosystem variability
The structure and functioning of marine ecosystems result from the tight interaction between their different physical, chemical, and biological components, driven by fluid dynamic processes over a wide range of spatial and temporal scales. A considerable part of this variability may be correlated with physical forcing. For example, on small scales, water turbulence and viscosity may directly and indirectly affect the physiology of small marine organisms. At the scale of a few to tens of meters, advective and turbulent flows transport planktonic organisms and nutrients around the water column. Mesoscale structures such as eddies and fronts affect the dynamics of the ecosystem from low (primary producers) to high (fish) trophic levels. We need to identify and understand key processes across different scales of variability in order to model accurately and predict ecosystem dynamics (Valdés et al., 2007).

g) Understanding the deep ocean
The open ocean and deep sea beyond national jurisdiction of coastal nations covers almost half of earth’s surface and gives refuge to unique and varied biodiversity. Additionally, options for mitigating the impacts of climate change will certainly involve the use of the high seas and deep seafloor for carbon sequestration, sinks, and storage. These issues require international interdisciplinary discussion. Also related to these issues are the establishment of global regulation and governance of transboundary and high-seas marine protected areas and the consequent protection of biodiversity, connections to straddling fish stocks, and regulation of high-seas biodiversity (IDDRI, 2009).

h) Impacts of new pollutants on ecosystems
Special attention should be given to marine pollution and impacts on habitats and ecosystems. for instance, during the past 40 years, world production of plastic resins has increased some twenty-five-fold, while the proportion of material recovered (5%) has remained constant, so that plastics account for a growing segment of urban waste. once discarded, plastics are weathered and eroded into very small fragments known as microplastics. These particles, together with plastic pellets, are already found on most beaches around the world (Ogata et al., 2009), and we still do not know the impacts they will have on the marine environment and on the marine food web (Sutherland et al., 2009). The rapid identification of new pollutants and mechanisms to address them in an adequate time frame is another concern (e.g., the use of fire retardants in clothing and their subsequent reappearance in the arctic marine environment, and antibiotics’ role in generating antibiotic-resistant microbial strains, which is largely unknown).

References


Structural and functional indicators of ecosystem health: Sharing the inland seas - Great Lakes experience for global conservation

M. Munawar*, I.F. Munawar, M. Fitzpatrick and H. Niblock

Fisheries & Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Road, Burlington, Ontario Canada L7R 4A6

Corresponding author's email: mohi.munawar@dfo-mpo.gc.ca

Abstract

Throughout the globe, aquatic ecosystems have been adversely affected by multiple anthropogenic stressors including pollution, eutrophication, over-exploitation of fisheries, the establishment of exotic biota and climate change. As a result of rapid globalization and population growth, the impacts of such stressors have been compounded. The proliferating, cumulative challenges to aquatic ecosystems require integrated, adaptive, science-based approaches to management. A holistic approach to ecosystem management must balance both the maintenance of and benefits from healthy ecosystems. Aquatic resource management is changing from a species-based to a space-based approach. Identifying ecologically significant areas that require attention is a priority. The Great Lakes provide an ideal example of ecosystem based management due to their enormous size (245 000 km² containing almost 20% of the global supply of fresh water) which could be applied globally. Since the 1800s, nearly 200 exotic species have become established in the Great Lakes causing a wide range of impacts affecting all trophic levels. The effects of climate change are already evident, affecting productivity and habitats by decimating existing biodiversity and allowing new invasive species to flourish. A comprehensive understanding of the vulnerability and sensitivity of different habitats to stressors is a critical dimension of risk assessment which provides advice in the face of uncertainty. Given the complexity of ecosystem processes, a risk-based approach to aquatic ecosystem health and management may provide the most effective framework. Models are being developed in the Great Lakes (inland seas) to synthesize knowledge, helping to identify risks and evaluate hypotheses for an ecosystem approach to management. The lessons learned from the long term management of the majestic Great Lakes - inland seas has resulted in the development of ecosystem based management tools which are applicable globally to large marine and freshwater ecosystems.

Keywords: multiple stressors, eutrophication, contaminants, pollution, models, management

Introduction

Throughout the globe, aquatic ecosystems have been adversely affected by multiple anthropogenic stressors including pollution, eutrophication, over-exploitation of fisheries, the establishment of exotic biota and climate change. As a result of rapid globalization and population growth, the impacts of such stressors have been compounded. The proliferating, cumulative challenges to aquatic ecosystems require integrated, adaptive, science-based approaches to management. A holistic approach to ecosystem management must balance both the maintenance of and benefits from healthy ecosystems. Aquatic resource management is changing from a species-based to a space-based approach. Identifying ecologically significant areas that require attention is a priority. The Great Lakes provide an ideal example of ecosystem based management which could be applied globally. Since the 1800s, close to 200 exotic species have become established in the Great Lakes, causing a wide range of impacts affecting all trophic levels. The effects of climate change are already evident, affecting productivity and habitats by decimating existing biodiversity and allowing...
new invasive species to flourish. A comprehensive understanding of the vulnerability and sensitivity of different habitats to stressors is a critical dimension of risk assessment which provides advice in the face of uncertainty. Given the complexity of ecosystem processes, a risk-based approach to aquatic ecosystem health and management may provide the most effective framework. Models are being developed in the Great Lakes to synthesize knowledge, helping to identify risks and evaluate hypotheses for an ecosystem approach to management.

**Background and Methodology**

The multiple stressors affecting the Great Lakes have resulted in the degradation of coastal regions significantly and have been called “Areas of Concern (AOCs)”. The remediation, restoration and recovery of AOCs has been the focus of attention for some time, however not much is known about the recovery process due to a paucity of robust, sensitive and rapid indicators for the state of ecosystem health. Our evaluation of ecosystem health consists of two stages 1) initial screening of the problem, followed by 2) intensive research. We explored several routine parameters (chlorophyll levels, primary productivity, nutrients etc) as well as integrated, multi-trophic models which may be better indicators of ecosystem change. Based on our assessment we adopted a battery of tests strategy consisting of phytoplankton biomass, species composition, Vollenweider's phosphorus model and the Planktonic Index of Biotic Integrity (P-IBI). Such holistic and sensitive indicators are necessary for the assessment of stress and recovery of these degraded ecosystems. The experience gathered in developing scientific and ecosystem-based indicators in the Great Lakes will hopefully provide guidance to researchers and managers for application in other aquatic ecosystems of the world. Some examples of the battery of tests approach adopted in the Great Lakes for gauging the restoration and recovery of stressed of the AOCs will be highlighted in this presentation (Table 1).

<table>
<thead>
<tr>
<th>Structural</th>
<th>Functional</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoplankton Biomass</td>
<td>Primary Production</td>
<td>Vollenweider’s Eutrophication Model (Vollenweider et al., 1974)</td>
</tr>
<tr>
<td>Zooplankton Biomass</td>
<td>Bacterial Production</td>
<td>Phytoplankton Biomass Trophic Ladder (Munawar and Munawar, 1982)</td>
</tr>
<tr>
<td>Biodiversity and Species Composition</td>
<td>P/B (Carbon Turnover)</td>
<td>P-IBI (Kane et al., 2008)</td>
</tr>
<tr>
<td>Edible: Inedible Phyto</td>
<td></td>
<td>Food Web Dynamics and Linkages</td>
</tr>
<tr>
<td>Plankton Size Spectra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbial Loop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autotrophs: Heterotrophs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Budget</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Results and Discussion**

From several tests outlined in Table 1 we have adopted a few as a part of an integrated weight of evidence approach in the Great Lakes. The following example from the Bay of Quinte AoC is outlined below:

Phytoplankton biomass
Phytoplankton species composition
Vollenweider’s eutrophication model (Phosphorous loadings, Primary Production and Chlorophyll α)
Planktonic Index of Biotic Integrity (P-IBI)
**Phytoplankton Biomass**
Mean phytoplankton biomass, based on microscopic analysis, is a good indicator of trophic status of aquatic ecosystems (Munawar and Munawar, 1982). Table 2 shows the classification of trophic status within the Great Lakes. A further example is given from the Bay of Quinte (Figure 1). Based on this scale, the Bay of Quinte was found to be eutrophic (4 – 8 mg m\(^{-3}\)).

**Table 2.** The classification of lake trophic state based phytoplankton biomass.

<table>
<thead>
<tr>
<th>Trophic Status</th>
<th>Mean Phytoplankton Biomass mg m(^{-3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultraoligotrophic</td>
<td>≤ 0.5</td>
</tr>
<tr>
<td>Oligotrophic</td>
<td>&gt; 0.5 – 1.0</td>
</tr>
<tr>
<td>Mesotrophic</td>
<td>&gt; 1.0 – 2.0</td>
</tr>
<tr>
<td>Mesoeutrophic</td>
<td>&gt; 2.0 – 4.0</td>
</tr>
<tr>
<td>Eutrophic</td>
<td>&gt; 4.0 – 8.0</td>
</tr>
<tr>
<td>Highly Eutrophic</td>
<td>&gt; 8.0</td>
</tr>
</tbody>
</table>

(Source: Munawar and Munawar, 1982)

**Figure 1.** Mean phytoplankton biomass in the Bay of Quinte, Lake Ontario. The theoretical mesotrophic target is <3 g m\(^{-3}\).

**Phytoplankton species composition**
There is a wealth of data available in the global literature about the use of species composition as indicators of pollution (Hutchinson, 1967). The species composition is determined by experienced taxonomists following the Utermöhl inverted microscope technique using Lugol’s preserved samples (Munawar and Munawar, 1996). Phytoplankton species observed during a late summer algal bloom in the Bay of Quinte are listed below in Table 3, which confirms its eutrophic status.

**Table 3.** Phytoplankton species observed during an algal bloom in the Bay of Quinte, Lake Ontario on September 19, 2006.

<table>
<thead>
<tr>
<th>Cyanophyta</th>
<th>Diatomeae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyngbya limnetica xxxxx</td>
<td><em>Cyclotella sp.</em> xxx</td>
</tr>
<tr>
<td>L. diguetii</td>
<td><em>Melosira islandica</em> xx</td>
</tr>
<tr>
<td>Anabaena spiroides</td>
<td><em>Chrysophyceae</em></td>
</tr>
<tr>
<td>A. circinalis</td>
<td><em>Mallomonas spp.</em> xx</td>
</tr>
<tr>
<td>A. planctonica</td>
<td><em>Cryptophyceae</em></td>
</tr>
<tr>
<td>A. flos-aquae</td>
<td><em>Cryptomonas ovata</em> xxx</td>
</tr>
<tr>
<td>A. wisconsinense</td>
<td>C. caudata xxx</td>
</tr>
<tr>
<td>A. affinis</td>
<td>C. erosa xx</td>
</tr>
<tr>
<td>Aphanizomenon flos-aquae</td>
<td>C. tetrapyrenoidosa xx</td>
</tr>
<tr>
<td>Microcystis aeruginosa</td>
<td>C. Marssonii x</td>
</tr>
<tr>
<td>M. incerta</td>
<td>C. tenuis xx</td>
</tr>
<tr>
<td>Gomphosphaeria lacustris</td>
<td>Rhodomonas minuta xxx</td>
</tr>
<tr>
<td>Raphidiopsis sp. xx</td>
<td><em>Katablepharis ovalis</em> xx</td>
</tr>
</tbody>
</table>
**Oscillatoria limnetica**  x  **Dinophyceae**

**Chlorophyta**
- Coelastrum sphaericum  xx
- Gloecystis gigas  xx
- Crucigenia fenestrata  xx
- Scenedesmus quadricauda  xx
- Oocystis lacustris  xx
- Dictyosphearia pulchellum  xx
- Chlamydomonas globosa  xx
- Gemellicystis neglecta  xx
- Closterium parvulum  x
- Pediastrum duplex  x

**Vollenweider’s Eutrophication Model**

The eutrophication models developed by Vollenweider et al. (1974) relate (1) Annual Phosphorus Loadings to Annual Primary Production and (2) Annual Mean Chlorophyll α to Annual Primary Production. Together, these models predict trophic state from phosphorus loadings which can be used as a tool for controlling eutrophication. Examples from the Bay of Quinte and Hamilton Harbour AoCs are given in Figure 2. The model classifies both AoCs as being eutrophic based on the 3 parameters. In Table 4, the Bay of Quinte is given as an example of how to use the models to achieve a desired trophic state.

![Figure 2](image_url)

**Table 4.** Application of Vollenweider’s eutrophication model in Great Lakes Areas of Concern (Bay of Quinte).

<table>
<thead>
<tr>
<th>Chlorophyll a (mg m$^{-3}$)</th>
<th>Primary Production (g C m$^{-2}$ y$^{-1}$)</th>
<th>Phosphorous Loadings (kg d$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP Target</td>
<td>12.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Meso - Eutrophic Target</td>
<td>9.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**Application to:** Bay of Quinte and Hamilton Harbour

Original models: Vollenweider, Munawar, Stadelmann, 1974

![Original models](image_url)

Vollenweider’s TP- Eutrophication Model applied to the Bay of Quinte and Hamilton Harbor, Lake Ontario.
**Planktonic Index of Biotic Integrity**

The Planktonic Index of Biotic Integrity (Kane et al., 2009) incorporates several parameters including phytoplankton, zooplankton and total phosphorus to assess the health of aquatic ecosystems on a scale from oligotrophic to hyper-eutrophic. Our analysis from the Bay of Quinte dating back to 1975 indicates that the status of the ecosystem was typically hyper-eutrophic or eutrophic (Figure 3).

**Figure 3.** The planktonic Index of biotic integrity applied to the Belleville station on the Bay of Quinte, Lake Ontario.

**Conclusions**

The proposed battery of tests strategy has been applied in the Great Lakes over a long period of time in diverse environments. Our example from the Bay of Quinte demonstrates that it is a very effective tool for assessing ecosystem health and it is being applied to other AoCs. This integrated weight of evidence approach including both structural and functional indicators appears to be sensitive and effective for the management of aquatic ecosystems. Since many of these tests have been applied in other bodies of water, the proposed battery of tests is appropriate for global applications in both fresh and marine waters.

**References**


KEYNOTE ADDRESSES
Sustaining aquatic ecosystem services through integrated management of river basins and the coastal seas

Thia-Eng Chua

Chair, Partnership Council
Partnership in Environmental Management for the Seas of East Asia (PEMSEA)

Corresponding author’s email: chuate@pemsea.org

Abstract

The inland and marine aquatic ecosystems have long served mankind. They not only ensure our survival but also enriched our lives and living standards through the provision of air, water, natural resources, medicines, transport, energy and recreation, which in turn create employments and livelihoods for millions. Human activities on the other hand have increasingly damaged the functional integrity of these aquatic ecosystems. Our economic activities have generated enormous negative impacts on these fragile ecosystems.

Considerable efforts have been made during the last 3 decades in promoting coastal and river-basin management largely through the initiating efforts of international donors and UN agencies. In the East Asian Seas Region, Integrated River-Basin and Coastal Area Management (IRBM-ICM) has evolved into a new management paradigm that addresses the management problems associated with the ecological continuum from river-basins to the coastal seas.

Two major regional initiatives have taken place during this period. One is the establishment of the inter-governmental Mekong Committee in 1957 to promote regional cooperation in water resource management in the Mekong River Basin. The other major regional initiative is the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) consisting of 12 country and 19 non-country partners. PEMSEA’s primary focuses are the development and implementation of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA). PEMSEA plays a critical role in promoting and facilitating the development of national coastal and marine policy of the participating nations, strengthening the concept and practices of ICM through the development of Integrated Coastal Management System (ICM), organising a network of local governments implementing ICM; improving financing mechanism for environmental improvement through the public and private sector partnership mechanism; enhancing individual and institutional capacity through on the job training, areas of excellence, institutional and individual networks. PEMSEA builds partnerships with governments, private sector, scientific and academic communities, ngos and other stakeholders to collectively address the coastal management challenges.

Ecosystem services

The three most important basic needs to support human lives are air, water and food. The seas and oceans provide more than 90% of the oxygen we breathe while the water we drink came from the aquifers, lakes, reservoirs, rivers and rains. Much of the food we eat came from the aquatic environment. Thus the rivers, seas and oceans are intimately related to our own survival.

From the socio-economic standpoint, most people live in areas close to the water fronts: near river banks and coasts. More than 50% of the world population lives within 100 km from the coasts and the number is still increasing especially rural migration to the coastal urban centers. Much of the economic activities also occur near the river banks, estuaries and coasts. In fact the coastal areas and the adjacent coastal seas constitute the center of more than 90% of human economic activities.
The inland and marine aquatic systems which are represented by water catchments, river basins, estuaries, coastal seas and the oceans have long served mankind. The aquatic ecosystems therein have been generating the goods and services that not only ensure our survival but also enriched our lives and living standards through the provision of air, water, natural resources, medicines, transport, energy and recreation, which in turn create employments and livelihoods for millions. They provide the primary resources that support industrial development. These ecosystem services especially their regulatory services are difficult to quantify but all along they have faithfully protected our lives and properties against natural disasters, clean up our wastes, regulate our climate and enriched our brain tissues to cope with challenges of our changing world.

**Threats to sustainability of ecosystem services**

Human activities on the other hand have increasingly damaged the functional integrity of these aquatic ecosystems. Our economic activities have generated enormous amount of pollutants which contaminate inland as well as coastal waters. Large quantity of pollutants from untreated sewage, pesticides and fertilizers from agriculture farms, toxic chemicals from industries enter the water ways into the rivers, estuaries and the coastal seas. Nutrient pollution has become a key environmental concern that often results in eutrophication. The nutrient-rich waters have given rise to the frequent occurrence of red tides and harmful algal blooms which often causes mass fish mortality while the algal toxin can be fatal to human consumers. Red tides occurrence and harmful algal blooms have been reported in many coastal waters in East Asia. In recent years, another type of algal bloom known as green tide (caused by macrophytes) were reported especially spreading rapidly along the Chinese coasts of Shantung province.

Eutrophication remains a paramount concern of most coastal nations especially in the East Asian Seas region causing a column of low dissolved oxygen below the surface of the water. This column of hypoxic condition (also known as the “dead zone”) where most species of fish and other aquatic animals are unable to live as the level of dissolved oxygen fell below 2 mg/L. According to UNEP, the number of “dead zone” has increased over the last 10 years reaching 105 in 2007.

Industrial discharges into the sea have also caused health hazards. The Minamata disease was a world renowned case in Japan caused by consumption of fish contaminated with mercury; however such Minamata diseases are still prevailing in some areas. Worst of all, heavy metal pollution have entered the aquatic food chain and there are increasing reports of mercury contamination of tuna and other finfish. Contamination of fishery products either due to water contamination at the source or during the process of fish processing has become a world health concern.

Another devastating impact caused by human activities is the loss or impairment of habitats. Large scale wetland conversion for shrimp farming in the 70s and 80s had resulted in heavy loss of the valuable mangrove habitats which not only serve as the nursery grounds but also as a source of natural defence against typhoons, tidal storm, tsunami, etc. Reclamation of land from coastal wetland is another recent development in many countries resulting in the total loss of mangrove habitats. Only about 30% of mangroves were left in the region.

Large areas of sea-grass beds were also destroyed due to various human activities notably those related to sand mining in the adjacent coasts, discharge of sediments from rivers due to heavy deforestation upstream and land development on the sides of rivers. This has resulted in extensive loss of nursery and feeding grounds. Sea grass bed is one of the feeding habitats of dugongs and dauphins. Most sea grass beds in the region have been
destroyed although few patches of them are sparsely distributed in the region.

Coral reef is perhaps the most vulnerable habitat in the tropical seas not only because of the rich and diverse biodiversity of over 3000 species of corals and other organisms but also as a strong and effective natural defence mechanism. About 32% of the world coral reefs are located in Southeast Asia but more than 88% are being damaged by overfishing, pollution and climate change (such as ocean acidification). Some of these habitats can be restored but at a high financial costs and over an extended period of time. Moreover, it is doubtful whether one can fully restore the full function of these ecosystems.

Overexploitation is another human impacts on the ecosystems and hence the goods and services from them. Soon after the second world war, rapid rural reconstruction and fast economic development in countries around the world including the expansion of the fishing industry, the improvement of fishing and processing technology have resulted in the loss of most fish stocks as current fishing methods and intensification of fishing activities have fished down the food chain. This has hampered fish recruitments and severely threatened the capacity of the seas and oceans to maintain or restore the current fish populations. Many inland and coastal waters were overfished. The dilemma of the fishing industry is the continue depletion of fish supply from the wild, the aging of fishermen and the trends of limited entry of new fishing force as noticed in several countries around the world.

Overexploitation of natural living resources is followed by massive exploration and exploitation of non-living resources such as fossil fuels, minerals and sands in inland areas, coasts and sea beds. Big and small oil spills arising from oil drillings, leakages from oil wells, and discharges from ship accidents are some of the common man-made disasters that devastated the aquatic environment and impacts on the natural habitats.

There are many other human activities that threatened the sustainable supply of ecosystem services Further threats to the fragile ecosystems might led to net loss of goods and services and eventually threatens environmental and economic sustainability. Solution to stop or prevent massive human destruction to the aquatic ecosystems is rather obvious and that is to regulate human activities at all levels of the society.

**Governance**

In most countries of the East Asian Seas region, conventional governances of river basins and coastal seas which are sectoral in nature have not been effective to address the immense and increasing complex, cross-sectors management problems. The level of environmental protection efforts are inadequate, ineffective and could not catch up with the faster rate of economic development. Despite increase in public expenditures on environmental protection and management in many countries, both the inland and coastal ecosystems are in a critical stage of loosing their delivery capability of ecosystem services (both provisional and regulatory).

The need for paradigm shifts in the concept and governance of river-basin and coastal seas has become more urgent. There is a need for policy reform; development of new and comprehensive strategies and action plans to address a host of management challenges; harmonization of sector legislation and strengthening of their enforcement, etc. There is also a need for financial reform from public sector dependence to the privatization of environment and water related management services. Above all, democratization and transparency in environmental management is critical in order to be able to effectively involve all concerned stakeholders at all levels of the society. Of particular importance is the development of the much needed institutional and individual capacity to plan and manage the river-basins and
the coastal seas at central, provincial and local levels.

**Integrated management**

Recognizing the ecological and management complexity of river-basins and coastal seas is the fundamental first step towards the application of integrated management approach to resolve multiple use conflicts through interagency, multi-sector coordination, integration of sector policy and agency functions, streamlining concerned coastal and river-basin legislation, etc. It is also essential that the role of science in providing the needed information and interpretation of ecosystem functions are fully understood by policy and decision-makers at all levels. Science-based management is the key to effectiveness in the administration of policy, strategies and action programs.

**International efforts**

The challenge to sustain ecosystem services is only recognized in the last three decades. Damage to ecosystem functions only become noticeable arising from the intensification and multiplication of economic activities after the Second World War when countries began large scale economic and social reconstruction. Within a span of 60 years, some countries have indeed developed their economy, become rich and prosperous whilst others remain poor and thus creating a huge disparity between the developed and developing nations in terms of human, financial and technological capacity; posing serious problems for addressing environmental and natural resource use issues across national boundary which is critical for transboundary management.

Considerable efforts have been made during the last 3 decades in promoting coastal and river-basin management largely through the initiating efforts of international donors and UN agencies. In the East Asian Seas region, integrated management efforts began in the late 70s largely devoted to the integrated management of natural resources such as water resources and fisheries, or habitat management such as Marine Protected Areas. Over a span of 30 years, various forms of management approaches have been used including coastal resource management (CRM), Community-based Management (CBM), Integrated Water Resource Management (IWRM), Integrated Coastal Zone Management (ICZM) and Integrated Coastal Management (ICM) and a host of the management approaches.

There is increasing recognition of the need to integrate river-basin management with coastal area management in order to effectively address the pollution and water use issues arising from the close ecological, socioeconomic and political linkages of the ecological system which are further aggravates by climate change. Integrated river-basin and coastal area management (IRBM-ICM) has evolved into a new management paradigm that addresses the management problems associated with the ecological continuum from river-basins and the coastal seas.

Towards the early 90s, several nations in East Asia have already established and promoted ICM or ICZM projects at local levels and some have achieved remarkable results. Complementing these individual efforts are international initiatives promoted by the Global Environmental Facilities, United Nations agencies, multi-lateral financial institutions (World Bank and Asia Development Bank) and other international donors and aid programs. These have laid the foundation for integrated management in the region.

Two major regional initiatives have taken place during this period. One is the establishment of the Mekong Committee in 1957 to promote regional cooperation in water resource management in the Mekong River Basin. In 1995, the Mekong Committee was transformed
into the Mekong River Commission through an agreement between Cambodia, Laos DPR, Thailand and Vietnam. The Commission is to promote cooperation for sustainable development of the Mekong River Basin. In addition to water resource management, the Commission also undertakes other activities including fisheries management, safe navigation, watershed management, flood management, environmental monitoring and hydropower development amongst others.

The other major regional initiative is the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) which began as a GEF/UN regional projects since 1994 and finally transformed into an international organization after attaining its international legal personality in 2009. PEMSEA’s primary focuses are the development and implementation of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA). Within the context of the SDS-SEA, PEMSEA plays a critical role in promoting and facilitating the development of national coastal and marine policy of the participating nations, strengthening the concept and practices of ICM through the development of Integrated Coastal Management System (ICM), organizing a network of ICM demonstration and parallel sites; improving financing mechanism for environmental improvement through the public and private sector partnership mechanism; enhancing individual and institutional capacity through on the job training, areas of excellence, institutional and local government networks. PEMSEA builds partnerships with governments, private sector, scientific and academic communities, ngos and other stakeholders to collectively address the coastal management challenges. Currently, PEMSEA has 11 country partners and 19 non-country partners. Together they implement the 227 action programs of the SDS-SEA on a voluntary basis.

Now that the Mekong Commission and the PEMSEA have the political mandates to assist the region in planning the protection and sustainable use of the ecosystem services from river basins to the coastal seas, the real challenge lays in the implementation of the strategies and action programs particularly the individual and institutional capacity to implement them.
Marine biodiversity and resource management – What is the link?

Derek J. Staples* and Rudolf Hermes

Bay of Bengal Large Marine Ecosystem (BOBLME) Project
FAO Regional Office for Asia and Pacific
39 Pra Athit Rd, Bangkok, 1020, Thailand

Corresponding author's email: derekstap@gmail.com

Abstract

Marine biodiversity refers to the variation of life at all levels and is much more than just a count of species. Marine biodiversity decline is occurring across the globe and is characterized not only by extinctions (sometimes local), but also by invasions and hybridizations, reductions in the abundance of some species, degradation of habitats and changes in ecosystem processes (e.g. cycling of water, nutrients and energy).

The major threats in marine diversity can be categorized as (i) unsustainable resource use; (ii) land-based impacts; (iii) coastal and marine pollution; (iv) introduced pests; and (v) climate change. All these pose major risks in tropical seas where the high biodiversity in the past has allowed the tropical ecosystems to provide more services with less variability than more temperate systems in the past.

There is a strong link between better resource management and better biodiversity outcomes. With the introduction and acceptance of the concept of sustainable development, a way was opened up to ensure that human development did not impact irreversibly on the physical environment, thereby preserving biodiversity for future generation so that they could also enjoy the services that healthy ecosystems can provide. Along with the concept came a range of “approaches”, many of which developed in parallel by different sectors and disciplines. Because they were all developed to implement sustainable development there is considerable agreement on principles and management tools.

Given that the concept, approaches and tools to better manage resource are available, why have there been so many failures and biodiversity continues to decline? Several reasons for these failures are grouped under four pillars that are considered essential for successful resource management. These are: (i) an enabling policy legislative environment, (ii) empowerment of stakeholders, (iii) effective linkages and institutions and (iv) adequate resources – people and finances to implement the management system. The use of large marine ecosystem management is also put forward as an approach that can address some of the issues that the reasons highlight.

Keywords: biodiversity, natural resources, management, sustainable development, large marine ecosystem

Introduction

Biodiversity is more than just a count of species. Biodiversity refers to the variation of life at all levels ranging from genes to ecosystems. Marine biodiversity decline is characterized not only by extinctions (sometimes local), but also by invasions and hybridizations, reductions in the abundance of some species, degradation of habitats and changes in ecosystem processes (e.g. cycling of water, nutrients and energy).

Marine ecosystems across the globe are experiencing declining biodiversity, with largely unknown consequences. Recent studies have suggested that these declines are increasingly impairing the ocean’s capacity to provide food, maintain water quality and
recover from perturbations (Worm et al., 2006). Tropical oceans typically enjoy high diversity and it is this characteristic that has allowed these ecosystems to provide more services with less variability than more temperate systems in the past. For example, the tropical and subtropical waters of the Asia-Pacific region provide over 50% of the world’s marine fisheries production, that until relatively recently, enjoyed substantial growth every year. The level of exploitation these systems can withstand, compared with that of more temperate countries, has not been fully appreciated. In the future, loss of this biological diversity will have serious economic and policy implications and affect a large proportion of the world’s population.

**Threats to marine biodiversity**

The major threats in marine diversity can be categorized as:
- Unsustainable resource use;
- Land-based impacts;
- Coastal and marine pollution;
- Introduced invasive species; and
- Climate change

Unsustainable resource use includes fishing (including illegal, unreported and unregulated fishing), dredging and reclamation of coastlines, conversion of coastal areas for other uses such as aquaculture, mineral and oil/gas exploration and extraction, shipping and tourism. Fishing and aquaculture change marine ecological communities through changes in physical habitats (e.g. dynamiting and poisons on coral reefs), selective removal of predators and prey (“fishing down the food chain”), increasing removals of small low value/trash fish (often containing a large proportion of juvenile fish) for aquaculture food, and impacting on vulnerable or protected species. Other resource-use activities such as dredging, shipping and tourism can all disturb and alter marine communities. Clear-felling of mangroves and conversion of mangroves for aquaculture ponds are well-documented examples.

Human activities on land pose a major threat to the health, productivity and biodiversity of the marine environment. Globally, about 80% of marine pollution is generated from land-based activities and includes hydrocarbons, pesticides, other persistent organic pollutants, heavy metals, pathogens, nutrients, sediments and litter. Once in the marine environment, pollutants either settle or are distributed by marine currents and eddies to become absorbed by marine life, often far from the sources. Toxic materials can accumulate throughout the food chain as different species eat or be eaten. Clearing of floodplains and deforestation has exacerbated the impacts of increased sediment loads and nutrients.

The sea is the ultimate destination of the wastes of many activities in coastal areas. Coastal and marine pollution includes oil, sewerage, marine debris, residues in industrial waste waters, antibiotics, metals, radioactive wastes and thermal pollution. These can result in degradation or loss of seafloor habitats, displacement of marine species and changes in their distribution and density, and changes in ecosystem structure through selective impact on predators or prey.

Introduced invasives are a broad-scale threat to biodiversity, but little is known about them in tropical seas. Pests can be introduced by intentional translocations or unintentional introductions through such agents as hull fouling, ballast water or fishing gear. Once established, many species flourish in a new ecosystem having few predators or little competition. Incursions can result in displacement and distribution changes of native species, establishment and spread of new aquatic diseases, introduction of new parasites and pathogens and loss and degradation of habitats, to mention a few.

Climate change is recognized as one of the major threats to marine biodiversity, and marine,
coastal and estuarine systems are among the most vulnerable. The more obvious impacts of climate change such as temperature changes and effects on current patterns can lead to lowered ocean productivity, latitudinal shifts in distribution, and disrupted/changed food chains. Changes to monsoonal patterns have the potential to cause mismatches between such important ecological processes as phytoplankton blooms and zooplankton growth, this causing major changes in species composition and species diversity. Ocean acidification as another major impact of global warming that has far-reaching negative consequences not only for shell forming marine organisms, but also on the metabolism and behaviour of early life history stages of fish.

Management solutions and constraints

All these threats can be managed to reduce their impact and according to recent studies, many of the current trends are still reversible. Thus, there is a strong link between resource management and halting the decline in biodiversity. Because of the multidimensional nature of the threats, a holistic approach to managing these threats is needed. Such an approach is provided in the concept of sustainable development that strives to balance human well-being with ecological well-being. The concept was formalized in World Commission on Environment and Development (1987) that recognized that environment and development issues are inextricably linked and concluded:

Environment and development are not separate challenges. Development cannot subsist on a deteriorating environmental resource base; the environment cannot be protected when growth does not include the costs of environmental destruction. These problems cannot be treated separately by fragmented institutions and policies.

Following on from this conclusion, many approaches were developed to implement the concept of sustainable development. These included; Ecosystem approach to Fisheries (EAF), Ecosystem approach to Aquaculture (EAA), Ecosystem-based management (EBM), Sustainable livelihoods approach (SLA), Integrated coastal management (ICM), Integrated catchment management (ICM) and Large Marine Ecosystem (LME) management, to name a few. These were all developed in parallel by different sectors/disciplines, and because they were all based on the concept of sustainable development, all espouse the same principles. The two main differences among them being (i) the priorities placed on the balance between ecological well-being and human well-being, and (ii) the number and scope of sectors being considered. All of these approaches have management “tool boxes” to apply to the approach.

Through the “tool boxes” a range of management tools are available, including protecting biodiversity by seasonal and/or spatial closures (e.g. by introducing marine protected areas (MPAs) in selected areas), and attempts to reduce destructive or damaging practices. However, as stressed by all the approaches discussed above, implementation of any of the tools requires consultation and ownership by affected stakeholders, a principle often ignored in the past. The tools also have to be applied to meet agreed objectives, and in many cases, a suite of tools will be required.

If we have concepts, approaches and the tools, why are there so many failures and marine diversity is still declining? Past experience with both successful and failed resource management in tropical waters has highlighted the need for 4 critical factors or pillars for success, viz:

an enabling policy legislative environment;
empowerment of stakeholders;
3) effective linkages and institutions; and
adequate resources – people and finances to implement the management system.
The full paper and presentation will consider each of these and provide some insights on future directions.

**Large Marine Ecosystems**

One approach that addresses several of the points highlighted above is large marine ecosystem (LME) management. There are two important features in the LME approach that should result in better natural resource management and biodiversity outcomes. First and foremost, the physical extent of the LME and its boundaries are based on ecological, rather than political or economic, criteria. These are: (i) bathymetry, (ii) hydrography, (iii) productivity, and (iv) trophic relationships. The size and extent of the LME usually results in several countries being involved and transboundary issues being considered. Based on these four ecological criteria, 64 distinct LMEs have been delineated around the coastal margins of the Atlantic, Pacific and Indian Oceans.

The second important feature of the LME approach is the application of a holistic 5-module strategy for measuring the changing states of LMEs, and for taking remedial actions toward the recovery and sustainability of degraded goods and services. The 5 LME modules are (i) productivity and oceanography, (ii) fish and fisheries, (iii) pollution and ecosystem health, (iv) socioeconomics and (v) governance. In this way, all the important dimensions of sustainable development are covered and a system to monitor progress towards better management using a suite of indicators has been developed. The main constraint to a more widespread use of the LME approach is the parochial nature of many national governments who argue that their problems are national and should be addressed at the national or lower level. However, through the Global Environment Facility (GEF) support, recognition of the importance of regional sharing to addresses what are usually transboundary issues is increasing. A case study involving the Bay of Bengal LME will be briefly discussed.

**References**


Coral Triangle Initiative - Coral reefs, fisheries and food security (CTI-CFF)

Nor Aieni Haji Mokhtar

National Oceanography Directorate
Ministry of Science, Technology and Innovation (MOSTI)
Federal Government Administrative Centre, Putrajaya, MALAYSIA
Corresponding author's email: noraieni@mosti.gov.my

Abstract

“We, the leaders who are entrusted with the management of the world's most pristine coral reefs pledge to conserve the sustainability and productivity of biodiversity for generations to come”. This was the declaration made by the leaders of the six Coral Triangle Initiative (CTI) countries namely Indonesia, Malaysia, Philippines, Papua New Guinea, Timor Leste and Solomon Islands as they penned down their signatures to promise for the regional collaborative action in protecting the 6 million km² of Coral Triangle region; home to more than 75% of the world’s known species of corals, exceeding 600 species, 35% of all known coral reef fish species-3,000 species of fish, largest tuna fishery spawning and juveniles growth area, large presence of six of the world’s seven species of sea turtles, migrating sharks and manta rays, whales dolphins and coelacanths. This momentous occasion took place during CTI Summit, Manado, North Sulawesi, Indonesia on 15th May 2009 in conjunction with the World Ocean Conference 2009.

Malaysia’s Prime Minister, the Honourable Datuk Sri Mohd Najib Tun Haji Abdul Razak in his speech mentioned “Malaysia is very committed to ensuring that our marine ecosystem remains healthy so that this rich biodiversity can be enjoyed in perpetuity and sustainably utilized for wealth creation in line with our objective to be a fully developed nation by 2020”.

The bio-geographical conditions within CT may enable the region to maintain its exceptional productivity in the face of the threats of unsustainable fisheries practices, future impacts of climate change, making it the world’s most important refuge for marine life. CTI which has received a lot of global attention with international donors and partners pledging their contribution had created vast opportunities for regional cooperation and capacity building in marine resource management. This paper highlights the initiatives of the National Focal Point in MOSTI through the National Oceanography Directorate in planning the CTI outlined framework; goals, targets and programs, focusing on seascapes, sustainable fisheries management, marine protected areas, climate change adaptation and threatened species, aligning the national priorities with that of the regional aspiration.

Introduction

The Coral Triangle Initiative (CTI) involves high-level political commitments and proactive implementation by governments of the Coral Triangle area - supported and carried forward by private sector, international agencies and civil society (NGO) partners. This collaboration provides major undertakings toward safeguarding the region’s marine and coastal biological resources for the sustainable growth and prosperity of current and future generations. The Coral Triangle (CT) region (Refer to Figure 1) is located along the equator at the confluence of the Western Pacific and Indian Oceans. The bio-geographical area of the designated Coral Triangle is located in the East Asian Seas. Malaysia: Sulu-Sulawesi Seas (bordering South China Sea), Indonesia: Makassar Strait, Molucca Sea, Flores Sea, Banda Sea (bordering Java Sea, Timor Sea, Indian ocean), Philippines: Sulu-Sulawesi (bordering South China Sea), Papua New Guinea: Bismark Sea, Solomon Sea (bordering Arafura Sea, Torres Strait), Timor Leste: Flores Sea, Banda Sea (bordering Timor Sea) and Solomon Islands: Solomon Sea (bordering Pacific Ocean).
Figure 1. The Coral Triangle, known as the centre of the world's marine biodiversity covers portions of water and coastal region on all or part of six countries: Indonesia, Malaysia, Philippines, Papua New Guinea, Solomon Islands and Timor-Leste.

Using coral and reef fish diversity as the two major criteria, the boundaries of this region are defined by scientists as covering all or part of the exclusive economic zones of six countries: Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor Leste. Covering only 1.6% of the planet’s oceanic area, the CT is known as the global epicentre of marine life abundance and diversity and the marine and coastal resources provide profound benefits to the 363 million people who reside within the six countries that compose the Coral Triangle, along with benefits to many millions more outside the region. About one third of the inhabitants or approximately 120 million people within the CT are coastal communities that depend directly on local marine and coastal resources for their income, livelihood and food security.

The estimated annual value of the coral reefs, mangroves and associated natural habitats in the CT totals US$2.3 billion. Healthy reef systems and mangrove belts provide ecosystem services and protect coastal communities from storms and tsunamis, reducing casualties, injuries whereby upon such disasters and threats of climate change to marine and coastal resources, future capacities on adaptation and mitigative measures for marine hazards, environmental degradation, resource depletion; construction or reconstruction costs, alternative livelihoods thus both internal and external data and information as well as aid have to be considered and supported.

In supporting the concept of CT regional cooperation initiated since Bali Plan of Action in 2007 and continuously discussed in APEC Forums, the CT6 governments are made up of Leaders and Prime Ministers supported by a Council of Ministers related to the Environment
and Fisheries, of which for Malaysia is represented by the Hon Minister Datuk Seri Dr. Maximus Johnity Ongkili, Ministry of Science Technology and Innovation (MOSTI). The National Coordination Committee (NCC) having representatives from various Ministries and agencies of the appropriate stakeholders especially in Sabah, is chaired by the Director General of MOSTI, Dato’ Madinah Mohamad and the secretariat or the national focal point being the National Oceanography Directorate (NOD). The Senior Officials from the respective ministries of the CT6 work closely with each other through regular Senior Officials Meetings (SOM) held and hosted in rotation and coordinated through the Coordination Working Group by the interim CTI Regional Secretariat based in Indonesia. The Financial, Monitoring and Evaluation Group will also be established. The Ministerial Meetings (MM) already held twice, that is the first in Indonesia in May 2009 and Solomon Islands in November 2009. The CT6 have pledged support and contributions and through SOMs prepared the Regional Plan of Action (RPOA) whilst each country have also prepared their own National Plan of Action (NPoA) with the assistance of CTI support Partners or CTSP namely USAid, AUSaid, GEF through ADB, WWF, Conservation International, TNC, etc.

Discussion

The Sulu-Celebes (Sulawesi) Sea LME for example is considered a class II, moderate productivity ecosystem (150-300 gCm\(^2\)yr\(^{-1}\)). The tropical climate, warm waters, ocean currents and upwellings make this region as one of the world’s most biologically diverse marine environments. The steady warming of the sea is accentuated by the warm events due to El-Nino (1997-98) and recent episode (2009-10) with SST anomaly exceeded 2°C. Extreme and prolonged thermal stress led to widespread restructuring of coral reef communities and coral bleaching. The fisheries are multi-gear and multi-species reef fisheries that provide essential sustenance to artisanal fishers and their families in the region while high value fish products are exported to expanding international, national and local markets. Live food and aquarium reef fish exports to Hong Kong and the Chinese mainland have burgeoned since 1990s. Aquaculture of prawns, oysters, mussels, fish, seaweeds and other species is an important industry in the three boundary countries of Malaysia, Philippines and Indonesia. Total reported landings have increased tremendously (1 million tonnes in 2004) and have risen at a value of more than US$900 million in 2000. The Philippines accounts for the largest share of the ecological footprint in the LME.

There is a great uncertainty in the fisheries data and the region is faced with multiple threats of destructive, over-exploitation and unsustainable fishing, (fish-bombing, Illegal, Unregulated and Unreported from commercial fishers throughout South East Asia) not to mention the life reef fish trade particularly on groupers and Napoleon wrasse, capturing of wild fry and fingerlings for mariculture industry in Taiwan and Thailand that could have detrimental impact to the environmental and socio-economy. The Tri-National Committee was established prior to CTI for the Sulu-Sulawesi Marine Eco region (SSME) and has achieved significant improvement in enforcement through joint operations led by Malaysian Maritime Enforcement Agency in combating IUU. Malaysia, Philippines and Indonesia proposed activities under SSME as CTI RPOA priority and also as National Priority Action. Rapid industrialisation and economic growth have led most pollutants entering the marine environment from land-based sources particularly in major urban centres. Sources of pollution putting risks to ecosystem health arise from sewage, industries, agriculture, aquaculture, shipping and harbours. The Makassar Strait and Celebes Sea LME is a major oil-tanker route between Japan and the Greater Pacific Ocean, the Indian Ocean, West Asia and Europe, with associated risks of collisions and oil spills.

The Sulu-Celebes Sea LME includes diverse habitats such as estuaries, sandy foreshores, mangroves, seagrass meadows, coral reefs and deep sea. Deforestation, loss of mangrove areas contribute to the habitat and community modification that is largely caused by coastal
land conversion for aquaculture and other industrial development. With a total population of 33 million the region has diverse economic activities with major export earners in fisheries, mariculture, agriculture, mining and coastal tourism. The socio-economic impact of overfishing is severe, with reduced subsistence livelihood and food supply as well as reduced economic returns to small-scale fishers. Marine resource management and exploitation are, in theory, already controlled by policy and regulatory frameworks. Decentralised management and establishment of MPAs are measures taken, of which the success rate have yet to be ascertained. One of the greatest challenges is non-compliance with existing laws and regulations, which is exacerbated by weak institutional capability for enforcement, most importantly due to communication gaps and the information base is too limited.

Based on UNEP Large Marine Ecosystem Report (Study no.182) increasing number of countries and organizations are engaged in LME projects aimed at moving towards the World Summit on Sustainable Development (WSSD) marine targets. The LME approach provides a framework for utilizing ecologically defined placed-based areas around the globe to focus on the methods of marine science, policy, law, economics and governance on a common strategy for assessing, managing, recovering, and sustaining marine resources and their environments at risks. Two important features of the LME approach include: (1) The physical extent of the LME and boundaries which are linked ecologically rather than politically or with economic criteria namely; bathymetry, hydrography, productivity and trophic relationships; (2) The use of 5-module strategy for measuring the changing states of the ecosystem and for taking remedial actions towards recovery and sustainability of degraded resources and environments namely; productivity, fish and fisheries, pollution and ecosystem health, socio-economy and governance. UNEP, IOC-UNESCO and subsidiary bodies and CTI regional seas, islands and coastal programs call to develop and promote a common vision towards increasing observations for baseline information, ecosystem health checks and integrated management, based on ecosystem approaches, of priorities and concerns related to the coastal and marine environment in the form of action plans, introducing amongst others; proactive, creative and innovative partnerships or co-management for sustainable financing such as Payments for Ecosystem Services (PES), knowledge management and learning networks on models, tools and best practices via effective communication strategies.

CTI plan of action

Against the backdrop of the valuable marine ecosystem resource under stress from various threats; overfishing, illegal and destructive fishing practices, invasive and threatened species, coral bleaching, ocean acidification, sea-level rise and other marine hazards, do we have enough data to support the status and future viability of fish stocks and how do we improve income, livelihoods and food security in an increasingly number of coastal communities across the region?

The overarching regional commitments to action are translated in to the 5 goals of the RPOA and appear in CT6 NPOA, namely:
Priority seascapes designated and effectively managed
Ecosystem Approach to Management of fisheries (EAFM) and other marine resources fully applied
Marine Protected Areas (MPAs) established and effectively managed
Climate change adaptation achieved
Threatened species status improving

Malaysia Draft National Plan of Action (2010-2020) has been developed through consultations with relevant stakeholders and the guiding principles for implementation
actions address planning and management, funding, information and awareness, output, indicators, target date and proposed primary actors.

Conclusions

The CTI Forum is a valuable platform created as learning networks to ascertain the position of the countries in the CT6 on the action for the joint resource assessment and management of the ecological value of the Large Marine Ecosystems (LMEs) and regional seas specifically in the CT region; particularly for the coastal and island communities within the Sulu-Celebes Sea and Indonesian Sea, and their strategic relation to other countries in the sub-region of the South East Asian Seas, South China Sea, Indian Ocean and the Western Pacific.

The regional seas program and projects as part of LME initiative under GEF, the IOC-UNESCO capacity building programs particularly that of IOC/WESTPAC not to mention other earlier and exiting platforms and programs addressing climate change, biodiversity and sustainable economic development such as APEC, BIMP-EAGA, ASEAN ++, through ASEAN-COST (SCMSAT), JSPS and through bi-lateral and multi-lateral cooperation with countries in EU, US, China, Japan, Korea, Australia, India and so forth. The new CTI with increased support from GEF, US and Australia would certainly strengthen the academic, administrative and political environment based on decision support tools from science supported by effective communication of the real facts, data and information on the CT region.

The complexity of the modern ecosystem oriented approach of fisheries, integrated coastal zone management and marine spatial planning calls for a new generation of professionals addressing the sustainability issue in a much broader sense than before. The over-arching issues debated would address the importance of policy and governance and the responsibilities for ocean resource management in the multiple sectors of the environment, fisheries, energy, tourism, finance and international affairs. Not only do the preservation of the fish stocks and the other goods and services of the ecosystem in ensuring economic sustainability including the protection of marine biodiversity have to be taken care of, but also the socio-economic development of the region. Management goals have to be defined and defended under the pressure of conflicting ecological interests with societal and political constraints.

Thus, this International Conference on ECOSEAS2010 is very significant in supporting and contributing towards the global initiative on international waters assessment and also as part of the UN call for Regular Process in the Assessment of Assessment, focusing on the scientific discoveries, technical as well as policy and management considerations for environment and coastal ecosystems in tropical seas.

Acknowledgements

I would like to thank the Malaysian Government, Leaders and other CT countries for supporting CTI. Special thanks to the government of Indonesia for introducing and spearheading the initiative and our deepest appreciation directed to the cooperation given by the teams from the CT6, CTI Malaysia Committee and secretariat and also special thanks to the CTI support partners and donors.
References

CTI Malaysia, information booklet (2010).


Regional Plan of Action, Coral Triangle Initiative on Corals Reefs, Fisheries and Food security (CTI-CFF), www.cti-secretariat.net.

Coastal fisheries management in developing countries – Issues and policy concerns

Dilip Kumar*, P.S. Ananthan, Latha Shenoy and Nalini Ranjan

Central Institute of Fisheries Education (ICAR)
Panch Marg, off Yari Road, Andheri West
Mumbai – 400061, India

Corresponding author’s email: dk.dilipkumar@gmail.com

Abstract

Fisheries sector is passing through a difficult transition encompassing biological, environmental, economic and social changes, which are placing mounting pressure on the natural resource. Small-scale fisheries which is vital for food and nutritional security, economy and livelihoods of millions of coastal fishing communities, especially in developing countries of Asia and Africa is most affected. Recent phenomena of globalisation of markets and global warming have further impacted the life and livelihoods of small-scale or artisanal fishers who depend on this natural resource for their survival. On the other side, this is also realised that small-scale fisheries have yet to fully realise its potential to significantly contribute to sustainable human development and attaining the millennium development goals (MDGs). However, to accomplish this there is immediate need to bring sustainability to this sub-sector. Current fisheries management approaches based on centralised government intervention have failed to meet any reasonable set of objectives including preventing stock depletion, resolving user-group conflicts, increasing income and quality of life of fishing communities and preventing social disruption. Consequently, in their desperate bid to survive, the fishing communities are left with no other option than to exert further pressure on the fragile coastal fisheries resources by intensifying fishing and employing certain highly destructive gear and fishing practices. Though several acts and regulations are in place, their compliance level is decimal. The management is still largely government-driven although experiences in several countries, specifically Japan show that effective partnership between government and fishers strengthen management and produce results. Recognising the rights of fishing communities over the resources, making them legitimate and effective partner in developing supporting policies and legislation, providing access to institutional finance and assigning them responsibilities in management of fisheries are essential elements to ensure responsible fisheries activities and brining sustainability to the sub-sector. However, empowerment of fishing communities is vital and pre-requisite to enable them function as an effective partner along with the government in the co-management regime. It is a process and grows over time, and has several dimensions, which mutually reinforce each other. A holistic approach is required to empowerment involving a two pronged approach, interventions at the community level as well as outside at the institutional and policy level. Parallel to empowerment of fishing communities also requires a symmetric disempowerment of government agencies, which formerly had full control over the resources. This would involve strong re-orientation in their mindsets and attitude. Besides, they also need to develop their capacity and skill to facilitate social mobilisation, conflict resolution and ability to work with the fishing communities and their organisation in the co-management regime.

Overview

Fisheries sector is passing through a difficult transition encompassing biological, environmental, economic and social changes, which are placing mounting pressure on the resources. Wide ranging destruction of habitats, increasing coastal pollution, escalating number of fishers and fishing units resulting in overfishing and destruction fishing practices, are rampant. The most affected ones are the large number of traditional primary producers -
the small-scale or artisanal fishers themselves. Livelihoods of these stakeholders, who belong to one of the poorest and most disadvantaged section of rural society, are gravely threatened with the degrading coastal habitats and dwindling trend of fish stocks. Globalisation, has also allowed international economic forces to exert certain level of influence on the fishery and fishing activities leading to exclusion for fishing communities to considerable extent.

Small-scale fisheries is relatively more significant in the context of developing countries where it produces the bulk and also provides primary source of livelihoods to millions of coastal fishing communities. An estimated 90 percent of the 38 million people recorded by the FAO globally as fishers and fish-farmers are classified as small-scale. An additional more than 100 million people are estimated to be employed in other fisheries associated occupations, particularly in processing and trading, bringing the total estimated to be directly or indirectly employed in small-scale fisheries and aquaculture to about 135 million in 2002. In addition, there are millions of other rural dwellers involved in seasonal or occasional fishing activities, who are not recorded as “fishers” in official statistics. These people include many millions, especially in Asia and Africa, living along the remote coastal areas, where there are few other sources of alternative income and employment opportunities. As fishing being their traditional livelihoods, switching over to other form of livelihoods is an extremely difficult proposition.

Recently concluded global conference on small-scale fisheries (FAO, 2008) noticed that in many developing countries small-scale fisheries contribute directly to food and livelihood security, balanced nutrition, poverty reduction and wealth creation, foreign exchange earnings and rural development\(^1\). The conference also reinforced that small-scale fisheries have yet to fully realize their potential to significantly contribute to sustainable development and the attaining the millennium development goals (MDGs).

Considering fishing primarily as industry and opportunity for investment with ensured high production and returns, and not as vital food production system based on renewable natural resources, or as employment provider for large number of disadvantaged and poor coastal communities, is certainly going to bring unsustainability to the sector and cause serious social and environmental damage. All these call for human and ecology sensitive policy and active participation of primary stakeholders in decision-making and policy development process.

The paper emphasizes on small-scale fisheries sub-sector in the context of developing countries where it is vital for ensuring food, nutritional security and livelihoods of millions of poor and disadvantaged fishing communities.

**Confronting issues**

Coastal fisheries is passing through a stage of crises. A leveling off / depleting trend in fish production is being experienced in coastal fisheries sub-sector since two decades. The catch is highly dominated by the juveniles and young ones, and many important fisheries are on the verge of collapse. The predominant hilsa fishery of Bangladesh that was the largest fishery of the country contributing about half of fish production has declined to 13% level. There are several such examples. Consequent to all these, the livelihoods of poor coastal fishing communities have come under serious threat. Their proximity to coast and sea-borne nature of their living also expose them to other vulnerabilities like recurrent natural disasters, sea-borne accidents, pirate attacks, conflicts with industrial fishing operators and other professional hazards. Further, the remoteness and inaccessibility of their hamlets along the coast also deprive them of various support and social services including access to information provided by the government. Being highly un-organized and the poorest section
of rural society, they are also subjected to various kinds of exploitations by boat owners, fish traders and local money lenders and market intermediaries.

Consequent to all these and in their desperate bid to survive, they are left with no other option than to exert further pressure on the fragile coastal fisheries resources by employing certain highly destructive gear and fishing practices. Population pressure continues to place a severe burden. Some of the traditional gear that were not considered destructive in the past due to limited numbers are causing disaster as the number of fishermen employing such gear has also increased many folds.

Habitat destruction and pollution is mounting further pressure on the coastal fisheries resources. The Sundarbans, the biggest coastal tropical forest in the world and serving as the biggest nursery ground for a large number of fish, shellfish and other species, supporting Bay of Bengal fisheries and benefiting millions of small-scale fishers of the rim countries is also declining fast. Besides, several mangrove-rich coastal segments along the shoreline have also been badly impacted in many maritime states of Asia and other tropical regions. About 0.45 million people go on catching shrimp fry on dial basis all along the coast of Bangladesh and part of India and sell to shrimp seed traders who in turn supply these seed to shrimp farmers. While catching shrimp fry, they also destroy enormous amount of larvae of other non-target species of finfish and shellfish thereby causing a real threat to marine fisheries and aquatic biodiversity. If such a situation is allowed to continue, it may result in an irreversible state of coastal fisheries.

The coastal fishing communities are highly un-organised and wherever any institutions exist, they are also not able to cope with these rapidly developing pressures either. Besides there are also attempt by vested interests and political entities to enter such organisations and deviate them from concentrating on their main objectives of bringing sustainability to fisheries based livelihoods and well being of renewable natural resources.

Current fisheries management approaches based on centralised government intervention have proven inadequate to deal with these issues and meeting any reasonable set of objectives including preventing stock depletion, resolving user-group conflicts, increasing profitability and preventing social disruption. Though several acts and regulations are in place, their compliance level is decimal. The management is still largely government-driven although experiences worldwide show that various forms of partnership between government and fishers strengthen management and produce results.

The growing concerns and possible impact of global warming and consequent sea level rise and climate change are also going to affect the sector and the sector-dependant local communities to unprecedented levels. Mean sea level is predicted to rise from 10 to 90 cm during this century, with most predictions in the range of 30-50 cm. Storm surges that can damage the coasts and the coastal infrastructure may become more frequent and intense under the influence of climate change. This is likely to damage or destroy many coastal ecosystems such as mangroves and salt marshes, which are essential to maintaining wild fish stocks. The current species composition of living marine resources in the tropical seas is likely to change as more and more of these species migrating to higher latitudes due to the extension of the range of required temperatures. People living along the coasts and on low islands will be most directly affected by sea level rise and by economic impacts on fisheries, property and infrastructure. Many small islands are facing the first impacts of climate change ahead of other regions. There are limited opportunities for agriculture development and in most of the Pacific islands fisheries development is the only option. Bangladesh, a densely populated and painfully poor nation, though contributes only a minute fraction of the global Green House Gas (GHG) emissions, due to its geography and demographic characteristics will be the hardest hit. Impact is already felt in some of the coastal villages according to a report published in LA Times and Washington Post. Heavier than usual floods have wiped...
out homes and destroyed paddy fields in certain areas resulting in increased salinity of the water which is contaminating wells, killing trees and slowly poisoning the mighty mangrove forest that forms a natural barrier against the Bay of Bengal. The rise in sea level averages 1.8 mm a year globally but is higher in Sundarbans because of the neo-tectonic movement of the Bengal basin. In the adjoining Sagar island of India the rise is 3.4 mm. From Sagar towards Khulna in Bangladesh the rate of rise reaches upto 10mm a year. As a result, Sunderban is loosing about 100 sq. km. every year. Salination of ground water has led to more complications. This is also predicted that developing countries in the tropics are more likely to be impacted and the poor coastal communities are going to be affected most due to their poor adaptive capacity.

Small-scale producers, processors and marketers face various constraints in realizing benefits from globalization including expanding trade in fish and fishery products. These include inadequate access to markets, financial services, know-how and capacity to make better use of and add value to their catches and meet increasingly demanding sanitary requirements. This situation is aggravated by fishery resource declines, coastal habitats loss, and by user conflicts both within and outside the fishery sector.

The small-scale fisheries sub-sector is experiencing ever-increasing number of fishers due to population increase and new entrants while the situation calls for significant withdrawal. The problem is highly complex which requires participation, endorsement and action by the communities for solution. However, there is currently hardly any legitimate platform for them to discuss and take decision.

**Policy gaps and desired interventions**

Responsible fishing requires optimizing the benefits that can be gained from the resource for society as a whole. This will imply *ending of open access and start of the assignment of rights and rights to groups*. Recognizing the existing rights of fishing communities is a fundamental element in building a successful fisheries management system. Doing so provides a basis of legitimacy, which can significantly enhance system compliance. We need to develop and place policy to support a system of community rights-based management. This pro-poor policy will protect the rights of access by poor small-scale fishers. By restricting the access to the resources or to a specific segment of the resource to a well-identified group, community property rights will help to reduce the risks of overfishing, thus preventing the fishers from falling into the downward spiral of poverty and resource overexploitation, which is largely experienced with open access regimes. Such property rights are granted to groups rather than to individuals. This may ensure a certain level of equity within the community by allowing all members (including the poorest) to access the fishing grounds and therefore to rely on fishing to sustain their livelihoods.

FAO-CCRF clearly mentions the need to include all stakeholders in the policymaking process in Articles 6.13 and 6.16 thus: *States should, to the extent permitted by national laws and regulations, ensure that decision-making processes are transparent and achieve timely solutions to urgent matters. States, in accordance with appropriate procedures, should facilitate consultation and the effective participation of industry, fishworkers, environmental and other interested organizations in decision-making with respect to the laws and policies related to fisheries management, development, international lending and aid. [Article 6.13]. [States]...should ensure that fishers and fish farmers are involved in the policy formulation and implementation process, also with a view to facilitating the implementation of the Code. [Article 6.16]*

*Improving policy processes:* The way the policy content is discussed and defined (i.e. the policy process) may affect how issues of poverty and food insecurity are addressed. In
particular, including poor and food-insecure fishers and fish workers in the policy process is likely to improve the potential for pro-poor content of policy.

**Cross-sectoral policy:** In addition to policy specifically for the fisheries sector, there are issues that deserve policy interventions. These are cross-sectoral policies at the national level, policies in other sectors, and local policies – all of which can impact on small-scale fisheries.

Looking into the issues confronting with small-scale fisheries sub-sector it is imperative to bring changes in the management policy in the way small-scale fisheries are perceived and managed. It calls for and stress upon the importance of a people-focussed strategy involving grassroots as a partner in development to build on the strengths of small-scale fishers and their commitment to the sustenance of fishery resources. Concepts such as co-management and user rights need to be encouraged. Management agencies need to understand the capacity of millions of small-scale or artisanal fishers to build better partnerships and trust. To enforce and strengthen co-management the four main pillars i. supporting legislation and policies, ii. empowerment of communities, iii. creating linkages between players and, iv. finance and capacity development are essential. Co-management entails wider and larger government partnerships with fishing communities and other stakeholders and is driven by, amongst other things, an awareness of resource depletion, conflicts both within the sector and between fisheries and other sectors, and the perceived benefits of co-management as an approach. Greater government involvement in empowering the communities and providing technical, institutional, policy and legislative support is important for the success and effectiveness of this partnership based management.

**Way forward**

The FAO Global Conference on Small-scale fisheries identified several critical ways forward in securing sustainable small-scale fisheries that integrate social, cultural and economic development, address resource access and use rights issues guided by human rights principles, and recognize the rights of indigenous peoples and affirmed that human rights are critical to achieving sustainable development. Importance of small-scale fisheries in the Southeast and South Asian region is increasingly realised, common understanding is developing between the various regional organizations, government agencies and civil society organizations and priority is being given by some of the Governments to support the sub-sector through introduction of co-management regime and providing matching policy support. However, many of the current co-management initiatives are donor driven and limited to pilot studies only. As a result the progress towards providing nature of policy and legislative frameworks is still inadequate. Commitment by governments to co-management though emerging - in many cases support is more rhetoric than reality, with insufficient real transfer of powers and financial resources to local levels. Key interventions that are likely to drive sustainable management of small-scale fisheries sub-sector need to consider the following:

At the beginning stage, when co-management approach is yet to be made fully operational, the government efforts is limited to involving fishing communities in the implementation process. It is desired that the Governments need to perceive co-management as a means to introduce more democratic principles into fisheries management and not merely as an instrument to reach its management objectives by involving fishing communities in the implementation.

Co-management requires a clear commitment on the part of government to the sharing of power and authority with local government and local fishers and community organisations. In order to have co-management systems originate and prosper, governments and fishers
ought to hold consultations to discuss problems and solutions and develop organisations and institutional arrangements for management.

To enable the fishers express their concerns and ideas they may be given ample opportunities and support to develop their own organisations and form networks of such organisations at district, state and national levels and coalitions for co-operation and co-ordination. The role of government in establishing conditions for co-management is the creation of legitimacy and accountability for the local organisation and institutional arrangements. The often-quoted cases of long standing marine fishery co-management arrangements that work, in Norway and in Japan have a legal basis. This suggests that beyond the simple call for more community involvement and fisher participation, governments must establish commensurate legal rights and authorities and devolve some of their powers.

Open access to fishing grounds will fail to motivate the fishers to conserve stocks (the tragedy of the commons). Ownership rights over the resource would be an incentive for them to begin applying long-term management principles.

The process of establishing co-management requires changes in the government organisation assigned to collaborate with fishing communities. It involves a symmetric disempowerment of government agencies, which formerly had full control. This requires strong re-orientation in the mindsets and attitude of both government officials and the communities as well. In addition, they also need to develop their capacity to facilitate social mobilisation, conflict resolution skills and ability to work with fishing communities and their organisation in the co-management regime.

Incorporation of local level and indigenous knowledge into fisheries management is essential, as this is likely to minimise adverse social and environmental impacts of management and lead to more socially and environmentally sustainable systems.

Financial aspects of fisheries are gaining increasing recognition. The lack of access to affordable credit and their inability to develop habit of savings are major constraints for many poor small fishers and fish workers. Making financial institutions work for the poor at the micro-level, is an important precursor to ensuring that more general market reforms do not disadvantage the poor. In rural areas in developing countries, informal savings schemes and credit markets are widely developed and may have positive attributes in terms of providing access to capital or assets because they are “closer” to the users, more flexible, and more adapted to their needs.

Facilitating access to insurance and social security schemes and enhancing their ability to save warrant special mention. These are of vital importance in minimizing the vulnerability of the poor to sudden changes in income.

Empowerment of fishing communities is vital to enable them function as an effective partner along with the government in the co-management regime. It requires that they are organised and their organizations are further strengthened and their capacities enhanced. With their enhanced capacity the communities will be able to withstand changes, undertake economic and social development programmes, ensure greater community cohesion, manage crises, perceive their mutual interests in sustaining fisheries resources, regulate fishing, elevate pride in their own culture, access information and services and gain optimism about the future. Empowerment is hard to visualize and even harder to achieve. It is a process and not a blue print. It grows over time and it has several dimensions, which mutually reinforce each other. Increasing the number of dimensions increases the chances of success of empowerment. A holistic approach is required to empowerment involving a two pronged approach, requiring intervention at the community level as well as outside the community to
promote an enabling environment\(^6\). Community level interventions include facilitating a sense of unity by improved and strengthened organization; assisting in their capacity development and promoting various socioeconomic, cultural and welfare activities that are directed, planned, and implemented by their organizations; networking of community organizations at local, regional and national levels; and setting up an enabling environment by bringing conducive policies, legal and regulatory framework, amenable political and administrative environment including simple procedures and practices. They need to become capable of identifying new resources and opportunities and develop new approaches to economic gains and community well being. Empowerment approach must consider equal emphasis on both men and women members of the community. Women play equally important role. Most of the women work behind the scene managing small business, taking care of entire family including old and disabled and provide vital organizational, economic and emotional support. Ironically while resources management is concerned they are kept out of sight. The holistic approach recognizes that responsible fisheries and fishery resource management cannot be achieved unless all aspects of human-wellbeing are also improved.

The scale or geographical area covered by the empowerment initiative is also important. The bigger the area, the bigger the community organization and its networks need to be, and the larger the number of the community members need to be involved. However, only a bigger scale intervention can create a convincing impact. Pilot scale intervention covering only a few villages may not be able to impress upon the policy and planning level personnel of the government to consider policy reforms to support co-management approaches.

References


Posted online: Monday, February 26, 2007.


Bioaccumulation of organotins by fish and rock shell

Jiro Koyama1*, A. Takenouchi1, S. Nigaya1, M. Murakami1, E. Kokushi2 and S. Uno1

1Faculty of Fisheries, Kagoshima University, Shimoarata, Kagoshima, Japan
2The United Graduate School of Agricultural Sciences, Kagoshima University
4-50-20 Shimoarata, Kagoshima 890-0056, Japan
Corresponding author’s email: koyama@fish.kagoshima-u.ac.jp

Abstract

Although organotins have been banned since 2003 as anti-fouling paints for boats, many coastal areas are still contaminated with these chemicals because they are highly persistent in the environment. Organotins are also known to induce imposex in female gastropods. Hence, imposex induction and organotin residues in the rock shell Thais clavigera and in their prey were investigated at Iso (reference site) and Akobaru (polluted site) in Kagoshima Bay, Japan from 2003 to 2006. Almost all female rock shells at Akobaru had induced imposex but none at Iso. Higher concentrations of tributyltin (TBT) and triphenyltin (TPT) in sediments (123 µg/g dry weight for TBT and 6.4 µg/g for TPT), rock shell (97-182 µg/g for TBT and ND for TPT) and their prey (2.7-289 µg/g for TBT and 1.8-4.1 µg/g for TPT) were detected at Akobaru compared with Iso. However, organotins in the water were less than 2.6 ng/L and less than 0.1 ng/L for TBT and TPT at Akobaru, respectively. Five out of 7 female rock shells transplanted from Iso to Akobaru had induced imposex after 13 weeks. These results suggest that prey organism are one of the main sources of organotins for rock shells.

Due to their immunotoxicity, immune function in relation to their body burdens were also examined for marine fishes, red sea bream, Pagrus major, and sea bass, Lateolabrax japonicas. Increased TBT inhibited respiratory burst of neutrophil but not phagocytosis in both fishes. TBT concentrations of some wild sea bass and cultured red sea bream were higher than the observed TBT concentrations of the exposure group with lowest concentration. The study suggests that non-specific immune function of wild sea bass and cultured red sea bream can be inhibited by TBT contamination.

Keywords: organotin, rock shell, imposex, transplantation, immunotoxicity, red sea bream, sea bass

Introduction

Organotin compounds, which are active biocides in antifouling boat paints, have been known as environmental contaminants (Strand et al., 2005; Ueno et al., 2004; Wade et al., 2004; Yamada et al., 1997) that induced shell thickening in oysters (Alzieu et al., 2000) and imposex in some snails (Smith, 1981; Horiguchi et al., 1994). Tributyltin (TBT) oxide is the most toxic organotin compound, which was widely used as antifouling for boats. The International Maritime Organization proposed to prohibit the application of organotin compounds for antifouling by 1 January 2003 and completely prohibit their presence in ships by 1 January 2008. While TBT and triphenyltin (TPT) concentration in coastal waters have decreased recently, imposex induction in common whelk (Viglino et al., 2006) were still observed and the reported TBT contamination of bivalves (Inoue et al., 2006) suggest that organotin compounds continue to contaminate the marine environment. However, the main uptake route was not yet clarified.

Organotins show toxicities on fish immune function. (Regala et al., 2001; Nakayama et al., 2007) However, most of them examined the toxicities of chemicals on immune function in
vitro but did not relate immunotoxicity to body burdens of chemicals. In the present study, the main route of organotin uptake for rock shell was investigated by transplantation experiment. Moreover, their immunotoxicity on fish was also examined in relation to their body burden.

**Materials and Methods**

Sea water, sediment, rock shell, *Thais clavigera*, and its prey organisms were collected at 2 sites, Iso and Akobaru, in Kagoshima Bay, Japan. Iso has not been polluted but Akobaru has been heavily polluted by organotins. The rock shell from Iso was divided into two groups and was transplanted to Akobaru. One of the groups was placed in the net not to take their prey organisms and the other was placed in the cage with their prey organisms for 13 weeks.

The test fishes, red sea bream (*Pagrus major*) and sea bass (*Lateolabrax japonicas*) were fed food spiked by TBT to clarify its immunotoxicity for 2 weeks. After isolating neutrophil from blood, their phagocytosis and NBT reduction as a measure of respiratory burst were determined.

Organotin compounds were analyzed by GC-MS [HP GC 6890 coupled to a 5973 mass spectrometry detector (Agilent Technologies, USA)] following the method developed by the Japanese Environment Protection Agency (1998).

All data were statistically examined by one-way ANOVA using SPSS. Relationships between respiratory burst and TBT body burden in fish were also examined by curve fitting through SPSS. Statistical difference level was set at $p<0.05$.

**Results and Discussion**

The frequencies of imposex of rock shell in Iso and Akobaru were 0 % and around 80% as shown in Figure 1. Organotin compounds in sea waters, sediments, rock shells and their prey organisms were shown in Figure 2. Although organotin concentrations in the waters were less than 2.6 ng/L in both sites, the frequencies of imposex in Akobaru have been around 80%. Organotin concentrations in rock shell and their prey organisms at Akobaru were 97~182 $\mu$g/g for TBT and ND for TPT and 2.7~289 $\mu$g/g for TBT and 1.8~4.1 $\mu$g/g for TPT, respectively. These results suggest that the main source of organotins were their prey organisms.

![Figure 1. Frequency of imposex in rock shell at Akobaru.](image1)

![Figure 2. RPL index of female rock shell at Akobaru.](image2)

To clarify the main source of organotins, rock shells collected at Iso, whose imposex were not induced, were transplanted to Akobaru. As shown in Figure 3, rock shell fed their prey organisms induced imposex after 13 weeks. The organotin concentrations of rock shell with...
food were much higher than those without any food. These results also suggest that main uptake route was their prey organisms.

![Graph](image)

**Figure 3.** Imposex induction in transplanted rock shell.

To clarify the risks of organotins on fish immunotoxicites, red sea bream and sea bass were exposed to dietary organotins. TBT concentrations in exposure groups were significantly higher than that of control. While phagocytosis of neutrophil was not inhibited by TBT, respiratory burst (NBT reduction) was significantly inhibited in exposure groups as shown in Figure 4.

![Graph](image)

**Figure 4.** The relationship between respiratory burst and TBT concentration in sea bass (A) and red sea bream (B).

TBT concentration in wild and cultured fishes were sometimes higher than that of this exposure groups. These results suggest that organotins inhibit fish immune function and the immune function of some wild and cultured fish have been already adversely affected.

We conclude that organotins have been accumulated though food chain from sediment to rock shell and fishes and inhibit fish immune function.

**References**


Distributed network of environmental monitoring in the South China Sea and its implication for the regional collaborations

Dong-Xiao Wang

Laboratory of Tropical Marine Environmental Dynamics, South China Sea Institute of Oceanology
Chinese Academy of Sciences, Guangzhou 510301, China

Corresponding author’s email: dxwang@scsio.ac.cn

Abstract

The historical and present observation systems in the South China Sea (SCS) operated by the South China Sea Institute (SCSIO) are reviewed. Studies of the characteristics of the seasonal circulation and eddies in the SCS, the plume over the Northern SCS, the western boundary currents off the Vietnam coast and their related biological features through utilizing various types of observation data from cruise, moorings, Argos drifter, and satellite images reveal their distinct seasonal and interannual variability, and complex structures. In addition, the results also show that the combination of the different data sets does help us to get a three-dimensional and time-dependent view of the physical and biological processes in the ocean. However, the available data still could not satisfy our demand of higher spatial and temporal resolution and further understanding of the fundamental hydrological and ecosystem dynamics. Thus collaborations among regional countries to establish an extensive and long-term environment monitoring network in the SCS should be the primary goal and deserve our efforts.

Keywords: cruise, long-term observation

Introduction

South China Sea (SCS), located between 99E~122E, 0~25N, consists of a deep basin (~4000m deep) and large areas of continental shelves along the northern and southwestern coasts, it also includes more than 200 small islands, rocks, and reefs, with the majority located in the Paracel and Spratly Island chains. The SCS has one third of the entire world’s marine biodiversity, and is rich in natural resources with total estimates of 40000 million ton crude oil and 7,500 km³ natural gas. There are many marine exploitation work and fishery around the populated coastal regions of the SCS, and it also has one of the busiest sea lanes in the world. However the excessive human activities and damages caused by typhoon led many environmental problems and threaten the health of the ecosystems around the SCS. To solve this problem, we need first understand the characteristics of the hydro-dynamics in the SCS and related biological responses, thus extensive observation is undoubtedly the best way of this study. Additionally, as the SCS is surrounded by many countries and its circulation and hydrology patterns have distinct seasonal features and interannual variability owing to the influence of the East Asian Monsoon (northeasterly in winter and southwesterly in summer), therefore, setting up a long-term, distributed environmental monitoring network with the effort from the regional countries should be our primary goal, which will benefit not only the scientific study but also the environment protection and policy making.

In this paper, the historic and ongoing observation systems in the SCS operated by the South China Sea Institute (SCSIO) are briefly reviewed in section 2, the major and representative findings from these observations are summarized in section 3, and the conclusion remarks are given at the last section.
Review of the observation program
Several observation programs have been carried out regularly in different parts of the SCS for years. These include:
The yearly “open cruise” in the Northern SCS (NSCS) initiated from 2004
This program aims to obtain the comprehensive marine environment information in the NSCS by uniting various groups from different research fields and institutes to join the cruise freely. The cruise transects cover the whole NSCS shelf and Luzon Strait, and the 18°N transects is incorporated in the CLIVAR (Climate Variability and Predictability) project (Fig. 1).

Figure 1. Locations of the observation stations of the “open cruise” in the NSCS in 2006, and the long-term monitoring stations (triangles).

The key program of the “knowledge innovation project”
This program focuses on the development of the meso-scale eddies, front, internal waves and related biological features in the northern shelf and the LS (Fig. 2).

Figure 2. Locations of the observation stations of the key program in 2008.

Three monitoring stations
There are three environmental monitoring stations (shown by triangles in Fig. 1) established in Daya Bay, Sanya and Xisha Island respectively, for long-term study of the hydrological and biogeochemical processes and the SCS western boundary current.
Other theme-based cruises
Such as “SCOPE (northern SCS Coastal Oceanography Process Experiment)” co-organized by five institutes and university in order to investigate the upwelling and plume processes in the NSCS.

Representative Results
By utilizing the available observation data, Argos drifters, satellite images and numerical simulation, we have obtained some representative achievements.

Basic circulation patterns in the SCS
The formation of SCS warm current is due to the co-effects from horizontal advection of the potential vorticity, the stretch of the vortex tube and the JEBAR term. The way how the Kuroshio intrudes into the SCS and the seasonal variation of the SCS western boundary currents and its relation with the wind, stratification and topography and studied as well.

Coastal upwelling
Monsoon wind is the most important physical forcing of the coastal upwelling, while the cross-shelf transport in the bottom boundary layer is another important factor.

Meso-scale eddies in the SCS
The vertical structures and path of the warm and cold eddies identified from the satellites images are selected for case studies with the cruise data. Their appearance and strength are found to be closely related with the wind forcing and heat flux.

Health of the ecosystem in the Pearl River Estuary (PRE)
Eutrophication, hypoxia and salt water intrusion phenomena in the PRE and their relation with the river plume and coastal upwelling processes.

Coral reefs
The primary productivity of the coral reef ecosystems in the SCS are 2~3 times higher than the adjacent waters, and the transition of the primary to the secondary productivity in the southern SCS is higher than the northern SCS.

Biological response to typhoon and coastal upwelling
Typhoon could contribute to about 3.5% of the total annual primary productivity according to the preliminary estimate.

Conclusions
However most of these observation and research shown are carried out in the NSCS. More collaboration from the countries surrounding the SCS is badly-needed to set up a distributed observation network, and finally help us to obtain a comprehensive figure of the physical and biological environment in the SCS.
Marine pollution abatement through microbial bioremediation

David J. W. Moriarty

School of Biological Sciences, The University of Queensland
Queensland 4067, Australia

Corresponding author’s email: djwmoriarty@bigpond.com

Abstract

The impact of wastes on the coastal environment from urban sources and the agriculture, manufacturing and aquaculture industries can be mitigated by the use of appropriate microbes either individually or in consortia with plants. Aquaculture — coastal land-based and estuarine or bay cage culture — and urban sewage and industrial organic wastes are particularly amenable to microbial technologies. Microbial ecology is the scientific field that is the basis for biotechnological applications that are critical to minimising the impact of these wastes on the coastal environment. Our knowledge of microbial ecological processes from studies in lakes and the sea has been applied to aquaculture ponds and to improving the performance of treatments of waste water from urban, agriculture and industrial sources. Several criteria must be applied to ensure success. Appropriate bioremediation species, i.e. microbes that are natural to or integrate easily into the natural ecological communities and provide the desired beneficial actions, have to be selected and produced at a cost that is acceptable to the end users. The microbes have to be added at a high enough population density to compete with the natural flora in the treatment sites. Bacteria that carry genes for antibiotic resistance and disease virulence must not be used in sites where they could affect not only human, but also fish and shrimp health; safety checks must be made during selection and production processes. Microbial remediation and related technologies are now being used widely in the field of aquaculture. The maintenance of good water quality and the control of disease are closely linked to managing the communities of microbes, which include the microalgae. An obvious cost-benefit is seen by the aquaculture producer at harvest, whereas the costs of bioremediation in treatment of urban and industrial wastes are additional; they do not result in an increase in net profit. Therefore, pollution abatement from the latter sources requires government regulation and enforcement.

Keywords: Bacillus, nutrients, waste treatment, aquaculture

Introduction

The oceans have been used as a dumping arena for human wastes for a long time, but with the large increase in population, pollution is becoming more of a problem; it affects seafood quantity and quality. As demand for seafood rises with population increase, aquaculture is now one of the most rapidly growing sectors of the economy. Pollution of the coastal environments by aquaculture wastes affects not only the wild capture fisheries, but also the long term sustainability of the aquaculture industry itself. If we want to be sure that the fish we eat are safe or that there is sufficient to meet demand, we have to prevent or mitigate pollution of coastal environments from urban sewage, industrial and agricultural wastes as well as waste water from aquaculture. That means coastal ecosystems must be kept in a healthy state or restored to that state where necessary. Of the many strategies that are required, the application of microbial technologies is essential.

Microbial ecology is the scientific field that is the basis for biotechnological applications, but it does not provide a magic cure for pollution problems. Prevention is very important, especially in the case of recalcitrant chemicals that cannot be degraded or that take a very long time to decompose to a non-toxic state, e.g. fuel oil spills. Microbial remediation and related technologies have been accepted by users most readily in the field of aquaculture.
The maintenance of good water quality and the control of disease are closely linked to managing the communities of microbes, which include the microalgae. When the microbial communities are managed correctly, which may include the addition of appropriate species of bacteria, an obvious cost-benefit is seen by the aquaculture producer at harvest. In contrast, the costs of bioremediation for treating urban and industrial wastes are additional; they do not result in a net profit to the immediate user. However, the benefits to the wider community should be considered in any economic analysis or modelling of the cost-benefits of microbial bioremediation, whether in aquaculture or treatment of other industrial or urban wastes. Such analyses need to be viewed not only from a regional or national one, but from a global perspective, as ocean currents do not respect national borders, and seafood is transported and marketed in countries far removed from pollutants that might affect the production zone. Our health depends upon the health of coastal ecosystems, including the coastal microbial communities.

What is a healthy coastal ecosystem and how can microbial remediation maintain or restore it? An ecosystem in itself cannot be healthy or unhealthy. We use the term by analogy with human health, which assists in discussion with a wide audience, but it is not a rigorous scientific term. For example, an anaerobic waste treatment pond at a rubber factory would be a healthy microbial ecosystem functioning well for the factory, but would be lethal to fish. Healthy fish in an aquaculture pond or a coastal ecosystem will be responding to variables that include interactions of the fish with each other, with the physico-chemical environment (in particular oxygen concentration) and the microbial community. As ponds are shallow, the water chemistry is influenced primarily by the chemistry of the sediment or soil, which is governed by bacterial activities. Therefore, for a partial answer to the question of how we can maintain or restore the health of a coastal ecosystem, we have to discuss the microbial ecology of these and similar aquatic ecosystems and ways in which we can modify the microbial communities and thus their activities, i.e. microbial bioremediation. Pollution from aquaculture is a noticeable problem in many regions, and as we have information on that application of microbial ecology, I will focus on aquaculture in this review.

In many countries, fish and shrimp farmers are being requested to meet stricter guidelines for product quality and effluent water quality. Microbial biotechnology, including bioremediation, will assist them in meeting regulatory requirements and improve their profitability and the sustainability of the industry at the same time. This biotechnology includes not only manipulating physico-chemical factors to alter microbial species composition and rates of metabolic activity, but also adding appropriate numbers of selected microbes to carry out particular functions at faster rates than those occurring under existing conditions.

**Microbial Processes in Bioremediation**

The major role of microbes in pollution abatement is the decomposition of waste organic matter to carbon dioxide and nitrogen gas. In some environments, such as sewage treatment ponds and lagoons, microbes can assist in removing heavy metals and phosphorus or in degrading complex hydrocarbons e.g. fuel oil.

Some stages in waste treatment require anoxic conditions, but ultimately, for the complete decomposition of organic matter an aerobic environment is essential. Decomposition of organic carbon compounds is an oxidative process, with oxygen being the most energy efficient electron acceptor. Where oxygen is not available, but nitrate is present, the nitrate will be used as an electron acceptor and reduced to nitrogen gas. Thus a combination of aerobic and anaerobic processes is required for the decomposition of organic matter containing nitrogen, such as food and faecal wastes. As these wastes degrade very readily, a large influx into a coastal waterway, e.g. effluent from aquaculture ponds with a high
stocking density or wastes under sea cages for salmon or *Lates calcarifer*, usually exceeds the rate at which natural communities of bacteria can degrade the wastes aerobically with oxygen or with nitrate. The resulting build up of organic matter in the sediment means that anaerobic bacteria predominate, particularly fermenters that release organic acids and sulphate-reducing bacteria that release toxic sulphides.

A major aim of microbial bioremediation is to enhance the rate at which readily-degraded organic wastes are decomposed at their source where possible, rather than after release into the sea. Therefore, shrimp and fish culture ponds should be treated with a combination of probiotics and bioremediation — or water and soil treatment — products that permit decomposition of wastes throughout the culture period at rates that match the input of organic matter, *viz*.: from feed and faeces and algae (see Fig. 1). With appropriate bioremediation, water and soil quality remain high during the crop cycle, resulting in fast growth and healthy animals and of course the effluent water then has little deleterious impact on the coastal environment.

![Figure 1. A shrimp pond in Brazil on the day of harvest after 90 days of culture with a commercial *Bacillus*-based water treatment product applied every week. Stocking density was 45 shrimp/m². Only a little sediment accumulated in the pond, which was refilled and stocked after 3 days. The pond soil was clean at the surface and had a light-coloured zone in the upper 3-5 mm; below that the anoxic zone was not very black (inset); there was no odour of hydrogen sulphide. This shows that oxygen was diffusing into the upper layer of the sediment and thus indicates that the rate of decomposition of organic wastes in the pond was greater than the rate of deposition into the sediment. In contrast with previous crops before the *Bacillus* products were added to the pond, organic matter accumulated and the pond soil was black throughout, due to the presence of sulphides.](image)

Aquaculture practices can be improved or modified to include the use of beneficial microbes for eliminating or minimising wastes and thus impacts on the coastal environment. For example, a commercial probiotic product containing a mixture of *Bacillus* species increased feed conversion efficiency by around 25%, so that less feed was used and thus less wastes generated for the same amount of fish or shrimp produced. On the farm shown in Fig. 1, when shrimp at this moderate stocking density were given feed coated with *Bacillus*-based probiotics, the feed conversion ratio decreased from 1.5 to 1.2, saving 1700 kg of feed per
hectare per crop. At stocking densities of 150 – 200 shrimp/m², which are common in Asia now, a similar decrease in feed conversion ratio would mean that 4 or 5 t less feed was used per crop cycle per hectare, and therefore that less coastal pollution was from the effluents would occur. Large decreases of feed used per hectare per crop cycle provide a significant benefit not only to the farmer (lower costs of production), but also to the coastal environment which receives the effluents. Similarly, the problem of pollution from wastes under sea cages for fish production could be lessened if Bacillus waste treatment products were applied under the cages and Bacillus probiotics were mixed with the fish feed; faecal wastes degrade faster due to the activity of the Bacillus from germinating spores that survived the digestive process.

The selection of microbes — usually bacteria — for bioremediation should be based on several criteria. Obviously, the microbes should be able to live and function under the environmental conditions of interest, so would normally be native to that or a similar environment. In aquaculture or coastal environments where food fish species are produced or caught, the selected bacteria must not be pathogenic to humans, who could be infected after handling or eating the shrimp or fish. The selected bacteria must not carry transmissible resistance genes against clinically important antibiotics. They must not produce toxins that affect humans, shrimp or fish. They should, obviously, have appropriate functional properties for degrading the organic wastes, including the secretion of exo-enzymes for a wide range of organic polymers. Technological properties that they require include being cost-effective to manufacture under industrial conditions and having long term stability and shelf life. Gram negative bacteria, e.g. Pseudomonas species, do not form spores and thus do not survive well when dried; this makes them expensive to use on a large scale in bioremediation.

There are strains and species of bacteria in the Bacillus group that meet the criteria for use in commercial bioremediation products. Many Bacillus have an additional benefit for the aquaculture producer: strains can be selected that inhibit the growth of pathogenic bacteria such as Vibrio and Pseudomonas species, and thus improve survival of the cultured animals and prevent the increase and spread of pathogens to other animals in the coastal environment. However, like many groups of heterotrophic bacteria, the Bacillus genus contains species that are opportunistic pathogens. In particular, the B. cereus group must not be used where food animals are produced or in sites that would affect human health. The complexity of microbial and environmental interactions means that products for bioremediation that are cost-effective, i.e. have the desired microbial activity when applied at a cost and rate that is acceptable to the users, have to be designed carefully. Care must be taken to ensure the species used are safe not only for humans, but also for fish, shrimp and other animals.

Not all bioremediation processes require the addition of selected microbes. Wetland and/or lagoon bioremediation, utilising interactions of bacteria, microalgae, fungi, protozoans and macroalgae or higher plants is another procedure for treating organic matter wastes and removing nitrogen and phosphorus and heavy metals. The nutrient and/or redox state of the environment could be modified to enhance the action of natural microbial populations.

Bioremediation strategies must be both effective and not too costly for the industry sectors to apply them. Appropriate government regulations and their enforcement are required for microbial technology strategies to be beneficial in preventing pollution. Regulations for applying microbial bioremediation must be developed in consultation with microbial ecologists to ensure they are appropriate and not unnecessarily restrictive.
Responsible coastal fisheries and aquaculture for sustainable ecosystem health

Meryl J. Williams

17 Agnew Street, Aspley, Australia

Corresponding author’s email: meryljwilliams@gmail.com

Extended Abstract

In tropical seas, modern coastal fisheries and aquaculture are seen as presenting great threats to ecosystem health, while providing major sources of food, livelihood and income to millions of people, most of whom are small-scale operators or labourers. As a major human use of sea space and marine life, fisheries and aquaculture create and face extraordinary challenges, especially the pressures to exploit and develop the resources beyond sustainable limits, driven by growing seafood markets, environment stresses, inadequate management and knowledge for management. Nevertheless, modern ecosystem and fisheries management developments and burgeoning capacity for improving aquaculture efficiency and sustainability offer promises of a more sustainable future. This paper addresses both sets of promises.

Often treated handled by the same government management and policy agencies, the fisheries and aquaculture sectors actually occupy different political and social domains, yet they also merge, overlap and even compete in other domains, such as coastal space and the market. Like all food production, fisheries and aquaculture operate as exploiters of ecosystems and are beholden to them for their productivity.

Fisheries exploit natural populations of fish, mollusks, crustaceans, echinoderms and aquatic plants, capturing over 5,000 different recorded species, the majority of which are tropical. This is thus a major exploiter of natural biodiversity. Exploitation is based on catching from populations that fluctuate annually and where the catches and returns contain a large element of uncertainty and variability. Over millennia, fishing by humans has altered the exploited natural populations in several ways, removing many of the larger species almost totally, favouring smaller and faster growing species and, within species, tending to slowly drive the evolution towards populations of smaller individuals with younger ages and less stable population numbers. At the same time, the exploitable populations of marine organisms have been further impacted by coastal habitat changes from land-based pollution by agriculture, industry and urban sewage and habitat destruction for cities, ports and resorts. In recent years, scientific evidence is mounting that the disruption of the global nutrient (especially nitrogen and phosphorous) and carbon cycles are causing ocean deoxygenation, acidification and warming that is starting to show measurable and largely negative impacts on coastal habitat and fisheries.

The global, including tropical, fisheries production has been flat or even declining in most countries for the last 20 years and sustainable catches are only possible by further reducing the harvest. Despite this advice, fisheries effort continues to expand in many countries and the open oceans and deep seas, especially in areas beyond national jurisdictions, Fisheries management is still not adequate to control fishing effort in the face of strong market demand for fish.
Aquaculture production has been accelerating rapidly, including in tropical countries, over the last 40 years. Harvests come from nearly 400 species of fish, molluscs, crustaceans, echinoderms and aquatic plants. The majority of these species are not yet properly domesticated, i.e., the full life cycle of the species is not closed and the species has not been bred or adapted to life in culture conditions. Overall, only about 20% of the cultured species have achieved some level of domestication. However, of the species from which more than 1 million tonnes is produced annually, three quarters are fully domesticated. The effect of having a large number of culture species of which the majority is not domesticated is that aquaculture is still an inefficient form of seafood production and marine biodiversity and other resources are frequently wasted. Coastal species face especial challenges because suitable coastal space is particularly limited and competed over by fisheries and many other forms of coastal development.

The plateau in natural fisheries production and the rapid rise of aquaculture production has brought about a revolution in fish production and the world is experiencing a transition from mainly hunting to hunting and farming fish (Figure 1). How much further the revolution proceeds will largely depend on making aquaculture much more sustainable and less haphazard than present, while attempting to achieve sustainability of the fishery from natural populations.

![Figure 1. World Fisheries and Aquaculture Production 1950-2008 (Source: FAO). All production statistics are in millions of tonnes and exclude aquatic plants and mammals.](image)

This paper focuses on the current state of fisheries and aquaculture in SEA, with reflections on developments in other tropical regions, specifically South Asia, Africa and the Caribbean and Meso-America. In global terms, Southeast Asia is the most productive tropical region in the world, supports the largest population of people dependent on fish and the largest trade in fish. It is also a hub for tropical marine aquaculture development. The region therefore
serves as an excellent case study in the interaction between ecosystem health and renewable resource use and management in tropical seas.

In Southeast Asia, coastal fisheries have a long history of intensive exploitation that has intensified further in the last 100 years due to the introduction of mechanized and mobile fishing operations such as gill nets, demersal trawls and purse seines. Indonesia, Thailand, Philippines, Vietnam, Myanmar and Malaysia are world ranking marine fishing nations, landing the 4th, 9th, 11th, 12th, 14th and 16th largest catches in the world. The pace of fisheries development in all SEA countries has been swift but national and regional fisheries management has been much slower to develop and is still hindered by sea boundary uncertainties and tensions and lack of reliable resource and environment information.

Aquaculture has a more recent history of modernization and intensification, dating largely from the 1970s and still being underdeveloped in some key aspects, such as the low level of domesticated species used, and over-developed in others, such as intensification of production methods.

Positive steps to better environment outcomes are better international cooperation, improved controls over fisheries and aquaculture development and enhanced and accessible public information on the sectors.

With respect to international cooperation, SEA, along with East Asia more generally, has the lowest global levels of international cooperation over ocean management. This partly arises from the ongoing tensions over sea boundaries, such as in the South China Sea and around archipelagic waters, and part is due to the low level of trust among countries emerging from wars and armed conflicts in the last 50 years or less. Until bilateral and eventually multi-lateral cooperation is improved, fisheries will continue to be a source of tension and joint efforts to manage shared resources will not succeed.

In SEA, internal (national) controls over fishing are fairly weak and very challenging. The large number of fisheries dependent operators fall into two main types – the small-scale operators who rely on the fish for food and livelihood and larger operators who fish for supplying urban and export markets. Although the former groups also sell most of their catch, they operate at a different level. Governments find both groups difficult to downsize in the face of evidence of overfishing. The small-scale operators have few other alternatives, especially in remote island locations and the large-scale operators often wield considerable economic and political power. The market and trade provides strong incentives, and in contrast to the weak international cooperation on fisheries management, ASEAN has strongly supported free trade in fisheries products. Thus, all the incentives drive towards fishing harder, with little counter-balance on controlling fishing to sustainable levels. The SEA countries, however, are gradually developing more modern fisheries approaches, including exploring the ecosystem approach to fishing, co-management, removing some (but still too little) of the excess fishing capacity, cooperating on blatantly illegal fishing and several attempts by NGOs to find and support certification of some sustainable fisheries.

Lack of regular and reliable information on the state of fished stocks also hampers action on sustainability. Without resource surveys and publicly accessible information on the state of the fisheries, progress will be more difficult.

With respect to aquaculture development, despite the progress being made, long-term solutions are still needed to sustainable development. A central problem is still the need to more carefully focus on species suitable for long-term domestication and breed improvement. Many of the marine species grown still rely on wild seed or broodstock for much of their production. Earlier species selection decisions made by many farmers and government, for example, to focus on growing the giant tiger prawn (*Penaeus monodon*) as
the primary prawn species resulted in a large move away from this species when
domestication became difficult. Many farmers in the region then illegally took to farming an
exotic species from the Americas, *Penaeus vannamei*, which is readily bred in captivity. For a
region that will come to rely more and more on aquaculture, SEA must take a more serious
approach species selection and domestication in aquaculture. Species choices (Table 1) are
central to breeding, feeds and farming systems, including multi-species aquaculture systems
that are showing some promise of addressing the mounting coastal ecosystem health
challenges. The latter systems will likely need support from ecosystem services accounting
to be profitable.

Table 1. Species choice criteria for aquaculture.

<table>
<thead>
<tr>
<th>Biology</th>
<th>Economics</th>
<th>Culture system and environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- life-cycle closed</td>
<td>- marketable</td>
<td>- feasible farming system</td>
</tr>
<tr>
<td>- feed available</td>
<td>- potentially profitable</td>
<td>- sites available</td>
</tr>
<tr>
<td>- behavior permits handling, confinement</td>
<td>- disease resistant</td>
<td>- Minimal or positive environmental impact, including on biodiversity</td>
</tr>
<tr>
<td>- disease resistant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- large size and good growth rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Oral: Session 1A
Coastal and Riverine Interactions
Abstract

Tidal lowland is located mainly along the lower reach of a river down to the coastal area. It bears many functions including conservation of abundant biodiversity and uniqueness of landscape, protection of surrounding coastal and marine areas, development of resource based activities such as agriculture, fishery, ecotourism and more. Tidal lowland development varies with regard to these various functions.

Water management is a key concept in tidal lowland development, particularly for agriculture development. Its objective includes improving water distribution, recovering cost, and achieving efficient water allocation. Which objective to be achieved relies partly on water users’ willingness to bear the cost required to achieve the objective. This study examines the achievement of water management objective based on water users’ willingness to pay for water service.

The results indicate that only improvement of water distribution objective can be achieved with current willingness to pay for water service fee. This willingness to pay is significantly affected only by the income of water users. Therefore, efforts to increase willingness to pay for water service fee to achieve higher water management objective should be directed towards the increase of income of water users.

Keywords: water management, water service fee, tidal lowland

Introduction

Among various objectives of water management, the objectives of improving water distribution, recovering cost, and achieving efficient water allocation are likely to be put into priorities in tidal lowlands. Not only these objectives support the sustainable use of lowland resources, but also provide proper treatments to surrounding coastal areas. To achieve these objectives, fee that covers the cost of water management is required, besides functional water structures and established water management guidelines (Schultz, 2007; LWMTL, 2006). Since this fee is used to carry out operation and maintenance of the system, this fee is considered as water service fee (WSF).

Water service fee has been estimated in various different cost concepts using various different methods (Gonzalez-Alvarez et al., 2006; Bar-Shira et al., 2006; Esteban et al., 2008; Molle et al., 2008). The basis for estimating the cost of water (WSF) was established to include different cost components that may be factored into a calculation of the costs of water management. These cost components include operation and maintenance (OM) costs, capital depreciation and replacement, opportunity costs, and environmental costs. Accordingly, three types of water cost (WSF) are set to include supply cost (OM costs and capital depreciation and replacement), economic cost (supply cost and opportunity costs),
and the full cost (economic cost taking into account environmental externalities associated with the use of water).

Different costs incurred reflect different water management objectives. Water distribution improvement objective requires only operation and maintenance (OM) costs. Cost recovery objective considers OM costs including or excluding capital depreciation and replacement costs. Whilst efficient water distribution objective requires even higher costs in order to cover opportunity and external costs.

**Materials and Methods**

Due to the absence of direct measures of water management achievement at the field level, it was indirectly assessed using WSF for which water users were actually willing to pay. Actual WTP reflects water users’ current ability to pay for WSF. Therefore, it represents the actual achievement of water management objective. Water users’ actual WTP for WSF has three consequences on water management achievement as the following:

1) If actual WTP for WSF is less than or equals to OM costs, only water distribution objective is expected to achieve.
2) If actual WTP for WSF also covers depreciation and replacement costs and WUA management cost in addition to OM costs, then the cost recovery objective is expected to achieve.
3) If actual WTP for WSF covers all the costs, the efficient water distribution is expected to achieve.

The WSF for which water users were actually willing to pay was affected by farmers’ socio-demographic characteristics such as age, education, family size, length of settlement, socio-economic index, land area owned, and income. The effect of these variables on the actual WSF was modeled in the following equation:

\[ W_i = f(Q) \]

where \( Q \) represent some socio-demographic characteristics

Assuming regression was a sufficient tool to predict the actual WSF, the above model was specified as the following:

\[ W_i = \beta_0 + \beta_1 AGE + \beta_2 EDU + \beta_3 FAM + \beta_4 SET + \beta_5 SEI + \beta_6 ARE + \beta_7 INC + \varepsilon_i \]

where \( W_i \) = actual WSF water users’ were willing to pay

\( AGE \) = age
\( EDU \) = educational attainment
\( FAM \) = family size
\( SET \) = length of settlement in the area
\( SEI \) = index of some socio-economic factors
\( ARE \) = farmland area owned
\( INC \) = income

The above regression equation was predicted using ordinary least square method to yield with the predicted actual WSF based on its affecting factors. Subsequent to predicting this equation, some statistics were employed to examine the goodness-of-fit of the overall model and the significance of each of the affecting factors. In addition, interpretations on the significant factors were made in term of direction and magnitude of their effects on the actual WSF water users were willing to pay.

This study was designed as a survey, conducted in the deltaic area of Telang, South Sumatra, Indonesia. Telang, a reclaimed tidal lowland area for agriculture, is located in the lower reaches of Musi River. Research sample of 500 farm water users were drawn using
Results and Discussion

Willingness to pay for water service fee may reflect the achievement of water management objectives. Based on field observation, water distribution improvement can be achieved if actual WTP for WSF is less than Rp 315,000 per hectare per year, cost recovery can be achieved if actual WTP for WSF is Rp 315,000 up to Rp 350,000 per hectare per year, and efficient water distribution can be achieved if actual WTP for WSF is Rp 350,000 or higher. Actual WTP for WSF is respondents’ reported amount of WSF they were willing to pay, obtained from the interview with individual respondent. Actual WTP for WSF indicates current status of operation and maintenance of the system. Therefore, it can be utilized in the evaluation of achievement of water management objectives.

In order to measure the achievement of water management objectives based on the amount of actual WSF respondents willing to pay, univariate and multivariate analyses were conducted. Amount of actual WTP for WSF are directly affected by several socio-demographic variables such as age, education, family size, years of settlement, household’s socio-economic progress (an index variable), land area owned, and income. Descriptive univariate statistics of these variables are presented in Table 1. The mean actual WTP for WSF is considerably low compared to the cost of operation and maintenance.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual WSF</td>
<td>102,530</td>
<td>98,594</td>
<td>5,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Age (years)</td>
<td>46.78</td>
<td>12.23</td>
<td>22</td>
<td>90</td>
</tr>
<tr>
<td>Education (years of schooling)</td>
<td>6.61</td>
<td>2.10</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Family size</td>
<td>3.2</td>
<td>1.06</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Years of settlement</td>
<td>25.73</td>
<td>5.59</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Socio-economic index</td>
<td>17.26</td>
<td>1.82</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Land area owned</td>
<td>1.84</td>
<td>0.99</td>
<td>0.25</td>
<td>12</td>
</tr>
<tr>
<td>Income (Rupiah)</td>
<td>12,452,131</td>
<td>7,477,686</td>
<td>1,810,000</td>
<td>105,600,000</td>
</tr>
</tbody>
</table>

The result of regression analysis on the actual WTP for WSF is presented in Table 2. Out of 7 independent variables assumed to affect the actual WSF, income is the only variable that has statistically significant effect on the actual WSF. The coefficient of income indicates that every Rp 1,000 increase in income will increase the actual WSF by Rp 6.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Un-standardized Coefficients</th>
<th>Standard Error</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>96,896.71</td>
<td>56,026.82</td>
<td>1.729</td>
<td>0.084</td>
</tr>
<tr>
<td>Age (years)</td>
<td>-41.177</td>
<td>436.05</td>
<td>0.094</td>
<td>0.925</td>
</tr>
<tr>
<td>Education (years of schooling)</td>
<td>-636.34</td>
<td>2,314.61</td>
<td>0.275</td>
<td>0.783</td>
</tr>
<tr>
<td>Family size</td>
<td>2,763.15</td>
<td>4,326.24</td>
<td>0.639</td>
<td>0.523</td>
</tr>
<tr>
<td>Years of settlement</td>
<td>-321.96</td>
<td>833.61</td>
<td>0.386</td>
<td>0.699</td>
</tr>
<tr>
<td>Socio-economic index</td>
<td>-2004.51</td>
<td>2410.31</td>
<td>0.832</td>
<td>0.406</td>
</tr>
<tr>
<td>Land area owned</td>
<td>-13,732.52</td>
<td>8,732.07</td>
<td>1.573</td>
<td>0.116</td>
</tr>
<tr>
<td>Income (Rupiah)</td>
<td>0.006</td>
<td>0.001</td>
<td>4.895</td>
<td>0.000***</td>
</tr>
</tbody>
</table>

F-test = 8.116; Sig. of F-test = 0.000
Conclusions

1) Three objectives of water management are recognized in tidal lowland agriculture, namely improvement of water distribution, cost recovery, and efficient water allocation.

2) With the value of actual WTP for WSF, the achievement of water management objective is limited to the improvement of water distribution. Neither cost recovery nor efficient water distribution can be realized with this actual WTP for WSF.

3) Among socio-demographic variables assumed to affect the actual WTP for WSF, only income significantly affects it.

References


Wave attenuation ability of *Rhizophora* species at Kemaman, Terengganu

Mohd Lokman Husain, P.C. Sinha and Isfarita Ismail*

Institute of Oceanography, Universiti Malaysia Terengganu
21030 Kuala Terengganu, Terengganu, Malaysia

Corresponding author’s email: isfarita@yahoo.com

Abstract

The wave reduction ability of *Rhizophora* species was investigated at Pulau Sekepeng, Kemaman, Terengganu in Peninsular Malaysia. A 12 m transect for *Rhizophora* species was set up inside the mangrove forest from the vegetation's edge. Many fishing boats pass through the estuary, each producing a set of waves in their wakes. Based on observations, the effect of vertical and horizontal variations on wave attenuation was analyzed. The average wave reduction increases with increasing distance inside the mangrove forest. Also, the wave reduction decreases with increasing water level. From this study also recorded that the wave attenuation ability of *Rhizophora* species at Kemaman ranged from 3.27% to 20.66% (average 11%).

Keyword: wave attenuation, Pulau Sekepeng, *Rhizophora* sp., Kemaman (Terengganu)

Introduction

Mangrove forests are one of the world’s most threatened tropical ecosystems. In Peninsular Malaysia, the total extent of mangrove forests is about 103,203.11 ha. Out of the total, about 88,406.61 ha or 85.6% is gazetted as Permanent Forest Estates (PFEs) while the remaining 14,796.5 ha (14.4%) is designated as state land mangroves (Mohd Lokman, 2004).

Mangrove forests serve many useful purposes including providing habitat to many plant and animal species (Cannicci et al., 2008; Nagelkerken et al., 2008). The quantitative effects of selected mangrove species on the reduction of sea waves was earlier studied by Magi et al. (1996), Mazda et al. (1997) and Massel et al. (1999). Later, Mazda et al. (2006) discussed the characteristics of wave reduction due to the drag force of *Sonneratia* sp. at the Vinh Quang coast in northern Vietnam while Quartel et al. (2007) discussed the wave reduction due to the drag force for *Kandelia kandel* in the Red River Delta, Vietnam.

This paper focuses on the ability of *Rhizophora* species on the wave attenuation at Kemaman, Terengganu. For this purpose, we have chosen a study site at Pulau Sekepeng having *Rhizophora* sp. in order to investigate the reduction of waves generated by the passage of fishing boats in the estuary. The main objective of this paper is to quantify the percentage of wave reduction by *Rhizophora* sp. at Kemaman, Terengganu. It is found that the wave reduction increases with increasing distance inside the mangrove while it decreases with increasing water level.

Materials and Methods

The study site is located in Pulau Sekepeng mangrove area which is situated in the district of Kemaman, Terengganu (latitude 4°13’50.43”N and longitude 103°25’54.52”E). The Figure 1 shows the map of Pulau Sekepeng in the district of Kemaman and a 12 m long idealized transect of *Rhizophora* sp.
Along the transect we chose 12 locations, each 1m apart. The first location at the vegetation’s edge has been designated as plot 0, while plot 1 refers to the next location 1 m inside the mangrove, and so on. In this study, 12 sets of readings were recorded. For reading 1, the water loggers were set up at plot 0 and 1; for reading 2, they were set up at plot 0 and 2; and so on. For each reading, the data were collected for one tidal cycle during the spring tide.

Figure 1. Map of Pulau Sekepeng, Kemaman and idealized transect of *Rhizophora* sp. at Kemaman, Terengganu.

Wave height data were collected using water loggers (Boart Longyear Interfels, Netherlands). For each reading, two water loggers were set up at two locations to sample the water level and associated parameters at 1-second interval. The water loggers are left for one tidal cycle and the data is analyzed for the mean wave height, and subsequently attenuation, as the equipment is moved to other locations inside the mangrove. The dates, readings and number of wave bursts recorded during the sampling are presented in Table 1.

**Table 1. Wave sampling using two water loggers for *Rhizophora* sp. at Kemaman, Terengganu.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Reading</th>
<th>No. of wave burst</th>
<th>Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>27/12/2007</td>
<td>1</td>
<td>2</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>15/2/2008</td>
<td>2</td>
<td>9</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>23/11/2007</td>
<td>3</td>
<td>3</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>14/9/2007</td>
<td>4</td>
<td>5</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>2/10/2007</td>
<td>5</td>
<td>6</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>14/9/2007</td>
<td>6</td>
<td>5</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>16/2/2008</td>
<td>7</td>
<td>4</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>21/2/2008</td>
<td>8</td>
<td>0</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>22/2/2008</td>
<td>9</td>
<td>1</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>15/9/2007</td>
<td>10</td>
<td>6</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>29/2/2008</td>
<td>11</td>
<td>2</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>28/2/2008</td>
<td>12</td>
<td>5</td>
<td>✓ ✓</td>
</tr>
</tbody>
</table>
During the course of wave data collection, fishing boats would pass through the area and generate small waves. The wave fluctuations recorded by the water logger due to each passing boat is called a wave burst, which ride over the tidal wave and are captured by the water logger. One of these wave bursts are shown in Figure 2. Each burst contains a set of waves. Wave heights of more than 2 cm are taken into account while waves smaller than 2 cm are ignored as they are considered wind induced waves (Quartel et al., 2007).

![Figure 2. An example of a wave burst and identification of associated waves.](image)

After identifying the waves 1 to 7 in Figure 2, their mean height was used to calculate the wave reduction. Following Mazda et al. (1997), the wave reduction is given by, 

\[ r = \frac{H_S - H_L}{H_S} \times 100 \]

where \( r \) = reduction, percentage reduction=\( r \times 100 \), \( H_S \) = wave height in front of mangrove (plot 0) and \( H_L \) = wave height at a location’ L’ inside the mangrove forest.

**Results and Discussion**

The Figure 3 shows the relation between average wave reduction and distance inside *Rhizophora* sp and a relation between average wave reductions vs. vertical level. It may be seen that overall the percentage wave reduction increases with increasing distance inside the mangrove forest (Figure 3a) while Figure 3b shows the largest wave reduction to be 18.874% in (0 - 20cm) level and the smallest is 11.534% in (60-80cm) level. Also, the wave reduction decreases with increasing water level. This is similar to the results reported by Quartel et al. (2007) and Mazda et al. (2006). Thus, it is found that *Rhizophora* sp. is a good species for wave attenuation. The percentage wave reduction ranged from as low as 3.27% to as high as 20.66%, with about 11% overall reduction in the wave height.
Figure 3. Relation between wave reduction and distance inside mangrove forest and relation between wave reduction and vertical level.

Acknowledgements

This study was supported by an e–Science funding from MOSTI. The authors would like to thank the facilities provided by the Institute of Oceanography, Universiti Malaysia Terengganu.

References


Ecological capability evaluation for sustainable land use planning

Sara Kaffashi¹* and Mandana Yavari²

¹Faculty of Environmental Studies, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

²Department of Environmental Management, Science and Research Branch, Tehran, Iran

Corresponding author's email: sarakafashi@gmail.com

Abstract

Land is important property and land use planning is a science that considers the integrity between type of land use through studying the ecological aspects of the land as well as its socio-economic characteristics. Concept of ecotourism has been recently pay increasing attention, not only as an alternative to mass tourism, but also as a means of economic development and environmental conservation. It is possible to plan for the appropriate use of the land for ecotourism and to enhance the present management of the land use by utilizing Geographic Information System (GIS). To do so, investigations were identified and took steps toward developing maps to determine the ecological and socio-economic resources of the coastal zone of Haffar and Bahmanshir Rivers that encompasses an area of 155 square kilometres located in lowland area of south west of Iran. Ecological resources and socioeconomic structure of concerned area were recognized, surveyed and changed into digital figures and together with the other descriptive data were shifted to ArcGIS software for the purpose of creation of data base. Makhdoum analytical and systematic analysis model was applied to determine the ecological capability of concerned area for ecotourism development. The result showed that only 23 square kilometres of study area has capability for class two of ecotourism purpose.

Keywords: land use planning, geographic information system, Haffar and Bahmanshir coastal zone, lowland area, ecotourism, analytical analysis
Modelling sustainable development indicators for coastal cities - Case study of Mahshahr City in Iran


Faculty of Environmental Studies, Universiti Putra Malaysia
43400 UPMSerdang, Selangor, Malaysia

*Corresponding author’s e-mail: fereshtehjaderi@yahoo.com

Abstract

Sustainability indicators relate economic, social and environmental factors, for assessing performing in achieving to sustainable development. This paper present a sustainable development model using Sustainability indicators for coastal Iran. The methodology used include multi criteria decision making, Analytical hierarchy process, Delphi group, ranking and rating with using ordinal preferences and percentage, and GIS. The indicators developed contain seven basic orientors of Existence, Effectiveness, Freedom of action, Security, Adaptability, Coexistence and Psychological needs. A scale from 0 to 10 is used to grade orientor impact from very low to very high sustainability. The model is applied to Mahshahr city and evaluated the city as being of medium sustainability. The average of the sustainability indicators distinguished the economic and environmental systems are in better condition than the social system. For achieving the sustainability, there needs to be suitable balance between three systems. The model indicates for Mahshahr city that more attention should be paid to the social system.

Keywords: sustainable development, orientors, modelling, indicators, coastal area
Conservation and management programmes for nesting habitats of sea turtles in Persian Gulf, Iran

Rouhollah Zare
Marine Biology Department, Chabahar Maritime and Marine Science University, Iran

Corresponding author’s email: ru_zare@yahoo.com

Abstract
Globally, marine turtles are experiencing serious threats to their survival and are considered internationally as species of conservation concern. They are threatened by coastal development, pollution and pathogens, global warming and fisheries impacts. In Persian Gulf and Oman Sea, the most common species is the hawksbill turtle (Eretmochelys imbricata). Nesting season of this species occurs from March to May. In this research nest site locations, their health and the status of conservative programs has assessed. Our study shows that unfortunately available conservative programs are not sufficient to can prevent decreasing sea turtle populations in Iran. In concern to conservative importance of hawksbill turtles and by using this information, we can prevent to increase depletion of these stocks in these areas and protect nesting habitats. In addition, continuous monitoring of nesting beaches, their conditions and nesting activity of sea turtles can help us in designing better conservative programs.

Keywords: conservation, nesting, management, marine turtles, Iran

Introduction
Globally marine turtles are experiencing serious threats to their survival and are considered internationally as species of conservation concern (Davis, 2005). Due to this status, they are listed in the World Conservation Union “Red List of Threatened Animals”; listed in the Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Baillie and Groombridge, 1996). Out of the five sea turtle species, Loggerhead (Caretta caretta Linnaeus, 1758), Green (Chelonia mydas Linnaeus, 1758), Olive Ridley (Lepidochelys olivacea Eschscholtz, 1829), Leatherback (Dermochelys coriacea Vandelli, 1761) and Hawksbill Turtle (Eretmochelys imbricata Linnaeus, 1766) were reported to occur in the Persian Gulf. The hawksbill turtle is most abundant species nesting on the beaches of the mainland and islands Iran (Mobaraki, 2004; Zare, 2008a). In the past, there has been a great deal of nesting of the hawksbill turtle at Persian Gulf but egg collection and entanglement of adult females is rife. There are many factors threatening sea turtles in Iranian coasts. In most parts of the nesting sites, egg collection for traditional usage as well as aphrodisiac purposes is usual, in some parts turtles harvest for their meat for the same purposes too. Different kinds of pollutions are usual, like the debris, oil and light. By catch in fishery activities is another important threat, as the turtle habitats are important fishing grounds too. Natural predators like the other parts of the world are usual, like the mammals, birds, crabs and insects. Density of the body pits in the small beaches prevents hatchlings to reach the sea. Mismanagement causes problems in some parts; boat strike is usual and increasing in some parts; different kinds of coastal area development is another threat for the nesting sites and turtles. Other natural factor like the erosion is usual in most places, especially in small beaches (Mobaraki, 2004; Zare, 2008a).
Materials and Methods

Daily beach surveys performed from March to May 2008. These surveys carried at some important islands in Persian Gulf (Figure 1) and nest locations were recorded. Each nest location was initially recorded relative to the nearest building, street or other landmark. These locations were later cross-referenced to the nearest survey marker. The field survey also attempted to assess the suitability of the beaches for turtle nesting. The assessment only looked at the surface level of the beach area at high water mark (through which the turtle would crawl) and the nesting area (above high water mark). When there were many nests requiring relocation, additional trips were occasionally necessary. After recording all pertinent information, the crawl marks were obliterated to avoid duplication.

![Figure 1. Persian Gulf and studied islands.](image)

Results

Table 1. Total hawksbill nests and nesting densities expressed as nest per kilometre.

<table>
<thead>
<tr>
<th>Island</th>
<th>Total nests</th>
<th>Beach length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shidvar</td>
<td>36</td>
<td>2.1</td>
</tr>
<tr>
<td>Lavan</td>
<td>24</td>
<td>3.2</td>
</tr>
<tr>
<td>Qeshm</td>
<td>56</td>
<td>6.7</td>
</tr>
<tr>
<td>Hormuz</td>
<td>34</td>
<td>3.4</td>
</tr>
<tr>
<td>Farour</td>
<td>35</td>
<td>4.6</td>
</tr>
<tr>
<td>Hendurabi</td>
<td>46</td>
<td>5.7</td>
</tr>
<tr>
<td>Overall</td>
<td>231</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Table 2. Current anthropogenic threat to sea turtle populations in Persian Gulf Islands.

<table>
<thead>
<tr>
<th>Threat</th>
<th>Shidvar</th>
<th>Lavan</th>
<th>Qeshm</th>
<th>Hormuz</th>
<th>Farour</th>
<th>Hendurabi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat alteration and loss</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Beach armouring (e.g., concrete sea walls)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Beach nourishment/ sand mining</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Beach cleaning and beach driving</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Human presence on beach</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Artificial light</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Boat strikes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Animal predation at rookeries</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>Oil pollution</td>
<td>?</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Other pollution sources and entanglement</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fishing and incidental capture</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Shrimp trawling</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Pelagic fishing gear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Gill nets</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Traditional and commercial fishing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Egg harvests</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Adult harvests</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

All measures that prevent sea turtles from being killed would be of priority. These are:

1) Conservation measures or techniques that reduce the incidental catch of adult and juvenile turtles in fishing gears e.g.: (i) use of TEDs in trawlers (shrimp and fishing); (ii) regulate or ban the use of high seas gill-nets; (iii) regulations to protect turtles or restrict the use of fishing methods harmful to turtles off their nesting grounds during the nesting season

2) Conservation measures to curb the hunting and trade of live turtles, adults and juveniles, for meat and other turtle products

3) Conservation measures to curb commercial exploitation of eggs, both legal and illegal

4) Conservation measures to curb the destruction of nesting grounds by beachfront development, seawalls, land reclamation, etc.

5) Conservation measures to curb the destruction of feeding grounds by trawlers, pollution, land reclamation, etc.

6) Conservation measures to prevent the killing or drowning of turtles in man-made structures (e.g. oil rigs) or by powered watercrafts

7) Conservation measures to curb marine pollution to reduce the mortality of hatchlings, juveniles and adults caused by marine debris like plastic bags, tar balls, Styrofoam, etc.

8) Conservation measures to prevent the inducement and spread of diseases that may be anthropogenically related such as fibriopapillomas.

In Iran there are some conservative programs and legislation pertaining to marine turtles and their habitats that include nomination of sea turtles as “Endangered animals” of the country, a fine of about 6,400,000 Rials for each killed turtle, about $US 700, and also fine for egg collection, about $US 233 for each, nominating of the nesting sites as "under management and control Area" like Mond protected area and Shidvar wildlife refuge and monitoring of the sites by DOE guards (Mobaraki, 2004).

In order to respond to a critical conservation situation, as is the case of these sea turtle populations, an agreement must fulfill some requirements:

1) it must include all, or most of the countries involved in the problem

2) it must be an “agile” organization, capable of facing a dynamic situation without getting bogged down with time consuming formalities

3) it must turn words into actions very rapidly; and perhaps also

4) it must have the capability to implement and execute a comprehensive program, and

5) if possible, it is preferable that the agreement is a binding one.

It is quite clear that the institution must have a level of credibility with the different stakeholders. In summary, these data undoubtedly confirm that there is still significant
hawksbill and green turtles nesting in Persian Gulf islands and also Oman Sea. It is hoped that further work at these sites will yield status information and allow prioritization of conservation efforts.

References


Zare, R. 2008a. Identification of spawning habitats of Hawksbill turtle (*Eretmochelys imbricata*) in some of Iranian Islands of Persian Gulf. Paper presented at International Conference on Biodiversity Conservation and Management, Cochin University of Science and Technology, Cochin, Kerala, India.

Oral: Session 1B
Marine Biodiversity and Resource Management
The study of genetic diversity of *Eretmochelys imbricata* in the Persian Gulf using microsatellite analysis

Mohammad Ali Salari-Aliabadi, Hossain Zolgharnian and Somayeh Roshani

Department of Marine Biology, Faculty of Marine Science
Khorraramshahr University of Marine Science and Technology
P.O. Box: 669, Khorraramshahr, Khuzestan, Iran

Corresponding author’s email: salari@kmsu.ac.ir

Abstract

Information on the genetic structure of marine species is essential for stock improvement programs. In pursuance of Hawksbill turtle (*Eretmochelys imbricata*) genetic diversity in Kish and Qeshm Island by microsatellite genetic method, 64 samples were caught from them beaches. 2-5 grams of internal tissue were separated, fixed in absolute ethanol (96%) and transported to marine biotechnology lab. Total genomic DNA was extracted according to Phenol-Chloroform method then quality and quantity tested by electrophoresis and spectrophotometer respectively. Polymerase chain reactions (PCR) were done using 5 pairs of Microsatellite Primers. The results of this study indicate that all 5 pairs of Microsatellite Primer were polymorphic. Average number of Real Allele and Effective Allele were 4.90 and 2.989 respectively. Average rate of observed heterozygosity was 0.570 and 0.616 for expected heterozygosity. Study of Hardy-Weinberg Equilibrium was shown all the locus had not equilibrium except Cm3 and Ei8 locus in Kish area. \( F_{st} \) (0.166) and \( R_{st} \) (0.634) calculated by AMOVA test illustrated there are separate populations of Hawksbill turtle in this part of Persian Gulf (Kish and Qeshm islands). It seems that Kish’s turtles have the better condition in contrast to Qeshm’s. Decrease of genetic difference lead to decline genetic potential and diminution of adaptation to environmental changes. So it’s necessary to monitoring of variation in populations genetic structure. The present study showed that at least two different populations of *E. imbricata* were found in the northern coasts of Persian Gulf.

Keywords: genetic variation; polymorphism; hawksbill turtle

Introduction

Hawksbill sea turtle, *E. imbricate* (Linnaeus, 1766), are established mainly in the tropical regions of the Indian, Atlantic and Pacific oceans. Adult’s weigh of *E. imbricata* is 45 to 68 kg on average, but can develop as large as 91 kg. It reaches a length of about 60-110 cm. Mating occur approximately every 2 to 4 years. The mean natural life of hawksbill is thought to be about 30 to 55 years, however biologists are not sure exactly how long they live (Lutz and Musick, 1997; Marquez, 1990).

The study of turtle population genetics has come a long way in the past few decades. In the early 1990s, technologies such as polymerase chain reaction (PCR) and automated DNA sequencing spearheaded a boom in molecular ecology. Microsatellite and mitochondrial DNA haplotype markers became the methods of choice for many turtle studies (Lee, 2008). Taxonomy and systematic has undoubtedly benefited from DNA sequencing technology (Hillis et al., 1996). The evolutionary history of turtles and how they relate to each other and to other vertebrates has been explored using mitochondrial DNA sequences (Bowen et al., 1993; Dutton et al., 1996; Karl and Bowen, 1999; Kumazawa and Nishida, 1999; Krenz et al., 2005). Ireland et al. (2003) determined the level of multiple paternities in a population of green turtles from Ascension Island using microsatellite data obtained from three females and their offspring. Aggarwal et al. (2004) developed six nuclear-encoded microsatellites from a genomic DNA library of olive ridley turtle and screened among a sample of 83 individual olive ridley turtles. Therefore, the principal objectives of this study were assessing...
the intra- and inter-population genetic variation and genetic differentiation in two populations of hawksbill turtle in the northern coasts of Persian Gulf (Kish and Qeshm Island) using the microsatellite DNA markers developed by FitzSimmons et al. (1995).

**Materials and Methods**

64 specimens of immature *E. imbricata* were hand-captured from the beach’s nest in two locations (Kish Island, n=34; Qeshm Island, n=30) between February and April of 2007. Five primer pairs for hawksbill sea turtle microsatellite markers, CM3, Ei8, Cc117, CM84 and CM72 developed by Fitzsimmons et al. (1995), were used in this study. The PCR conditions, especially the annealing temperatures, were optimized for the five microsatellite loci as necessary to produce score able amplification products. The annealing temperatures varied from 55°C for CM72 and CM3 and 57°C for Ei8 and CM84 to 58°C for Cc117. PCR was performed in a 25 μl reaction volume containing 50 ng of genomic DNA, 2 μM of each primer, 0.4 mM each of the dNTPs, 1 unit of Taq DNA polymerase (Fermentas), 2 mM MgCl2 and 2.5 μl 10X reaction buffer. The temperature profile consisted of 3 min initial denaturation at 94 °C followed by 30 cycles of: 30 s at 94 °C, 45 s at the respective annealing temperature, and 1 min at 72 °C, ending with 10 min at 72 °C.

The PCR products were separated on an 8% denaturing polyacrylamide gel containing 19:1 acrylamide: bis-acrylamide and 5 M urea. The size of each allele was estimated using the software DNAfrag, version 3.03 (Nash, 1991). A genotypic data matrix was constructed for all loci. The program MICROCHECKER version 2.2.3 (Van Oosterhout et al., 2004) was used to identify possible null alleles, large allele dropout, scoring error due to stutter peaks, and possible typographic errors before proceeding with further analyses. Allele and genotype frequencies that were identified as affected by the presence of null alleles were adjusted according to the Brookfield I method (Van Oosterhout et al., 2004). Fit of genotype data to Hardy–Weinberg proportions was estimated using the software POPGENE version 1.31 (Yeh et al., 1999) with 1000 simulated samples. The GenAIEx version 6 software package (Peakall and Smouse, 2006) was used for estimating allele frequencies and for applying the homogeneity test between populations. GenAIEx 6 is written in Visual Basic for Applications (VBA) within Excel. GenAIEx requires all data to be coded as numbers and formatted within Excel as numeric data. The dendrogram was constructed and drawn using MEGA version 4 (Tamura et al., 2007).

**Results**

All 5 microsatellite loci was polymorphic in all the studied population of hawksbill sea turtle, *E. imbricata* and the level of polymorphism variation depends on the locus (Table 1). A total of 49 different alleles were found over all loci for all populations. The number of allele per locus ranged from 3 to 10. The average of observed and expected heterozygosity ranged from 0.304 to 1.000 and from 0.436 to 0.849, respectively. The maximum and minimum of the unique allele’s number were found in loci Ei8 (9) and loci Cm84 (1) respectively. Considerable differences among two populations in the number of alleles were found at some of these loci (Table 1). The number of alleles in Cm72 ranged from 4 to 8 and Cm84 from 5 to 7 with a tendency to a reduction in the Qeshm Island population. Allele sizes ranged from 151 to 349 bp across the microsatellite loci. The effective number of alleles varied from 1.772 for Ei8 to 6.613 for Cm72. In all populations, the effective number of alleles was lower than the observed number of alleles.
Table 1. Allelic variation at five microsatellite loci in two populations of *E. imbricata*.

<table>
<thead>
<tr>
<th>Population</th>
<th>Parameters</th>
<th>Locus</th>
<th>Cm3</th>
<th>Cm72</th>
<th>Cm84</th>
<th>Cc117</th>
<th>Ei8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kish Island</td>
<td>N</td>
<td>3</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ne</td>
<td>1.966</td>
<td>6.613</td>
<td>3.296</td>
<td>2.836</td>
<td>1.772</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ho</td>
<td>0.652</td>
<td>0.957</td>
<td>0.435</td>
<td>1.000</td>
<td>0.304</td>
<td></td>
</tr>
<tr>
<td>Qeshm Island</td>
<td>N</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ne</td>
<td>2.000</td>
<td>3.380</td>
<td>2.770</td>
<td>1.984</td>
<td>3.245</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ho</td>
<td>0.499</td>
<td>0.849</td>
<td>0.694</td>
<td>0.647</td>
<td>0.436</td>
<td></td>
</tr>
<tr>
<td></td>
<td>He</td>
<td>0.500</td>
<td>0.704</td>
<td>0.639</td>
<td>0.495</td>
<td>0.692</td>
<td></td>
</tr>
</tbody>
</table>

(N=Number of alleles per locus; Ne=Number effective alleles; Ho=observed heterozygosity; He=expected heterozygosity).

All five loci used in this study were tested for departure from Hardy–Weinberg equilibrium. 8 out of 10 (five loci × two populations) possible tests for HWE were statistically significant (P < 0.05). The Population differentiation (F<sub>ST</sub>) was modest and F<sub>ST</sub> value between the Qeshm Island and Kish Island population was 0.167 and significant. R<sub>ST</sub> value between the two populations was high (0.643) and significant. The estimated gene flow (N<sub>m</sub>) value between the Qeshm Island and Kish Island population across all the studied loci was 1.260. Genetic distances among the respective populations were small. The genetic distances and genetic similarity computed by Saitou and Nei (1987) between the Qeshm Island and Kish Island populations were 0.331 and 0.776 respectively.

**Discussion**

In this study 64 specimen of *E. imbricata* were collected from two locations; although the sample number is suitable for this purpose. Because the number of alleles observed in microsatellite loci is usually large and the frequency of each allele may be low, a large sample size is necessary for satisfying subsequent statistic analyses (Salari Aliabadi et al., 2009).

Heterozygosity is an important measurement of population diversity at the genetic level and has drawn much attention from ecologists and aquaculturists (Xu et al., 2001). Greater observed heterozygosity was found when compared with the expected heterozygosity at most of the 5 microsatellite loci in all the two populations. These results are compatible with previous study that had been conducted for hawksbill sea turtle populations (FitzSimmons et al., 1995). The Kish Island population even showed 100% heterozygosity at Cc117. However, the Qeshm Island population showed the lowest genetic diversity between the two populations in terms of the average number of alleles and genotypes per locus, the number of unique alleles, and low-frequency alleles. The results from our study indicated that inter population genetic analysis based on allelic and genotypic frequencies, along with an intra population heterozygosity excess test, provide a more sensitive measurement of genetic changes than heterozygosity excess test alone.

Significant deviations from Hardy–Weinberg expectations (HWE) were observed in all six populations. Genetic drift, inbreeding and divergence evolution is likely causes for deviation the H–W disequilibrium. These results are compatible with previous study that had been conducted for hawksbill sea turtle populations (FitzSimmons et al., 1995), and with studies on other fishes (Salari Aliabadi et al., 2009; Hansen and Mensberg, 1998; Alam and Islam, 2005; Bradshaw et al., 2007).
The partitioning of variability of populations seen after F-statistics comparisons with total types of markers showed that most of the genetic variation is within populations. There was a high level of genetic differentiation among the two populations, with a highly significant overall $F_{ST}$ value of 0.167 ($P < 0.01$). Based on Analysis of Molecular Variance (AMOVA) $F_{ST}$ (0.167) was observed between the Qeshm Island and Kish Island population ($N_m=1.260$). Therefore, geological structures separate the Qeshm Island from the Kish Island stocks and may limit the gene flow between these two populations. The genetic distances between these two populations estimated 0.331, which indicates that the genetic difference among the studied populations is pronounced. However, the loss of genetic variability in Qeshm Island population also might be caused by sampling error, as the sampling sizes were relatively small for characterizing allele frequencies at marker loci as variable as microsatellites. A result obtained from the present study show that at least 2 different populations of hawksbill sea turtle is found in the northern coasts of Persian Gulf, which are including the Qeshm Island population and the Kish Island population.

References


Demographic composition of green turtle *Chelonia mydas* at foraging ground off Semporna Waters, Sabah

Juanita Joseph* and Chong Yee Kuen

*Department of Marine Science, Faculty of Maritime Studies and Marine Science
Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia
Corresponding author’s email: juanitajoseph@gmail.com*

**Abstract**

In recent years, the poaching of sea turtles at foraging grounds around Southeast Asian waters had becoming more serious, especially those in Malaysia and Indonesia. Previous studies had reported that foraging ground will consists of numerous nesting colonies, hence the exploitation of sea turtles at foraging ground might affects several nesting populations. Sadly, not much is known about the foraging grounds off Malaysian waters. An effective sea turtle conservation strategy will depend on the understanding of the migratory pathways and the source (nesting colony) for foraging stocks. Based on our survey, Semporna waters is identified as one of the biggest foraging grounds of sea turtles in Malaysia, and was chosen as our pioneer sampling site. To determine the origin of green turtles (*Chelonia mydas*) at this area, mitochondrial DNA control region sequences were compared to haplotypes from nesting populations around Southeast Asia and Western Pacific. A total of 69 green turtles were captured around Tun Sakaran Marine Park and Sipadan Island, Semporna. Out of these, six haplotypes (C3, D2, A3, Caru, C5, E2) were identified which known to be from the nesting populations of Malaysia, Philippines, Indonesia, Micronesia and Australia. The present study confirmed that sea turtle foraging ground off Semporna waters are consists of several nesting colonies. Illegal harvesting of sea turtles from this area will affect several nesting populations around Southeast Asia and the Western Pacific. International collaborations and policies are urgently needed in order to overcome poaching of sea turtles at foraging grounds.

*Keywords: green turtle, Chelonia mydas, foraging ground, mitochondrial DNA, haplotypes*

**Introduction**

The major threats of sea turtles in Malaysia include a continuous over-exploitation of eggs and adults (as by-catch in trawl fisheries and long-line fishing), habitat loss, environmental degradation, direct human disturbances, pollution, and the latest alarming incident – the illegal harvesting of sea turtles from foraging grounds. Recent news had shocked us on the poaching incidences of sea turtles around Malaysian waters by foreign fishermen from Vietnam and China (Asean-Wildlife Trade Initiative, 2007). Sea turtles conduct long migrations and take decades to mature, hence serve as important indicators of health of coastal and marine environments on both local and global scales. In other words, conserving sea turtles means protecting both turtle populations and the coastal areas they live in.

It is known that sea turtles move extensively between nesting and feeding grounds (e.g. Liew et al., 2000), but in most cases, for example in Malaysia it is not known which reproductive populations occupy a particular feeding habitat. Previous study had shown that a feeding ground will consists of several nesting colonies (e.g. Sears et al., 1995), hence the exploitation of sea turtles at foraging grounds will affect several nesting populations. Currently, not much is known about the foraging grounds around Malaysian waters. Since the harvesting of sea turtles at foraging ground is becoming serious, there is an urgent need to identify location of feeding grounds throughout Malaysia, and as well as to determine sea turtle stocks occupying these particular feeding grounds. When a turtle is captured on a foraging area, does this activity impact our rookery or more distant nesting populations? In the absence of direct observations of migratory pathways, molecular genetic markers have
proven useful for resolving migration patterns in sea turtles (Bowen and Karl, 1996). In this study, mitochondrial DNA (mtDNA) sequences will be used as a tool to determine and to identify sea turtles at foraging grounds. Genetic isolation among nesting colonies, and corresponding mtDNA haplotype frequencies differences, provide opportunity to identify the origins of juveniles and adults at foraging grounds.

This research aimed to identify feeding grounds around Malaysian waters and to identify the turtle stocks occupying each area. It is hoped by identifying sea turtles at feeding grounds, we can determine which breeding populations are affected by commercial fisheries and poaching activities. This is still an on-going research and only data from foraging grounds off Semporna waters will be presented in this paper.

**Materials and Methods**

Turtles were captured using hand either by SCUBA diving or snorkelling. Sampling was conducted only during daytime, when the turtles is resting or feeding on the bottom. Turtles were caught regardless of their size. Once captured, turtle was lifted up to the boat to withdraw a small amount (0.5ml) of blood sample, following the procedures of Dutton (1996). The turtle was tagged using inconel on both front flippers for future identification and long term monitoring purposes. It was then measured, and examined for any injuries and ectoparasites, before releasing it to the water. Blood sample was preserved in a lysis buffer (100mM Tris-HCL, 100mM EDTA, 10mM NaCl, 1% SDS; pH8.0) in a 1:10 ratio of blood to buffer (Dutton, 1996).

DNA was extracted using quick CTAB protocol (Bruford et al., 1992) and amplified using TCR5 and TCR6 primers (Norman et al., 1994). Polymerase Chain Reaction (PCR) was performed in a total reaction volume of 50µl containing 25 - 50ng of turtle genomic DNA, 1u/50µl Taq Polymerase (Bioline), 10mM Tris-HCl buffer, 2.5mM MgCl₂, 0.125mM deoxynucleotide triphosphates (dNTPs) and 0.2µm of primer TCR5 and TCR6. Cycling parameters consisted of an initial predenature at 94°C for 2 min, followed by 30 cycles of 30 sec denaturation at 94°C, annealing at 55°C for 35 seconds and extension at 72°C for 30 seconds and followed by a final elongation step at 72°C for 2 min. Standard precautions will be taken to avoid contamination during the preparation of PCR. Following PCR, the amplified products were checked for correct sizes by electrophoresis on 2% agarose gels, purified using PCR cleanup kit and will be sent off to company for sequencing.

The sequences were aligned and edited using Eyeball Sequencing Editor (ESEE3: Cabot, 1997). Sequences were compared to other mtDNA sequences of green turtles from previous studies in Southeast Asia and Western Pacific using Mega 3.0 (Kumar et al., 2001). The GenBank database (National Centre for Biotechnology Information, USA: [http://www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)) was searched for similar sequences for phylogenetic comparisons.

**Results**

Sampling was conducted from 29 June to 7 July 2010. A total of 69 green turtles were caught and tagged around Tun Sakaran Marine Park and Sipadan Island, Semporna, Sabah. Curved carapace length of sea turtle ranged from 40cm to 100cm, with an average of 61cm. For the curved carapace width, it ranges from 38cm to 83cm, with an average of 55cm. Majority of the turtle caught were juvenile (96%), except for the three individuals green turtle (one male and two females). All samples were successfully analysed and a total of six haplotypes were identified as presented in Table 1. The highest haplotype found was D2 (41%), followed by C3 (26%) and A3 (23%). Haplotypes C5, E2 and Caru were also
found but occurred in low frequency. Detailed descriptions of these haplotypes are given in Table 1.

**Table 1.** Green turtle haplotypes from the 69 samples collected from Tun Sakaran Marine Park and Sipadan Island, Semporna. These haplotypes were previously identified by Moritz et al. (2002).

<table>
<thead>
<tr>
<th>Haplotype</th>
<th>Haplotype occurrence in samples</th>
<th>Haplotype description as reported by Moritz et al. (2002) and Joseph (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
<td>26%</td>
<td>This is the common haplotype for the nesting population of green turtles in Southeast Asia and Western Pacific, differentiating them from the green turtles in the Atlantic/Mediterranean</td>
</tr>
<tr>
<td>D2</td>
<td>41%</td>
<td>Occur in high percentage for the nesting populations around Sulu Sea (Sabah Turtle Island and Philippines Turtle Islands) and low frequency from the nesting population of the Celebes Sea</td>
</tr>
<tr>
<td>C5</td>
<td>6%</td>
<td>Occur in high frequency from the nesting populations in Indonesia (Sangalaki and Pengumbahan). Also found in a very low frequency for the green turtles from Sulu and Celebes Seas</td>
</tr>
<tr>
<td>E2</td>
<td>1%</td>
<td>This haplotype is only found in Micronesia</td>
</tr>
<tr>
<td>Caru</td>
<td>3%</td>
<td>Mainly occurred in samples from Indonesia, but also occurred at very low frequency in Australia</td>
</tr>
<tr>
<td>A3</td>
<td>23%</td>
<td>This is the dominant haplotype for the Pacific green turtles and absent in Southeast Asia (except in a low frequency for the nesting population from Enu Island, Indonesia)</td>
</tr>
</tbody>
</table>

**Discussion**

The present study had demonstrated that the foraging ground around Semporna waters, Sabah, are consists of sea turtles from several nesting populations of Malaysia (Sulu and Celebes Seas), Philippines, Indonesia (Sangakali, Pangumbahan, Enu Island), Micronesia and Australia. Genetics analyses had successfully confirmed the demographic origin of the sea turtles occupying at this foraging ground. Most of the samples collected were found to have D2 haplotype. D2 was previously reported by Moritz et al. (2002) and Joseph (2006) to occur in a very high frequency from the nesting populations of Sulu Sea (Sabah Turtle Islands and Philippines Turtle Islands). The Sulu Sea green turtle populations are known to be one of the biggest populations in South East Asia, and because of that, the turtles can be found more compared to other turtle nesting population. The second most found haplotype was the C3, the common haplotype for all green turtles nesting populations around Southeast Asia and Western Pacific. Interestingly, about 23% of the samples were found to have A3 haplotype, the dominant haplotype for the nesting populations of green turtle from the Pacific. The Pacific is well known for their sea turtles conservation and management in this region. Since sea turtles spent most of their life at foraging grounds, it is crucial to protect them at these areas so that those tedious conservation efforts at nesting grounds are not wasted. Conservation at foraging grounds is far more complex than those at nesting areas. Not only we have to safeguard the waters from illegal poachers and fishing activities, we also have to protect the sea grasses bed (main diet of green turtles), coral reefs, water quality and many other factors. Clearly, international collaboration and policies are urgently needed in order to conserve the sea turtles from extinction. More study should be done to identify the location of foraging grounds and determine the stock composition occupying the foraging areas throughout Southeast Asia and the Pacific.
Acknowledgements

We gratefully thank the Director of Sabah Parks, Mr. Paul Basintal for approving the project and providing logistical support and accommodation throughout the study. Sample collection would not have been possible without the help and support from the staff of Tun Sakaran Marine Park, Semporna. This research was funded by the Fundamental Research Grants Scheme of the Ministry of Higher Education (Vot no. 59123).

References


Cabot, E. 1997. ESEE eyeball sequence editor, version 3.1. Simon Fraser University, Burnaby, Canada.


Population biology and the resilient features of mudskipper species in mangrove ecosystem

Marina H.1, D.Z.A. Atiqah1, Z. Nur-Diana1, A. Arshad2 and A.G. Mazlan1

1Marine Ecosystem Research Centre, Faculty of Science and Technology
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
2Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia
43400 Serdang, Selangor, Malaysia

Corresponding author’s email: magfish05@yahoo.com

Abstract

Population biology of several species of mudskipper fishes was described. The results showed that all mudskipper species established different and specialized mode of living. Further analysis on aerial respiration organs denoted that, the mudskipper species possess a well-adapted aerial respiratory organ (ABO), inculcating higher degree of resiliency amongst the mudskipper species living in such a harsh ecosystem.

Keywords: mudskipper fishes, population biology, aerial respiration

Introduction

Mudskippers are members of the subfamily Oxudercinae (tribe Periophthalmini), within the family Gobiidae (Gobies). They are completely amphibious fish, fish that can use their pectoral fins to walk on land. Being amphibious, they are uniquely adapted to intertidal habitats living in the different forms of burrows and establishing territorial guard surrounding it burrow. During high tide, the mudskipper species will stay in the burrows and during low tide, they established their amphibious mode of living on the exposed mudflat. Mudskippers are quite active when out of water, feeding and interacting with one another, which involves various activities such as mating display, feeding and fighting in defending territories. Detail analysis on population biology and resilience features determines survival success of mudskipper species in mangrove ecosystem is still lacking. Therefore, this study was aimed to describe the population biology of commonly found mudskipper species in the mangrove ecosystem and to further elucidate the resilience features that determine their success of living in such a harsh environment.

Material and Methods

Sampling of mudskipper was carried out at mangrove swamp in Bagan Lalang, Selangor. Sampling methods involved various fishing gears such as hook and line, traps and scoop net. Throughout the survey, a total of 105 small mudskippers comprising four major species dominating the study areas. These are the blue spotted mudskipper, Boleopthalmus boddarti, the dusty gilled mudskipper, Periopthalmus novemradiatus, the orange spotted mudskipper Periopthalmus chrysospilos and the giant mudskipper, Periopthalmodon schlosseri. These mudskipper species were examined for their growth population and their feeding behaviour to understand their food niche. Further in-depth analysis was also carried out to investigate the fine structural organization of aerial respiration organs of these mudskipper species. B. boddarti and P. schlosseri are two co-existing species of mudskippers inhabiting muddy mangrove area. Fine structural organization of aerial respiration organs of mudskipper species was examined. Gills were dissected out and samples were treated following the standard electron microscopy sample preparation.
Results

Figs. 1-8. Gills of *Periopthalmus novemradiatus* (Figs. 1-2), *Periopthalmus chrysospiros* (Figs. 3-4), *Boleophthalmus boddarti* (Figs. 5-6), *Periopthalmodon schlosseri* (Figs. 7-8) seen at various magnifications of SEM. Labels: GR, gill raker; GF, gill filament; SL, secondary lamellae; AP apical pores.
Length-weight analyses were carried out to examine the population growth and their wellbeingness in the harsh mangrove ecosystem. It was found that all mudskipper species exhibits both form of growth pattern based on the length-weight relationship analysis \( W=aL^b \). *B. boddarti* exhibits an allometric negative growth rate \( W=0.0208L^{2.65} \) while *P. chrysospilos, P. novemradiatus* and the *P. schlosseri* exhibit an allometric positive growth rate at \( W= 0.00233L^{3.59} \), \( W=0.0000065L^{3.052} \) and \( W=0.0012L^{3.32} \) respectively. Analysis of feeding guilds showed that small mudskippers species *B. boddarti* and *P. chrysospilos* fed on detritus particulate, which consist of benthic diatoms whiles the giant mudskipper species were the only carnivorous oxudercine species feeding on fiddler crabs. Among the small mudskipper species, a comparison had been made between the stomach contents and sediment sample and they showed similarities in diatom variation such as *Coscinodiscus, Gyrosigma, Navicula* and *Nitzschia*. Concentrations of Chlorophyll-a were also extracted from the non-grazed and grazed sediment. The results showed a significant difference in chlorophyll-a concentration between grazed area and non-grazed area surrounding the territory, \( T=-2.77; P<0.005 \) in Bagan Lalang. Examination on the electron micrographs showed that *P. novemradiatus* had shorten, thick, bent and slightly coiled at the end of filament (Figure 1). The filament appeared to support secondary lamellae that graded towards the tip. Further investigation on micrograph showed there are eight secondary lamella attached to 290\( \mu m \) long filament of gill filament (Figure 2). Four-gill arches of this species have different gill rakers. Secondary lamellas of *P. novemradiatus* were rectangular in shape and thick (25-30\( \mu m \)) contain many apical pores and wrinkles structural (Figure 2). *P. chrysospilos* gill is short, thick, curved, and have filaments that are arranged not too close to each other. Gill structure under an electron microscope with 47 X magnification showed that the size of a gill filament length 1200\( \mu m \) consists of 28 secondary lamellae is calculated on average (Figure 3). Secondary lamellae of *P. chrysospilos* is a short 90 \( \mu m \) and thickness of 14-16 \( \mu m \) in size. (Figure 4). The results of this study under an electron microscope clearly showed that *B. boddarti* (Figure 5) has a more rigid filaments and the distance between the filaments is 319 \( \mu m \) closer than *P. schlosseri* (Figure 7) with a distance of 687 \( \mu m \). Filaments of both species were found to support the secondary lamella graded to the end. *P. schlosseri* secondary lamella structure (Figure 8) clearly shows the distance between the secondary lamella closer to each other which is 28 \( \mu m \) compared to *B. boddarti* (Figure 6) is 59 \( \mu m \).

**Discussion**

Population biology of the smaller mudskippers species in the study areas demonstrated a complex and specialized living characteristic. As such, *B. boddarti* and *P. schlosseri* are found to share a similar habitat even though the mode of living are completely different (Mazlan and Rohaya, 2008; Takita et al. 1999). The growth pattern of all the mudskipper species are independent to each other due to the facts that, the growth condition factors in fishes are mostly influenced by the state of physiological changes and environment of living (Gordon, 1969; King and Udo, 1997a,b). *P. chrysospilos* were mostly dominated the exposed sandy low tide areas and normally formed large schooling in the tide pools (Mazlan et al., 2006) where as other species *P. novemradiatus* dominated at the higher level the exposed sandy tidal flat. The gills of *P. chrysospilos, P. schlosseri* and *B. boddarti* exhibit different features of morphology. The secondary lamella of *P. chrysospilos* and *P. schlosseri* decreases in size towards the tip of the filament. Besides that, the filament gills of *P. schlosseri* are relatively short, branching and the thick lamellae have connected inter-lamellae structure. This unique feature will give an advantage to both of these species while they are on land by exposing lamellae surface area for gaseous exchange even though if the lamellae are to coalesce upon terrestrial exposure (Low et al., 1988). However, the thick build-up of the secondary lamellae may contribute to the prevention of the juxtaposition of these lamellae towards each other while they are exposed to air. Wilson et al. (1999) found that the thin structure lamellae of mudskipper *P. schlosseri* increases the surface area and serves a suitable medium for gas exchange. When the mudskippers breathe on land, the
thin structure of lamellae is supported by the big and branched filaments to evade the breathing organ structure from coalesces. Hughes and Datta Munchi (1979) reported that the thick lamellae structure of air-breathers teleost act as an oxygen-conserving device or to prevent oxygen loss when the surrounding water has low oxygen tension. Beside that, the secondary lamellae surfaces of P. chrysospilos are wrinkled that may increase the gill surface area. However, a problem that this mudskipper species faces during terrestrial exposure is that the gills may face the threat of desiccation. In order to prevent desiccation of the respiratory surface, the surface of the secondary lamellae may raise to function as a mucus-supporting tool (Morgan and Tovell, 1973; Morris and Pickering, 1975).

The results of this study showed that both species are able to breathe air using specially modified gills apparatus. B. boddarti possesses long and unbranched filaments, smaller distance between filaments and the thickened lamellae whereas the P. schlosseri has short filament, branching, larger distance between filaments supporting thinner lamellae. As a conclusion, results of the study showed that, there were differences in size, distances between and numbers of the secondary lamellae attached to axis of the filaments in both species of mudskipper. The gills of P. schlosseri showed some unique features that enable them to successfully survive out of water in terrestrial life compared to B. boddarti that capable to adapt in both terrestrial and aquatic life. Special architectural plan of gills and skins of these oxudercine species may have contributed to their successful existence in muddy mangrove area.

Acknowledgements
This research was funded by UKM-Science Fund 04-01-02-SF0124.

References
Diversity of seaweeds in the vicinity of Johor: With emphasis on the east coast of Peninsular Malaysia Expedition II 2006

M.H. Gan¹ ², A. Siti Aishah¹, A. Nur Wahidah¹, K. Amyra Suryatie¹ and M.P. Noraien¹

¹Department of Marine Science, Faculty of Maritime Studies and Marine Science,
Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia
²Institute of Tropical Aquaculture, Universiti Malaysia Terengganu,
21030 Kuala Terengganu, Malaysia

Corresponding author’s email: mh_gan@yahoo.com

Abstract

Johor is the southernmost state in Peninsular Malaysia. It has a long coastline that is divided into the west, southern and east coasts. These three different coasts attribute varying habitats such as sandy beaches, rocky shores, mangrove fringes, estuaries, coral reefs and seagrass beds. These important aquatic ecosystems support a rich biodiversity of flora and fauna. East Coast Peninsular Malaysia Expedition II 2006 was conducted to document the diversity and distribution of seaweeds and seagrasses at 49 localities along the Johor coastline. A relatively high diversity of seaweeds were found in these collection areas. The present tally of seaweeds from the Johor coastline stands at 197 taxa, which is represented by 7 families, 15 genera, 26 species of Cyanophyta; 14 families, 21 genera, 56 species of Chlorophyta; 6 families, 14 genera, 34 species of Ochrophyta/Phaeophyta; and 17 families, 42 genera, 81 species of Rhodophyta. Out of the many species, 57 of them are new records in Malaysia. Also in this paper, ecological and economical importance of some species will be discussed.

Keywords: Chlorophyta, Cyanophyta, distribution, Phaeophyta, Rhodophyta

Introduction

Seaweeds are macroscopic marine-benthic algae that can be divided into four large groups namely divisions Cyanophyta, Chlorophyta, Ochrophyta or Phaeophyta and Rhodophyta. Apart from being an important source of food for humans, seaweeds play an important role in coastal and marine habitats. Seaweed beds serve as a unique habitat for marine vertebrates and invertebrates. They form an underwater forest, providing shelter, spawning, feeding and nursery ground for economically important marine fishes and crustaceans (Lobban and Harrison, 1997). Seaweeds, together with phytoplankton, are the primary producers of the marine ecosystem. They are capable of carrying out photosynthesis, thus forming the foundation of the food web. Marine life also depends on organic substances that can be obtained from seaweeds directly or indirectly (Ahmad, 1995). In modern aquaculture, seaweeds are used as biofilters in integrated farming to remove nutrients from aquaculture effluents (Bushmann et al., 1996). Seaweeds can also act as bioindicators by efficiently monitoring the quality of aquatic environment (Haglund et al., 1996).


Johor state has a coastline of about 400 km facing the South China Sea, Straits of Tebrau and Malacca. Mangrove swamps dominate the west coast of Johor, which is sheltered by Sumatra, Indonesia. River estuaries with mangroves fringed with extensive seagrass beds characterize the southern coast of Johor. Sandy and rocky shores with coral reefs are mainly located on the east to south-east coastal regions of Johor. The seaweed flora of Malaysia is
subjected to the equatorial climate, dominated by the Northeast and Southwest Monsoons (Phang, 1998). During the surveying period, hydrological parameters such as salinity ranged between 8.52 and 31.30‰; surface water temperature ranged between 27.50 and 30.96°C; specific conductivity was 16.57 to 52.99mS cm⁻¹; total dissolved solid ranged between 9.64 and 31.35g L⁻¹ and pH values between 6.62 and 9.97.

The East Coast Peninsular Malaysia Expedition II (ECPME II) is the second scientific expedition after ECPME I (Gan et al., 2008), and it was carried out from May until June 2006. From both expeditions, 49 localities were visited. We hereby document a comprehensive checklist of Johor’s seaweeds with an extensive collection from 2000-2006.

**Materials and Methods**

**Description of collection sites**
In the complete checklist compilation, 49 localities were noted. Of these, 40 sites (S1-S16, S19-S42) were visited during the ECPME II 2006. Four types of habitats with natural seaweed population growth (except for man-made earth ponds) were described. Sandy or muddy rocky shores with tidal pools were prominent habitat for many epilithic species. Seaweeds attached themselves to solid substrates such as rocks, pebbles and coral rubbles. This harsh environment is mainly located at the east to south-east coasts of Johor. Extensive seagrass beds at the southern coast of Johor were supported by epiphytic and epizoic species. Here, seaweeds were seen growing on seagrasses and shellfishes. Another favourite habitat of seaweeds is the intertidal mangrove sometimes fringed with seagrass stretches on neither rocky nor muddy substrata. Here, epiphytic seaweeds can be found growing on the mangrove plants’ neumatophores. Lastly, cage cultures, green mussel rafts, jetties at river estuaries or coastal areas provide artificial substrates such as fish nets, plastic drums, concrete or wooden structures for seaweeds to grow.

**Sample collection and identification**
Seaweed specimens were collected during low tide or by snorkelling at deeper areas. Specimens were cleaned and fixed in 5% formalin in seawater. Some were subsequently dried and made into voucher herbarium specimens. The external morphology and internal structures, such as cells and reproduction characteristics of the specimens were studied. Specimens were sectioned by hand using a razor blade. The sections were then stained with 0.5% (w/v) aniline blue in acetic acid/phenol/glycerol/water (1:1:1:1) solution and mounted in 50% glycerol-seawater on microscope slides. Taxonomical identification was made by using published keys and taxonomic references. All specimens are deposited in the Marine Algal Reference Collection (MARC), Institute of Oceanography (INOS), Universiti Malaysia Terengganu. MARC currently catalogues more than 7000 voucher specimens collected from Malaysian waters while some are from the Philippines and Japan.

**Results**

Table 1. Summary of taxon according to different coasts.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Cyanophyta</th>
<th>Chlorophyta</th>
<th>Ochrophyta</th>
<th>Rhodophyta</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>S</td>
<td>E</td>
<td>T</td>
</tr>
<tr>
<td>Class</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Order</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Family</td>
<td>7</td>
<td>14</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Genus</td>
<td>15</td>
<td>21</td>
<td>14</td>
<td>42</td>
</tr>
<tr>
<td>Species</td>
<td>3</td>
<td>18</td>
<td>10</td>
<td>26</td>
</tr>
</tbody>
</table>

W: west coast; S: southern coast; E: east coast; T: total; L: literature (Phang, 2006; 2007)
In Johor, the most diversified seaweeds are represented by Rhodophytes (81 taxa), followed by Chlorophyta (56 taxa), Ochrophyta (34 taxa) and Cyanophyta (26 taxa) (Table 1). This finding is concurrent with Phang (2006), whereby states that Rhodophytes dominate the tropical seaweed flora and many of these are filamentous epiphytic species. The total taxa accounted for Chlorophyta, Ochrophyta and Rhodophyta in this study is half the number of taxa recorded by Phang (2006) and Phang et al. (2007). Nevertheless, blue-green algal taxa have a much higher number when compared to the records of Phang (2006) and Phang et al. (2007). Fifty-seven taxa (21 taxa of Cyanophyta, 13 taxa of Chlorophyta, 6 taxa of Ochrophyta, and 17 taxa of Rhodophyta) were identified as new records in Malaysian waters. *Phormidium* (5 spp.) and *Lyngbya* (4 spp.) of Cyanophyta; *Caulerpa* (11 spp.) and *Cladophora* (9 spp.) of Chlorophyta; *Sargassum* (12 spp.) and *Dictyota* (7 spp.) of Ochrophyta; and *Gracilaria* (12 spp.) of Rhodophyta were identified as highly diversified genera among each division.

In terms of floristic distribution, the highest number of taxa (127 taxa) was recorded in the east coast, followed by the southern coast (115 taxa) and the west coast (31 taxa) of Johor. Blue-green algae and green seaweeds were mainly distributed in the southern coast of Johor. Brown and red seaweeds on the other hand were more abundant in the east coast. The most abundant blue-green algae, *Lyngbya majuscula*, was distributed in massive or drifted form along the east to south-east coasts of Johor. *Ulva intestinalis* and *U. clathrata* were the two dominant green seaweeds found in all coasts of Johor. *Padina australis* and *Dictyota dichotoma* complex are brown seaweeds mainly distributed in the east coast and southern coast of Johor, respectively. Two agarophytic seaweeds, *Hydropuntia edulis* and *Gracilaria changii* were ubiquitous in Johor coasts. Based on the Sorensen’s Coefficient of Similarity (S,%), the seaweed flora of 4 localities in Mersing exhibit high similarities. Besides that, seaweed flora of several areas with cage culture in the southern coast is also similar to those in Sungai Sedili Besar, east coast of Johor.

**Discussion**

Tanjung Setajam, Tanjung Balau, Tanjung Penawar (Desaru), Pantai Air Puteri, Teluk Iskandar, Pantai Chalet D’Rimba and Batu Sirik (Mersing) are sandy rocky shores which recorded the highest number of taxa. Mangrove fringed with seagrass stretches or rocky substrata such as Sungai Pulai, Kampung Pasir Gogok, estuary of Sungai Santi, Tanjung Kopok and Tanjung Langkah Baik are areas with moderate diversity of seaweeds. According to Phang et al. (2005), coral reefs support the highest diversity of seaweed species, followed by rocky shores and sandy-muddy areas. Mangrove areas around the Malaysian coastline are also known habitat for seaweeds, especially for the epiphytic species (Teo and Wee, 1983). In addition, certain abiotic environmental factors such as water current and kind of substrates will also contribute to the type of innate distribution of marine floral communities.

Beneficial and detrimental features of the cyanobacteria are of considerable significance. These nitrogen fixing species contribute globally to soil and water fertility. *Trichodesmium* spp., which were documented during this expedition, play an important role in the nitrogen cycle and carbon sequestration (Kana, 1993). *Spirulina subsalsa* and *Spirulina* sp. are sources of nutrient supplements in human diets. Cyanobacteria are also sources for substances of pharmaceutical interest, such as antibiotics (Geoffrey, 2000). On the detrimental side, blue-green algae’s extensive bloom can create a nuisance for management of inland waters (Geoffrey, 2000). They can also release unpleasant or toxic substances into the waters (Brian and Malcolm, 2000). *Lyngbya majuscula*, a filamentous cyanobacterium which is widely distributed in Johor waters may cause massive blooms. It contains chemical substances that exert a range of biological effects, including skin, eye and respiratory irritation (Dale and Paul, 1997).
Other than their ecological roles, seaweeds have been utilized for direct human consumption or as raw materials in phycocolloid, pharmaceutical or neutraceutical industries. *Caulerpa, Solieria* and *Gracilaria* are made into salads and eaten raw. However, its application is only restricted to small local fishing folks who stay nearby the coastal regions. Several potentially useful agarophytic genera were collected. Among them are *Gelidium, Gelidiella, Pterocladiella* and *Gracilaria*. Agar from *Gracilaria* was extracted and was shown to be good in quality, thus it has the potential for commercial application (Phang and Vellupillai, 1989). *Ulva* can be used as a natural bioindicator during eutrophication in coastal waters. *Halymenia* and *Grateloupia* are species with potentially bioactive natural compounds that are yet to be discovered.

**Conclusions**

The coastal areas of Johor, Peninsular Malaysia support a relatively high diversity of seaweeds. Many commercially important as well as scientifically interesting species have been identified. To be able to assess or monitor the status of marine floral communities in our Malaysian waters, more collaborative networks among experts is needed.

**Acknowledgements**

This project is partially funded by INOS, Universiti Malaysia Terengganu. First author would like to thank to Choy Mun Kuin and Chai Zi Fei for their assistance to make the checklist possible. Appreciation is also extended to Ms. Teo Woon Li who was helping to review this manuscript.

**References**


Oral: Session 2A
Governance and Socio-Economics
Responsible small scale capture fisheries

Abdul Rahim Ibrahim\textsuperscript{1} and Saharuddin Abdul Hamid\textsuperscript{2}

\textsuperscript{1}Dept. Nautical Science and Maritime Transport, Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu, Kuala Terengganu, 21030 Terengganu, Malaysia

\textsuperscript{2}Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu, Kuala Terengganu, 21030 Terengganu, Malaysia

Corresponding author’s email: ibrahim@umt.edu.my

Abstract

Fish is becoming scarcer, and increasingly difficult and additionally costly to capture. Hence, the price of the aquatic creatures multiplied daily, depending on the current supply and demand. However, the escalating values of the animals bring much profit to fishermen and this generates incentives for them to go out searching and seizing the much sought protein food. As a result, the fisher folks have to pay more for their effort, time and fuel. This paper highlights costs, sales and incomes or profits of small-scale outboard-engine sea fishers of Terengganu and suggests new technique to capture the organisms. The escalating price of petroleum (gasoline) set back the small-scale fishermen who just make ends meet routinely. In order to save on fuel, it is offered to them to use sails in some time in their endeavour to catch the life forms. Method used is by observation of the industry and in-depth interviews of the catchers. Results show that some of them agreed to the suggestion of exploiting the sail power, interchanging with the operation of outboard engines, while some other respondents say that it would be rather difficult for their small vessels to carry sails onboard. Moreover, new boat designs have to be constructed for the purpose. The propositions and contradictions are further deliberated and it is concluded that besides reducing costs, sail power could diminish aquatic, air and land pollutions, as well. However, sails could be employed together with the outboard engines because sometime winds are not always available in certain areas and during particular time. Overall, this would enhance more profits to the small scale artisanal fishers.

Keywords: artisanal fisheries, costs, outboard engines, sail power, pollutions, profits
Co-management arrangements for Kota Marudu, Sabah

Illisriyani Ismail1*, Fatimah Mohamed Arshad1, Kusairi Mohd Noh1, Tai Shzee Yew1, Zahira Mohd. Ishan2 and Suryani Darham1

1Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, 43400 Serdang, Selangor
2Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor

Corresponding author’s email: illisriyani@gmail.com

Abstract

This paper is based on the project titled “Co-management Arrangements for Kota Marudu”, funded by Ministry of Science and Technology Innovation (MOSTI), Malaysia. The general objective of this study was to design policy, institutions and projects for sustainable fisheries management in Kota Marudu, Sabah. The three specific objectives were; (i) to identify and determine the status of stakeholders in the Kota Marudu area with respect to poverty and gender issues; (ii) to identify opportunities for poverty reduction, income generation and alternative livelihood without compromising the ecological integrity of coastal resources, and; (iii) to evaluate and improve the management of coastal resources with respect to sustainability issues.

A Logical Framework Analysis (LFA) and a Key Informant Survey (KIS) were conducted in preparation for the Household Survey (HHS). From the LFA analysis conducted in February 2009, in general the stakeholders (representatives from the government agencies, fishers and NGOs) were in agreement that the fishing industry in the area was not developed and sustainability managed. The return to fishing was very low.

The KIS survey (conducted in May 2009) involved 14 representatives of the fishing community (comprises village heads, members of development and security committee and Ketua Anak Negeri) and eight respondents from the agencies (public and NGO). The village heads and community representatives in the KIS study highlighted the socio-economic conditions of the fishing community. It was mentioned that the area lacked facilities and infrastructures, low skilled workers and little government investment into the area.

The HHS survey covered 13 villages with 170 respondents who were mainly fishers. This was conducted in June 2009. The survey on the households provided the socio-economic profile of the fishing community in the area. Besides having high percentage of poverty in the area, the community also lack education and other basic amenities.

For a successful co-management plan for the area, it is recommended that two committees be set up to initiate the plan as well as to identify the activities to be carried out. The two committees are the Coordination and Monitoring Committee and Fisheries Resource Management Committee. This is similar to the administrative set-up at the Langkawi co-management plan. Several activities are also suggested based on the findings and observations of the study. The activities are aquaculture, agriculture, marketing and processing, input supply and services, tourism and hospitality.

The success of the plan however is a function of multitude of factors. Since the fishing industry in Kota Marudu is small scale and subsistence-based and basic infrastructure are clearly lacking, the plan requires involvement from all parties that is the local community, institutions, agencies and external assistance.

Keywords: fisheries co-management, Kota Marudu, (Sabah), Key Informant Survey (KIS), Household Survey (HHS), Legal Framework Analysis (LFA) and socio-economy
Introduction

Kota Marudu is one of the districts in Kudat division with approximately 19.17 square kilometres of land. The environment around the coastal area is rich in mangroves and associated flora and fauna. It is an important breeding area for commercial fishery for both finfish and prawns and mangroves (Rooney, 2001). In conserving and preserving the natural resources there is no doubt that an improved management of the coastal area based on an integrated and comprehensive approach involving the various stakeholders and local communities is vital for sustainable development and enhancement of the value of these resources.

The population in Kota Marudu as at 2009 is approximately 72,900 with the average population of five per household (Department of Statistics Malaysia, 2010). Fishing is the predominant economic activity in Kota Marudu with 93.8% of the community involved in fishing (Department of Statistics, Sabah, 2007). Other than the problem of declining fish stocks, other factors that contribute to the poor condition of the coastal area are the land-based pollution, flood and excessive forest cutting.

Since the majority of the community depend on fisheries resources to support their livelihood, there is a need to ensure policies, institutional arrangements and investment projects that will help improve the condition of coastal and marine fisheries and aquatic resources. Moreover, it will aid in reducing poverty in coastal communities by improving the management of coastal resources and ecosystems, minimizing threats to their ecological integrity, and providing income generation and alternative livelihood opportunities.

Co-management covers various partnership arrangements and degrees of power sharing and integration of local (informal, traditional and customary) and centralized government management systems. It is about relationships and stresses the need to involve and empower those people in the management decision-making processes whose livelihoods depend on coastal resources, and who are affected by management decisions. At the same time, co-management also invites the positive contribution of user groups and civil society, since they possess and control knowledge that may inform the management process, thus producing more viable outcomes (Pomeroy, 1995).

Materials and Methods

A Logical Framework Analysis (LFA) and a Key Informant Survey (KIS) were conducted in preparation for the Household Survey (HHS).

LFA were conducted as to plan and solicit the nature of problems faced by the stakeholders as well as to derive policy suggestions for improvement. It helped to provide a standardized summary of the project in a logical and systematic way. There were four major steps involved in the LFA which are (1) stakeholder analysis; (2) objective analysis; (3) alternative strategies analysis and; (4) log frame matrix. This method was adopted from the AusAid (Australian Agency for International Development, 2005). These were carried out with the stakeholders to identify their problems, interests, expectations and economic potentials of all important groups and institutions in the area. These participants include village heads, government officials and representatives from WWF.

The KIS was designed to identify several important indicators in order to establish a simple baseline for the community profile. It involved 14 representatives of the fishing community or the stakeholders (comprises village heads, members of development and security committee and Ketua Anak Negeri) and eight respondents from the agencies (public and NGO).
The HHS survey covered 13 villages involving 170 respondents who were mainly fishers. This was conducted to determine their socio-economic status, economic activities and their perception and readiness in adopting a co-management approach in the area.

The study utilised both descriptive and inferential statistical analyses. Descriptive statistics were calculated to describe demographic and socio-economic profile of the respondents, as well as their attitude and perception towards coastal resource management. In addition, factor analysis also was used to examine the latent factors that might contribute to the success of coastal resource management.

Results

The LFA analysis, indicated that the stakeholders were in agreement that the fishing industry in the area was not developed and sustainability managed. The return to fishing was very low and there were a number of contributing factors to that. The factors were non-sustainable fishing practices such as the use of explosives and poison, declining fish stock, unskilled human resource, undeveloped institutional capacities, and lack of government support, basic infrastructures and legislative enforcement.

As for the KIS survey, the socio-economic conditions of the fishing community was highlighted by the 14 village heads and community representatives. In terms of demographic characteristics, most of the population in the community were local. The major ethnic groups were Bajau and Dusun. Their major languages were Bajau, Dusun and Malay. Most of the population were predominantly Muslim. Both representatives from villages and the agencies were of the opinion that the area lacked facilities and infrastructures, low skilled workers and little government investment into the area. The respondents believed that the area holds good prospects in terms tourism, aquaculture and fisheries development while ensuring resources will be conserved in a sustainable manner.

The survey on the households (HHS) provided the socio-economic profile of the fishing community in the area. Besides having high percentage of poverty in the area, the community also lack education and basic amenities. The respondents agreed that the fisheries resource management in Kota Marudu is in need of a revamp so that wastage and damage are minimised and enough fish will be available for the future. They reported several major problems faced in the area such as excessive cutting down of mangrove forests, pollution of rivers and coastal, declining of the fishery resources because of the use of bomb and poison and encroachment by trawlers. They have also proposed several projects that they perceived to have potential to improve their livelihood such as farming and processing factory for mussels, fish and crabs; the need for ponds and cages for fish, crabs and shrimps and fishing gears. To support all these activities proposed, basic infrastructures are crucially needed in the area.

Discussion

The situation of the coastal resource and socio-economic condition in Kota Marudu is obviously in a crisis as indicated by deteriorating catch and rampant unsustainable fishing practices and poverty in the community. There is a need for policies, institutions and investment projects to improve the condition of coastal and marine fisheries and related resources. Moreover, it will reduce poverty in coastal communities by improving the management of coastal resources and ecosystems, minimizing threats to their ecological integrity, and providing income generation and alternative livelihood opportunities.

As a starting point, it is recommended that two committees to be set up to initiate the co-management plan as well as identifying the activities to be carried out. The recommended
committees are the Coordination and Monitoring Committee and Fisheries Resource Management Committee. The Coordination and Monitoring Committee functions as an advisory body to the management committee. The matters to be advised include; resource management and policy, to monitor the implementation, to decide on unresolved matters raised by the management committee, to plan and formulate policy and concept implementation of CBRM and to review and decide on the type of assistance and support services to be provided towards the successful implementation of the management plan including R&D, training, information collection, etc. The Fisheries Resource Management Committee is responsible for the day to day management decisions in the implementation plan including; planning of the resource management of the area, managing and protecting the resources, ascertaining the method of resource exploitation conforms to the procedures and licensing policy of the DoF, assisting the government in managing and preparing policies on the resources, resolving problems and conflicts and providing information to members.

However, the achievement of these goals requires a number of investments from the government in all dimensions such as the infrastructures, social amenities, education and commercialisation of agricultural activities.

References


Sustainable fisheries of the east coast of Peninsular Malaysia: Is traditional fishing the "best hope" for it?

A. Azizi* and A.H. Saharuddin

Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu, Terengganu, Malaysia

Corresponding author's email: gsk0798@pps.umt.edu.my

Abstract

Many of those involved in fishing (fishers, industry, policy-makers, and environmental organizations) are already acutely aware of the rapid depletion of key fish stocks and the serious disruption and degradation of the marine ecosystems. Therefore, The Code of Conduct for Responsible Fisheries was adopted as a guiding principle on how sustainable fisheries can be achieved at national level in all aspects of fisheries. The Code provides necessary framework for national efforts to ensure sustainable exploitation of aquatic living resource in harmony with the environment. Government policies and projects continue to focus on improving and upgrading coastal fishing activities. However, it has insufficient steps toward efficient management and sustainable development of fisheries.

Therefore, one of the alternatives is to encourage and emphasis the traditional fishing methods toward sustainable fishing practice. The objective of this paper is to review the status and trend of traditional fishing activity in the East Coast of Peninsular Malaysia (drift or gill nets, lift nets, hooks & lines, stationary and portable traps) as a whole and illustrates the real situation from 1998 to 2007. This study, are based upon the annual report of national official published data by the Department of Fisheries Malaysia and short interviews with the several local fishers in Kuala Terengganu District.

The statistics shows that the traditional fishing fleet contributed over than 70% of the total licensed fishing vessels between 1998 and 2007 but they discard almost no fish (very little unwanted fish and almost all of their catch is used for human consumption). On the other hand, trawls nets contributed about 50% of discard fish from their catch and 10% for seine nets each year. Thus we can make initial conclusion that the traditional fishing is our best hope for sustainable fishing.

However, further study is needed to address this issues, because scientific evident and knowledge about our traditional fishing such as technology, human resource and socio-economic is very limited. Improved documentation of these fisheries is needed to gauge global trends, identify the threats to their sustainability, and assess management options.

Keywords: fishing trends, responsible fisheries, fishing fleet, human consumption, discard

Introduction

Maintaining a biological, social and economic system considers the health of the human ecosystem as well as the marine ecosystem. A fishery which rotates among multiple species can deplete individual stocks and still be sustainable so long as the ecosystem retains its intrinsic integrity. Such a definition might consider as sustainable fishing practices that lead to the reduction and possible extinction of some species (Hilborn, 2005).

Unfortunately, similar to other environmental issues, there can be conflict between the fishermen who depend on fishing for their livelihoods and fishery scientists who realize that if
future fish populations are to be sustainable then some fisheries must reduce or even close. Traditional fisheries have high potential of contributing to the achievement of sustainable development goals. It is widely recognized that such fisheries play an important role in resource conservation, food and livelihood security, poverty alleviation, wealth creation and foreign exchange earnings (FAO, 2005a).

Despite the intense fishing pressure and a decline in productivity, the fishery sector in Malaysia still plays important role in providing food, income and employment. Traditional fishing is, in terms of the number of people involved, the dominant fishing sector at the national level. It is particularly important as a source of livelihood for the poor, and may contribute more to the national economy than commercial fishing. As we know, problems with traditional fishing are well recognized. Many coastal fishers are facing the dilemma of fisheries collapse, the search for income, and the difficulty in sustaining fishing livelihoods (Lymer et al., 2008)

Some of the relative advantages of traditional fishing for sustainability conditions are; Lower running costs and fuel consumption. In general, having less mechanical power than commercial and industrial fisheries, they tend to optimize human power and reduce fuel costs, using more passive gears and practices such as handlining, longlining, gillnets, fish traps and light attraction. Lower ecological impact, it is usually agreed that their environmental impact is reduced because they employ mainly passive gears. Higher employment opportunities, being more labour-intensive, traditional fisheries are naturally suited in rural areas with high demographic growth, providing employment in catching as well as processing and trade of fish and fishery products (FAO, 2005b).

However, based on national traditional fishing, low-input fisheries is poorly understood, and inadequately documented. In many cases, sector catches are not properly recorded, and statistics are lacking on catch value, vessel numbers, numbers of operators, the amount of employment generated, the demographic profile, and the distribution of benefits. This means that the contribution of the sector to sustainable social and economic development and to environmental sustainability is not well recognized.

Materials and Methods

To provide basic information of the traditional fishing effort, the traditional fishing industry statistics in this paper are based upon the annual report of national official published data by the Department of Fisheries Malaysia from 1997 to 2007 and short interview with the several local fishers in Kuala Terengganu District. The statistics do not reflect an un-quantified rate of fisheries effort, activities, landings and sales outside of this published data-set, in particular as a result of unreported and unregulated traditional fisheries. Based on the data available, the trend of licensed issued, fishers and comparison catches and discard of traditional fishing and commercial fishing (trawl and seine nets) was explained.

Results

The result shows that the traditional fishing fleet contributed over than 70% of the total licensed fishing vessels each year (Table 1) and the rest (30%) is from the trawl and seine nets. However, both (trawls and seine nets) produced about 30% (average) of discarded fish compared to traditional fishing gear group (Figure 1). This explained that the traditional fishing is more selective and far less destructive to the environment as they discarded very little unwanted fish and almost all of their catches are used for human consumption.
**Table 1:** Percentage of licensed fishing vessels issued compared to overall (1998-2007).

<table>
<thead>
<tr>
<th>Year</th>
<th>Traditional vessels</th>
<th>Overall Vessels</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>4,229</td>
<td>5,759</td>
<td>73.43</td>
</tr>
<tr>
<td>1999</td>
<td>4,229</td>
<td>5,717</td>
<td>73.97</td>
</tr>
<tr>
<td>2000</td>
<td>3,934</td>
<td>5,469</td>
<td>71.93</td>
</tr>
<tr>
<td>2001</td>
<td>4,207</td>
<td>5,781</td>
<td>72.77</td>
</tr>
<tr>
<td>2002</td>
<td>3,774</td>
<td>5,320</td>
<td>70.94</td>
</tr>
<tr>
<td>2003</td>
<td>3,795</td>
<td>5,283</td>
<td>71.83</td>
</tr>
<tr>
<td>2004</td>
<td>4,471</td>
<td>5,995</td>
<td>74.58</td>
</tr>
<tr>
<td>2005</td>
<td>4,800</td>
<td>6,430</td>
<td>74.65</td>
</tr>
<tr>
<td>2006</td>
<td>4,841</td>
<td>6,480</td>
<td>74.71</td>
</tr>
<tr>
<td>2007</td>
<td>5,104</td>
<td>6,769</td>
<td>75.40</td>
</tr>
</tbody>
</table>

**Figure 1.** The comparison of marine fish landing and discard between traditional fishing and both trawl and seine nets in East-Coast of Peninsular Malaysia.

**Figure 2.** The trend of traditional fishers by fishing gear between 1997 and 2008 in East-Coast of Peninsular Malaysia.
It was found that various trends of registered traditional fishers by fishing gear shown in Figure 2 above. However, the explanations of the result require more scientific study.

**Discussion**

To promote sustainable development of traditional fishing, decision-makers have to recognize the roles and importance of fisheries to livelihoods, the diverse and complex nature of fishery-related livelihoods, and ensure fisheries are sustainable. Initiatives and experiences in sustaining fisheries livelihoods and creating wealth developed and implemented worldwide can shape and reinforce future efforts in traditional fisheries development. Understanding interrelationship between fisheries, livelihoods and wealth creation including their underlying factors as well as identify available options for better recognition, value and support of such linkages can ensure that traditional fishing could form strong partnership in the sustainable development.

However, these fisheries are generally poorly documented and their impacts not well understood because the large numbers of small boats characterizes traditional fishing that, fishing in dispersed and remote locations in Malaysia. Knowledge of their characteristics, fishing gear, technology, seasonality, catches, yields, revenues and cost of this sector is still limited. The priority and the most important now are to gather scientific data and information to meet the needs to all parties especially for the future of the traditional fishing communities.

**Acknowledgements**

Many of the ideas in this paper have been developed over the past several months through discussions with my PhD thesis supervisor. I would like to thank my supervisor, Assoc. Prof. Dato’ Dr. Saharuddin b. Dato’ Abd. Hamid (Dean of Maritime Studies and Science Marine Faculty, Universiti Malaysia Terengganu) for useful comments and his support in this paper and to several fishermen along the coastal communities in Pulau Duyung and Mengabang Telipot of Kuala Terengganu District for the useful information. This paper should be part of earlier versions for my thesis in The Future of Traditional Fishing in East Coast of Peninsular Malaysia.

**References**


Socio-economic profile of sea cucumber *Apostichopus japonicus* gatherers in the coastal areas of Bantayan Island, Cebu Province

Corazon P. Macachor* and Noel Dierran

*Cebu Technological University, Main Campus*
*R. Palma St., Cebu City, Philippines*
*Corresponding author’s email: cora_macachor@yahoo.com*

**Abstract**

Sea cucumber, *Apostichopus japonicus*, locally known as “bat hanginan” is one of the marine resources in the island of Bantayan, Cebu which contributed in uplifting the economic status of sea cucumber gatherers. This study was conducted in Bantayan Island, Cebu province particularly in Madridejos, Sta. Fe, and Bantayan, Cebu as research gleaning sites. The socio-economic-profile of shell gatherers from the three research sites was investigated. The sea cucumber gatherers was above the poverty-lined community who depended on fishing and gathering of sea cucumber as means of livelihood with an average gross income of PhP6,150.79 a month.

*Keywords: sea cucumber gatherers, Bantayan Island, Cebu, Philippines*

**Introduction**

Sea cucumber, *Apostichopus japonicus*, locally known as “bat hanginan” occurs in many coastal places in the Philippines. A local legislative member traded 2-3 tons of dried sea cucumber per week from 1988 until 1991 at P300.00 to P1000.00 per kilo depending on the quality of the processed foodstuff to other countries particularly Hong Kong and Singapore, as two major Asian export centres. However, the Asian economic crisis in 1997 drastically affected the catering business and demand for sea cucumbers was decreased. Thus, the world takes off the pressure on sea resources for a while, being now in danger of depletion in many producing countries (SEAFDEC, 2000).

Thus, this study is limited only to assess the socio-economic profile of sea cucumber gatherers in Bantayan Island, Cebu Province, specifically in the coastal areas of Madridejos, Sta. Fe and Bantayan to provide baseline information of its status to be used for management for a period of four months. Thus, this study assessed the socio-economic profile of Sea Cucumber, *Apostichopus japonicus* gatherers in the coastal areas of Bantayan Island, Cebu province, specifically in the towns of Madridejos, Sta. Fe and Bantayan as to its demographic profile of the sea cucumber gatherers and the socio-economic status of the sea cucumber gatherers.

**Materials and Methods**

The descriptive method of research was used in conducting the study using a survey questionnaire to determine the socio-economic profile of the *Apostichopus japonicus* gatherers from the three identified research stations.

The socio-economic profile of the *Apostichopus japonicus* gatherers was assessed using a self-made interview schedule. There were 38 respondents interviewed representing the three identified research sites from the coastal areas of Madridejos, Sta. Fe and Bantayan, Cebu Province (Figure 1). The questionnaire was translated into local dialect and administered by the researcher. The responses were recorded in the appropriate space provided in the questionnaire.
Results and Discussion

Socio-economic profile of the sea cucumber gatherers

Demographic profile
There were 38 gatherers of sea cucumber, who are interviewed, where Madridejos, Sta. Fe and Bantayan had 14, 9 and 15 sea cucumber gatherers, respectively. Madridejos and Bantayan sea cucumber gatherers composed of 100% male, and Sta. Fe had 78% male and 22% female. Most of the respondents of Madridejos, Sta. Fe and Bantayan are 74% married and 26% single (Table 1). Age distribution of the respondents from Madridejos was 20-70; Sta. Fe has 23-63; and Bantayan has an age ranging from 21-61.

Table 1. Gender composition, age and marital status of respondents from the three research sites.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Married</th>
<th>Single</th>
<th>Male</th>
<th>Female</th>
<th>Age Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madridejos</td>
<td>11</td>
<td>3</td>
<td>14</td>
<td>-</td>
<td>20-70</td>
</tr>
<tr>
<td>Sta. Fe</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>23-63</td>
</tr>
<tr>
<td>Bantayan</td>
<td>10</td>
<td>5</td>
<td>15</td>
<td>--</td>
<td>21-61</td>
</tr>
</tbody>
</table>

Economic profile of the respondents
Out of 15 respondents in Madridejos, Cebu, 64% has a gross income above PhP7,600.00 and 29% had a income ranging from PhP5,400 – 7,599.00 and 7% had an income ranging from PhP1,000.00 – 3,199.00. Sta. Fe sea cucumber gatherers (22%) had an income of above PhP7,600.00, 33% had an income ranging from PhP5,400.00 - 7,599.00 and 45% had a gross income ranging from PhP3,200.00 – 5,399.00. Bantayan sea cucumber gatherers (47%) had a gross income above PhP7,600.00, 27% had an income ranging from PhP5,400.00 – 5,399.00, 13% had an income ranging from PhP3,200.00 – 5,399.00 and another 13% had a gross income ranging from PhP1,000.00-PhP3,199.00 (Table 2). The average gross income of 38 sea cucumber gatherers from the three research gleaning sites was PhP6,150.79 per month.
Table 2. Monthly gross income of the respondents from fishing activities.

<table>
<thead>
<tr>
<th>Monthly Gross Income (T)</th>
<th>Respondents from the 3 research sites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Madridejos</td>
</tr>
<tr>
<td>PhP7,600 above</td>
<td>9</td>
</tr>
<tr>
<td>5,400 - 7,599</td>
<td>4</td>
</tr>
<tr>
<td>3,200 - 5,399</td>
<td>-</td>
</tr>
<tr>
<td>1,000 - 3,199</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
</tr>
</tbody>
</table>

The 75% of the respondents had a supplementary income of above PhP3,200.00 and 25% had an income ranging from PhP1,000.00 – 3,199.00 as fisherman. The average supplementary income of PhP3,000.00 was determined from the 33% of Bantayan sea cucumber gatherers.

Poverty incidence is reportedly quite high in most of the fishing communities in the country. Various reports in different regions showed that fishing village in Zamboanga City and Basilan in Region IX has an average monthly income from fishing of PhP1,506.71 (Ranilo et al., 1994), Pujada Bay of Mati, Davao Oriental in Region XI with PhP379.67 (ERDS, 1994), Apo island of Dauin, Negros Oriental with an average monthly income of PhP1,715.00 (CEP, 1994) Bansaan Island of Talibon, Bohol with PhP1,362/month (Aliño, 1992) and PhP1,830.00/month in the northwestern Bohol (Alcaria, 2001).

Based on these reports, this monthly income of the fisher folks particularly sea cucumber gatherers which is PhP6,150.79/month is above the poverty threshold level. With this report, the average household gross income in Central Visayas from fishing source is below the poverty line. The National Statistical Coordinating Board of the National Economic Development Authority reported that the poverty threshold in 1997 for rural areas in Central Visayas is PhP4,107.00 per month in order to sustain his family needs. Even though the secondary source of income of the respondents having an average of PhP3,000.00 per month will be included in the gross monthly income, most of the fisherman are still living below the poverty threshold level.

An evidence would manifest some of the household economic indicators in the site to support the findings of the study that 45% of the respondents’ dwelling units are made of wooden with bamboo and GI units, 29% are made of concrete materials and 16% are made of bamboo and nipa while 82% of the respondents possessed with television set, 79% with radio, 63% with an electric fan, 45% with refrigerator, 37% with VHS and 13% karaoke (Table 3).

Table 3. Housing materials used by the respondents and possession of appliance and fixture.

<table>
<thead>
<tr>
<th>Housing materials</th>
<th>No. of Respondents</th>
<th>% (n=38)</th>
<th>Fixtures &amp; Appliances</th>
<th>No. of responses</th>
<th>% (n=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>11</td>
<td>29</td>
<td>TV</td>
<td>31</td>
<td>82</td>
</tr>
<tr>
<td>Semi-concrete</td>
<td>17</td>
<td>45</td>
<td>Radio</td>
<td>30</td>
<td>79</td>
</tr>
<tr>
<td>Wood</td>
<td>6</td>
<td>16</td>
<td>VHS</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td>Pagpag</td>
<td>3</td>
<td>8</td>
<td>Karaoke</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Refrigerator</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Electric fan</td>
<td>24</td>
<td>63</td>
</tr>
</tbody>
</table>
Conclusions

The demographic profile of the sea cucumber gatherers in the coastal areas of Bantayan Island are mostly male, married and age ranging from 20 to 70 years old. Most of the sea cucumber gatherers in the coastal areas of Bantayan Island have PhP7,600.00 and above, with other sources monthly gross income of P3,200.00 and above, lived with a semi-concrete housing materials and possessed different kinds of appliances after five years of experience as sea cucumber gatherers. The follow-up research on the socio-economic profile of the sea cucumber gatherers with technology transfer on trepang preparation be recommended.

References


Governance of mangrove rehabilitation in Carles, Central Philippines

Didi B. Baticados1* and Tsutomu Matsuura2

1Southeast Asian Fisheries Development Centre Aquaculture Department
Tigbauan, Iloilo 5021, Philippines
2National Research Institute of Fisheries Science in Japan, Yokohama 236-8648, Japan

Corresponding author’s email: didib@seafdec.org.ph

Abstract

This study describes the governance structure of a community-based forest management project to rehabilitate mangroves in Carles, central Philippines, and how this affects property relations in mangrove areas. Four people’s organizations, two mainland-based and two island-based, representing the seven primary organizations managing the project in Carles were studied. Two types of governance structure existed at the primary level – the corporate-type and communal. In the former, the allocation of individual ownership is well-defined and the owner is free to decide whom to allow access. Control rights, however, only become valid upon the issuance of individual certificate of stewardship contract, which could strengthen incentives for long-term conservation-oriented decision making. Conversely, stewardship contract also causes conflict considering that mangroves are vital source of aquatic resources where most (66%) community members depend upon their livelihood. New institutional arrangements may have to be formed to avert conflict. In communal, the allocation of ownership is given to a group. Both governance structures, however, regulate access by excluding activities destructive to mangroves. Significant improvements in the overall state of the resource, household income, community’s compliance with resource management, ability to participate, and influence in community affairs were noted resulting from beneficiary participation in the project. The people’s organizations, however, need to link up with government to strengthen and legitimize its rules.

Keywords: mangrove areas, community-based forest management, institutional arrangements

Introduction

Mangrove degradation is an important issue because of its implications to coastal fisheries and livelihoods of coastal dwellers. The global rates of mangrove loss range from 20-35% in the past two decades (Walters et al., 2008) and its threat is particularly high in Southeast Asia where mangroves represent 34-42 percent of the world’s total (Giesen et al., 2006). Its effect becomes evident with the loss of coastal fishing productivity, loss of livelihood of coastal community, and loss of property in the wake of tsunami (Giensen et al., 2006). Thus, mangrove restoration, rehabilitation, and conservation became increasingly important and has been given high priority (Sudtongkong and Webb, 2008; Walters, 2008). But managing and use of the natural resources require effective governance.

In the Philippines, mangrove loss from 1970 to 2000 was almost 180,000 ha. The 1991 Local Government Code (LGC), however, caused a dramatic change in the national-local balance of power as it devolved some basic services to the local government units (LGUs). Accordingly, Executive Order 263 of the Department of Environment and Natural Resources (DENR) institutionalized the adoption of community-based forest management (CBFM) in 1995 as a national strategy to ensure the sustainable development of forestland resources. This paper describes the governance structure of the community-based forest management and how it affects property relations in mangrove areas. The study assesses the changes over time in the use and management of mangroves at the study sites. Also examined are
the institutional arrangements within and between different levels of governance and the project impact on the coastal dwellers.

Study Area and Methods

Located in the municipality of Carles, northern Iloilo, central Philippines, the 486 ha CBFM project funded by Japan Bank for International Cooperation (JBIC) covered seven villages (Figure 1). It was established in 2000 to rehabilitate the mangrove ecosystem in Bancal Bay. The covered villages have a total of 2,285 households, majority (66%) of which depend on coastal resources for their livelihood such as fishing, salt-making, and aquaculture, 20% on farm, and the rest, off farm (14%). The communities in each covered village were organized into associations, trained, and coalesced to form the Manlot-Cabila-Bancal-Tarong Association for the Rehabilitation of Mangroves (MACABATA-ARM), Inc. The four Peoples’ Organizations (POs) of MACABATA-ARM were studied (two mainland-based and two island-based) in 2003 for its location and history of mangrove use and management. Thirty respondents, fifteen members each from the POs and from a listing of village fishers and key informants were interviewed. Focus groups discussions were also conducted. Secondary data were reviewed and analyzed including laws and regulations. Using a quasi-metric scale of ten, the respondent indicated in a ladder-like diagram the situation that best described the situation before and after the project implementation on the eight indicators to determine the project impacts. The t-test (paired sample) was used to determine significant differences between variables before and after project implementation.

Results

Table 1 shows the profile of the association and the result of mangrove plantation with the implementation of the community-based forest management project.

Table 1. Profile of selected people' organizations and their covered mangrove area for protection and rehabilitation in Carles, Central Philippines.

<table>
<thead>
<tr>
<th>Name of PO and location</th>
<th>Year formed</th>
<th>Solid planting</th>
<th>Enrichment planting</th>
<th>Total (ha)</th>
<th>Members with CSD (area)</th>
<th>Members (active)</th>
<th>Total FLA (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TABAKA¹ Tarong, Carles</td>
<td>2001</td>
<td>58.60</td>
<td>13.57</td>
<td>72.17</td>
<td>25</td>
<td>21 21</td>
<td>42</td>
</tr>
<tr>
<td>TUPARA² Tupaz, Carles</td>
<td>2002</td>
<td>4.0</td>
<td>26.8</td>
<td>30.80</td>
<td>Group</td>
<td>14 7</td>
<td>21</td>
</tr>
<tr>
<td>Island</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABAKAS⁶ Manlot, Carles</td>
<td>2001</td>
<td>107.25</td>
<td>64.0</td>
<td>171.25</td>
<td>38</td>
<td>22 17</td>
<td>39</td>
</tr>
<tr>
<td>PABABAYADA’ Pantalan, Carles</td>
<td>2002</td>
<td>30.07</td>
<td>5.0</td>
<td>35.07</td>
<td>Group</td>
<td>10 03</td>
<td>13</td>
</tr>
</tbody>
</table>

¹ Community site development; ² A total of 78 members distributed in four POs were inactive as of CY 2003, 60% of which came from Tarong; ³ Fishpond lease agreement; ⁴ Tarong Bantay Katunggan; ⁵ Tupaz Planters for Rehabilitation Association; ⁶ Manlot Bantay Katunggan Association; ‘Pantalan Bantay Baybay Yaman Dagat
Historically, mangrove utilization is a common practice among coastal dwellers in the study sites. Resource use, however, varies and differs in magnitude among the four villages due to the open access nature of the resource. Tupaz inhabitants were the earliest to convert mangroves into fishponds aside from the usual use of mangroves for fuel wood and poles. Manlot and Pantalan locals began exploiting the mangroves in 1940s. The pattern of mangrove destruction followed the national trend thereafter, which started to boom in 1950s to 1960s with many conversions of mangroves into fishponds. The intensification of mangrove conversion into ponds in Tarong and Tupaz led to collective actions in both villages in 1990s, but with differing outcomes. Tarong was successful in their collective action in preventing the pond expansion to 50 ha more from the shoreline seaward. On the other hand, the bid of 21 members of Tupaz Small Fisherman Association in 1994 to prevent a pond owner illegally expand his ponds up to their oyster farms where they customarily operate was unsuccessful.

**Governance arrangements**
The awarding of CBFMA covering 688.1942 ha to include sea lanes and a protected area to MACABATA-ARM paved the way for the new governance and institutional arrangements in the mangrove ecosystem in the project site. The CBFMA is a tenurial instrument contracted by the government, represented by DENR, to MACABATA for the latter to manage the project for 25 years, renewable for another 25 years. MACABATA also deals with the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) because of the latter administrative jurisdiction on aquatic resources within mangrove areas. The CBFMA endorsement of LGU enabled the project to move forward.

MACABATA Board of Trustees composed of 21 members, three-members each from seven primary POs, formulate policies and set the rules and guidelines of MACABATA. It created an Advisory Committee composed of elective village and municipal officials, DA-BFAR, Bancal Bay FARM C, NGO and DENR to provide direction, facilitate technical and financial linkages, and assist in making solutions to unresolved issues besetting the Federation. Unfortunately, this initiative was not pursued after the initial meeting. The primary POs, on the other hand, manage their respective organization at the village level. Each PO makes its own strategies to operationalise the rules in their own area of jurisdiction, which was apportioned to PO based on existing village boundaries.

The communal (Tupaz and Pantalan) and the corporate–type (Manlot and Tarong) of mangrove governance were noted at the village level. POs in communal governance managed their respective allocated area as a group. Decision-making is vested on the members based on majority votes relative to the harvest of goods and resources including the use of area for aquaculture activity. Communal decision-making, however, was difficult to achieve because of diverse membership. In Tupaz, members were mostly farmers (53%) while in Pantalan the fishers were mostly (83%) crew member of commercial fishing vessels (zipper). In corporate-like governance, the mangrove areas were apportioned to individual-member based on his/her capacity to manage and maintain his/her own area. Access to and use of resources, e.g., harvest of propagules, depends on the member-owner's decision. Thus, owners are free to sell their rights or lease to third parties subject to PO and MACABATA rules. Both types follow formal rules such as banning of the cutting of mangroves trees and the use of illegal fishing methods. No other formal rules were enacted at the village and municipal levels for the project. No tagad (excavation of soil), informal rule, was imposed inside the project area. Gleaning of bivalve clam was banned in Manlot.

**Impact**
All respondents recognized the positive uses of the resource, particularly in fisheries, for they directly felt the negative effects of mangrove loss on their livelihoods. Mostly (73%) claimed that they benefited from the project. Members not only got incentives from planting and maintaining the mangroves, but also improved fish catch. Overall, respondents claimed improvement in all impact indicators except in the access of resources. Significant
improvements in the overall state of the resource, household income, community’s compliance with resource management, ability to participate, and influence in community affairs were noted resulting from beneficiary participation in the project.

Discussion

Results show that two types of governance structure – the corporate-type and communal – operate in the CBFMA area at the primary level. In the former, the allocated area for the primary PO becomes a collective property of a group of lot owners who are free to decide whom to grant access to their appointed lots. Control rights, though informal at present, become valid upon the issuance of individual certificate of stewardship contract (CSC), which could strengthen incentives for long-term conservation-oriented decision making. Primavera (2000) asserts that stewardship agreements offer mangroves better protection than official proclamation of reserve status, which cannot be enforced. The high survival rates of mangrove rehabilitation projects, particularly in Manlot, also corroborate Sudtongkong and Webb (2008) findings that the involvement and commitment of the community and the grant of tenure spells better results. Both governance structures, nonetheless, regulate access by excluding activities destructive to mangrove trees.

Complicating the effective mangrove governance, however, is mangroves unique ecology, being part land and part water. The issuance of CSC, for example, may stir up conflict, particularly in Tarong, if CSC holder exercises his right to control access to aquatic resources in the guise of ensuring mangrove tree protection. A scenario, which local officials do not look forward to, considering that fishing is a major income source of most (66%) community members. Tarong history of collective action stemmed from exclusion of resource users in the use of a 50 ha area, now under CBFMA, for fishing. A new form of institutional arrangements may have to evolve to avert such conflict. Revival of the Advisory Committee is may be necessary for their inputs are valuable in designing appropriate rules to be adopted upon issuance of CSC.

Given the evidence, corporate-type of internal governance structure seems to work well in a contractual management set up. This confirms Townsend and Pooley’s (1995) contention that corporate governance creates a stronger and clearer incentive for long-term investment in the resource. Regardless of the type of internal structure, however, the link with LGU has to be strengthened both at the village (for the primary PO) and municipal levels (for MACABATA) to legitimize rules to be enforceable and sustain positive improvements in most impact indicators.

Acknowledgements

This study was part of the collaborative research project on Sustainable Utilization of Brackishwater Mangrove Areas between the Southeast Asian Fisheries Development Centre Aquaculture Department and the Japan International Research Centre for Agricultural Sciences. The authors thank the SUSIMO-DENR project staff, the MACABATA-ARM, Inc., the municipal and villages officials, and the communities for their cooperation and support.

References


Community-based tourism of mangrove ecosystem in Kota Marudu, Sabah


Faculty of Forestry, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: awangnoor@gmail.com

Abstract

Poverty eradication in Malaysia still remains as one of the important issues to be addressed before the nation will become a developed nation by 2020. There is still some regional imbalances in some parts of the country in terms of economic development especially in the rural areas. Tourism can play important role in contributing to local socio-economic development through harnesing the natural resources found in the vicinity of the area. These resources can be utilized for tourism industry development to improve rural livelihoods and sustainable resource management. The local community, therefore, should take the opportunity to fully participate in providing services and deliver the products to satisfy visitors’ needs. A study was conducted in mangrove ecosystem including the local community of Kota Marudu, Sabah to identify their opportunities and willingness to participate in community-based tourism. Specifically, the project aimed to gather background information on eco-tourism resources (flora and fauna, community and culture) and linking mangrove ecosystem to tourism product development. The research involved inventory of mangrove resources, survey of socio-economic status and perception on tourism development. The study found that the local community is too dependent on fishing and marine resources for their livelihood without taking advantage of other potential use of mangrove ecosystem such as tourism. This is due to lack of technical know-how, low income, lack of capital and lack of access to loan facilities. The survey also found that the local community were willing to participate in tourism activities and they acknowledged that the mangrove forests are pristine and undisturbed. Hence, this mangrove ecosystem is valuable for the protection of wildlife habitat and environmental protection. Demand for tourism that can attract outside visitors to the area is still low because of lack basic facilities in tourism industry, specific promotion, special events, recreational activities and cultural showcase. Community-based tourism in relation to mangrove ecosystem to be capitalized in the development of tourism products include trip to mangrove forest, cruising along river and bay, fishing and cultural villages as show-case, home-stay for tourist to understand local culture, aquaculture including sea food and local menu, recreational fishing and provide services to eco-tourism industry. Long-term community-based tourism development plan is needed in order to increase local people participation, contribute to a higher income, and improve quality of life.

Keywords: Mangrove, local community participation, tourism industry, tourism product, tourism development plan
Oral: Session 2B
The Straits of Malacca Special Session:
Safety Navigation for Resource Protection
Ecosystem-based management of the marine resources in the Straits of Malacca

H. M. Ibrahim

Dept of Environmental Management, Faculty of Environmental Studies
University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: ibrahim@env.upm.edu.my

Abstract

The Straits of Malacca (SOM) is arguably the most important strait for international navigation. It is presently the shortest route from the Indian Ocean and the Atlantic Ocean to the South China Sea and beyond. This advantageous disposition has led to its preferred use by ships to traverse from Europe and the Middle East to the Asian industrial powerhouse of China, Japan, Korea and ASEAN. More than 75,000 ships traverse the straits annually carrying 1/3 of the world’s trade and ½ of the world oil and energy shipments. Yet its importance as a cradle of biodiversity being one of the mega-diverse regions of the world, providing fish, mangrove, coral reefs, marine recreation, tourism and as an important life support system to the riparian community has not been eclipsed by the advent of world trade and maritime transport.

The ecological services provided by the Straits of Malacca are presently under threat. The fish biomass of the area have depleted by some 80% from its 1956 high. Aside from the celebrated Larut Matang mangrove, which is acclaimed as the best managed mangrove forest for over 100 years, this coastal resource has been on the decline. Coral reefs of the straits which were predominant in the Malacca, Port Dickson, Pangkor and Langkawi Islands are now only protected in the group of 4 islands in the Pulau Payar Marine Park. This year even these reefs are suffering from coral bleaching. With the increase of marine pollution from the land and marine sources, the importance of the Straits as a tourism destination, marine aquaculture and most of all as a life support system is threatened. The lack of a comprehensive Integrated Coastal Zone Management policy, IZCM plan, efficient monitoring and enforcement are among the other reasons for the degradation of the natural resources of the Straits of Malacca. An ecosystem-based management (EBM) of the Straits, which comprehensively addresses the natural resources, physical and stakeholder’s interest is necessary to arrest the natural resource degradation prior to its absorption into a more comprehensive ICZM plan. Is there a more urgent and compelling reason for implementation of EBM in SOM?
Maritime law enforcement for oil waste disposal in the Straits of Malacca

Sutarji Kasmin* and Wan Nor Azmin Sulaiman

Faculty of Environmental Studies, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: sutarji@env.upm.edu.my

Abstract

The causes that transformed white sandy beaches at the Southwestern coasts of Johor to blackish in colour have not been extensively studied. Beyond these beaches, there are about 60 large ships of various types anchoring illegally within Malaysia’s territorial waters. These ships have been at anchor for a long term lasting from a few weeks to months. Depending on the nature of their tasking, some of these ships carried out fuel transfer, tank cleaning and removal of oily wastes and disposal of garbage while at anchor. In this study, we evaluated the intricacies faced by the Malaysian maritime enforcement agencies to enforce proper disposal of oily wastes as provided in the Environmental Quality Act 1974 and the Merchant Shipping Ordinance 1952. This study was primarily carried out by observing shipping activities, visits to bases of the maritime enforcement agencies and extensive interviews of selected officials of these agencies. The study found that the maritime enforcement agencies are unable to continuously monitor shipping activities at the anchorage area and their efforts to reduce the number of ships anchoring in this area have not been successful. These shortcomings encourage ships to illegally disposed oily waste by dumping them into the sea resulting to the blackening of the white sandy beaches along the Southwestern coasts of Johor.

Keywords: oily waste, maritime law enforcement, maritime surveillance, sludge disposal

Introduction

Malaysia is blessed with beautiful white sandy beaches along its coastal areas especially the southwestern coasts of Johor. The waters off the coasts are bounded by the southern portion of the Strait of Malacca to the northwest and the western portion of the Singapore Strait to the south. Both the Straits of Malacca and Singapore are the busiest sea line of communication that links the South China Sea in the east and the Indian Ocean to the northwest. The area shares common maritime boundaries with Indonesia, Malaysia and Singapore. Due to its proximity to Malaysia and Singapore ports, this area is a popular anchorage area not only for ships awaiting clearance to enter Singapore or Johor ports, but for other reasons such as undergoing maintenance, use as floating storages for crude oil and waiting for new charters. While at anchor, these ships need to run generators to provide electricity for lighting and the running of other equipment onboard. The running of these machineries generated dirty oil that is collected in the ship’s bilges and once these bilges are full, the dirty oil has to be removed. One of the most convenient and the cheapest way to remove the dirty oil is by pumping the oil into the sea illegally. Likewise, there are ships which took advantage to clean their oil tanks by employing illegal cleaners to cut cost. These cleaners simply packed the oil sludge into plastic bags and dumped them into the sea at night instead of transferring them for disposal ashore. The dumped oil sludge bags will invariably end up on the beaches along the southwestern coasts of Johor. According to the Department of Environment (DOE), Johor Bahru there were 15 such cases in 2006, 16 cases in 2007, 15 cases in 2008 and 3 cases in 2009. Yet no ships have been arrested for illegal disposal of oily wastes into the sea.
This study is intended (1) to determine the maritime enforcement agencies responsible to enforce the Environmental Quality Act (EQA) 1974 in the maritime zone, (2) to identify the causes of poor enforcement on the oily wastes disposal by the maritime enforcement agencies and (3) to propose new approaches to enhance the effectiveness of maritime surveillance and law enforcement in the coastal areas southeast of Johor. To this end, research methodology, Malaysia’s legislation to control marine pollution, results and discussion of the results will be discussed. This study concluded that the legislations pertaining to the disposal of oily wastes is sufficient. However, law enforcement efforts are lacking mainly due to low availability of marine and air assets to patrol the most vulnerable areas, except for the MMEA, other maritime enforcement agencies has no capacity to enforce the laws related to marine environment and poor cooperation in law enforcement among the three littoral states namely Indonesia, Malaysia and Singapore.

Materials and Methods

This study was conducted at the waters off the southwest coast of Johor within Malaysia’s territorial sea as shown at Figure 1. This area was selected because the coastal areas and the waters off the coasts are badly polluted, yet not much visible efforts have been made to overcome the problem. Interestingly, this area is only about 15 - 30 nautical miles from where most of the regional offices of the maritime enforcement agencies are located. These agencies are the Malaysian Maritime Enforcement Agency (MMEA), the Department of Environment (DOE), the Department of Fisheries (DOF), the Marine General Force of the Royal Malaysian Police (RMP), the Marine Department Peninsular Malaysia and the Royal Malaysian Navy (RMN). To meet the stated objectives, this study was conducted using qualitative research method namely library searches, observations of shipping activities and interview of selected officials from these agencies. All the information obtained was collated and analyzed.

![Figure 1. Study Area at Southwestern Johor, Malaysia.](Adapted from MAL 1515, National Hydrographic Centre, Malaysia)

Malaysia’s Legislation to Control Marine Pollution

In Malaysia, the main source of marine pollution from sea-based sources is largely attributed to accidents at sea and incidents of oil spillage through collisions as well as operational and deliberate dumping of hazardous, toxic and oily slops from ships. Other sea-based pollution sources include shipping traffic, port operations, and offshore oil and gas exploration and production rigs. Presently, there are several legislations for controlling ship-based marine pollution in Malaysia's maritime zone. These are the EQA 1974 (Act 127), the Merchants’ Shipping Ordinance 1952 (Act 70), the Exclusive Economic Zones (EEZ) Act 1984 (Act 311), the Merchant Shipping (Oil Pollution) Act 1994 (Act No. 515) and MMEA Act 2004 (Act No. 633).
The EQA 1974 deals with the prevention, abatement, control of pollution and enhancement of environment in the territorial waters. The Merchants’ Shipping Ordinance of 1952 contains provisions regarding pollution from ships. The EEZ Act 1984 is devised to implement certain aspects of UNCLOS 1982 such as the protection and preservation of the marine environment. The Merchant Shipping (Oil Pollution) Act 1994 provides for civil liability of ship owners for oil pollution, the legal personality and liability of the International Oil Pollution Compensation Fund as well as the jurisdiction and enforcement of its provisions through the Director of Marine. For enforcement of marine pollution, Article 217 of UNCLOS 1982 provides that flag states shall enforce violation of pollution laws applying to their ships whenever committed. Flag states must provide penalties adequate in severity to discourage violations, prohibit their vessels from proceeding to sea unless they comply with the requirements of international rules and standards, ensure that their vessels carry the certificates required by such rules, periodically inspect their vessels and investigate alleged violations of the rules by their vessels. Under Article 220 (6) of UNCLOS, if the coastal state has clear evidence that the vessel committed a violation of applicable international rules and standards for the prevention, reduction and control of pollution from vessels, may arrest the vessel.

Results

Based on the foregoing discussions, the results of this study are as follow:

1) There are about 240 ships passing through the Straits of Malacca and Singapore daily and at any one time, there are about 60 ships of various types are anchored illegally in Malaysian territorial waters off the southwestern coast of Johor.

2) The maritime enforcement agencies responsible to enforce various laws related to marine pollutants including oily wastes are the DOE (as the lead agency to manage the marine environmental quality), the Marine Department, the DOF, the Royal Customs Department, the RMN, the Marine Operations Force of the RMP and the MMEA. However, with the exception of MMEA, these departments have their own specific roles and only carried out law enforcement on marine environment on opportunity basis.

3) Law enforcement on marine environmental quality along the coastal areas of the Southwestern Coasts of Johor is within the jurisdiction of the MMEA Southern Region, the General Marine Force of the RMP Southern Region, the Marine Department Southern Region, Johor; the DOF Johor, the Royal Customs Department, Johor and the Headquarters of the 1st Naval Region RMN. However, the MMEA seemed to be most visible among the maritime enforcement agencies in enforcing the laws in the southwestern Johor.

4) Law enforcement by the MMEA seemed to focus on illegal activities onboard ships such as illegal disposal of oily waste and transfer of fuel. However, no known efforts are made to reduce the number of ships anchoring illegally. Reducing the number of ships at anchor will invariably reduce the probability of illegal discharge of oily waste into the sea.

5) There are no regional cooperation among the three littoral states, namely Indonesia, Malaysia and Singapore to police the area.

Discussion

The Straits of Malacca and Singapore which are very busy shipping route meet off the southwestern coasts of Johor. About 10 ships are observed to pass the Strait every hour.
Ships coming from the Strait of Malacca heading eastward are converged here before entering the traffic separation route south of Singapore toward the South China Sea. Likewise, ships heading northward toward the Strait of Malacca will continue their passage within the traffic separation scheme. At the anchorage off the coast of Southwestern Johor, there are about 60 ships anchored close to each other every day. The presence of these ships within the confined space off the southwestern coasts of Johor are not only endangering navigation but made surveillance for any illegal activities such as dumping of sludge or discharge of dirty oil very difficult. Trail of dirty oil will disperse very fast and hit the beaches within a short time making sampling and pin-pointing the sources of the dirty oil almost impossible. The situation is worst at night and during rainy day when visibility is reduced tremendously. The MMEA is not able to police this anchorage effectively due to shortage of assets, their patrol boats are already 15 – 44 years old, the ships are not provided with sophisticated surface detection equipment and their availability are comparatively lower.

Marine pollution affecting the coastal areas of the southwestern Johor is also affecting the coastal areas of the west coast of Singapore and Karimun Islands of Indonesia. Currently, there exist tripartite cooperative security measures to combat armed robbery in the Strait of Malacca implemented by these three countries such as “Eye in the Sky”, the Malacca Strait Cooperative Patrol (MSCP) and the Maritime Cooperative Mechanism. Unfortunately, to date this cooperation is not extended to monitor marine pollution.

Conclusions

The presence of large number of ships within the confined space off Johor is damaging the clean environment of the coastal areas and affected navigation safety in this busy shipping route. Its impact on the environment is made worst because law enforcement by the maritime enforcement agencies has been very minimal. Reasons for poor enforcement are not associated with the legal system but due to inadequate assets, poor cooperation among the agencies and lack of “political” will power. These shortcomings could be overcome should the government considers the challenges facing the marine environment with the same light as maritime security in the Strait of Malacca. Cooperation among the three littoral states, namely Indonesia, Malaysia and Singapore to jointly address the problem by increasing the effectiveness of its surveillance, law enforcement and policy review would be most appropriate. Thus, the environmental safety of Malaysia’s maritime areas is protected at all the times.

Acknowledgements

This study was funded by the Research University Grant Scheme (RUGS) of the Universiti Putra Malaysia, Serdang, Selangor, Malaysia (2008 – 2010).

References

i. Interview of the DOE officials at the DOE Office, Johor Bahru. on 28 January 2009.


iii. “Malaysian waters” as defined by the EQA 1974 means “the territorial waters of Malaysia as determined in accordance with the Emergency (Essential Powers) Ordinance, No 7 1969 (P. U. (A) 307 A/69). The territorial waters extend up to 12 nautical miles from the baseline. The Act is not applicable in the EEZ.


Cooling of sea surface waters near Cheju Island responding to strong wind and positive geopotential tendency by a typhoon

Hyo Choi1 and Soo Min Choi2

1Dept. of Atmospheric Environmental Sciences, Gangneung-Wonju National University
Gangneung 210-702, Korea
2Konkuk University High School, 265 Guiro, Kwangjin-Gu, Seoul 143-853, Korea

Corresponding author’s email: du8392@hanmail.net

Abstract

The response of sea surface temperature before and after the passage of Typhoon-18 Songda in the vicinity of Cheju Island in the south sea of Korea was investigated using GOES SST, GOES cloud image and a 3D-Weather Research and Forecasting Model-2.2 with FNL initial meteorological data on September 5 ~ 8, 2004. On September 4, before the typhoon passed by Cheju Island, the SST near the island was 27°C. On the other hand, after the island including Korean peninsula was entirely out of the influence of the typhoon at 2100 LST, September 7, the SST was 25°C, showing a 2°C decrease. Cyclonic surface wind generated by the typhoon caused divergence of ocean surface currents, which could induce upwelling of deep sea colder water to the sea surface and outward spreading of cold water near the island, resulting in the decrease of the SST. Simultaneously, negative minimum geopotential tendency of 500 hPa for 24 hours (\(\partial\Phi/\partial t\); m/day) was detected in typhoon eye and its vicinity, where the shrunken of atmospheric layer existed. Its positive maximum was detected behind the typhoon on its track, where a maximum expansion of atmospheric depth existed and its expansion induces ascending of sea surface and results in upwelling of deep sea cold water to the sea surface, showing the SST decrease to 25°C.

Keywords: sea surface temperature, GOES-MCSST satellite images, GOES infrared image of cloud, WRF model-2.2, geopotential tendency of 500 hPa

Introduction

Tropical cyclone such as typhoon in the northeastern Asia occurs frequently in summer and causes disasters including strong winds, severe flood due to heavy precipitation and storm surges and cold sea water outbreak in the coastal and open seas and harmful marine ecosystems. Gill (1982) and Kantha and Clayson (2000) showed that hurricane-induced upwelling is observed a few days after the passage of a hurricane across the Gulf of Mexico and Ekman transport takes place away from the path of the storm centre on the storm track, resulting in horizontal displacements of particles in the surface layer which can amount to some tens of kilometres. It means that consequently, water near the axis of the storm is upwelled, possibly by some tens of meters vertically. Similarly, Knauss (1997) insisted that cyclonic surface winds of a hurricane result in upwelling of bottom colder waters into the sea surface, because the surface wind stress can cause surface divergence of sea surface water and upwelling of bottom colder water in the open ocean by the changes in the wind speed or direction, resulting in occurrence of colder surface water in the wake of a hurricane. Through the upwelling process, deep, colder, and nutrient-laden waters can greatly affect coastal fisheries with aquaculture and environmental stressors in marine ecosystems.

The research is focused on how much sea surface temperature affecting marine ecosystem near Cheju Island, Korea responded to both atmospheric pressure change (i.e., geopotential tendency for 24 hour) of the typhoon and strong cyclonic surface wind before and after the passage of the typhoon, from September 6 to 8, 2004, using WRF-2.2 model GOES-MCSST daily mean sea surface temperature and GOES-Infrared image of cloud.
Materials and Methods

Study area
Figure 1 describes topographical features around Korean peninsula and a box as study area covers the vicinity of Cheju Island in the South Sea of Korea, whose climate is greatly affected by the Yellow Sea Warm Current in the west of the study area and the East Korea Warm Current in the east. Cheju Island (W-E: 73km; S-N: 41km) is the largest island with a bell shape topographical feature in the shape of an oval. The adjacent sea of Cheju Island is shallower less than 100 m in the west, north and east of the box domain and relatively deep greater than 100 m to 300 m in the south, closing to the East China Sea. In summer, most of typhoons pass by this island reaching Korean peninsula or Japan.

Numerical method and input data
A 3D-grid point Weather Research and Forecasting Model (WRF)-version 2.2 with a terrain following coordinate system was adopted for the generation of wind, precipitation and 500 hPa height change for 24 hours (i.e., geopotential tendency ($\frac{\partial \Phi}{\partial t}$); m/day) near Cheju Island. Numerical simulation by the model was carried out from 0000 UTC, September 5 through 21 UTC, September 7, 2004. In the numerical simulation, one way, triple nesting process from a coarse mesh domain to a fine mesh domain was performed using a horizontal grid spacing of 27 km covering a 91 x 91 grid square in the coarse mesh domain and a 9 km interval also covering a 91 x 91 grid square in the second domain. The third domain through final nesting process consisted of a 3 km horizontal grid spacing again on a 91 x 91 grid square. NCEP/NCAR reanalysis FNL (1.00 x 1.00) data was used as meteorological input data to the model and was vertically interpolated onto 36 levels with sequentially larger intervals increasing with height from the surface to the upper boundary level of 100 hPa (Choi and Choi, 2009; 2010). Hourly archived data set of wind, air temperature, relative humidity, cloud and geopotential tendency by Cheju Meteorological Office were used for the verification of numerical results of meteorological elements.

Results and Discussion

Typhoon track and synoptic situation
At 1100 UTC, August 26, 2004, Japan Tropical Warning Centre (JTWC) reported a new area of convection which had developed and persisted approximately 210 nautical miles northeast of Kwajalein (Figure 2). JTWC at 1200 UTC, August 27 gave the first warning on Tropical Depression 22W with its centre at 270 nautical miles east of Eniwetak atoll in the
Pacific Ocean and at 0000 UTC, August 28, the tropical depression with its surface wind speed of 35 kts was assigned the name, tropical storm, Songda. At 1800 UTC, August 30, it became a typhoon of 95 kts and its was about 17 nautical miles north-northeast of Agrigan Island in the Northern Mariana Islands at 0300 UTC, September 1. At 0000 UTC, September 5, its strength began to weak and at 0000 UTC, September 7, as Typhoon Songda, which changed its direction to northeastward across the East China Sea made landfall on the northwestern coast of Kyushu Island, Japan, and Cheju Island, Korea in the left of Kyushu Island was in the strong influence of the typhoon. However, its strength began to slowly drop off to be downgraded to a tropical storm at 1800 UTC, September 7 and at 0600 UTC, September 8, it became an extratropical low.

**Cold water outbreak under changes of wind fields and geopotential tendency**

On September 4, before the typhoon passed by Cheju Island, the SST near the island was 27°C (Figure 3a). On the other hand, after the island including Korean peninsula was entirely out of the influence of the typhoon at 2100 LST, September 7, the SST was 25°C, showing a 2°C decrease (Figure 3b). At 0900 UTC, September 6, before the typhoon made landfall on the northwestern coast of Kyushu Island, Japan, marine surface wind by cyclonic circulation of the typhoon near Cheju Island was over than 20m/s and cyclonic marine surface wind caused divergence of ocean surface currents outward from the typhoon eye, which could induce upwelling of deep sea colder water to the sea surface and outward spreading of cold water near the island, resulting in the decrease of the SST (Figures 4a). This trend continued to be until the island was entirely out of the typhoon effect (Figure 4b).

Using Ekman vertical displacement formula by Gill (1982) and Leipper (1967) on the hurricane-induced upwelling normal to the storm track, as moving speed of the typhoon passing by Cheju Island was 6 ~ 7 m/s and surface wind speeds were 5 ~ 22m/s, corresponding current speeds were strong around 0.15 ~ 0.66 m/s and upwelling might be more than 40 m. Thus colder sea water from less than 40 m deep sea could ascend to the sea surface and spread outward near the Cheju Island, resulting in cold water outbreak.

![Figure 3](image)

**Figure 3.** Daily mean of sea surface temperature by GOES-9 MCSST satellite images of Japan Meteorological Agency in (a) September 4, 2004 (27°C near Cheju Island before the typhoon passage); and (b) September 7 (25°C near Cheju Island after the typhoon passage), respectively. Wide black area and a small box denote cloud covered area and a fine-mesh domain of a 91 x 91 grid square with a 3 km horizontal grid near Cheju Island, Korea.

Simultaneously, negative minimum geopotential tendency of 500 hPa for 24 hours ($\partial \phi / \partial t$; m/day) more than - 316 m/day was detected in typhoon eye and its vicinity, where the shrunken of atmospheric layer existed, inducing downwelling of surface water (Figures 5a and b). However, its positive maximum of 317 m/day was detected behind the typhoon on the typhoon track, where a maximum expansion of atmospheric depth existed and the expansion of atmospheric layer induces ascending of sea surface and results in upwelling of deep sea colder water into the sea waters and causing cooling of surface water to 25°C.
Figure 4. Surface winds (m/s) in (a) a coarse-mesh domain with a 27 km horizontal grid interval at 0900 LST, September 6, 2004, before typhoon Songda passed by Cheju Island; (b) 1800 LST, September 7. A box denotes vicinity of Cheju Island in the South Sea of Korea.

Figure 5. (a) 500 hPa height change for 24 hours (i.e. Geopotential tendency (\(\partial\Phi/\partial t\); m/day) over the sea and land surfaces; and (b) GOES-9 satellite infrared image of cloud before the passage of typhoon Songda by Cheju Island at 0900 LST, September 5, 2004.

Acknowledgements

This work was funded by the Korea Meteorological Administration Research and development Program under Grant CATER 2006-2308 for 2010-2011.

References


Persistent organochlorine pesticides (OCPs) residues in marine food chain

M. Maruf Hossain1*, Zubir Din2 and Sani Ibrahim3

1Institute of Marine Science and Fisheries (IMSF), University of Chittagong
Chittagong-4331, Bangladesh
2School of Biological Sciences, Universiti Sains Malaysia (USM), 11800 Penang, Malaysia
3School of Chemical Sciences, Universiti Sains Malaysia (USM), 11800 Penang, Malaysia

Corresponding author's email: marufctgu@yahoo.com

Introduction

There has been a growing concern globally in highlighting the hazards of organochlorine pesticides (OCPs) exposures and their impact on bio-diversity and human health, particularly those involving hormone-disrupting chemicals (WWF, 1998). Now it is well proven that, the chlorinated pesticides are persistent, lipophilic and hazardous to health and are suspected to carcinogenic and or mutagenic (Ritter et al., 1995; WWF, 1998). Earlier studies in different parts of the world have shown that OCPs can be magnified up to 100, 1000 or even million times in animal tissues, especially due to their lipophilic nature (Kannan et al., 1998; Tanabe et al., 1997; Ramesh et al., 1990; Phillips, 1985). There has been scanty research conducted on OCPs (which form the major components of POPs) in majority of the Far East including Malaysia than trace metals as reported by Phillips (1985) and Tanabe et al. (1997). Even for OCPs, most reported studies in Malaysia are from water bodies, confined to agriculture catchment areas or river systems (Tan et al., 1994). However, detailed studies on the level of these chemicals in the food chain or trophic level of the marine or coastal eco-system has not been done in Malaysia, though this has been emphasized by several authors (Tanabe et al., 1997; JKM, 1996; Tan et al., 1994).

Materials and Methods

Program, planning and selection of sampling sites were determined considering different factors, first considering different reports and studies on major pollutant sources, specifically major agriculture practices area, forest and plantation area, where most of the persistent organic pollutants were used and also following the guidelines as suggested by FAO (1976). However, biological samples were collected from the coastal area (estuarine mouth) of River Muda, River Kerian and from the coast of Teluk Bahang and Muka Head, Penang as reference station. The samples were collected twice once in July 1998 and another in September 1999.

The protocol for biological sample collection followed the guidelines as suggested by FAO (1976), whereas method for extraction and clean up of organism samples for OCP analysis and fat content determination followed the method as suggested by Hughdahl (1978) in CPMS ii, which is a modification of the method recommended by USA-EPA (1996). The method was further tested by spiking samples with standard mixtures of 16 organochlorine pesticides and by checking their recovery. Pesticides analysis were carried by using a Perkin-Elmer Auto-system gas chromatograph with an auto-sampler and attached with a capillary column (SPB-608) and Ni63 Electron Capture detector (GC-ECD). The results were quantified with standard mixture of OCP (16 OCPs) supplied by Supelco, USA. OCP concentrations in samples were then determined by comparing with five points calibrated standards (0.5 ppb, 5 ppb, 20 ppb, 80 ppb, 200 ppb.). Identification and confirmation of
peaks in samples were done by different way, along with further confirmation of OCP peak was done by running some samples in GC-MSD.

Results and Discussion

For the determination of 16 organochlorine pesticides from the selected sites of the west coast of Malaysia, 9 edible and highly commercially valuable marine organisms from different compartments of the food chain were selected, of which 5 species of fishes (83 individual samples), 1 species of shrimp (26 composite and individual samples) and 3 bivalve species (mussels, cockles and clam) (22 composite samples) were analysed for OCP analysis.

This study shows that, although some of the organochlorine pesticides have been banned or restricted for several years, they still remain in nature, this may be due to the persistent nature of the chemicals and possibly they are still being used illegally or with restriction.

It seems that location and usage pattern (usage pattern of BHC, Endosulfan and Heptachlor) could be the important factors that can explain the differences in contamination, reflecting the inland origin of pollution. Lipid content can also play an important role (0.28% - 8.21%). The BCF in lipid tissues of organisms showed significantly high values compared to the wet weight values of the species concerned.

Conclusions

Although the values of OCPs analysed for all the species in the present investigation did not exceed the MRLs recommended by the FAO/WHO, some of the pesticide are close to MRLs value in lipid weight and these may pose a threat to human beings and other biota. High magnification of DDT was evident in the lipid tissues of the various organisms studied, in comparison to their levels in coastal waters. It is suggested that further research on OCPs be continued in view of the gravity of the problem, especially to the higher trophic levels and need to be done on lipid in order to make real assessment of the danger they pose.

Acknowledgements

Sincere gratitude and appreciation to PhD supervisor Prof. Zubir Bin Din and Co-Supervisor Prof. Sani Ibrahim, USM, Malaysia. Also grateful to Malaysian Government for supporting this research through IRPA grant. Highly indebted to Mr. Mark Hughdahl, ASL Laboratories, Canada for help and guidance during method validation test and throughout experiment period. Also highly indebted to Emeritus Prof. E.K Duursma, former Director, NIOZ, Netherlands, Prof. Chong Chon Sing (USM) for kind review of the thesis and suggestion. Also like to say sincere thanks to Dr. Tanabe, Dr. Kannan and Prof. P. G. Meier for giving their publications on OCP and their keen interest, advice in this research work.

References

Hughdahl, P. 1978. ASL laboratories Procedure Section: Trace Organics, Rev. no. CPMS ii .r03, Canada.1-16 p.


Assessment of anthropogenic influences of heavy metals from Klang River into the Straits of Malacca: An index analysis approach

Abolfazl Naji*, Ahmad Ismail and Syaizwan Zahmir Zulkifli

Department of Biology, Faculty of Science, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: Abolfazlnaji@gmail.com

Abstract
Surface sediments (0-5 cm) from Klang Estuary were analyzed for six metals (Cd, Zn, Ni, Cu, Pb, and Fe). This investigation was conducted to determine metals geographical, lithological distribution and the influence of heavy metal contamination by Klang River into Strait of Malacca. The evaluations of surface sediments pollution were carried out by using geoaccumulation index (Igeo) and modified degree of contamination (mCd). And also, the results were compared with marine Sediment Quality guidelines (SQGs). Based on the geoaccumulation index, Klang Estuary surface sediments were treated as “moderately to strongly contaminated” with Cd. The results of modified degree of contamination (mCd) determined that surface sediments of Klang Estuary were moderate degree of contamination in station 1 and low degree of contamination in stations 2, 3, 4 and 5. Klang Estuary can be classified as moderately polluted estuary. Overall, there is no high anthropogenic input from Klang River into Estuary of Malacca.

Keywords: heavy metals, indices, surface sediment, anthropogenic input, Klang River

Introduction
The west coast of Peninsular Malaysia is subjected to a great variety of pollutants since its offshore (Straits of Malacca) is a major international shipping lane. There are also considerable agricultural and industrial urban activities concentrated in this area (Abdullah, 1999). Klang estuary is located on the West coast of Peninsular Malaysia, in the state of Selangor (Figure 1). Klang River estuary is also likely to receive impacts from shipping activities in the Straits of Malacca and agricultural, industrial and urban activities from Klang River (Abdullah et al., 1999; Chua et al., 2000).

Due to rapid industrialization and uncontrolled urbanization around many cities and coastal areas, an alarming level of pollutants has contaminated these aquatic environments (Naji et al., 2010). Estuaries are complex and dynamic environmental components which receive large amounts of contaminants from urban areas and industrial sites (Alkarkhi et al., 2009). Heavy metals are major concern because of their persistent and bio-accumulative nature (Kaushik et al., 2009). Heavy metals can be introduced into the aquatic environment and accumulate in sediments through disposal of liquid effluents, chemical leachates and runoff originating from domestic, industrial and agricultural activities, as well as atmospheric deposition (Mucha et al., 2003). Since they can act as point sources of contamination during anthropogenic activities, sediments are suitable tool for measuring the extent of metal enrichment using geoaccumulation index (Igeo) and modified degree of contamination (mCd). This study therefore aimed to identify the quality assessment of surface sediments using modified degree of contamination (mCd), geoaccumulation index (Igeo) and to appraise their lithogenic inputs.
Materials and Methods

Field and laboratory methods
Surface sediment (0-5) samples were collected from 5 stations along Klang River (Figure 1). The surface sediments of each sample were placed in polyethylene plastic bags and they were then kept in an ice box. As soon as the field work was finished, samples were brought to the Ecotoxicology laboratory at University Putra Malaysia and stored in a deep freeze unit for future analysis (UNEP, 1985). Concentration of total metals in surface sediment following the method of Ismail (1993).

Quality control
To preclude uncertain contaminations, all laboratory equipments used were washed with phosphate-free soap, double rinsed with distilled water (DDW) and left in 10% HNO₃ for 24 hr and all equipments were then rinsed two times with double distilled water and left semi-closed to dry at room temperature. Certified Reference Material (CRM) (International Atomic Energy Agency, Soil-5, and Vienna, Austria) was determined as a precision check. The agreement between the analytical results for the reference material and its certified values for each metal was satisfactory.

Results and Discussion

Distribution of heavy metals
Metal concentrations (µg/g, dw) in the surface sediments from stations varied from 1.05 to 1.93 µg/g for Cd, to 43.94 to 119.5 µg/g for Zn, 10.99 to 14.46 µg/g for Ni, 14.09 to 42.07 µg/g for Cu, 26.90 to 51.78 µg/g for Pb (Table 1). The highest concentration of metals was found in those stations along the highly populated centres. Surface sediments in these areas have high anthropogenic flux. Mean concentrations of Cd, Zn and Pb in the surface sediments in the study area were higher than the average crust abundance (Taylor, 1964). Whereas, the average concentration of Ni and Cu were less than average crust abundance (Table 1).

Table 1. Total concentrations (µg/g, d.w.) of sediments, and various guidelines for metals.

<table>
<thead>
<tr>
<th>Element</th>
<th>Stations</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>5</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cd</td>
<td></td>
<td>1.93</td>
<td>1.41</td>
<td>1.48</td>
<td>1.13</td>
<td>1.05</td>
<td>0.2</td>
<td>1.20</td>
</tr>
<tr>
<td>Zn</td>
<td></td>
<td>119.5</td>
<td>83.8</td>
<td>106.16</td>
<td>66.81</td>
<td>43.94</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>Ni</td>
<td></td>
<td>14.25</td>
<td>11.30</td>
<td>14.46</td>
<td>11.43</td>
<td>10.99</td>
<td>75</td>
<td>20.9</td>
</tr>
<tr>
<td>Cu</td>
<td></td>
<td>42.07</td>
<td>16.60</td>
<td>24.55</td>
<td>19.85</td>
<td>14.09</td>
<td>55</td>
<td>34.0</td>
</tr>
<tr>
<td>Pb</td>
<td></td>
<td>51.78</td>
<td>24.73</td>
<td>33.40</td>
<td>26.90</td>
<td>17.51</td>
<td>12.5</td>
<td>46.7</td>
</tr>
</tbody>
</table>

*Taylor (1964); ERL Effect range low, ERM effect range median.
**Geoaccumulation Index (I_{geo})**

The Geoaccumulation Index (I_{geo}) was calculated to determine metals contamination in sediments of Klang River. This expression was proposed by Müller (1981) in order to calculate metals concentration in sediments by comparing current concentrations with undisturbed or crustal sediment (control) levels. Müller (1981) has classified I_{geo} in relation to contamination levels into seven classes, Unpolluted (Class 0, I_{geo}<0), unpolulated to moderately polluted (Class 1, 0< I_{geo}<1), moderately polluted (Class2, 1< I_{geo}<2), moderately to strongly polluted (Class3, 2< I_{geo}<3), strongly polluted (Class4, 3< I_{geo}<4), strongly to very strongly polluted (Class5, 4< I_{geo}<5) and very strongly polluted (Class6, I_{geo}>5). The undisturbed sediment values utilized were (Taylor, 1964) (Table 1). The geoaccumulation index (I_{geo}) suggested that individual metal contamination in the surface sediments could be classified as “unpolluted to moderately polluted to strongly polluted” (Table 2).

<table>
<thead>
<tr>
<th>Station</th>
<th>Cd</th>
<th>Zn</th>
<th>Ni</th>
<th>Cu</th>
<th>Pb</th>
<th>I_{geo} class</th>
<th>Sediment quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I_{geo}</td>
<td>I_{geo}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.68</td>
<td>0.18</td>
<td>2.98</td>
<td>0.97</td>
<td>1.46</td>
<td>0-3</td>
<td>Unpolluted to moderately to strongly polluted</td>
</tr>
<tr>
<td>2</td>
<td>2.23</td>
<td>0.32</td>
<td>3.31</td>
<td>2.31</td>
<td>0.40</td>
<td>0-3</td>
<td>Unpolluted to moderately to strongly polluted</td>
</tr>
<tr>
<td>3</td>
<td>2.30</td>
<td>0.01</td>
<td>2.95</td>
<td>1.74</td>
<td>0.83</td>
<td>0-3</td>
<td>Unpolluted to moderately to strongly polluted</td>
</tr>
<tr>
<td>4</td>
<td>1.91</td>
<td>0.65</td>
<td>3.29</td>
<td>2.05</td>
<td>0.52</td>
<td>0-2</td>
<td>Unpolluted to moderately polluted</td>
</tr>
<tr>
<td>5</td>
<td>1.80</td>
<td>1.25</td>
<td>3.25</td>
<td>2.54</td>
<td>0.01</td>
<td>0-2</td>
<td>Unpolluted to moderately polluted</td>
</tr>
<tr>
<td>Average</td>
<td>2.18</td>
<td>0.40</td>
<td>3.18</td>
<td>1.92</td>
<td>0.62</td>
<td>0-3</td>
<td>Unpolluted to moderately to strongly polluted</td>
</tr>
</tbody>
</table>

**Modified degree of contamination (mCd)**

The contamination factor and degree of contamination for the surface sediment at station were calculated using equation of Hakanson et al. (1980) modified by Abrahim and Parker (2008). Abrahim and Parker (2008) has classified mCd in estuarine sediments in relation to contamination levels into seven classes: mCd < 1.5 Nil to very low degree of contamination, 1.5 ≤ mCd < 2 Low degree of contamination, 2 ≤ mCd < 4 Moderate degree of contamination, 4 ≤ mCd < 8 High degree of contamination, 8 ≤ mCd < 16 Very high degree of contamination, 16 ≤ mCd < 32 Extremely high degree of contamination, mCd ≥32 Ultra high degree of contamination. The results of mCd for surface sediments were tabulated in Table 3. The background values of the heavy metals were the same as applied in the geochemical index calculation. The mCd data determined very low to moderate degree of contamination.

<table>
<thead>
<tr>
<th>Station</th>
<th>Cd</th>
<th>Zn</th>
<th>Ni</th>
<th>Cu</th>
<th>Pb</th>
<th>mCd</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.65</td>
<td>1.70</td>
<td>0.19</td>
<td>0.76</td>
<td>4.14</td>
<td>16.45</td>
</tr>
<tr>
<td>2</td>
<td>7.05</td>
<td>1.19</td>
<td>0.15</td>
<td>0.30</td>
<td>1.98</td>
<td>10.67</td>
</tr>
<tr>
<td>3</td>
<td>7.40</td>
<td>1.51</td>
<td>0.19</td>
<td>0.44</td>
<td>2.67</td>
<td>12.22</td>
</tr>
<tr>
<td>4</td>
<td>5.65</td>
<td>0.95</td>
<td>0.15</td>
<td>0.36</td>
<td>2.15</td>
<td>9.26</td>
</tr>
<tr>
<td>5</td>
<td>5.25</td>
<td>0.62</td>
<td>0.14</td>
<td>0.25</td>
<td>1.40</td>
<td>7.68</td>
</tr>
</tbody>
</table>

**Ecotoxicological evaluation of trace metal contamination**

The sediment quality guidelines developed by Bakan and Ozkoc for marine and estuarine ecosystem (Bakan and Ozkoc, 2007) were used in the present study to determine the ecotoxicological sense of metal contamination in the Klang estuary. Chemical concentrations corresponding to the 10th and 50th percentiles of adverse biological effects were called the effects range-low (ERL) and effects-range median (ERM) guidelines, respectively (Long etal.1995).Considering the results, the heavy metal concentration of Cd at those stations were higher than ERL and less than ERM, which represents a range with in which biological effects occur occasion- ally. Whilst, those studied metals (except Pb and Cu in station 1) were below ERL and ERM (Table1).
Conclusions

The influence of anthropogenic metals pollution in surface sediments of Klang estuary were determined using geoaccumulation index ($I_{geo}$) and modified degree of contamination ($mC_d$) for Cd, Zn, Ni, Cu, Pb and Fe in fine-grained fraction. Although the levels of most trace metals in the surface sediments did not show extreme enrichment and did not present any serious threat to the local fauna and flora, it is still highly recommended that further investigations and monitoring be conducted to assess long term effects of anthropogenic inputs into the Klang River ecosystems.

References


Marine debris composition and abundance:  
A case study of selected beaches in Malaysia  

A.K. Khairunnisa*, S.H. Fauziah and P. Agamuthu  
Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia  
Corresponding author's email: nisakamil_um@yahoo.com.my

Abstract
Spatial and temporal variations are proven to affect the composition and abundance of marine debris on beaches. A study on two beaches in Port Dickson, Malaysia was done from January to March 2010. The objective of this study is to compare the density of solid waste in two beaches with different function as current assessment and baseline for future reference. Pasir Panjang and Teluk Kemang are fishing and recreational beaches respectively. Pasir Panjang recorded a higher amount of waste ranging from 31.64 g/m$^2$ – 57.75 g/m$^2$ compared to that of Teluk Kemang which recorded 0.7625 g/m$^2$ – 3.225 g/m$^2$. Plastic bags, high density polyethylene (HDPE) and polystyrene were the most frequent types of waste found at both beaches. On the fishing beach, bulky waste and rubber contribute the highest composition of waste (53% and 35%) in terms of weight. Results indicated that the density of solid waste is highly dependable to the economic activities on the relevant beaches.

Keywords: litter, solid waste, beach pollution

Introduction
Solid waste disposal on beaches has been one of the major aspects in coastal zone management. Commonly known as marine debris, this type of waste affects marine wildlife, interfere fishing and recreational activities and damaging the aesthetical value of an area (Good et al., 2010; Boland and Donohue, 2003; Clark, 2001; Hanni and Pyle, 2000; Hess et al., 1999; Ofiara and Brown, 1999). These contribute to economical, environmental and social losses. United Nations Educational, Scientific and Cultural Organization (UNESCO) in their report had listed 6 items as marine debris sources such as ocean sources, fisheries, shipping and petroleum industries, land-based sources, urban runoff and recreational activities (UNESCO, 1994). Plastics are the most prevalent item found in most of marine debris studies (Ivar do Sul and Costa, 2007; Frost and Cullen, 1997). Studies suggested that tourism and recreational is the main contributor of marine debris (Santos, 2005; Claereboudt, 2004). Most of previous studies indicated that temporal variation affects the amount of waste collected (Morishige et al., 2007; Madzena, 1997). Since the composition of waste is affected by temporal and spatial variation, studies on marine debris should take this factor into account. The objective of this study is to compare composition of waste on two selected beaches with different function as current assessment and baseline for future reference.

Materials and Methods
The sampling area for each beach corresponded to the actual width and length of the beach. The area sampled was 10% of the actual length i.e. from the low tide lines until the vegetation line. All visible marine debris were collected and weighed. These, were then sorted and categorized into 19 predetermined type of waste. Data obtained from the beaches were analyzed and compared.
Results and Discussion

The average density of most type of waste is higher in Pasir Panjang than that of Teluk Kemang (Table 1). The present of fishing material such as drift net (bulky waste) and tyres (rubber) contribute significant weight to the fishing beach. This is based on the fact that waste composition and abundance on beaches are always affected by the activities around the area. In a study in Oman, the relative abundance of fishing-related and recreation-related debris was different between types of beach (Claereboudt, 2004).

Table 1. Density of waste on Pasir Panjang and Teluk Kemang beaches.

<table>
<thead>
<tr>
<th>Type of waste</th>
<th>Pasir Panjang (fisheries beach)</th>
<th>Teluk Kemang (recreational beach)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>Food waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed paper</td>
<td>0.3000</td>
<td></td>
</tr>
<tr>
<td>Newspaper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrugated paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic/ HDPE</td>
<td>0.4250</td>
<td>1.2000</td>
</tr>
<tr>
<td>Plastic bag</td>
<td>3.5000</td>
<td>0.4500</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>0.2000</td>
<td>0.2000</td>
</tr>
<tr>
<td>Textile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber</td>
<td>0.7500</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-coloured glass</td>
<td>1.1500</td>
<td>1.2000</td>
</tr>
<tr>
<td>Coloured glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td>0.0125</td>
<td></td>
</tr>
<tr>
<td>Aluminium tin</td>
<td></td>
<td>0.3000</td>
</tr>
<tr>
<td>Aluminium (others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic waste (others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulky waste (drift net)</td>
<td>25.0000</td>
<td>25.0000</td>
</tr>
<tr>
<td>Total density</td>
<td>31.6375</td>
<td>53.7500</td>
</tr>
</tbody>
</table>

Types of waste found on both beaches were the same with most frequently found included plastic/HDPE, plastic bags and polystyrene. Newspaper and corrugated paper were present only at the recreational beach while bulky waste and rubber were found only at the fishing beach (Figures 1 and 2).

The composition of waste observed in Teluk Kemang is comparable to other recreational beaches around the world where plastics (plastic bags and HDPE) were the most abundance item (43%) followed by newspaper (33%) and corrugated paper (9%). Comparing the waste composition in terms of weight, fishing-related debris such as drift net (53%) contributes the highest amount of waste found in Pasir Panjang. This is in an agreement with other study, where fishing debris contributes the largest portion of waste in terms of weight (Claereboudt, 2004).
Based from the visual observation, wastes found on Pasir Panjang were full of mosses and barnacles, indicated that these had been discarded years before. This bulky waste was never been removed throughout the three months study (Figure 3). The removal of waste in fishing beach which is often in rural area always depends on locals’ initiatives.

Comparatively, wastes on Teluk Kemang are new and removed daily. Although the density of visitors was higher in this recreational beach, it does not reflect the amount of waste found (Figure 4). This is contradicting to other study done in Brazil on litter generation (Santos et al., 2005). Public interest on recreational beaches demands the responsible action from authorities. This is also true in a study done in Australia where the greatest number of debris was not found on beaches with the highest number of users because of the extensive system of litter bins present (Frost and Cullen, 1997).
Conclusions
Different function of beach affects the composition and abundance of marine debris differently. Therefore, the data obtained can be used as baseline for future references particularly in improving the waste management on beaches in Malaysia.

Acknowledgements
This project is funded by Postgraduate Research Fund (PPP) from University Malaya (P0099-2009C).

References


A preliminary study of zooplankton composition associated with thermal effluents from a power plant at Manjung, Perak, Malaysia

Jiang-Wei Chan¹, Omar Ahmad¹, W.O. Wan Maznah¹² and Khairun Yahya¹²

¹Centre for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia, Penang, Malaysia
²School of Biological Sciences, Universiti Sains Malaysia, Penang, Malaysia

Corresponding author’s email: wmaznah@usm.my

Abstract

The increased demand for coastal power stations has been associated with an increased concern over the environmental impact of plankton entrainment in associated cooling waters. Certain preliminary information is necessary and important in the investigation of zooplankton diversity at the vicinity of thermal power plant. Zooplankton species composition was studied in the coastal waters of a thermal power plant in Manjung, Perak, Malaysia from September 2009 to February 2010. Plankton samples were collected by vertical hauls from a depth of 3.5m at three sampling stations with a WP-2 plankton net adjacent to the thermal power plant. Sampling stations were characterized by the inlet and discharged point of a thermal power plant as well as the surrounding area. Zooplankton was identified, enumerated and grouped into respective taxonomic groups. Temperatures recorded at the effluents ranged between 27.7 to 37.9 °C and a total of 10 phyla of zooplankton were identified. Calanoid copepods were the dominant group at all stations and accounted for 41.21%, 55.98% and 41.52% at each station, respectively. Mean total zooplankton abundance was higher at a station located near mangrove area (18204.43 ± 6200.53 ind/m³). However, mean total zooplankton abundance was lower at an area close to the water inlet (9655.40 ± 4387.10 ind/m³). Zooplankton abundance and water temperature were significantly different among the sampling stations (p<0.05 and p<0.01, respectively). The preliminary results of this study demonstrated that elevated temperatures from the effluents do not have a permanent effect on zooplankton abundance.

Keywords: zooplankton, power plant, temperature

Introduction

The use of coastal water in power plants for cooling purposes is common practice in a number of countries (Dias and Bonecker, 2008; Hoffmeyer et al., 2005). Such heated water effluents in the open environment may affect the organism in the vicinity. The survival and abundance of circulating plankton was studied to evaluated impact heat effluent (Capuzzo, 1980; Hwang et al. 2004; Hoffmeyer et al., 2005). Zooplankton is a sensitive bio-indicator of environmental change. Therefore, zooplankton, particularly copepod has been one of the key components in the power plants’ cooling water monitoring program. Researches indicated that higher mortality value of zooplankton (copepod and crustacean larvae) at water discharge site of a power plant cooling system (Hoffmeyer et al., 2005).

Materials and Methods

Zooplankton species composition was studied in the coastal waters of Manjung, Perak, Malaysia from September 2009 to February 2010. Three sampling stations were selected. These sampling stations were characterized by the intake and discharge points of cooling water from power plant station operation activities as well as the surrounding waters. Global Positioning System (GPS) was used to record the area coverage of sampling sites, while water temperature was measured by using YSI 85 DO-SCT meter. Plankton samples were collected monthly by vertical hauls from a depth of 3.5m with a WP-2 plankton net (165 cm
long, 50 cm mouth diameter, 200 µm mesh sizes) adjacent to the thermal power plant. For each hauls, the volume ($m^3$) of filtered water was estimated taking into account the area of the net mouth. Zooplankton samples were removed from the cod end after intensive washing. Zooplankton samples were preserved immediately in 4% buffered-formaldehyde seawater solution. In the laboratory, zooplankton was identified, enumerated, grouped into respective taxonomic groups and counted using sub-sampling method. The identification of zooplankton was based on the keys outlined by Wickstead (1965), Pathansali (1968), Wongrat (2000), Boxshall and Halsey, (2004), and Conway et al. (2003).

Results

Water temperatures recorded at station near thermal water discharge was ranging between 35.5 to 37.9 °C, while the other two stations was in the range of 27.7 and 32.3 °C. therefore, temperature was a parameter of concern at water discharged of power station as the rise of temperature exceeded 2°C compared to the ambient water temperature. A total of 10 phyla of zooplankton were identified during the study period. Calanoid copepods was the dominant group at all stations. Other groups including Cnidaria, Annelida, Mollusca, Bryozoa, Ctenophora and Echinodermata were found in less abundance in the study area.

![Mean total zooplankton abundance (ind/m$^3$±s.d) at three sampling stations of Manjung, Perak.](image)

The mean total zooplankton abundance was higher at a station which located near mangrove area (18204.43 ± 6200.53 ind/m$^3$) (Figure 1). It was dominated by calanoid copepods and it contributed 41.21% of the total zooplankton abundance, followed by lucifer protozoa (14.60%) and cirripede nauplius (10.27%). However, mean total zooplankton abundance was lower at an area close to the water inlet (9655.40 ± 4387.10 ind/m$^3$). Calanoid copepods was accounted for 41.26% of total zooplankton abundance, followed by cyclopoid copepods (14.66%) and Lucifer protozoa (8.92%). Meanwhile, mean total zooplankton abundance at a station near the heat water discharge was 11501.44 ± 3450.62 ind/m$^3$. Calanoid copepods was the main group in this station and amounted for 41.52%, while cyclopoid copepods and cirripede nauplius was accounted for 10.71% and 6.20% respectively. Statistical analysis (one-way ANOVA) showed that zooplankton abundance and water temperature were significantly different among the sampling stations (p<0.05 and p<0.01, respectively).
Discussion

In the present study, lower zooplankton abundance of zooplankton was recorded at the water inlet but not at the station near thermal water discharge. Therefore, our results were in agreement with other study by Dias and Bonecker, (2008) who recorded higher zooplankton abundance at heat water discharge compared to water inlet at Ribeira Bay, near a power plant (Rio de Janeiro, Brazil). However, other studies showed that temperature was one of the factors that reduced the zooplankton abundance (Capuzzo, 1980). Hoffmeyer et al. (2005) indicated that a sharp decrease of zooplankton abundance was found in the area closed to heat water discharge at Bahía Blanca estuary, Argentina. In general, the dominant group of zooplankton is represented by the copepods at the thermal power stations. Our results on zooplankton abundance are in close agreement with those reported by Rezai et al. (2001, 2004, 2009) and Yoshida et al. (2006) in that copepods were the largest group among the zooplankton populations. Rezai et al. (2009) indicated that copepods were the most important constituents of the zooplankton in the Strait of Malacca, it accounted for 57-71% of total zooplankton abundance. It can be concluded that temperature was an important factor structuring the zooplankton community at the discharge site. The preliminary results of this study demonstrated that elevated temperatures from the effluents do not have a permanent effect on zooplankton abundance. The results from the present studies showed that copepods form the most dominant group of zooplankton in the vicinity of thermal power stations. Zooplankton abundance was varied spatially and temporally.

Acknowledgements

We are grateful to Tenaga National Berhad Research (TNBR), Centre for Marine and Coastal Studies (CEMACS) and Universiti Sains Malaysia for their financial and technical supports. The authors acknowledge the long term helps from the staff of CEMACS those who had help during sampling.

References


Utilization of locally isolated phototrophic bacterium for the treatment of palm oil mill effluent

Sujjat Al Azad* and Sitti Reahanah Mohd. Shalleh

Borneo Marine Research Institute, University Malaysia Sabah
Kota Kinabalu, Sabah, Malaysia

Corresponding author’s email: sujjat@ums.edu.my

Abstract
Phototrophic bacterium strain UMSPSB3 was isolated from Palm Oil Mill Effluent (POME). The bacterium was grown in settled non-sterilized POME. The aim of the study was to produce bacterial biomass for the reduction of chemical oxygen demand (COD) from wastewater. The growth characteristics and reduction of COD were compared using 10%, 20% and 30% (v/v) levels of inoculum developed in synthetic 112 media. The highest bacterial biomass ($X_{\text{max}}$) of 6.5g/L (dry weight) and 72% reduction of COD were obtained after 96-h culture with 20% (v/v) inoculum level. The reduction of COD (%) and cell yield ($Y_{x/y}$, g cell/g COD) in POME were 82% and 0.98 respectively, after 96-h culture with 30% (v/v) inoculum. Inoculum levels of 20-30% (v/v) developed in synthetic 112 media supported the growth of phototrophic bacterium in settled POME, but higher level of inoculum was required for faster removal COD from effluent. A 10% (v/v) level of inoculum in POME did not support the isolate to grow. Production of bacterial biomass for the bioremediation of effluent could be achieved in culturing strain of UMSPSB3 in POME.

Keywords: phototroph, inoculum size, Palm Oil Mill Effluent, growth, bioremediation

Introduction
The palm oil industry generates the largest amount of biomass in the oil industry. In the process of oil production, it generates many by-product and wastes especially palm oil mill effluent (POME), which may have significant effect on the environment (Igwe and Onyegbado, 2007). The palm oil mill effluent is the by-product that also has profitable and viable biotechnological applications (Wu et al., 2009). Palm oil mill effluent refers as the last stage of the palm oil production in the mill. It includes several of liquid dirties, residual oil and suspended solid, which have high organic loading load like chemical oxygen demand of 30000mg/L to 50,000mg/L. The methods in treating palm oil mill effluent generally include tank digestion and facultative ponds, the decanter-drier system, aerobic and facultative pond and distillation ponds (Okwute and Isu, 2007). Facultative digestion that relies upon microorganisms that plays vital roles in the breakdown of organic particles to inorganic forms. Purple non-sulphur bacteria (PNSB) are one of the potential candidates used by various researchers in the wastewater treatment process. PNSB has advantages as it can grow in wide range of substrate as well as in aerobically and anaerobically culture condition. The growth of PNBS have been used in the wastewater treatment includes treatment of sago effluent (Ibrahim et al., 2006), wastewater treatment by PNSB for single cell production in anaerobic waste treatment (Honda et al., 2006), sardine processing wastewater and uses biomass of PNSB as aquaculture feed additives (Azad et al., 2002) and utilization and treatment of tuna condensate by photosynthetic bacteria (Prasertsan et al., 1997). Further the inoculum sizes of PNSB play significant roles in the utilization of the wastewater (Azad et al., 2003; Prasertsan et al., 1997). The objectives of this study were to: (i) to evaluate the efficacy of inoculum sizes from locally isolated PNBS on the growth characteristics using POME as substrate, and (ii) to reduction of COD from POME.
Materials and Methods

Sample of POME was collected from Beaufort Palm Oil Mill Sdn. Bhd. located at 5°18’29″N 115°42’16″E in Sabah. On spot 5mL of collected POME was poured into 30mL universal bottles, containing previously autoclaved 112 media. In the laboratory, bottles were incubated under anaerobic light conditions at temperature of 30±2°C and 2500 lux illumination intensity. The pure culture of PNSB was obtained after repeated streaking of single colony in agar plate with 112 media. Preliminary identification was done biochemically in pure culture isolate. On the other hand, collected POME was immediately characterized before the utilizing as substrate. The settled and non-sterilized POME after adjusting pH at 7.0 was used as substrate. Pure PNSB was used to prepare inoculum in sterilized 112 media. A 48-h culture was used as inoculum. The growth profiles of PNSB in POME and reduction in COD were studied with 10, 20 and 30% (v/v) level of inoculum. The growth of the bacterium was determined everyday by using dry cell weight (g/L) method and the level of COD (mg/L) reduction was determined with the standard method (APHA 1998). Paired samples T-test in SPSS were used to determine significant level in dry cell biomass and reduction in COD by purple non-sulphur bacteria by different inoculums sizes.

Results

The pH of both settled and non-settled shows no differences, but COD reduces 63% upon settled POME in laboratory condition. Oil and grease, total suspended solid and total volatile solid of POME shows significant difference after POME allowed to settle. However, the nutrients in settled POME are enough to support the growth and survival of purple non-sulphur bacteria under anaerobic light culture system.

Table 1. Characteristic of settled and non-settled POME used in the experiments.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unsettled</th>
<th>Settled</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.55</td>
<td>4.55</td>
</tr>
<tr>
<td>Oil and Grease (mg/L)</td>
<td>0.61</td>
<td>0.24</td>
</tr>
<tr>
<td>Total solid (mg/L)</td>
<td>7.67</td>
<td>4.03</td>
</tr>
<tr>
<td>Total suspended solid (mg/L)</td>
<td>5.79</td>
<td>1.91</td>
</tr>
<tr>
<td>Total volatile solid (mg/L)</td>
<td>9.18</td>
<td>3.63</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (mg/L)</td>
<td>24000</td>
<td>15000</td>
</tr>
</tbody>
</table>

The highest bacterial biomass of 6.5g/L was obtained with 20% (v/v) inoculum level after 96-h culture, which was not significantly (p=0.075) different in dry cell biomass (Table 2) obtained with 30% (v/v) inoculum level (Figure 1).

On the other hand, the specific growth rate (µmax per hour) was the highest of 0.52 with 20% inoculum after 96-h culture, but at the same time, the lowest µmax of 0.47 obtained with 30% inoculum. No significant different values (p=0.68) were found in specific growth (Table 2) among the two level of inoculum sizes.

Table 2. Growth characteristics of an isolate cultured in settled POME after 96-h culture anaerobic light condition.

<table>
<thead>
<tr>
<th>Inoculum in % (v/v)</th>
<th>Xmax (g/L)</th>
<th>µmax (per h)</th>
<th>Yx/g (g/cell/g COD)</th>
<th>COD reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.1</td>
<td>not determined</td>
<td>not determined</td>
<td>not determined</td>
</tr>
<tr>
<td>20</td>
<td>a 6.5±0.02</td>
<td>0.52±0.003</td>
<td>a 0.53 ± 0.006</td>
<td>a 72± 2.6</td>
</tr>
<tr>
<td>30</td>
<td>a 5.8±0.05</td>
<td>0.47±0.003</td>
<td>0.98±0.010</td>
<td>a 82±3.0</td>
</tr>
</tbody>
</table>

Xmax is production in maximum cell (g/L) and µmax is specific growth rate (per h)
Different superscript shows significant differences
Reduction of COD was the highest of 82% with 30% (v/v) level of inoculum was determined after 96-h culture and was significantly different (p=0.03) from the reduction of COD with 20% (v/v) inoculum level (Figure 2; Table 2).

Figure 2. Reduction in COD (mg/L) of isolate cultured in settled and non-sterilized POME with 10%, 20% and 30% (v/v) level of inoculum.

Discuss

Purple non-sulphur bacteria have the capability to utilize the carbon and nitrogen sources, under anaerobic light condition. The removal of the solid particles from wastewater did not affect the nutrients essential for PNSB growth (Azad et al., 2003). The optimum pH values for the growth of PNSB are within the range of 6.5-7.5. In this experiment, pH was adjusted at 7.0 to get optimum growth. Most of the purple non-sulphur bacteria grow well at optimum pH of 7.0. Rhodocyclus gelatinosus cultured in tuna condensate the optimum pH was 7.0 (Prasertsan et al., 1997). The increase of dry cell biomass with 20 and 30% (v/v) inoculums level that have used in the treatment shows that the bacteria growing in the POME, but 10% inoculum level was not supportive to suppress other opportunistic bacteria in on-sterilized POME. The highest biomass was observed with 20 and 30% (v/v) inoculums in POME from a 96h culture. These levels of inoculums might provide a high number of bacteria to fully utilize the nutrients that are available in the substrate, in addition to suppress the growth of other bacteria (Azad et al., 2003). To suppress the growth of heterotrophic microbes in wastewater the inoculum must be of good quality, fast growing and of sufficient quantity to suppress the growth of contaminants (Noparatnaraporn et al., 1987). Purple non-sulfur bacterium, Rhodocyclus gelatinosus was prepared in synthetic G5 media from whom 10% (v/v) inoculum was used in cultures of diluted tune condensate and dry cell biomass of 5.7g/L with 86% reduction in COD were obtained (Prasertsan et al., 1997). The competition for nutrients in substrate with a 10% (v/v) level of inoculum, however, is comparatively less than that of 30% (v/v) level of inoculum. In cassava starch, 13% (v/v) inoculum of Rhodopseudomonas gelatinosa was used for single cell production. Under anaerobic light condition, maximum biomass of 1.8g/L was obtained in experimentation (Noparatnaraporn et
al., 1987). Under different culture conditions, PNSB was observed to reduce the chemical oxygen demand of wastewater. PNSB strain *Rhodovulum sulfidophilum* cultured in settled and undiluted sardine processing wastewater with a 15% (v/v) inoculum had shown a reduction of 76% and 68% of COD under aerobic dark and anaerobic light conditions respectively. But under aerobic dark condition with 15% (v/v) inoculum at 200, 300 and 400 rev/min agitation speed COD reduction was 78%, 69% and 73% respectively (Azad et al., 2003).

Based on the present study, the optimum size of inoculum for biomass production lies between 20–30% (v/v), but for the reduction of COD a 30% inoculation are necessary for the utilization of PNSB in POME as substrate. Dual benefits could thus be achieved in PNSB utilization of POME: bioremediation of wastewater and production of beneficial biomass that might be utilized as feed additive in aquaculture industry.

**References**


Effect of cold stress on three genera of hard corals in Persian Gulf with 70KDa protein as stress indicator

Fatemeh Nozhat

Payame Noor University, Firoozabad, Fars Province, Iran

Corresponding author’s email: f_nozhat@pnu.ac.ir

Abstract

Over the past two decades, an increasing number of reports have documented dramatic changes and continuing declines in coral reefs communities, which have been attributed to both natural and anthropogenic factors. Corals respond to environmental disturbances by reducing their dinoflagellate symbiont densities, a phenomenon known as coral bleaching. Coral bleaching is caused by one or a combination of elevated and reduced sea water temperature, increased and decreased UV radiation, organic and inorganic pollutants and salinity disturbances. During this study we explore the role of 70KDa proteins in the coral bleaching as stress indicator in hard corals (Acropora sp., Favia sp., Porites sp.) of the Kish Island (in Persian Gulf) samples were collected from cold, temperate and warm seasons. We used electrophoresis and densitometry techniques for measurement of 70KDa proteins.

During cold season (February, 2005) 70KDa protein increased significantly in Favia sp., (ANOVA, P<0.05). The cellular stress response entails the rapid synthesis of a suite of proteins, called stress proteins, in response to environmentally adverse conditions. The response in highly conserved and stress proteins have been found in diverse organisms such as corals. Therefore, it is concluded that low temperature might influence the stress response in cold season. Molecular biomarkers (including 70KDa proteins) will be quantitatively assessed together with traditional measures of thermal tolerance (Chlorophyll a and zooxanthellae density). We propose to measure 70KDa protein that play a key role in stress responses. Finally, we discuss the utility of this parameter as molecular biomarker of biological disturbances in coral symbioses.

Keywords: cold stress, Acropora sp., Favia sp., Porites sp., stress proteins

Introduction

Corals are important organisms for microscale ecotoxicological studies on the health of coral reefs due to their key role in the ecosystem. Coral bleaching is a response to stresses such as abnormal temperatures (Fang et al., 1998). Photosynthetic pigment concentration, total protein concentration and heat shock proteins such as 70KDa proteins are useful in detecting sublethal stresses. In addition, coral reef ecosystems worldwide are being degraded or destroyed at an unprecedented rate (Grigg, 1994). The decline of these ecosystems is attributed to different stresses. This may result in habitat loss, mortalities of reef inhabitants, alterations in community structure and an overall reduction in the biodiversity of the reef (Peters et al., 1997). It seems that 70KDa proteins are suitable markers in corals to monitor the degree of environmental stress such as cold stress on these animals. In the present study 70KDa proteins have been selected to prove their potential usefulness as indicators in the field. Also corals taken from stressed locations in the field showed an increase in 70KDa proteins.
Materials and Methods

Colonies of *Acropora* sp., *Favia* sp., *Porites* sp. were collected from the big coral site of Kish Island in the Persian Gulf (26º30´N, 54ºE). All of them were collected from 3 and 7 meters depths in May, August 2005 and February 2006. Samples carried back to the laboratory with liquid nitrogen. 70KDa proteins can be correlated with live coral surface area that was determined by Marsh method (1970). To assay coral for 70KDa proteins tissue is removed from the coral skeleton using a high-pressure jet of air from an air brush and immediately placed on ice. Coral tissue was homogenized. The homogenate was thawed in a 37ºC water bath, boiled for 3 min in sodium dodecyl sulfate (SDS) sample buffer (Laemmli, 1970). We used electrophoresis and densitometry for this aim. Samples of equal total protein were loaded on a 12.5% polyacrylamide gel with a 5% stacking gel as described by Blattler et al. (1972). The method of Warburg (1941) was used for analyzing soluble protein in the animal supernatant.

Statistical analysis: Data were analyzed for changes in 70KDa proteins with SPSS-programme (version11) repeated-measures of analysis of variance (ANOVA).

Results

The means of these parameters obtained from the cold, warm and temperate seasons showed a distinct pattern with an increase in 70KDa proteins during cold season (winter 2006). The lowest temperature was recorded in winter 2006 (15ºC) Temperatures in spring 2005 (22ºC) and summer 2005 (27ºC) were normal for corals. 70KDa proteins also demonstrated significant declines with increasing temperature. 70KDa proteins showed significant fluctuations between *Favia* sp. and *Porites* sp. (ANOVA, P<0.05) (Figures 1 and 2), also between *Favia* sp. and *Acropora* sp. (ANOVA, P<0.05) (Figures 1 and 2). However, difference obtained between the *Porites* sp. and *Acropora* sp. was not significant (ANOVA, P>0.05) (Figures 1 and 2). There were no significant differences in 70KDa proteins between 3 and 7 depths (ANOVA, P>0.05) (Figures 3-4 and Figures 5-6). While, there were significant differences in there different seasons between all of the samples (ANOVA, P<0.05) (Figures 1-2).

![Figure 1. Seasonal changes in 70KDa protein concentration in 3 m depth.](image1)

Error bars indicate ± standard deviation.

![Figure 2. Seasonal changes in 70KDa protein concentration in 7 m depth.](image2)

Error bars indicate ± standard deviation.

![Figure 3. An electrophoretic diagram of proteins from coral cells in cold season and 3m depth. Showing the appearance of 70KDa protein.](image3)

M is the marker. F is *Favia* sp. A is *Acropora* sp. and P is *Porites* sp.

![Figure 4. An electrophoretic diagram of proteins from coral cells in cold season and 7m depth. Showing the appearance of 70KDa protein.](image4)

M is the marker.
Discussion

The importance of minimum temperature in limiting the survival of corals and the development of coral reefs was first proposed by Dana (1843). Bleaching has been correlated with decreases in sea surface temperatures (Coles and Jokiel, 1977). 18°C accepted as the lower temperature threshold for corals (Vaughan, 1918). However, certain species of corals can survive temperature as low as 11/5°C for several months (Coles and Fadlallah, 1991). Normal winter water temperature in the ROPME sea area rank among the lowest recorded on coral reefs (Downing, 1985). In addition, the branching coral Acropora and boulder coral Porites are found to be the main frame builders off the Iranian Island (Rezaei, 1995). The minimum temperature in the present study occurred during winter (15°C). Data from this experiment suggest that several of the criteria required for an ideal stress indicator may be met by examining the accumulation of 70KDa proteins in tissue after exposure to environmentally realistic contaminant concentration. To provide an early warning for potential biological damage at the organismal level and to be useful in evaluating ecological status a versatile indicator should be more sensitive than existing organismal indices presently available. In conclusion, the data reported in this study show that 70KDa proteins might become suitable indicators for monitoring environmental stresses on corals. Primitive tests were performed and we must do final test. The Persian Gulf is subject to seasonal cold water upwelling due to the Indian Ocean monsoon system, which creates large temperature differences between the seasons (Rezaei, 2004). This is reflected in the nature and distribution of coral communities. It seems that increase of 70KDa proteins in cold season (winter 2005) shows cold stress in all of them specially Favia sp. (Figures 3-4). Also according past studies coral bleaching was observed in mid-summer of 1996 around Kish Island in massive (Favia sp.) coral colonies showing some evidence of bleaching (Rezaei, 1995). Therefore, It seems Favia sp. is more sensitive than the other. The data from the present experiment suggests that the accumulation of 70KDa proteins may have potential as molecular indicator of cellular stress. However, additional research in needed to determine if other stress proteins, might also be useful as a stress indicator. If a predictable relationship between accumulation of one or more stress proteins and physiological indices is demonstrated under a variety of environmental conditions, the accumulation of these proteins may provide a sensitive early warning for adverse effects on the organisms, population and community.

Acknowledgements

The author would like to thank Dr Savari, Dr Rezaei and Dr. Eghtesadi for continuous supports in this project. This work was funded by Iranian National Centre for Oceanography.
References


Oral: Session 2D
South China Sea Special Session
A numerical study of coupled estuary-shelf circulation around the Pearl River Estuary

Ting-Ting Zu¹, Jian-Ping Gan² and Dong-Xiao Wang¹

¹Key laboratory of Tropical Marine Environmental Dynamics, South China Sea Institute of Oceanology, Chinese Academy of Sciences, China

²Department of Mathematics, Hong Kong University of Science and Technology

Corresponding author’s email: zutt@scsio.ac.cn

Abstract

A three-dimensional, high resolution, estuary-shelf coupled model that include the Pearl River Estuary (PRE) and adjacent shelf is developed to study the general estuarine and shelf circulation in the PRE and their responses to the wind, tide and buoyancy forcing during summer monsoon. Typical upwelling and upwelling relaxation period are chosen for the simulation and the model results show that the currents are rather steady and mainly flow southward in the shallower upper PRE where the strength of tidal mixing and buoyancy are dominant forcing factors that determine the structure, while in the lower PRE, as the estuary is becoming wider and deeper, the Coriolis force is becoming important and the circulation pattern is more complex and variable, since wind, tide, buoyancy as well as the coastal intrusion currents all contribute, and it is characterized by a mean outflow converging on the middle channel and coastal intrusion currents along the western bank of the PRE and along bottom of the two channels. The horizontal and vertical structures of the buoyant plume also show quick variation with the change of the vertical mixing induced by wind and tide. The net water transport between estuary and shelf is closely related with the variation of the along-shore wind which indicates that the pressure gradient developed by the far field wind rather than the local wind has more influence on the water exchange.

Keywords: Pearl River estuary, coastal upwelling, ROMS, coupled estuary-shelf circulation
Transportation and distribution of pollutant in Pearl River Estuary

Lin Luo*, Wei Zhou and Dong-Xiao Wang

Key Laboratory of Tropical Marine Environmental Dynamics, South China Sea Institute of Oceanology
Chinese Academy of Sciences, Guangzhou 510301, China

Corresponding author’s email: luolin@scsio.ac.cn

Abstract

In the recent years, million tons of sewage per year poured into the Pearl River from Guangdong Province and changed the water quality of Pearl River Estuary (PRE). A hydrodynamics model with conservative tracer submodel was used to investigate the impact of three main sources of discharge pollutant and water exchange to the water quality in PRE. DO was employed as an indicative index to assess the pollutant transportation and distribution pattern. The results indicated that Low-oxygen water input from 3 main pollutant sources, named Humen Channel, Shenzhen River and Longgang River, had distinguish impact on the pattern of DO distribution of PRE. The flushing time of low-oxygen water in Shenzhen Bay was longest, followed by Longgang River and Humen Channel. A series of model experiments showed the responses of the pollutant concentration and the flushing time of water body to the tidal forcing and local wind were diverse in the distinct area of PRE.
Seasonal water masses variation of the upper layer
South China Sea

Abd Muhaimin Amiruddin* and Zelina Zaiton Ibrahim

Department of Environmental Management, Faculty of Environmental Studies
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: muhaimin@env.upm.edu.my

Abstract

The seasonally reversing monsoon winds, northeast and southwest monsoons largely dominate the South China Sea (SCS). Understanding of the water masses variations over the monsoon seasons in SCS is essential to predict the current and circulation. The main aim of this study is to map the seasonal physical-chemical variation and to improve the understanding of movement and intrusion of upper layer water masses in the SCS. Water temperatures and salinity from World Ocean Database 2009 were used for this study. Ocean Data View was used to process the data and to create contour visualization. Winter is marked by strong northeasterly monsoon winds. In spring, the northeasterly wind retreats and southwesterly monsoon winds begin. Summer is dominated by the southwesterly monsoon, which is replaced by northeasterly winds in autumn. The winter and autumn surface temperature in the northeast monsoon show the southwestward movement of low temperature water from the northern SCS. In the southwest monsoon during spring and summer, there is northeastward movement of high temperature from the southern SCS. The temperature profiles during winter and spring show that low water temperatures anomalies occurred off northwest Luzon. Summer and autumn indicated low temperature anomalies also occurred east of the Vietnam coast. These occurrences may be attributed to the emergence of mesoscale eddies for each season at the different locations. Salinity pattern during winter and spring indicate the intrusion of a high salinity surface layer over the whole of the northern SCS from western Pacific Ocean through the Luzon Strait. Summer exhibited the northward movement of surface freshwater through the Karimata Strait into the southern SCS. In conclusion, the variation of seasonal water masses in the upper layer of the SCS is strongly affected by the alternating of northeasterly and southwesterly monsoon winds in the region.

Keywords: mesoscale eddy, monsoon, South China Sea, water mass, water movement
Environmental exposure and ecological risk of heavy metals from fishing harbours in the Pearl River Delta (PRD), South China

Wei-Hai Xu¹*, Xiang-Dong Li², Wen Yan¹, Tian Lin³ and Zhao-Hui Hu³

¹CAS Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology
Chinese Academy of Sciences, Guangzhou 510301, China

²Department of Civil and Structural Engineering, The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong

³State Key Laboratory of Organic Geochemistry, Guangzhou Institute of Geochemistry
The Chinese Academy of Sciences, Guangzhou 510640, China

Corresponding author’s email: whxu@scsio.ac.cn

Abstract

Fishing harbours are widely distributed in coastal regions in China. However, few studies about heavy metals in those fishing harbours were reported though they may have been heavily polluted. In this study, a total of 56 surface sediment samples were collected from nine typical fishing harbours along the coastal line of China to illuminate the heavy metals pollution and their potential ecological risk. Results reveal that Cu, Pb, Zn and Cd are four ubiquitous elements with high concentrations in the selected harbours. These four metals from the 3 harbours located in Pearl River Delta (PRD) are remarkably higher than those in other regions. The main finding of the study is that rather high Cu was observed in sediments with the highest concentration up to 1249 mg/kg in the PRD. This study reveals that Cu widely used in the antifouling paint for fishing ships may have been released into seawater and accumulated in marine sediment. The Enrich Factor values (EFs) clearly indicate that heavy metals are readily accumulated in harbour sediments, suggesting serious anthropogenic pollution in all harbours. The high correlation of Cu, Pb and Zn with TOC in sediments from these harbours suggests that the harbours may act as an important heavy metals source to the coastal environment of China. Cd values in both Macao harbour and Zhuhai harbour indicate a very high potential ecological risk, respectively. Zn value shows a very high potential ecological risk in Shenzhen harbour and a risk from low degree to moderate in other harbours.
Comparison and analysis of environmental constituents in the Pearl River Estuary during summer of 1999 and 2009

Wei Yang*, Lin Luo, Yong-Li Gao, Ting-Ting Zu, Wei Zhou and Dong-Xiao Wang

Key Laboratory of Tropical Marine Environmental Dynamics
South China Sea Institute of Oceanology, CAS, Guangzhou 510301, China
Corresponding author's email: yangwei@scsio.ac.cn

Abstract

By analyzing the salinity, dissolved oxygen (DO), Chlorophyll data observed in 1999, 2009 summer in Pearl River Estuary (PRE), we find that the spreading range of the fresh water plume in 1999 is larger than that in 2009 due to larger runoff from the Pearl River. The stratification inside the PRE is weaker in 2009 than 1999, owing to the effect of the small river discharge and strong winds brought by the tropical storm “Nangka”, and above 5-meter water layer is well mixed in 2009. The DO distribution patterns in the surface are similar for the two years, but quite different in the bottom, especially in the west shallow area of the PRE where the concentration of DO is under 3mg/L in 1999, while is above 5 mg/L in 2009 and the region outside the mouth of the PRE where DO is between 4-5mg/L in 1999, while less than 3mg/L in 2009. Strong stratification in PRE is the main reason for the low concentration of DO in the bottom water of 1999. In 2009, intensified vertical mixing brought by “Nangka” facilitates the exchange of dissolved oxygen between the surface and bottom water which prevents the forming of low concentration of DO. The consumption of oxygen by the phytoplankton blooms triggered by “Nangka” and stratification might be the reasons for the low DO content in the bottom water outside the mouth of PRE.

Keywords: summer, Pearl River Estuary, river plume, dissolved oxygen, stratification, tropical storm

Introduction

Figure 1. Station locations for cruises in 1999 (a, 24 stations) and 2009 (b, 30 stations). Black hexagram is Gaoyao station, black square is PRE. S1, S3 are along-estuary transects. S2, S4 are cross-estuary transects.

Two research cruises were carried out during 17th -23rd July 1999 and 26th June – 1st July 2009. The vertical salinity, temperature and dissolved oxygen profiles were measured using...
YSI instrument, water samples from surface, middle and bottom layer were collected at each station, DO and Chlorophyll were measured after the cruise for analyzing.

**Results**

Fresh water pours out from the surface and salty water from NSCS intrudes along the east side of PRE in the bottom. Salinity gradient is larger in the cross-estuary direction than that in along-estuary direction. The spreading range of the river plume in the surface is larger and the intrusion range of salty water in the bottom is further in 1999 than those in 2009.

Fig. 2 Salinity distribution in the surface (a) and (c), and bottom (b) and (d) in summer of 1999 and 2009

The DO distribution patterns in the surface are similar for the two years, but quite different in the bottom. DO is between 6-8mg/L in the surface. In the west shallow area of PRE where DO is under 3mg/L in 1999, while is above 5 mg/L in 2009 and the region outside the mouth of PRE where DO is between 4-5mg/L in 1999, while less than 3mg/L in 2009.

Fig. 3 Dissolved oxygen distribution in the surface (a) and (c), and bottom (b) and (d) in summer of 1999 and 2009
Discussion

Fig. 5 presents daily discharge of Gaoyao station from 17th - 23rd July 1999 and 26th June – 1st July 2009. River runoff from the Pearl River is larger in 1999 than that in 2009, this is the main reason for the larger fresh water plume size in 1999.

Fig. 4 Daily discharge of gaoyao station in one month before the cruise in 1999 and 2009

In 1999 strong stratification in PRE prevents the exchanging of DO between the surface and bottom waters. The stratification inside the PRE is weaker in 2009 than 1999 owing to the coeffect of small river discharge and strong winds brought by the tropical storm "Nangka". The intensified vertical mixing facilitates the exchange of DO between the surface and bottom waters, in the west shallow area of PRE, the vertical could be completely mixed.

Figure 5. Vertical profile of the Station 13 in 1999 and Station 8 in 2009 (a) Salinity (b) Temperature (c) Dissolved oxygen

Conclusions

Fresh water plume size is larger in 1999 than that in 2009. Stratification is stronger in 1999, due to the effects of smaller river runoff and strong winds brought by the "Nangka", stratification is weaker in 2009, and above 5-meter water layer is well mixed. The DO distribution patterns in the surface are similar for the two years, but quite different in the bottom, the Strong stratification in PRE is the main reason for the low concentration of DO in the bottom water of 1999. In 2009, intensified vertical mixing brought by “Nangka” facilitates the exchange of dissolved oxygen between the surface and bottom water which prevents the forming of low concentration of DO. The consumption of oxygen by the phytoplankton blooms triggered by “Nangka” and stratification might be the reasons for the low DO content in the bottom water outside the mouth of PRE.

References


A theoretical frame for ecosystem health assessment and its application to the Tolo Harbour, Hong Kong, China

Fu-Liu Xu
MOE Laboratory for Earth Surface Process, Department of Urban and Environmental Sciences
Peking University, Beijing 100871, P. R. China
Corresponding author’s email: xufl@urban.pku.edu.cn

Abstract

A theoretical frame for assessing ecosystem health was presented. The assessment includes the following five steps: (1) review of human activities; (2) identification of human-induced stresses; (3) analysis of ecosystem responses to the stresses; (4) development of ecosystem health indicators; and (5) assessment of ecosystem health. This procedure was applied to a marine coastal ecosystem in the Tolo Harbour, Hong Kong. Based on the relationships between the stresses and ecosystem responses, a set of comprehensive indicators integrating classical indicators with thermodynamic indicators was proposed and applied to assess the Tolo Harbour marine coastal ecosystem health. The indicators encompass the stress indicators and the responses indicators including physical, chemical, biological, general ecosystem-level and ecosystem-service-function aspects. The assessment results show that, in temporal, a relative order of ecosystem health states from good to bad was determined as follows: the 1970s > the 1990s > the 1980s; while, in spatial, a relative order of health states from good to bad is: Channel Subzone > Buffer Subzone > Harbour Subzone. Some recommendations to improve further the marine coastal ecosystem health in the Tolo Harbour are finally discussed.

Keywords: ecosystem health assessment, stress indicator, responses indicator, Tolo Harbour
Oral: Session 3A
Environmental Abatement Technologies
Reef restoration through coral transplantation in Malaysia

Mohamed Pauzi Abdullah\(^1\) and Ab Rahim Gor Yaman\(^2\)

\(^1\)Fisheries Research Institute (FRI), Dept. of Fisheries
11960 Batu Maung, Penang, Malaysia

\(^2\)Department of Marine Park Malaysia, Ministry of Natural Resources and Environment
62574 Putrajaya, Malaysia

Corresponding author's email: m pauzi@gmail.com

Abstract

Coral Transplantation in Malaysia was done in a small scale. That is in events whereby a site on the coral reef need to be cleared for development, efforts were made to relocate the affected corals to a safer area. The new site for the relocation was chosen to be as similar as possible to the origin in terms of depth, water clarity, position on the reef and substrate. The transplants were also placed in same orientation to the sun. Placing the transplants on the substrate at the new location was made possible by the use of locally available materials such as chicken wire mesh, steel pegs and steel wires. The coral transplanting activities were mostly conducted in the east coast of Peninsular Malaysia namely Perhentian Island and Tioman Island. Surveys quantifying the amount and species of corals needed to be moved were done in some other localities involving larger areas but actual transplanting work has yet to be done. In terms of success, all the transplants involved were in good condition and thriving well. The damage is minimal whereby the mortality is less than 10%. The chicken wire mesh coral transplantation method has since been improved by the use of sturdier and more expensive pre fabricated steel frames.
Characterization of Cebu City port water and waterways:
Clean-up strategies and technologies

Cecilio S. Baga* and Corazon P. Macachor

Cebu Technological University, Main Campus
R. Palma St., Cebu City, Philippines
Corresponding author’s email: csbaga@yahoo.com

Abstract

Cebu City Port Waters receive domestic and industrial wastewater which may carry pollutants, thus these were characterized to determine its quality based on biological parameters particularly total bacterial count, coliform count and *Vibrio* count in colony forming unit (cfu/ml), physical parameters including pH using Glass Electrode Method, dissolved oxygen using Membrane Electrode Method and water temperature. In this study, there were five sampling sites, namely sampling site 1 (Pier 1); sampling site 2 (Pier 2); sampling site 3 (Pier 3); sampling site 4 (Pier 4); and sampling site 5 (Pier 5). Water samples from sampling site 3 had the highest bacterial count (10^5 cfu/ml), with coliform count of more than 1600 MPN/ml, and *Vibrio* spp were detected. This is followed by sampling site 1 water samples, which had a bacterial count of 10^4 cfu/ml; coliform count of more than 1600 MPN/ml, however, *Vibrio* spp were not detected. Sampling site 2 water samples had same bacterial quantities of sampling site 1 with *Vibrio* spp detected; and sampling sites 4 and 5 had the lowest bacterial count (10^3 cfu/ml), with coliform count of more than 1600 MPN/ml, and *Vibrio* spp were detected. The total bacterial count of all sampling sites belong to a very high category (above 1.0 x 10^3 cfu/ml) as revealed by the Bureau of Fisheries and Aquatic Resources (BFAR) 7 quantitative bacteriology report. However, the coliform count for all sampling sites have the same level of more than 1600 MPN/ml, categorized as unsafe, based on water quality standard for bathing (1000 MPN/ml) adopted by the Department of Environment and Natural Resources (DENR). The electrometric method for pH and dissolved oxygen tests revealed that the water taken from sampling sites 1-5 are within the normal level. The researchers are currently verifying the seaport water characteristics to obtain data at various seasons. The data will serve as basis for clean-up strategies, rehabilitation technologies and benchmarks of good practices.

Keywords: pollutants, physico-chemical, bacteriology, seawater, waterways, clean-up

Introduction

Healthy environment, especially in densely populated urban areas like Cebu City, is one of the utmost concerns of the Cebu Technological (CTU), Main Campus particularly College of Technology (CoTech). The College is so concerned on the quality of water in the port areas which is now turning cloudy in colour. The deteriorating quality of seawater might be due to the improper disposal of community and industrial wastes. Water pollution is evident in Cebu City Port water since when agitated, it turns turbid and smells bad, with highly irritating odour. This might be attributed to the presence of slum areas, which “lacks sanitary toilets” extending from the Barangay San Roque and Barangay Tejero of Cebu City. Household effluents, septic wastes, and other types of domestic and industrial wastes are usually channelled towards the creeks and waterways which feed into Cebu City Port Water. One of the missions of the CTU, Main Campus is to address its efforts to the environmental problems in the area in collaboration with appropriate agencies. Aware of this mission, the faculty members are alarmed on the deteriorating quality of seawater in Cebu City port areas. Hence, periodic characterization of Cebu City port water was conducted.

The study characterized the quality of the Cebu City port water based on quantitative bacteriology, physical parameters at the Bureau of Fisheries and Aquatic Resources (BFAR) and sensory characteristics at the Cebu Technological University, Main Campus.
Methodology
The experimental method of research was used in the study employing the laboratory techniques and procedures. Three (3) samples of seawater per Research Station (1 - 5) were collected and examined (Figure 1).

Procedure
The water samples from Cebu City Ports were collected in replicates and brought to the Bureau of Fisheries and Aquatic Resources (BFAR 7) laboratory for quantitative bacteriology analysis, such as: Total Bacterial Count (cfu/), Coliform count in MPN/ml, and Total Vibrio Count (cfu/ml). Physical parameter analyses were done using the Membrane Electrode Method for Dissolved Oxygen (DO) on site, and Glass Electrode Method for pH. The water nutrients like phosphates, nitrates and ammonia-N were also monitored by BFAR 7 chemists.

Results and Discussion
The bacteriology results of the seawater samples taken from the five sampling sites are disclosed in Table 1.

Table 1. Bacteriology results of water samples taken from Cebu City Port.

<table>
<thead>
<tr>
<th>Parameters (cfu/ml)</th>
<th>Total Bacterial Count in cfu/ml</th>
<th>RS 1</th>
<th>RS 2</th>
<th>RS 3</th>
<th>RS 4</th>
<th>RS 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Bacterial Count</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.63 x 10^4</td>
<td>6.15 x 10^4</td>
<td>1.88 x 10^5</td>
<td>4.16 x 10^4</td>
<td>2.85 x 10^3</td>
<td></td>
</tr>
<tr>
<td>Total Coliform Count (MPN/ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;1600</td>
<td>&gt;1600</td>
<td>&gt;1600</td>
<td>&gt;1600</td>
<td>&gt;1600</td>
<td>&gt;1600</td>
</tr>
<tr>
<td>Vibrio spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>1.0 x 10^1</td>
<td>3.0 x 10^1</td>
<td>1.0 x 10^1</td>
<td>2.0 x 10^1</td>
<td></td>
</tr>
</tbody>
</table>

Total Plate Count (TPC) of bacteria
The water samples taken from the Sampling Site 3 had the highest bacterial count (1.88 x 10^5 cfu/ml), followed by the samples taken from Sampling Sites 1 and 2 (1.63 x 10^4 and 6.15 x 10^4 cfu/ml, respectively) and Sampling Sites 4 and 5 which had bacterial counts of 4.6 x 10^4 and 2.85 x 10^3 cfu/ml, respectively (Figure 2).

Figure 2. TPC (cfu/g) of Cebu City Port Water.

Total Coliform Count
Total coliform count of more than 1600 MPN/ml was detected in all sampling sites. The allowable TCC for fishery should not exceed 5,000 MPN/100 ml or 500 MPN/ml. All of the sampling sites of Cebu City Port water failed the criterion during the 3-month monitoring period. This means that the Cebu City Port water is unfit for bathing. The high TCC in sampling sites could be attributed to the domestic wastes being discharged into the sea by households, which are not connected to the sewerage system and those with toilets that are not properly dislodged and maintained.
**Total Vibrio Count**

*Vibrio* spp count ranging from $1.0 \times 10^1$ to $3.0 \times 10^3$ cfu/ml was evident in seawater samples taken from Sampling Sites 2 to 5 which belongs to below normal based on the standards given by BFAR 7 that is $2.2 \times 10^3$ to $1.3 \times 10^4$ cfu/ml.

These bacteriology results revealed that the quality of Cebu City port water belongs to category 2, which water “contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans”.

**Physical parameters**

The physical parameter analyses are limited to pH and Dissolved Oxygen of Cebu port water from Sampling Sites 1-5 with a rising temperature of 2°C.

*pH*. Results of the electrometric method for pH in Sampling Site 5 water revealed a higher pH (8.00), followed by SS 4, 1, 2 and 3 with pH levels of 7.95, 7.87, 7.80 and 7.76, respectively, which values considered as normal in seawater since the pH standards should be within 7.7-8.1 (Figure 3).

![Figure 3. pH level of Cebu City Port Water.](image)

**Dissolve Oxygen (DO)**

DO is an indicator of how polluted the water is and how well the water can support aquatic life. A very low DO concentration indicates poor water quality which could cause the death of fishes and other aquatic animals. All sampling sites have the same trend for dissolved oxygen (DO) in ppm. Sampling site 5 water had a higher DO (6.26), followed by SS 4, 1, 2 and 3 with DO in ppm of 5.86, 5.42, 4.95 and 4.55, respectively. These values belong to the acceptable range for seawater since DO standards should be within 4-9 ppm, however the values are almost near the minimal level (4-5 parts per million (ppm) which could still support a large, diverse fish population ([http://www.h2ou.com/h2wtequal.htm](http://www.h2ou.com/h2wtequal.htm)) with water temperature ranging from 13.5 - 15.5 degrees Celsius (Figure 4).

![Figure 4. DO level of Cebu City Port Water.](image)

The DO level of Cebu City Port water is ranging from 4.55 to 5.83 ppm. The DO level has almost the same of that Pangil River which showed annual average concentrations that consistently passed the DO criterion of 5 mg/L minimum for fishery over the 10-year period.
In the coasts of Mandaue to Minglanilla in Cebu (Central Visayas), DO levels varied from 0 to 14 mg/l, which indicate that the ecosystem is already extent of water pollution in Philippine bays can be gleaned undergoing “stress” during certain periods JICA Master Plan Study on Water Resources Management in the Philippines (1998).

**Ammonia-N, Nitrate-N and Phosphates**

Figure 5 revealed that the Ammonia-N (0-1 ppm), Nitrate-N (5 ppm) and Phosphates (0-2 ppm), the Cebu City Port water are within acceptable range/standards.

<table>
<thead>
<tr>
<th>Level (ppm)</th>
<th>Ammonia-N (ppm)</th>
<th>Nitrate-N (ppm)</th>
<th>Phosphates (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS1</td>
<td>0.03 0.2 0.12</td>
<td>0.25 0.27</td>
<td>0.12</td>
</tr>
<tr>
<td>RS2</td>
<td>0.2 0.44</td>
<td>0.2</td>
<td>1.33</td>
</tr>
<tr>
<td>Std.</td>
<td>2.0</td>
<td>0.35</td>
<td>2.00</td>
</tr>
</tbody>
</table>

**Figure 5.** NH$_3$, NO$_3$ and Phosphates levels of Cebu City Port Water.

**Conclusions**

Based on bacteriology results, it can be concluded that the Cebu City Port Water is generally contaminated and is nearing the minimum count for physical parameters of safe water, which falls on Category 2 (“water that contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans”). The port water parameters (pH and DO) among all sampling sites are generally within acceptable and safe standards but nearing the minimum level. If nothing will be done on the continuing flow of household and industrial effluents into the sea through the rivers, this would get worst in due time.

**Acknowledgements**

To Dr. Bonifacio S. Villanueva, SUC President, of the CTU and Staff for his continuing support to the research activities of the University.

**References**

Brandys, B. Quantifying Bacteria Levels in Water Categories 1-3 in www.bio-reveal.com/articles.czm@state.ma.us. 1995, Coastal Zone Management 251 Causeway Street, Suite 800, Boston.


http://www.environnet.in.th/eng/evdb/intio/coast/coast10.html

Macrobenthos as saline intrusion indicator upstream of Sungai Sarawak

T.S. Leong¹, K.H. Khoo², S.H. Chong³, A.R. Enchana³ and D. Law³

¹No. 3 Cangkat Minden, Lorong 13, 11700 Gelugor, Pulau Pinang
²No. 34 Lintang Pekaka Dua, 11700, Gelugor, Pulau Pinang
³Chemsain Konsultant Sdn Bhd, No. 47, Wisma Ko-Perkasa Jalan Simpang Tiga, 93350 Kuching, Sarawak, Malaysia

Corresponding author’s email: mhpg@streamyx.com

Abstract

Sediments at three locations, M1, M2 and M3, at a kidney-shape bend, 35km upstream Sungai Sarawak were sampled for macrobenthos study. Station M1 was at the downstream outlet of the bend, Station M2 at the middle at the widest section and Station M3 at the upstream inlet. The macrobenthic communities were a mixture of both freshwater and marine forms at all three stations. The freshwater aquatic oligochaete and chronomid larva numerically dominated the benthos at these stations. Station M1 had the most number of marine organisms at 450 per m² and Station M2 having the least at 34 per m². The polychaetes constituted 69.3% (312 numbers per m²) and crustaceans 13.3% (60 numbers per m²) of the total number of marine organisms at Station M1. The spionid polychaete, Polydora sp. i was the most dominant that constituted 23.7% of the total number of marine organisms.

The results of this study indicated that seawater had penetrated 35km upstream of Sungai Sarawak. The value of using macrobenthic organisms in the sediment as environmental indicator organisms had been shown in this studied.

Keywords: macrobenthic organisms, environmental indicator organisms

Introduction

Sungai Sarawak is a relatively large river, running across the City of Kuching, dividing it roughly into two halves. The City of Kuching lies in relatively low-lying area and is subjected to frequent flooding. The drainages of the city are submerged and thus are tidal controlled under the Sarawak River Regime. In 1997, the flow of the river was controlled. This was done by constructing a barrage and ship causeway downstream from Kuching town. At the same time, the outlet via Sungai Santubong was blocked off completely. These constructions downstream from Kuching help to maintain stable water level, control tidal flooding, passage of ships, enhanced Kuching Waterfront and secure Kuching water supply from saline intrusion at Batu Kitang treatment plant.

To further control the frequent occurrence of flooding in the City of Kuching, a Kuching Flood Mitigation Master Plan was approved to construct a flood bypass channel, located close to Kampung Paroh, upstream from Kuching town, where the Sungai Sarawak is widest at 40m with a kidney-shape bend. This flood channel outlet is approximately 35km from the mouth of Sungai Sarawak, discharging into South China Sea through the Tebas Estuary. Figure 1 show the location of the kidney-shape bend, upstream of Sungai Sarawak, where the sampling stations were located.
The benthic community at this kidney-shape bend stretch of Sungai Sarawak was studied and results are presented here.

**Materials and Methods**

Three sites at this stretch of the kidney-shape bend of Sungai Sarawak were selected: one sampling station at each end and the third station at the middle of the kidney-shape bend of Sungai Sarawak. Five replicate samples of sediment were sampled using a large Ponar grab with mouth opening of 9 x 9 inch. The sediment samples were carefully washed in a 0.5mm mesh-size sieve and the materials preserved in 10% formalin in seawater with Rose Bengal dye.

In the laboratory, the formalin was removed by rinsing several times with tap water. A small amount of the materials were examined under a dissecting microscope and all invertebrates were removed with a forcep and preserved in 70% alcohol. The invertebrates were sort to the lowest taxon and emerated.

**Results**

The kidney-shape bend is approximately 35km from the South China Sea. The results of the macrobenthic organisms at the three sampling stations are summarized in Table 1. Both freshwater and marine organisms were recovered from the three study sites. Station M1 had the most number of organisms, while Station M2 had the least numbers. The freshwater organisms constituted 72.3% of the total number of organisms, where as the marine forms constituted only 27.7% at Station M1.

The freshwater organisms consisted mainly of oligachaete worms and chironomid insect larvae. The marine forms consisted mainly of crustaceans and polychaetes. Station M1 had the most number of marine organisms at 450 individuals per m² and total number of 60 species, and M2 had the least at 34 per m², and total number of species at 3. The polychaetes constituted 69.3% (312 numbers) and crustaceans 13.3% (60 numbers) of the total number of marine organisms at Station M1.
The dominant marine macrobenthic organisms at the three sampling stations are summarised in Table 2. Station M1 had the most number; with 5 out of 11 were polychaete species, followed by 3 species of molluscs. The spionid polychaete, *Polydora* sp. i was the most dominant that constituted 23.7% of the total number of marine organisms. Very few marine species were recovered from Stations M2 and M3.

**Table 1.** Macrobenthic organisms recovered from Stations M1, M2 & M3 upstream Sungai Sarawak.

<table>
<thead>
<tr>
<th>Benthic organisms</th>
<th>Station M1</th>
<th>Station M2</th>
<th>Station M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent total (No. marine Organisms)</td>
<td>27.7(450)</td>
<td>5.7(34)</td>
<td>19.5(65)</td>
</tr>
<tr>
<td>Percent total (No. freshwater Organisms)</td>
<td>72.3(1176)</td>
<td>94.3(562)</td>
<td>80.5(268)</td>
</tr>
<tr>
<td>Total No. organisms</td>
<td>1626</td>
<td>596</td>
<td>333</td>
</tr>
<tr>
<td>Total No. marine Crustaceans</td>
<td>60</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Total No. marine Polychaetes</td>
<td>312</td>
<td>4</td>
<td>57</td>
</tr>
<tr>
<td>Total No. marine Crustacean species</td>
<td>19</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total No. marine Polychaete species</td>
<td>33</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total Number marine species</td>
<td>60</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table 2.** Dominant macrobenthic organisms at Stations M1, M2 and M3 upstream Sungai Sarawak.

<table>
<thead>
<tr>
<th>Dominant benthic organisms</th>
<th>Station M1</th>
<th>Station M2</th>
<th>Station M3</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Polydora</em> sp. i (p)</td>
<td>107</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Tellina</em> sp. (m)</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Lumbrineries</em> sp. (p)</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Ophiotrichidae</em> sp. (o)</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Siliqua</em> sp.(m)</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Mytilidae</em> sp.(m)</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Syllis</em> sp. (p)</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Euclymene</em> sp.i (p)</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Sternaspis scutata</em> (p)</td>
<td>4</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td><em>Metapenaeus</em> sp. (c)</td>
<td>2</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td><em>Cyathura</em> sp.ii (c)</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1=polychaete; 2=molluscan; 3=others; 4=crustacean

**Discussion**

The macrobenthic organisms along Sungai Sarawak have not been studied before. This was the first such study. Station M1, M2 and M3 are located upstream of Sungai Sarawak. The macrobenthic communities of these three stations were a mixture of both freshwater and marine forms. The freshwater aquatic oligochaete and chronomid larvae numerically dominated the benthos at these stations. A large numbers of spionid polychaetes and a variety of marine benthos species were present at Station M1. This was rather unexpected as one would not expect to find marine organisms in a section of Sungai Sarawak which is predominantly freshwater in nature. The results on finding this mixture of marine and freshwater organisms indicated that saline intrusion must be more frequent than reported. Law and Lau (2002) reported that flooding in and flashing out operations of the Sarawak Barrage could contribute to the overall increase of saline into upstream Sungai Sarawak. The dynamic surge energy generated during and after the Barrage operations lead to a total mix-up of water in Sungai Sarawak and this accelerated saline intrusion by bringing water downstream upward. There were 5 saline intrusions reported between 1998 and 2000 that was 3 times more than that reported between 1975 and 1997. The Sarawak Barrage became operational in 1998.
Station M2 had very few marine organisms due primarily to the constant sand mining there.

Conclusions

The results of this study indicated that seawater had penetrated 35km upstream of Sungai Sarawak. The value of using macrobenthic organisms in the sediment as environmental indicator organisms had been shown in this studied.

Acknowledgements

We would like to thank Haslan Raeehan and Jemi Asau for their undertaking of the field sampling. This was part of marine ecology study for the Kuching Flood Mitigation project.

References


Simulation and prediction of seawater intrusion in a small island’s aquifer

S.M. Praveena1*, M.H. Abdullah1, A.Z. Aris2 and K. Bidin1

1School of Science and Technology, Universiti Malaysia Sabah
Locked Bag 2073 88999 Kota Kinabalu, Sabah, Malaysia

2Department of Environmental Sciences, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia.

Corresponding author’s email: smpraveena@gmail.com

Abstract

Simulation and prediction of seawater intrusion in Manukan Island, Sabah, has been achieved by applying a variable density model, SEAWAT-2000. It is the latest modelling software available in groundwater modelling that couples flow and transport together. This study was aimed to simulate the current seawater intrusion using selected scenarios of varying recharge and pumping rates. Moreover, two years of prediction was also conducted to predict the extent of seawater intrusion in low lying area of Manukan Island with all conditions assumed to remain same as those in December 2009. Selected scenarios of varying recharge and pumping rates represented El-Nino events and overpumping taking place in study area. The model output showed that current seawater intrusion will be more severe with an impact of El-Nino events on groundwater resources depletion in Scenario C. Artificial recharge as suggested in Scenario E can be considered to restore groundwater resource during El-Nino events. Scenario B can be considered to solve overpumping problem in Manukan Island. However, implementation of actual pumping and recharge strategies needs more data, precise calibration and validation. Concisely, the output will give a prelude view to combat seawater intrusion problem in study area.

Keywords: SEAWAT-2000, recharge rate, pumping rate, management

Introduction

In small islands, seawater intrusion is a result of natural and artificial stresses in many of small islands. Natural stresses are due to sea level rise and climate changes control the shape and thickness of the freshwater lens. Climate changes relate to reduction in recharge rate will results in aquifer depletion and leads to seawater intrusion. On the other hand, overpumping result in irreversible deteriorations of groundwater quality (Moustadraf et al., 2008; Rejani et al., 2008). Groundwater numerical modelling is an important prediction tool for managing water resources in coastal aquifers. Seawater intrusion has been simulated by means of different groundwater numerical models. Examples of SEAWAT-2000 applications in seawater intrusion studies were presented in Rejani et al. (2008) in Balasore, India and Don et al. (2005) in Kyushu Island. SEAWAT-2000 is the latest modelling software available in groundwater modelling that couples flow and transport together (Guo and Langevin, 2002).

Small islands located in the humid tropics and have no surface water resources. As in many small islands, Manukan has no surface water in an exploitable form and only rely on its fresh groundwater as water supply. Tourism plays an important role in Manukan Island as this island is known as diver’s paradise. This is supported by an increased in numbers of tourist arrivals to this island about 400% from 1997 to 2004. It has resulted in tremendous increased of groundwater extraction to meet the groundwater supply and domestic needs. In addition, a total of eight dug wells in low lying area have been shut down due to seawater incursion into the island’s aquifer. Currently, only one dug well is operating in groundwater...
extraction to meet the domestic supply (Aris et al., 2009). Recent study done by Praveena et al. (2009) showed seawater intrusion simulated by SEAWAT-2000 is taking place at the beneath of pumping well with mixing ratio of 14.6% between freshwater and seawater. Therefore, effective strategies for both management and protection of groundwater resources are required to avoid future irreversible environmental impacts such as depletion and deterioration of groundwater quality.

This paper describes the simulation of seawater intrusion in Manukan Island under selected scenarios of varying recharge and pumping rates. Prediction of seawater intrusion under selected scenarios was also done for two years with all conditions assumed to remain same as those in December 2009.

Materials and Methods

Manukan Island (5° 57‘-5°58’N and 115°59‘-116°01’E) covers an area of 206,000 m², with a crescent shape, (Figure 1). The study area is located offshore of Kota Kinabalu, Sabah, East Malaysia on the island of Borneo cover by South China Sea. The island consists of unconfined sandy aquifer and underlain by sedimentary rock (Abdullah et al., 2002). The sedimentary rock of Manukan Island dips (east-northeast) with angles of 15° – 45° and forms a slight symmetrical syncline in the low area. Abdullah (2001) conducted a study on the morphological of the island found that the thickness of the aquifer from the ground surface to bedrock are approximately, 5.7 m (northern part), 11 m (southern part) and 12 m (at the middle). The climate of the study area is humid with an average annual rainfall of 2250 mm. The annual temperature ranges from 21°C to 32°C as well as humidity between 80% and 90%.

Low lying area of Manukan Island (Figure 1) was selected in this numerical modelling. Installations of single level boreholes were based on flow measurements conducted by Abdullah (2001). Water samples were pumped through silicon tubing to polyethylene sampling bottles via a peristaltic pump. Groundwater samplings were done in 2009 (January 2009-December 2009) from the observation wells and boreholes. Hydraulic heads were measured at observation wells and boreholes using Solinst water level meter. Analysis for chloride was done using argentometric method (APHA, 1995). Meteorological data from the meteorological station was downloaded to a Twinhead laptop each month during samplings in 2009.

SEAWAT-2000 couples the flow and transport equations of two widely accepted codes MODFLOW (McDonald and Harbaugh, 1988; Harbaugh et al., 2000) and MT3DS (Zheng and Wang, 1999) with some modifications to include density effects based on the extended Boussinesq assumptions. Theoretical development, numerical solution techniques and data requirement of the model are described by Guo and Langevin (2002) and Anderson and Woessner (2002). The transient simulation model of SEAWAT-2000 with 12 total stress periods was performed from January 2009 to December 2009, with each stress period
representing 1 month of simulation month. One day was chosen as the time step in this study and to be increased by a multiplier factor by 1.2 within which all the hydrological stresses can be assumed constant as required for transient state. Model calibration is achieved through trial and error method using the observed data of groundwater hydraulic heads and chloride concentrations. Different scenarios of varying recharge and pumping rates based on threats received by Manukan Island were investigated with all conditions assumed to remain same as those in December 2009.

Results and Discussion

The trial and error method provided satisfactory results for the transient calibration and met the overall goals of the project (Figure 2).

Figure 2. Scatterplots between measured against calibrated hydraulic heads and chloride in observation wells.

Seawater-freshwater mixing concentration of 1.4% was chosen in this simulation to indicate that the mixing concentration exceeds the maximum chloride concentration level reported by USEPA (1972). Current seawater intrusion of the coastal aquifers in the low lying area of Manukan Island is observed and moves landwards after two years of simulation in Scenario A. Overpumping causes seawater intrusion and irreversible deteriorations of groundwater quality (Praveena et al., 2010). In order to control overpumping in this study area, the reduction in pumping rate (Scenario B) has resulted in backward movement of the 1.4% seawater-freshwater mixing ratio towards to coast after two years of prediction. Scenario C illustrated current contamination of the coastal aquifers by seawater intrusion will be more severe with an impact of El-Nino events on groundwater resources. This has resulted in the inward movement of 1.4% seawater-freshwater mixing ratio within predicted time Recharge rate reduces with an impact of El-Nino events. When the pumping rate is larger than recharge rate, overexploitation causes seawater intrusion in the study area. Reductions of pumping and recharge rates (Scenario D) have worsened the current seawater intrusion in the study area with inland movement of 1.4% seawater-freshwater mixing ratio. Thus, an aid of artificial recharge in Scenario E was introduced for groundwater storage recovery and management options. These combinations have resulted in movement of 1.4% seawater-freshwater mixing ratio towards the coast in two years prediction period.

Conclusions

Scenarios B and E (adjustments of pumping rate and artificial recharge rate) are suggested to overcome the threats received by groundwater resource of Manukan Island. Briefly, this finding will effectively contribute to groundwater management in the study area to combat current as well as future seawater intrusion problem.
Acknowledgements

The financial support of the Ministry of Science, Technology and Innovation, Malaysia (Science Fund: 04-01-10-SF0065) and the National Science Fellowship (NSF) Scholarship (primary author) are gratefully acknowledged. Our appreciation to Sabah Parks for permission to conduct this study on Manukan Island. Finally, we offer special thanks to Mr. Lin Chin Yik, Miss Li Ying Chua, Mr. Ong Jay Jim and Mr. Ng Lim Kuan Leang for their assistance in borehole construction.

References


Application of AHP model for land-use suitability analysis in Malaysian coastal areas

M. Bagheri*, Z.Z. Ibrahim, W.N.A. Sulaiman and N. Vaghefi

Department of Environmental Studies, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: S_milad.bagheri@yahoo.com

Abstract

Analytical hierarchy possess (AHP) has been a powerful model to overcome the issue of inconsistencies in expert opinion in assigning relative importance to different criteria for suitability analysis. AHP is also useful for capturing expert knowledge on environmental systems where data may be lacking. This study develops a framework for utilizing AHP to incorporate the decision making process in to selecting land suitable for coastal development. A systems approach has been applied to the examination of sustainable development in the coastal zone. This complex system is envisaged as comprising three sub-systems: environment and resources, economic development and society. A sustainability indicator system based on these three sub-systems has been set up to evaluate the nature of development in the coastal zone. According to literature review and study area Framework for Land Evaluation, the suitability value for building and housing in coastal area, criterion for each land-mapping unit is determined through the method of maximum limitation method that affects the land use. The 5 natural characteristics are used in the calculation, including: river, slope, land cover, built-up, and road. Before applying weighted linear combination equation to calculated suitability index, these calculated scores are standardized to measure scale 1 (low), 5 (medium), 7 (high), and 9 (very high suitability). According information from finally map (suitability – map) we can explain and select the best area among 5 areas (A, B, C, D, E) in the area A we have 4 areas (1, 2, 3, 4). Area of A in clouding of: Area: 6982.708945 m, Acres: 1.725465m, Hectares: 0.698271m, Perimeters: 336.5671m, Grid code: 2, Shape: polygon, Fid: 13, Id: 14. The findings indicate that the area 1 (2111 m) from A rea is the best area to build hotel in the coastal area.
Three dimensional water quality modelling for Sungai Segget watershed

Noor Baharim Hashim¹, Paul M. Craig², Dang Huu Chung², Nguyen Tat Thang² and Maznah Ismail¹

¹Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 UTM Skudai, Malaysia
²Dynamic Solution, LLC

Corresponding author’s email: drbaharim@yahoo.com

Abstract

The hydrodynamic and water quality model was used for the study of river pollution in the Sungai Segget system. It is composed of the diffusion dispersion model of six different quality parameters. These are: Chemical Oxygen Demand (COD), Ammonia Nitrogen (NH₄), Nitrate Nitrogen (NO₃), Total Phosphate (PO₄), Fecal Coliform Bacteria (FCB) and Dissolved Oxygen (DO). The aims of this study were to improve the water quality of Sungai Segget, Johor Strait that has been classified as polluted (Class IV) to a status as clean (Class II) and to maintain this status to an extent suitable for tourism and recreational purposes. In this paper, an application of a 3D EFDC Hydrodynamic water quality model is described to simulate and assess the pollution status of the lower Sungai Segget based on the data from the upstream and the combined sewer overflow (CSO). This study will support the ultimate goal of mitigating flooding occurrences in JB City Centre due to Sungai Segget watershed and reducing pollution loading to the Strait of Johor.

Keywords: water quality parameters, water quality model, EFDC

Introduction

The existing condition of Sungai Segget drainage system (Figure 1) is a concrete channel much of which is covered by sidewalk. The water is seriously polluted from different sources including construction, illegal factories, street litter, workshops and eateries. All the pollutants are currently untreated and flow into the sea with the water quality in the class of IV or V.
Materials and Methods

The three-dimensional Environmental Fluid Dynamics Code (EFDC) (Hamrick, 1992; 1996) has been selected as the hydrodynamic model to provide a rigorous mathematical and computational framework for simulating the hydraulics and hydrodynamics, and water quality of Sungai Segget. EFDC solves the finite-differenced form of the hydrostatic Navier-Stokes equations together with a continuity equation, and transport equations for salt, temperature, turbulent kinetic energy and turbulent macroscale (Hamrick, 1992). The equations are solved horizontally on a curvilinear, orthogonal grid and vertically on a stretched sigma-grid. Vertical diffusion coefficients for momentum, mass and temperature are determined by the level 2.5 turbulent closure scheme of Mellor and Yamada (1982) and Galperin et al. (1988). The physics of the EFDC model and many aspects of the computational scheme are equivalent to the Blumberg and Mellor (1987) class of advanced hydrodynamic models (ECOM-3D and Princeton Ocean Model) and CH3D model (Johnson et al., 1993).

A water quality model has been developed and integrated with EFDC (Park et al., 2000) to simulate the spatial and temporal distributions of water quality parameters including dissolved oxygen, suspended algae, carbon components, nitrogen, phosphorus, silica and fecal coliform bacteria. At the same time a sediment process model has been developed. The study also uses the program EFDC_Explorer (EE) (Craig, 2009).

Results

Error! Reference source not found. shows the model grid with 876 cells and two open boundaries of the Sungai Segget channel. The nine CSOs inside the domain are treated as source points.

Figure 2. Model grid and boundary for existing conditions scenario.
present the model calibration of the water quality parameters calculated by EFDC and compared with the measured data from DOE stations, SG01 and SG02. Although some parameters, such as COD and FCB show discrepancy between computational and measured values, the simulation result is quite good in general. It is clear that values measured at two closer stations, SG01 and SG02 are quite different. This variation will cause these differences we saw between the model and measured data.

Figure 9.5 shows the plan view of DO concentration distribution after ten days simulation. The simulation shows that the situation of water quality of Sungai Segget channel is very serious and requires treatment.

Figure 3. Comparison of COD concentrations.

Figure 4. Comparison of NH₄ concentrations.

Figure 5. Comparison of NO₃ concentrations.

Figure 6. Comparison of PO₄ concentrations.
Discussion

The computed results of existing condition were calibrated with measured data of two DOE stations SG01 and SG02. It showed that the model accuracy is quite good and the input parameters are reasonable. The simulations are only carried out for a typical dry season. This study will support the ultimate goal of mitigating flooding occurrences in JB City Centre due to Sungai Segget watershed and reducing pollution loading to the Strait of Johor.

Acknowledgements

The authors would like to thank Universiti Teknologi Malaysia, Skudai for providing the funding for this study under Science Fund, Vote 79381 and Fundamental Research Grant Scheme (FRGS), Vote 78663.

References


Usage of digital shoreline analysis system for coastal ecosystem management

A. Moradi¹, Z.Z. Ibrahim², M.M. Ibrahim³ and M. Yamani⁴

Dept. of Environmental Management, Faculty of Environmental Studies
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: abbas.moradi46@gmail.com

Abstract

Shoreline change due to global warming and sea level rise impacts coastal ecosystems. Shoreline change analysis system is an effective tool in successful coastal management to preserve and protect coastal ecosystems. The main objective of this research is to introduce new capabilities of geographic information systems to map, quantify and predict shoreline position change. Digital shoreline analysis system as a GIS-based method, historical shoreline data including aerial photographs and high accuracy satellite images conjunction with global positioning system have been utilized to carry out this research. The North coast of Qeshm Island in Persian Gulf as a main coastal mangrove ecosystem in this area has been chosen as example in this paper.

Keywords: shoreline change, coastal management, GIS, mangrove ecosystem, Qeshm Island, Persian Gulf
Oral: Session 3B
Fisheries
Mapping fishing ground of yellowfin tuna (\textit{Thunnus albacares}) with application of satellite multi-sensor and upwelling in Wakatobi National Park, Southeast Sulawesi Province, Indonesia

Muslim Tadjuddah*, Ahmad Mustafa, Utama K Pangerang and Farid Yasidi

Department of Management Fisheries Resources, Faculty Fisheries and Marine Science
Haluoleo University, Southeast of Sulawesi Province, Indonesia

Corresponding author’s email: muslim22jan@gmail.com

Abstract

The mapping of yellowfin tuna fishing ground can be used to avoid capture more resources (overfishing) due to the concentration of fishing vessel in a particular location that purposed for fishing operation would be more effective and efficient because the location of fishing ground has been previously known. In the short term the aims of this study: mapping fishing ground yellowfin tuna (\textit{Thunnus albacares}) with multi-sensor application of satellite technology and upwelling at Wakatobi is expected to eventually increase in the catch. The benefits of this research are: (1) with the information fishing ground yellowfin tuna in the district of Wakatobi then fishermen can reduce fuel, time and operational costs in the operation of fishing; (2) results from this study can be a reference in the preparation of resource management strategy of yellowfin tuna (\textit{Thunnus albacares}) to be conserved and sustainably. Results from this study show that the average of Sea Surface Temperature (SST) in the west season with of 29.79°C, on the west-east season with an average temperature of 29.70°C, in the east season with an average of 27.40°C and on the east-west season with an average 29.13 °C. Chlorophyll-a in the west season with the range of 0.15 mg/m³, at the west-east season with the range of 0.15 mg/m³, in the east season with the range of 0.27 mg/m³ and in east-west season with a range 0.21 mg/m³. Front found around Kaledupa and Koromaha reef in December, January and February. Front Kaledupa found around reefs and P. Runduma in March, April and May. Front happening around Kapota reef, Kaledupa reef, Koromaha and Koka reef in June, July, August, September, October and November. Upwelling occurred around Kapota reef, Kaledupa reef and Koka reef in June. Upwelling occurs in the vicinity of Runduma island, Kapota reef, Kaledupa reef in July and August. Upwelling occurs around Kapota reef, Kaledupa reef and Wangi-Wangi island in September. Mapping of predictive fishing ground in the west season, west-east transitional season, the season east and east-west transition season as seen in Figures 3, 4, 5 and 6.

Keywords: mapping fishing ground, sea surface temperature, chlorophyll-a, yellowfin tuna

Introduction

Information concerning the map of fishing ground yellowfin tuna is needed in the development of the fishing sector in location research considering these fish resources have the potential to be developed to support of increasing fish production, economic income of fishing communities and improving the partnership between fishermen and fishery-based local government. Furthermore, this study can be used as initial data for arranged the yellowfin tuna resource management in the future. Fishing activities skipjack and tuna in Wakatobi Islands estimated to 3-4 tons per day with fishing activities conducted throughout the year (PPT-LIPI, 2002). If the activity of the utilization of this resource is not managed properly, then the feared could lead to negative impacts on the sustainability of fish resources in the future. Determination of yellowfin tuna fishing ground in the district of Wakatobi been done fishermen using traditional methods but, the downside of this method made overfishing due to the concentration of fishing vessel in a particular location. Yet, the mapping of yellowfin tuna (\textit{Thunnus albacares}) can avoid overfishing, the concentration of fishing ground as a consequence fishing vessel at a particular location and operation of fishing can be more effective and efficient. Furthermore this result can arranged
management strategies yellowfin tuna (Thunnus albacares) to be conserved and sustainably.

Materials and Methods

Location and time research
This research was conducted around the waters of Wakatobi Regency Southeast Sulawesi Province, Indonesia at a position between 5°12’ - 6°10’ latitude and 123°20’ - 124°39’ longitude. This research was conducted between June and October 2009.

Materials and equipments
The materials used in this study:
1) Data of Sea Surface Temperature (SST) satellite aqua MODIS years 2004 to 2008 (weekly data) level 3 with a resolution of 4 km results from http://www.modis.gsfc.nasa.gov
2) Data of Chlorophyll-a satellite aqua MODIS years 2004 to 2008 (weekly data) level 3 with a resolution of 4 km results from the http://www.modis.gsfc.nasa.gov
3) Anomalies of sea surface height (mean sea level) during the years 2004-2008 (daily data) derived from the Topex-Poseidon satellite results from http://www-ccar.colorado.edu/ll address.
4) Flow pattern data are derived from survey results Wyrtky

The tools used in this study include:
1) Software SeaDas 7.4, version UBUNTU LINUX operating system for image processing SST, SST contours, the image of chlorophyll-a. Arc-view 3.2 for processing mapping fishing ground
2) Map Wakatobi waters no. 317. (Source: TNI-AL Dishidros 2001, Scale: 1:200.000) as a base map
3) Camera digital, create documentation for research
4) GPS (Garmin III Plus), to determine the position of the fishing area (latitude and longitude)

Data analysis methods
Analysis of Sea Surface Temperature, Chlorophyll-a and Sea Surface Height Anomaly data and flow pattern have selected for the processed image is cloud free image that is the weekly data over five years (2004-2008). 145 image data SST and 193 image data Chlorophyll a. MODIS image processing is used for level 3 courses Seadisp (General image and graphics display) contained in the menu SeaDAS. Anomali sea level data is with using TOPEX / POSEIDON. In this study, these data serve as supporting data to analyze changes in the condition as an indicator of the occurrence of upwelling waters. Data TOPEX / POSEIDON was obtained from http://www.ccar.colorado.edu/ site. Later, data flow pattern here obtained from a survey by Wyrtki (1961) which describes the general flow patterns in the region research. The method of analysis used in the mapping of fishing ground yellowfin tuna that is through the approach of Geographical Information Systems (GIS) with overlay every season of the image based on data SST, chlorophyll-a data from MODIS Aqua and supported by an average of data anomalies sea surface height from TOPEX / POSEIDON. Result from ascertainable waters that experienced thermal fronts, upwelling zones and divergent, convergent and eddies in some waters.

Results

The distribution of SST and chlorophyll-a in temporal and spatial
The observation can be generalized that the image of SST in the west season approximately 29.79°C. Warm temperatures ranging from 33.41°C. While cold temperature ranges 26.06°C, in the west-east transition season, approximately 29.70°C. Warm temperatures
ranged from 32.47°C. Cold temperatures ranged from 26.06°C. East season average sea surface temperature of about 27.40°C. Warm temperatures ranged from 29.13°C. Cold temperatures ranged from 26.06°C. In the summer shift east-west sea surface temperature averages about 29.13°C, the temperature of warm temperatures ranged from 32.91°C. Cold temperatures ranged from 26.06°C. Chlorophyll-a concentrations in the west season average chlorophyll-a concentration of 0.15 mg/m³. The highest concentration of the chlorophyll-a approximately 2.6 mg/m³, chlorophyll-a concentrations ranged as low as 0.05 mg/m³. In the west-east transition season average chlorophyll-a concentration of 0.15 mg/m³, chlorophyll-a highest concentration in the range of a 2.5 mg/m³. The concentration of chlorophyll-a in the east season average of 0.27 mg/m³. Chlorophyll-highest concentration ranged from a 3.7 mg/m³ chlorophyll-a concentration ranged from as low as 0.08 mg/m³ are all around east Runduma island and Wakatobi island. On the east-west transition season average chlorophyll-a concentration of 0.21 mg/m³. The highest chlorophyll-a concentration ranged from 0.5 mg/m³ and a low-concentration ranges chlorophyll-a 0.08 mg/m³ located on the western Kaledupa island, Tomia island, Binongko Island and the southern Runduma island.

Discussion

The distribution of SST and chlorophyll-a in temporal and spatial

In the summer shift west-east movement of SST with a visible difference in the west season. In the SST, this season indicated a mixed distribution between the mass of warm water and cold water masses, presumably are caused by changes in seasonal wind patterns that drive the movement of surface water masses. Nontji (1993) said that in the west-east transition season months of April, these eastward currents began to weaken even started to turn up in some places occur eddy-eddy (eddies). SST distribution of the overall image show that east season SST in spatial movement patterns of Wakatobi Islands waters moving from east to west with a mass of cold water. This result according Schalk (1987) that the mass of cold water in large numbers in the Banda Sea to the west will be shifted to follow the movement of surface currents on the season and continue east to the Flores Sea. Furthermore, from SST image show that the pattern distribution movement seen in transitional season in spatial east-west from the east side of Wakatobi Islands waters to the west side with the movement of cold temperatures tend to warm temperatures. This proceed from is the position of the sun at this season right in the southern hemisphere (Equatorial) so that the intensity of the radiation more effective. Weil's opinion referenced in Hutagalung (1988) stated that the sea water temperature, especially in the surface layers depends on the amount of heat received from the sun. At the west-east transition season, chlorophyll-a concentration image of the highest seen in the image of the month April for five years (2004-2008) while compared with the image of the month in March, April and May. Chlorophyll-a concentration on the east-west transition season has decreased compared to the east on the season. Nevertheless, in September the chlorophyll-a concentrations are still quite high but not as thick as in August (east monsoon). Vosjan and Nieuwland (1987) states that in the Banda Sea in the east there are two periods of seasonal plankton bloom, first in June and second week in August-September. Chlorophyll-a movement pattern remains the highest seen in the vicinity and the Kapota and Kaledupa reef (Wakatobi west). In general, the chlorophyll-a visible image of chlorophyll-a concentrations gradually declined in November.

Prediction fishing ground of yellowfin tuna

Front and upwelling

The intensity of the high frequency of fronts occur in the east season with a gradient of 0.5°C case temperature is thought to occur in areas of upwelling rock. Wyrtki (1958) reported that in the eastern Banda Sea on the season (June, July and August) occurred upwelling that began about May until about September. This information shows that there are close links between the regions around the reef with the phenomenon of the formation of fronts in the
research location. Convergent and divergent flows are met or collided with the back reef (ridge), which has a relatively shallow depth compared with the surrounding waters. Front pockets were formed from the cold water mass which was surrounded by a warmer water mass with a relatively stable pattern of movement. Indications of upwelling concentrated around Kapota reef and surrounding Kaledupa Island. Perfume-scented at the position 123°20'00" - 123°05'00" E and 5°10'00" - 5°55'00" latitude. According to Nontji (1987) in the Banda Sea upwelling events occur only in the east season. Where east monsoon winds pushing out the Banda Sea surface water at a rate greater than could be offset by the surrounding surface water. According to Wyrtki (1961) upwelling occurred in the Banda Sea can be classified upwelling alternating (alternating type) of upwelling and downwelling occurred alternately in one year. In one season (east monsoon) upwelling occurs and the following season (west monsoon) occurs downwelling.

Mapping fishing ground of yellowfin tuna potential
Based on incidence front, upwelling and SSH prediction data, fishing ground yellow fin tuna can be mapped. Predictive the mapping of fishing ground was mapped according to the seasons. For more details, predictions yellow fin tuna fishing area can be seen in the following figures 3, 4, 5 and 6.

Conclusions

Based on the research results can be summarized as follows:
1) SST in the west season with an average of 29.79°C, on the west-east transition season with an average of 29.70°C, in the east season with an average of 27.40°C. and on the east-west transition season average of 29.13°C.
2) Chlorophyll a-west on the season with a range of 0.15 mg/m³, at the west-east transitional season with a range of 0.15 mg/m³, in the east season with the range of 0.27 mg/m³ and in transitional season east- west by the range of 0.21 mg/m³.
3) chlorophyll-a concentration high in June tend to move from east to west to the Wakatobi Islands in September.
4) Front, was found in the vicinity and the Koromaha reef in December, January and February. Front Kaledupa found around reefs and P. Runduma in March, April and May. Front happening around Coral Kapota, Kaledupa Reef, Koromaha and Koka reef in June, July, August, September, October and November.
5) upwelling occurs around Kapota reef, Kaledupa and Koka reef in June. Upwelling occurs in the vicinity of P. Runduma, Kapota Coral, Coral Kaledupa in July and August. Upwelling occurs around Kapota Coral, Coral Kaledupa and P.Wangi-scented in September.

Acknowledgements

We are very Grateful to the Director of Research and devotion to the public the Director General of Higher Education Ministry of National Education, Indonesia was founded for the study and thanked to Dean of Fisheries and Marine Science Faculty, University Haluoleo.

References

Population, stock status and management of sergestid shrimp *Acetes indicus* (Decapoda: Sergestidae) in the coastal waters of Malacca, Peninsular Malaysia

S.M. Nurul Amin¹, Aziz Arshad¹,², Siti Shapor Siraj² and Japar Sidik Bujang³

¹Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia
²Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia
³Department of Animal Science and Fishery, Faculty of Agriculture and Food Sciences,
UPM Bintulu Campus, Nyabau Road, P.O. Box 396, 97008 Bintulu, Sarawak, Malaysia

Corresponding author’s email: smnabd@gmail.com

Abstract

Population parameters, growth, mortality and exploitation rate of planktonic shrimp, *Acetes indicus* were examined in the coastal waters of Malacca, Malaysia between February 2005 and March 2007. Monthly length frequency data were analyzed using FISAT software for estimating population parameters, including asymptotic length (*L*ₐ), growth co-efficient (*K*) and exploitation rate (*E*) to assess the status of the stock. The mean *L*ₐ and *K* for males were estimated at 29.93 mm and 1.60 yr⁻¹, and for the females that were 40.95 mm and 1.20 yr⁻¹, respectively. The mean growth performance index (*ϕ*') was calculated as 3.15 and 3.31 for males and females. The maximum life span (*t*ₘₐₓ) of males and females was 1.88 and 2.50 years, respectively. Total mortality (*Z*) was estimated at 4.30 yr⁻¹ for males and 3.62 yr⁻¹ for females. The rate of natural mortality (*M*) for males and females was calculated as 2.54 yr⁻¹ and 1.93 yr⁻¹, and the fishing mortality (*F*) was 1.77 yr⁻¹ and 1.70 yr⁻¹ for males and females, respectively. The recruitment pattern of *A. indicus* was continuous throughout the year with two major peaks. The exploitation rate (*E*) of males was 0.41 and that of females was 0.47. The exploitation rates were slightly less than the optimum level of exploitation (*E* = 0.50). Thus, the stock of *A. indicus* is under exploited in the coastal waters of Malacca, Malaysia.

Keywords: exploitation, stock status, *Acetes indicus*, Malaysia

Introduction

The sergestid shrimp of the genus *Acetes*, family Sergestidae, is a minor planktonic crustacean group represented by a small number of species, but is one of the economically important organisms in Asian and African waters (Omori, 1975). It occurs widely in the west coast of Malay Peninsula (Amin et al. 2009; Omori, 1975; Pathansali, 1966) and locally familiar as udang geragau. The world-wide geographical distribution of *Acetes* has been summarized by Omori (1975). The annual landing of *Acetes* in Malaysia was 13,797 tons in 2007 (DOF, 2007). Knowledge of various population parameters like as asymptotic length (*L*ₐ) and growth coefficient (*K*), motilities (natural and fishing) rate and exploitation level (*E*) are necessary for planning and management of *Acetes* resources. Therefore, the present study was undertaken to estimate the population parameters and stock assessment of *Acetes indicus* around the coast waters Malacca.

Materials and Methods

Monthly samples of *A. indicus* were collected between February 2005 and April 2007 from Klebang Besar (N 02°13.009' and E 102°11.921') in the coastal waters of Malacca, Straits of Malacca. *Acetes* spp. shrimps were caught by the push net (triangular shape) known locally
as ‘Sungkor’, as described by Omori (1975). The specimens of *Acetes indicus* were identified in the laboratory after 2-3 days of preservation using a Nikon dissecting microscope (Nikon-122764, Japan) and Omori (1975). Total length (TL) of 4900 individuals (males 1628 and females 3272) during 2005-06 and 5926 individuals (males 1792 and females 4134) during 2006-07 of *A. indicus* were measured from the tip of the rostrum to the tip of the telson to the nearest 0.1 mm. The data were then analyzed using the FiSAT software as explained in detail by Gayanilo et al. (1996).

Asymptotic length (L∞) and growth co-efficient (K) of the von Bertalanffy growth function (VBGF) were estimated by means of ELEFAN-1 (Pauly and David, 1981). Total mortality (Z) was estimated by using the length converted catch curve. Natural mortality rate (M) was estimated using empirical relationship of Pauly (1980). Fishing mortality (F) was estimated using the relationship: F = Z – M. The exploitation level (E) was obtained by the relationship of Gulland (1971): E = F/Z = F/ (F+M). The relative yield-per-recruit (Y/R) and relative biomass-per-recruit (B/R) were estimated by using the model of Bevorton and Holt (1966) as modified by Pauly and Soriano (1986). The approximate maximum sustainable yield (MSY) was then calculated by the equation proposed by Cadima (Troadec, 1980) for exploited fish/shrimps. MSY= Zt 0.5. Bt; where Zt is the exponential rate of total mortality and Bt is the standing stock size in year t.

Results

**Growth parameters**

The asymptotic length, L∞ values estimated for male *A. indicus* were 29.40 mm in 2005-06 and 30.45 mm in 2006-07 and it was 42.00 mm in 2005-06 and 39.90 mm in 2006-07 for female (Table 1). The growth co-efficient, K values were 1.70 yr⁻¹ in 2005-06 and 1.50 yr⁻¹ in 2006-07 for male and 1.20 yr⁻¹ in both 2005-06 and 2006-07 for female. The growth performance index, ϕ’ values of male were 3.22 in 2005-06 and 3.20 in 2006-07. The ϕ’ values of female were 3.44 in 2005-06 and 3.45 in 2006-07 (Table 1).

**Table 1.** Estimated population parameters of *A. indicus* in the coastal waters of Malacca, Malaysia.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>2005-2006</th>
<th>2006-2007</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Asymptotic length (L∞) in mm</td>
<td>29.40</td>
<td>42.00</td>
<td>30.45</td>
</tr>
<tr>
<td>Growth co-efficient (K), yr⁻¹</td>
<td>1.70</td>
<td>1.20</td>
<td>1.50</td>
</tr>
<tr>
<td>Response surface, Rn</td>
<td>0.205</td>
<td>0.284</td>
<td>0.211</td>
</tr>
<tr>
<td>Growth performance index, ϕ’</td>
<td>3.16</td>
<td>3.33</td>
<td>3.14</td>
</tr>
<tr>
<td>Maximum age (t½)</td>
<td>1.76</td>
<td>2.50</td>
<td>1.76</td>
</tr>
<tr>
<td>Total mortality (Z), yr⁻¹</td>
<td>4.15</td>
<td>3.50</td>
<td>4.45</td>
</tr>
<tr>
<td>Natural mortality (M), yr⁻¹</td>
<td>2.65</td>
<td>1.91</td>
<td>2.42</td>
</tr>
<tr>
<td>Fishing mortality (F), yr⁻¹</td>
<td>1.50</td>
<td>1.59</td>
<td>2.03</td>
</tr>
<tr>
<td>Exploitation level (E)</td>
<td>0.36</td>
<td>0.45</td>
<td>0.46</td>
</tr>
<tr>
<td>Maximum exploitation (E_max)</td>
<td>0.71</td>
<td>0.57</td>
<td>0.65</td>
</tr>
<tr>
<td>Sample size (N)</td>
<td>1628</td>
<td>3272</td>
<td>1792</td>
</tr>
</tbody>
</table>

**Mortality and exploitation**

Estimated total mortality (Z) values of male were 4.15 yr⁻¹ in 2005-06 and 4.45 yr⁻¹ in 2006-07, that of female were 3.50 yr⁻¹ in 2005-06 and 3.74 yr⁻¹ in 2006-07 (Table 1). The average natural mortality (2.54 yr⁻¹) was higher than the average value of fishing mortality (1.77 yr⁻¹) for male indicate the unbalance position in the stock. The average E value of male and female was 0.41 and 0.47 during two year the study period.
Age and growth
Based on the mean growth parameters of the two years study, the maximum life span ($t_{\text{max}}$) of male was 1.88 years and that of females was 2.50 years (Table 1). The sizes attained by male and female $A. \text{indicus}$ were 23.89 mm and 28.99 mm respectively, at the end of 1 year. The growth pattern of males and females are presented in Figure 1.

![Figure 1. Plot of age and growth for male and female $A. \text{indicus}$.](image)

Recruitment pattern
Annual recruitment pattern of male showed continuous recruitment with two major peaks in 2005-06. In 2006-07 the male recruitment pattern also showed continuous with two spells (Figure 2). In case of female annual recruitment pattern showed also two spells in both the years.

![Figure 2. Recruitment pattern of male $A. \text{indicus}$ in 2005-06 (a) and 2006-07 (b).](image)

Relative yield-per-recruit (Y/R) and biomass-per-recruit (B/R)
The mean $E$ and corresponding $E_{\text{max}}$ values of male were 0.41 and 0.68; that of female were 0.47 and 0.55, respectively (Table 1). The estimated $E$ values when compared with hypothetical 'ideal E' value of 0.50 for desirable fishing effort and $E_{\text{max}}$ both indicated the stock of $A. \text{indicus}$ is under exploited in the investigated areas. The values of total annual catches, standing stock size and MSY of $A. \text{indicus}$ were 37.24 mt, 24.10 mt and 46.09 mt in 2005 – 2006 and 88.65 mt, 46.29 mt and 94.78 mt in 2006 – 2007, respectively.

Discussion
The $L_{\infty}$ value for the combined sex of $A. \text{indicus}$ reported by Zafar et al. (1997) from Bangladesh waters was much lower than the value of the present study but $K$ value is more or less similar to the present value. The highest value of $L_{\infty}$ (41.48 mm) for female $A. \text{indicus}$ is observed in the present study. The $Z$ value obtained by Oh and Jeong (2003) for combined sex of $A. \text{chinensis}$ was far less than the present values. While Zafar et al. (1997) reported more or less similar $Z$ (6.07 yr$^{-1}$) value for $A. \text{indicus}$ in the Bangladesh waters. Only the total mortality ($Z$) of $A. \text{indicus}$ female (3.62 yr$^{-1}$) in the coastal waters of Malacca is close to the value (3.93 yr$^{-1}$) obtained by Oh and Jeong (2003) for $A. \text{chinensis}$ in the western coast of Korea. Higher natural mortalities of male $A. \text{indiclus}$ verses the fishing mortalities observed from the present study indicate the unbalance position in the stock of male population in $A. \text{indicus}$. Exploitation levels ($E$) of female are higher than males in $A. \text{indicus}$ population. This is based on the assumption that a stock is optimally exploited when fishing mortality ($F$) equals natural mortality ($M$), or $E = (F/Z) = 0.5$ (Gulland, 1971). It is may be for the larger size of females they cannot escape from the gear than males. Exploitation level ($E$) was computed as 0.41 (male) and 0.47 (female) indicate the fishery of $A. \text{indicus}$ in the coastal waters of Malacca is underexploited.
Acknowledgements

This work is part of a PhD thesis funded by the Ministry of Science, Technology and Innovation (MOSTI), Malaysia (Grant No. 5450247). The authors would like to thank to MOSTI for providing financial support to carry out this research work.

References


DOF. 2007. Yearbook of Fishery Statistics, Department of Fisheries, Malaysia.


Pauly, D. and David, N. 1981. ELEFAN-I BASIC program for the objective extraction of growth parameters from length frequency data. Meeresforsch 28(4): 205-211.


183
Finfish fisheries and resources of Sarawak, Sabah and Labuan

Albert Chuan Gambang*, Richard Rumpet and Nurridan Abdul Han

Fisheries Research Institute, Bintawa, Sarawak
P.O. Box 2243, 93744 Kuching, Sarawak, Malaysia

Corresponding author’s email: ippcs@streamyx.com

Abstract

Data from the Department of Fisheries Malaysia Annual Fisheries Statistic 2008 and recent research surveys were used to determine the current status of finfish fisheries in Sarawak, Sabah and Labuan. In 2008, the production of finfish (demersal and pelagic fish) in Malaysia is about 57.90% (807,453 tonnes) of the total marine fish landing. Pelagic fish contributed the highest landing at 533,404 tonnes (38.25%). Most of the catches are caught by purse seine nets at 378,391 tonnes (27.13%). The most dominant species landed by purse seine are round scad (24%), followed by tuna (14%), sardine (10%), Indian mackerel (7%), selar scad (6%), yellow striped trevally (3%), trash fish (7%) and others (29%). Marine fish productions from deep sea resources 315,779 tonnes (57,013 tonnes-Sarawak, 7,530 tonnes-Sabah, 3,766 tonnes-Labuan) have not achieve the national target of 380,000 tonnes annually as envisaged in the NAP3. The potential yield of pelagic resources in the exclusive economic zone of Malaysia was estimated at 1,374,500 tonnes (852,500 tonnes for Sarawak, Sabah and Labuan). However, landing of pelagic fish accounted for only 38.25% (533,404 tonnes) of the total landing of marine fish in Malaysia. Therefore, there are still more opportunities for expansion of pelagic fishery. In Sarawak, the pelagic finfish group (small pelagic and tuna) has a potential yield of 386,920 tonnes. In Sabah, pelagic fish and oceanic tuna has a potential of 344,800 tonnes and 20,000 tonnes respectively. In Labuan, the potential yield of coastal demersal fish is 14,865 tonnes against the current exploitation at 23,768 tonnes. In order to sustain the fisheries resources, some measures associated with fishing capacity, illegal, unreported and unregulated fishing (IUU), fisheries ecosystem management, marine protected areas and artificial reef are already implemented.
Recreational fisheries effort and value of Port Dickson, Negeri Sembilan, Malaysia

N. Gopinath, S.S. Puvanesuri* and S. Norhayati

Fanli Marine and Consultancy Sdn. Bhd.
27-3, Level 3, Block F2, Jln. PJU 1/42A, Dataran Prima, 47301 Petaling Jaya, Selangor, Malaysia

Corresponding author's email: fanlimarine@gmail.com

Abstract

Port Dickson is a major domestic tourist destination and supports a significant level of recreational (sports) fishing. Fishermen and boat operators rent out their boats to anglers. However, kelong, purpose built public jetties and breakwaters also support a significant level of recreational fisheries effort. Data were collected through assessment and interviews with anglers. Six (6) popular spots for recreational fishing were identified along the Port Dickson coastline i.e. at Kg. Telok, Kg. Balak, Kg. Telok Pelanduk, Kuala Sg. Chuah, Telok Kemang (Admiral Cove Marina and PD World Marina) and Kuala Lukut. These hotspots were dominated by three (3) main activities i.e. shore-based angling, kelong-based angling and boat-based angling. Both the shore-based and kelong-based anglers use line casting while boat-based anglers use trolling. The dominant catches were Gelama (Johnius sp.), Pari (Himantura walga), Jenahak (Lutjanus johnii), Bedukang (Arius sagor), Semilang (Plotosus canius), Siakap (Lates calcarifer), Kapas (Gerres sp.), Belanak (Liza sp.), Senangin (Polynemus sp.) and swimming crab (Portunus pelagicus). Baits used were live prawn, squid, small fish and pumpum. The investigation indicated the shore-based angling fishing effort was estimated 31,132 person-days per year while kelong-based angling and boat-based angling was estimated at 24,154 and person-days per year respectively. Though net contribution to table fishing landings is minimal, overall economic impact of recreational fishing were significant. The data indicate that the direct revenue from angling were estimated at RM7 million.

Keywords: recreational fisheries, fishing effort, angling revenue

Introduction

The waters off Port Dickson support a variety of fisheries activities, each of which has their own profile where the economy of the district is concerned and recreational fisheries fits as one of the major activity undertaken along its coastline. Recreational fishing, also known as sports fishing or angling, supports a large participant base. Though there is an absence of true game fish in the Districts’ waters, recreational fishing based on small pelagics, snappers, trevallies and similar species is widely popular and consistent with Port Dickson’s recreational and tourism appeal. Recreational fishing activities cover a wide range of gear, from rod and lines for fish to the use of traps and pods for crabbing. Though net contribution to table fishing landings is minimal, overall economic impact of recreational fishing is high.

Materials and Methods

The primary data collection involved site visits to recreational fishing hotspots along the Port Dickson coastline as well as assessment and interviews with the anglers. Observational descriptions and photographs were undertaken at all angling locations and their respective GPS locations were noted. The assessment was based on the following assumptions:
1) Anglers fish both during the night as well as during the day, their numbers increasing during weekends, public and school holidays. For the purpose of this assessment, neither school nor public holidays are taken into account.

2) The fishing effort is based on a person-day, each person controlling 1 to 4 rod.

3) A person-day is 8 person-hours.

4) There are 105 weekend days and 260 weekdays.

5) A boat-based fishing trip is 8 hours.

6) A kelong-based fishing trip is 12 hours.

7) Shore-based fishing time is broken up into time segments as follows:
   - 2 pm – 7 pm (weekend; 5 hours)
   - 5 pm – 7 pm (weekdays; 2 hours)
   - 7 am – 6 am (weekends and weekdays; 12 hours)

Results and Discussion

Six (6) popular spots for recreational fishing were identified during this study i.e. at Kg. Telok, Kg. Balak, Kg. Telok Pelanduk, Kuala Sg. Chuah, Telok Kemang (Admiral Cove Marina and PD World Marina) and Kuala Lukut (Koperasi Kuala Lukut, at the private jetty and near the abandoned shrimp farm). These hotspots were dominated by three (3) main activities i.e. shore-based angling, kelong-based angling and boat-based angling. Basically, the classification is made from a fishing skills point of view. Both the shore-based and kelong-based anglers use line casting while boat-based anglers use trolling.

Shore-based angling

Shore-based angling was undertaken at Kg. Telok, Kg. Telok Pelanduk, PD World Marina at Telok Kemang and Kuala Lukut. The investigation indicated the shore-based angling fishing effort was estimated at 31,132 person-days per year.

Kg. Telok Pelanduk is a productive fishing area and supports active shore-based fishing. Shore-based fishing involves all age levels, including primary school children, day or night. Over the weekends, there is an average of 7-9 anglers compared to weekdays (2-3 anglers). PD World Marina is a major local point for shore-based angling, both for finfish as well as crabs. An average of 5 anglers was spotted fishing over five weekdays and the number increased at night with more than 5 anglers. During weekends, up to 25 operate in the afternoon and increasing to 33 anglers at night. In total, the anglers spend about RM20, exclusive of the fishing rod, each time they come to fish.

Three locations were identified for shore-based angling at Kuala Sg. Lukut i.e. Kuala Lukut Jetty located near the Koperasi Kuala Lukut, private jetty and near the abandoned shrimp farm. At Kuala Lukut Jetty, the Koperasi Kuala Lukut manages the jetty and charges RM 3.00 for its use. Over the weekends, more than 20 people fish day and night on the jetty and each spent less than 5 hours fishing. About 10 anglers operate from the jetty during weekdays and spent less than 3 hours each. In terms of costs, the anglers spent an average of RM 53 each inclusive of jetty fee (RM 3) and fish baits. At the private jetty about 5-7 anglers operate at this jetty on weekends in the afternoon, while more than 10 anglers fish during night. On weekdays, only 2-4 anglers come to fish. The shrimp and small fish bait cost RM6/kg, while pumpum costs RM5/bag. Some anglers stay overnight and bring along tents, food, flashlights, bait and fishing gear. As for the location near the abandoned shrimp farm, during weekends, less than 13 anglers fish in the afternoon, while in the evening, the number of anglers ranges from 13 (afternoon) to 15 (evening). During weekdays, less than 5 anglers come in the afternoon and evening. The time spent for fishing is usually less than 5 hours during weekends and about 3 hours during weekdays. Overall, the anglers spent around RM 5 for fishing session.
**Kelongs-based angling**

Several *kelongs* were being used for recreational fishing activities. The anglers rent the boats from the nearest fish landing points to the *kelong*. The *kelongs* are located at Kg. Telok, Kg. Balak, Kuala Sg. Chuah and Kuala Sg. Lukut. Anglers mainly use live shrimp *pumpum*, and live *Selas* and trash fish mainly *Tamban*. The investigation indicated the *kelong*-based angling fishing effort was estimated at 24,154 person-days per year.

At Kg. Telok, only one *kelong* was operational and one boat is provided for anglers to fish from the *kelong*. The boat rental was charged at RM15-20/boat. At Kg. Balak fishing village, there are four *kelongs* located about 1-3 km from the beach. There was one boat that transports groups of people from the village to the *kelong*, each group consisting of 5 to 10 people. The rental rate is RM20 to RM30 per person, including transportation and *kelong* fee. The anglers usually spend about 12 to 18 hours for fishing and sometimes prefer to stay overnight at the *kelong*.

At Chuah fishing base, around 4-5 boats are available for rental to take anglers to 2 nearby *kelongs*. Each *kelong* is rented out for RM43 per person for overnight anglers. Based on the interviews, anglers spend as much as RM1000 on a trip to the *kelong*. Such trips are usually undertaken monthly. At Kuala Lukut there were 2 jetties used for transporting anglers to *kelong* i.e. Koperasi Kuala Lukut jetty and the private jetty. There are 3 *kelongs* located nearby off the Lukut coast. The *kelong* fee is RM35 per person for one day and one night. Based on the interviews, average expenditure per angler is RM350 per trip.

**Boat-based angling**

Boat-based angling was undertaken at Kg. Telok Pelanduk, Admiral Cove Marina and at a private jetty at Kuala Lukut. The investigation indicated the boat-based angling fishing effort was estimated at 12,361 person-days per year. At Kg. Telok Pelanduk, 2-3 boats are generally available for boat rental by fisherman. An average of 3 persons can be accommodated in each boat in one trip. Rental rates range from RM 50 to RM 150 per trip for outboards and RM 450 per boat for inboards. Admiral Cove Marina is a popular point for boat-based recreational fisheries. It provides boat rental services for anglers. Four (4) boats are available for rental. Usually, anglers prefer to fish near shipwrecks at Tanjung Tuan. Around 25 to 30 anglers spend their weekends and weekdays fishing in this area. The rental price is RM100 per trip (4-5 hours). Each boat can load up to 5 peoples on each trip. At Kuala Lukut private jetty, boat operators will bring a group of anglers to their desired fishing spot along Sg. Lukut. Usually, there are 5 to 6 persons in a group. The rate for boat rental is RM 120 per boat for small boat and RM 280 per boat for big boat.

**Beachcombers**

Beach combing activity was observed in the area adjacent to the Hotel Selat at Telok Kemang. At the end of the beach, there is a rocky and muddy stretch where people collect small crabs, shrimps, rocks, and seashells. The activity effort was estimated at 263 person-days per year.

The data from all the locations involved in the recreational fisheries activity along the Port Dickson coastline indicate that the total fishing effort amounted to 67,910 person-days per year. The economic value of recreational fisheries is difficult to estimate. In assessing the value, the outcome of the tourism study estimated an expenditure of RM150 per visitor-day. By adopting the following assumptions 1) a figure of RM100 per person day for *kelong* and boat based anglers and 2) a figure of RM 50 for shore based anglers, the economic value of recreational fisheries in the Port Dickson waters is estimated at RM7 million.
Acknowledgements

This study was carried out as part of the scope work for the environmental component for the Integrated Shoreline Management Plan (ISMP) Study for Port Dickson, Negeri Sembilan, Malaysia. The study was commissioned by the Department of Drainage and Irrigation, Malaysia. The authors would like to thank the National Hydraulic Research Institute of Malaysia (NAHRIM) for engaging our company to undertake the study. Thanks are also due to all involved in data collection and preparation of the report.
Impact of migratory birds on the production of fishery composition in Pongdam wetland in Himachal Pradesh, India

Ram Krishan Negi1* and Tarana Negi2

1Department of Zoology and Environmental Sciences, Gurukula Kangri University
Hardwar (UK) India, 249404
2Department of Zoology, Govt. College, Panchkula, Haryana, India
Corresponding author’s email: negi_gkv@rediffmail.com

Abstract

In the present study, fish samples were collected from Pong Dam reservoir. The total catch during the first year of the fishery was 98 tonnes which increased progressively attaining a peak of 453 tonnes in 1999-2000 there after it showed fluctuation in the total catch and at present it was 312.26 tonnes in 2006-07. A total of 27 fish species belonging to 7 families were recorded. Most dominant fish recorded was Aorichthys seenghala. Although, total catch during 2001-02 was 390.41 tonnes, it was declined to 311.52 tonnes during 2006-07. This sharp decline in fish production in this reservoir may be due to recent construction of hydral projects in the up streams of Beas and Satluj rivers which led to rapid sedimentation, loss and leaching of nutrients from the soil, decomposition of organic matter, destruction of spawning grounds of the fish and blocking of migrating channels of fish and secondary cause of decline in fish production is due increase in number of migratory birds in the reservoir last five decades. During the course of study a total of 95,000 water birds of 89 species were reported during Jan, 2009 to Feb. 2009. Most of migratory birds belonged to omnivorous in feeding guild.

Keywords: Pongdam, fish catch, fishery, Himachal Pradesh and migratory birds

Introduction

A large number of reservoirs have been constructed in India during the last five decades, with the primary objective of storing river water for irrigation and power generation. Although these water bodies hold tremendous fisheries development potential, they are not contributing to the inland fish production of the country to the extent they should. Unlike rivers, which are under increasing threat of environmental degradation, reservoirs offer ample scope for fish yield optimization through suitable management. Fisheries in reservoirs are usually a secondary activity and are given a lower priority; reservoirs are almost never impounded for developing a fishery.

Fortunately or unfortunately there is hardly a major river in Asia has not been dammed. The reservoir resource in Asia has been estimated by a number of authors (Costa-Fierce, 1991; Lu, 1992; De Silva, 1996). The utilization of hydroelectric and irrigation reservoirs as a comparatively cheap source of fish protein is receiving increasing attention, particularly in the Asia Pacific region (De Silva, 1988) and Africa (Kapetsky and Ptr, 1984; Blay, 1985). In many Asian countries, reservoirs contribute significantly to the total inland fish production (Sirisena and De Silva, 1989; Jhingran, 1992; Sifa, 1992). An increase in the number of man made, multipurpose reservoirs in India provides an opportunity for enhanced fish production. Pongdam reservoir was constructed on the river Beas, commissioned in 1974 is primarily meant for power generation and flood control. Its catchment area of 12561 km² and a surface area of 24529 ha at FRL and14312 ha at DSL. It originating in the south face of Rohtang passes at an elevation of 4062 m above mean sea level (Figure 2.). Himachal Pradesh is a small state of 55673 km², away in the Himalayas. Present attempt was made to find out impact of migratory bird on the production of fishes in Pongdam reservoir in Himachal Pradesh, India.
Materials and Methods

During the course of study fish catch data was collected from landing stations of Pongdam reservoir and some information regarding the catch data were also procured from Department of Fisheries Himachal Pradesh, India and data of migratory birds was collected from the State Forest Department. The represented specimens which were not identified on the spot were brought to the laboratory and identified up to species level using the standard references of Day (1875-1878) and Jayaram (1999).

Results and Discussion

Pong reservoir is an important reservoir from the fishery point of view, irrigation, generation of electricity and employment. Presently there were 27 fish species belonging to six families. Out of these following are commonly occurring fish species viz., Barilius bendilisis, B. vagra, Cirrhinus mrigala, Crossocheilus latius, Catla catla, L. dero, L. bata, L. rohita, Cyprinus carpio, Tor putitora, Puntius ticto, P. saran, Noemacheilus kangi, A. seenghala, Glyptothorax pectinopterus, Channa marulius, Channa punctatus and Ctenopharyngodon idella. The commercial fishing in the reservoir was initiated soon after its emergence. The total catch during the first year of the fishery was 98 tonnes which increased progressively attaining a peak of 453 tonnes in 1999-2000 there after it showed fluctuation in the total catch and at present it was 312.26 tonnes in 2006-07. (Table 1 and 2). A perusal of indigenous carp composition in the total catch from 1976-77 to 1997-98 showed that they dominated over catfishes till 1991-92. During 1991-92, the Indian major carps viz, L. rohita, C. catla, C. mrigala, L. calbasu accounted for 46.3% (225 tonnes) of the total catch while cat fishes viz. A. seenghala, W. attu accounted for 37.9% (60 tonnes) and others 2.4% (12 tonnes). Against this during 1997-98 the percentage composition of indigenous carps, cat fishes, mirror carp, T. putitora and others was 16.6% (69 tonnes), 58.71% (2246 tonnes), 4.0% (17 tonnes), 19.5 (81 tonnes) 0.91 (4 tonnes), respectively (Table 1). Among the Indian major carps, Labeo rohita is a dominant fish in the reservoir. The highest catch (339 tonnes) of this fish was recorded during 1995-96. However, in 2000-01 its catch was increased to (221 tonnes) and at present 2006-07 it was accounted low catches (84.11 tonnes). Catla Catla has always kept a low profile in the reservoir. The maximum (114.43 tonnes) was recorded during 2004-05. C. mrigala has suffered a marked decline in the catches. The highest catches (211.52 tonnes) were encountered during 2004-05 and at present (2006-07) it was 13.80 tonnes and minimum during 1998-99 i.e. (2 tonnes).
Labeo calbasu which once occupied significant position in the reservoir has declined considerably touching a low of 3 tonnes during 1999-2000 against during 2002-03 it was recorded (33.65 tonnes) but in 2006-07 it was just 2.55 tonnes (Table 2). Among the Indian major carps, Labeo rohita is a dominant fish in the reservoir. The highest catch (339 tonnes) of this fish was recorded during 1995-96. However, in 2000-01 its catch was increased to (221 tonnes) and at present 2006-07 it was accounted low catches (84.11 tonnes). Catla catla has always kept a low profile in the reservoir. The maximum (114.43 tonnes) was recorded during 2004-05. C. mirgala has suffered a marked decline in the catches. The highest catches (211.52 tonnes) were encountered during 2004-05 and at present (2006-07) it was 13.80 tonnes and minimum during 1998-99 i.e. (2 tonnes). Labeo calbasu which once occupied significant position in the reservoir has declined considerably touching a low of 3 tonnes during 1999-2000 against during 2002-03 it was recorded (33.65 tonnes), but in 2006-07 it was just 2.55 tonnes. Minor carp composition is quite erratic in the reservoir presumably due to the lack of breeding ground in the water body. This reservoir is only reservoir in India having a composite combination of carnivorous and herbivorous fishes. This reservoir is also known as Aorichthys seenghla reservoir because of its maximum production after the emergence of the reservoir. The limnological studies of the Pong dam reservoir showed curvilinear relationship with fish production.

<table>
<thead>
<tr>
<th>Years</th>
<th>C. catla</th>
<th>L. rohita</th>
<th>L. dero</th>
<th>L. calbasu</th>
<th>C. mrigala</th>
<th>C. carpio</th>
<th>C. idella</th>
<th>T. putitora</th>
<th>A. seenghla</th>
<th>W. attu</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976-77</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>98</td>
</tr>
<tr>
<td>1977-78</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>98</td>
</tr>
<tr>
<td>1978-79</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>53</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>53</td>
</tr>
<tr>
<td>1979-80</td>
<td>-</td>
<td>108</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>108</td>
</tr>
<tr>
<td>1980-81</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>57</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>63</td>
</tr>
<tr>
<td>1981-82</td>
<td>-</td>
<td>75</td>
<td>-</td>
<td>9</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>68</td>
</tr>
<tr>
<td>1982-83</td>
<td>-</td>
<td>2</td>
<td>71</td>
<td>85</td>
<td>27</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>227</td>
</tr>
<tr>
<td>1983-84</td>
<td>-</td>
<td>6</td>
<td>43</td>
<td>74</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>147</td>
</tr>
<tr>
<td>1984-85</td>
<td>1</td>
<td>24</td>
<td>22</td>
<td>76</td>
<td>35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>75</td>
</tr>
<tr>
<td>1985-86</td>
<td>3</td>
<td>84</td>
<td>24</td>
<td>80</td>
<td>51</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55</td>
</tr>
<tr>
<td>1986-87</td>
<td>4</td>
<td>97</td>
<td>26</td>
<td>74</td>
<td>49</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>43</td>
</tr>
<tr>
<td>1987-88</td>
<td>7</td>
<td>339</td>
<td>20</td>
<td>68</td>
<td>77</td>
<td>1</td>
<td>31</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>453</td>
</tr>
<tr>
<td>1988-89</td>
<td>4</td>
<td>145</td>
<td>13</td>
<td>56</td>
<td>43</td>
<td>32</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>476</td>
</tr>
<tr>
<td>1989-90</td>
<td>8</td>
<td>168</td>
<td>13</td>
<td>50</td>
<td>25</td>
<td>13</td>
<td>1</td>
<td>54</td>
<td>106</td>
<td>28</td>
<td>-</td>
<td>489</td>
</tr>
<tr>
<td>1990-91</td>
<td>7</td>
<td>138</td>
<td>3</td>
<td>42</td>
<td>17</td>
<td>5</td>
<td>-</td>
<td>65</td>
<td>121</td>
<td>24</td>
<td>-</td>
<td>442</td>
</tr>
<tr>
<td>1991-92</td>
<td>12</td>
<td>150</td>
<td>3</td>
<td>49</td>
<td>14</td>
<td>4</td>
<td>-</td>
<td>60</td>
<td>164</td>
<td>20</td>
<td>-</td>
<td>485</td>
</tr>
<tr>
<td>1992-93</td>
<td>15</td>
<td>95</td>
<td>1</td>
<td>39</td>
<td>7</td>
<td>2</td>
<td>-</td>
<td>71</td>
<td>199</td>
<td>14</td>
<td>-</td>
<td>448</td>
</tr>
<tr>
<td>1993-94</td>
<td>19</td>
<td>84</td>
<td>1</td>
<td>18</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>50</td>
<td>180</td>
<td>9</td>
<td>-</td>
<td>373</td>
</tr>
<tr>
<td>1994-95</td>
<td>34</td>
<td>57</td>
<td>-</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>62</td>
<td>193</td>
<td>6</td>
<td>-</td>
<td>371</td>
</tr>
<tr>
<td>1995-96</td>
<td>22</td>
<td>36</td>
<td>-</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>59</td>
<td>185</td>
<td>5</td>
<td>-</td>
<td>330</td>
</tr>
<tr>
<td>1996-97</td>
<td>22</td>
<td>36</td>
<td>-</td>
<td>9</td>
<td>3</td>
<td>14</td>
<td>-</td>
<td>64</td>
<td>236</td>
<td>4</td>
<td>-</td>
<td>397</td>
</tr>
<tr>
<td>1997-98</td>
<td>12</td>
<td>49</td>
<td>-</td>
<td>5</td>
<td>3</td>
<td>17</td>
<td>-</td>
<td>81</td>
<td>241</td>
<td>3</td>
<td>-</td>
<td>415</td>
</tr>
<tr>
<td>1998-99</td>
<td>9</td>
<td>41</td>
<td>-</td>
<td>6</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>74</td>
<td>208</td>
<td>2</td>
<td>-</td>
<td>360</td>
</tr>
<tr>
<td>1999-00</td>
<td>11</td>
<td>65</td>
<td>-</td>
<td>3</td>
<td>8</td>
<td>13</td>
<td>3</td>
<td>90</td>
<td>257</td>
<td>1</td>
<td>-</td>
<td>453</td>
</tr>
</tbody>
</table>
Table 2. Species wise production of fish in Pongdam reservoir during 2001-2007.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Catla catla</td>
<td>12.86</td>
<td>97.21</td>
<td>45.27</td>
<td>11.443</td>
<td>19.89</td>
<td>9.85</td>
</tr>
<tr>
<td>Labeo rohita</td>
<td>22.18</td>
<td>25.629</td>
<td>18.762</td>
<td>86.28</td>
<td>90.01</td>
<td>84.11</td>
</tr>
<tr>
<td>Cirrhinus mrigala</td>
<td>6.370</td>
<td>8.568</td>
<td>5.25</td>
<td>2.1152</td>
<td>18.637</td>
<td>13.805</td>
</tr>
<tr>
<td>Labeo calbasu</td>
<td>9.48</td>
<td>33.65</td>
<td>9.87</td>
<td>5.65</td>
<td>6.32</td>
<td>2.55</td>
</tr>
<tr>
<td>Tor putitora</td>
<td>62.874</td>
<td>51.83</td>
<td>30.390</td>
<td>30.205</td>
<td>36.456</td>
<td>50.59</td>
</tr>
<tr>
<td>Labeo dero</td>
<td>0.072</td>
<td>0.096</td>
<td>0.020</td>
<td>---</td>
<td>0.016</td>
<td>---</td>
</tr>
<tr>
<td>Wallago attu</td>
<td>7.47</td>
<td>5.78</td>
<td>4.06</td>
<td>1.60</td>
<td>2.10</td>
<td>9.36</td>
</tr>
<tr>
<td>Aorichthys seenghala</td>
<td>272.431</td>
<td>272.431</td>
<td>220.044</td>
<td>324.419</td>
<td>219.011</td>
<td>213.274</td>
</tr>
<tr>
<td>Channa spp.</td>
<td>1.835</td>
<td>1.920</td>
<td>1.469</td>
<td>1.820</td>
<td>2.319</td>
<td>2.308</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9.94</td>
<td>15.85</td>
<td>10.78</td>
<td>22.65</td>
<td>13.42</td>
<td>15.35</td>
</tr>
<tr>
<td>Ctenopharyngodon idella</td>
<td>0.01</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total catch</td>
<td>390.9</td>
<td>379.0</td>
<td>307.0</td>
<td>429.5</td>
<td>306.4</td>
<td>311.5</td>
</tr>
</tbody>
</table>

In Nagarjunasagar, despite regular stocking for 13 years, common carp did not form a part of the fishery (Sugunan, 1995). A more important disqualification of common carp is its propensity to compete with some indigenous carps like *Cirrhinus mrigala*, and *C. reba*, with which it shares a food niche. Instances of common carp causing the decline of *Cirrhinus* spp. are Girna (Valsankar, 1987) and Krishnarajasagar (Sugunan, 1995) reservoirs. Detailed accounts of mirror carp affecting the survival of native fish species in Gobindsagar reservoir, upland lakes of Kashmir and Kumaon Himalayas (*Schizothorax* spp.), and Loktaklake in the northeast (*Osteobrama belangiri*) are given by Sugunan (1995). However, most fishes that manage to multiply in the reservoir system are not very high in priority from commercial and ecological point of view. Jhingran and Natarajan (1978) cautioned against introducing the fish in Indian reservoirs connected to major river systems, as it might adversely affect catla and other precious indigenous carps of the country. In the present study, this type of changes was reported in Pong dam reservoir because this reservoir is connected with numbers of streams. During last one decade upcoming of large river water project has shown its drastic impact on fishery production in this reservoir. This sharp decline in fish production in this reservoir may be due to recent construction of hydral projects in the up streams of Beas and Satluj rivers, which led to rapid sedimentation, loss and leaching of nutrients from the soil, decomposition of organic matter, destruction of spawning grounds of the fish, blocking of migrating channels of fish and tremendous increase in migratory birds population in Pongdam reservoir. In the present investigation a total of 95,000 water birds of 89 species were reported during Jan, 2009 to Feb. 2009. Most of migratory birds belong to omnivorous in feeding guild. The maximum influx were Bar headed goose, north pintail, coot, great cormorant, common pochard and common tail.

Acknowledgements

The author is grateful to Gurcharan Singh, Deputy Director, Himachal Pradesh Fisheries Government of Himachal Pradesh for providing fish catch data.

References


Day, F. 1878. The fishes of India, being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon. London pp. 553-778.


Development of drawing ink from squid (*Thysanoteuthis rhombus*)

Cecilio S. Baga* and Corazon P. Macachor

Cebu Technological University (CTU), Main Campus
R. Palma St., Cebu City, Philippines
Corresponding author’s email: csbaga@yahoo.com

Abstract

The production of the solvent-based drawing ink from squid (*Thysanoteuthis rhombus*) developed by the Cebu Technological University (CTU), Main Campus, College of Industrial Technology and Engineering (CITE) researchers promote the clean technology of Cephalopods processing and could influence the decrease in the actual cost of commercial ink. The drawing ink from squid is superimposed with water, acid, glycerin, thinner and varnish. This is a liquid containing black pigment used for colouring a surface to render an image or text, drawing or writing with a pen. The newly developed product with 25% squid pigment and 50% acid concentration have descriptive properties of moderately black colour, slightly desirable solvent-like odour, ink dryness with a sharp irregular line, thick and dry ink consistency, which is comparable with the commercial ink as to its colour, dryness and consistency with an acceptability rating of like moderately for colour, dryness and consistency and like slightly for odour attributes, as perceived by the Bachelor of Science in Industrial Technology (BSIT) major in Drafting Technology students. The colour and dryness properties of drawing ink from squid had the same preference rating as in commercial ink based on Analysis of Variance and Duncan Multiple Range Tests at 5% level of significance. The drawing ink from squid had a density (1.045 g/ml) closer to commercial ink and is safe for use, since the lead content was less than 3.10 ppm. The researchers are on their way of refining the density requirements to expand the applications of the newly discovered ink from a natural source. The drawing ink from squid costs P39.00 per 100 ml with 210% return of investment.

Keywords: technology, marine, cephalopods, drafting

Introduction

The production of the solvent-based drawing ink from squid (*Thysanoteuthis rhombus*) developed by the Cebu Technological University (CTU), Main Campus, College of Industrial Technology and Engineering (CITE) researchers addressed the needs of the drafting students, promote the clean technology of Cephalopods processing and could influence decrease in cost of commercial ink. The drawing ink from squid is superimposed with water, acid, glycerin, thinner and varnish. This is a liquid containing black pigment used for colouring a surface to render an image or text, drawing or writing with a pen. Preliminary studies on the effects of squid ink concentration (5-10-15%) on its properties was conducted by Third year BSIT students major in Drafting Technology (2006) and found out that 15% squid ink resulted to a very light colour with very thin consistency ink. Since, drafting students at the CTU, Main Campus really felt the high cost of commercial ink product, thus, the faculty-researchers made a follow-up research on higher concentration using 25, 50 and 75% squid ink concentration and found out that 25% was comparable with the commercial ink (Baga et al., 2006). However, closer concentrations of 25% squid pigment for drawing ink should be further investigated with an odour enhancement.

Calamansi, *Cirfortunella microcarpa*, is a fruit native to the Philippines. This fruit contains pectin, ascorbic acid, citric acid and acetic acid (http://www.pectin-calamnsi.html) which serves as emulsifiers and deodorizers of a fishy odour commodity.

A kilogram of cephalopods, particularly *Thysanoteuthis rhombus*, could yield approximately 5.5 grams of pigment that would translate to 30 ml of drawing ink, with a production cost of...
P12.50. This amount is 35% cheaper than the prevailing low-cost commercial ink available in the market. The drawing ink from squid costs P39.00 per 100 ml with 210% return of investment.

Squid is one of the most abundant species in the Philippine fisheries (PCAMRD, 2000) found in the coastal areas of Cebu province. The producers of frozen marine products like squid are found in Mandaue City, Cebu and these industries will be the source of supply for ink.

**Materials and Methods**

The experimental method of research on the production of drawing ink from squid was used in conducting the study employing the laboratory techniques and procedures.

Phase 1 of this study was conducted to determine the properties of drawing ink from squid with its varying pigment concentration and compared these variables with the commercial sample. The drawing ink from squid was taken from the ink sac of the squid (Figure 1) which was the raw material for this study. The chemicals used in this study are glycerin, synthetic solvent and varnish, which were bought from a local drugstore in Cebu City. Other diluents like water and calamansi used in this study were also availed locally.

![Figure 1. The fresh squid with the ink sac used in the study.](image)

The drawing ink from squid was prepared by weighing, blending with glycerin, emulsifying with solvent and mixing with varnish and divided into three treatments, that is: Treatment 1, 20%; Treatment 2, 25%; and Treatment 3, 30%, then evaluated with the Treatment 4, the control sample/the commercial ink (Figure 2).

![Figure 2. Drawing ink from squid with varying pigment concentration.](image)

Phase 2 of this study was conducted to determine the appropriate concentration of acid, added to water, as diluents of the solvent-based drawing ink from squid. The drawing ink, with varying concentration of acid was then blended with glycerin, emulsified with synthetic solvent and thoroughly mixed for 15 minutes with varnish.
Experimental samples of drawing ink from squid with varying pigment and acid concentration were tested for three (3) trials by the drafting students to determine its acceptability and the mean significant difference of the three (3) treatments of research samples with the commercialized ink as control.

The data taken from the sensory evaluation responses, both in descriptive and preference testing as to its colour, odour, dryness and consistency in replicates were treated statistically using the weighted mean to determine its acceptability and subjected to Analysis of Variance and Duncan Multiple Range Test (DMRT) for difference at 5% level of significance.

**Results and Discussion**

The acceptability of drawing ink from squid was determined based on the sensory analyses using descriptive and preference tests of all treatments. Figure 3 shows the summary of the acceptability mean scores of drawing ink from squid, compared to commercial ink, as perceived by the panellists.

![Figure 3. Results of the acceptability mean scores of drawing ink from squid with varying acid concentration.](image)

After a series of analyses of the acceptability of drawing ink from squid, as revealed from the data gathered both from perceptions of the respondents, it can be concluded that only 25% pigment concentration is appropriate to be added to the solvents and resins; and 50% acid content of the water component added as solvent as ink emulsifier and deodorizer.

Table 1 revealed that all properties of the prepared drawing ink from squid with varying pigment concentration using the preference test significantly differ. However, DMRT results proved that dryness of the most preferred drawing ink (25%) is the same as that of the commercial ink.

**Table 1.** ANOVA and DMRT results of prepared drawing ink from squid with varying acid concentration using the preference test evaluated by 10 drafting students.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Mean Scores</th>
<th>Computed F Value</th>
<th>Tabular F Value (5%)</th>
<th>DMRT Results (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>50%</td>
<td>100%</td>
<td>CS</td>
</tr>
<tr>
<td>Colour</td>
<td>5.4(d)</td>
<td>6.7(b)</td>
<td>6.6(c)</td>
<td>8.7(a)</td>
</tr>
<tr>
<td>Odour</td>
<td>5.8(c)</td>
<td>6.9(b)</td>
<td>6.7(d)</td>
<td>8.2(a)</td>
</tr>
<tr>
<td>Dryness</td>
<td>6.6(c)</td>
<td>6.9(b)</td>
<td>5.9(d)</td>
<td>8.0(a)</td>
</tr>
<tr>
<td>Consistency</td>
<td>6.2(c)</td>
<td>6.7(b)</td>
<td>6.2(d)</td>
<td>8.5(a)</td>
</tr>
</tbody>
</table>

* Significant at 5% level

Table 1 revealed that all properties of the prepared drawing ink from squid with varying acid concentration using the preference test significantly differ. Further test (DMRT) revealed that all properties of experimental samples are significantly different from commercial ink.
Based on findings of this study, the researchers developed an applied manufacturing procedure for drawing ink from squid as a guide for production.

**Acknowledgements**

The researchers would like to acknowledge the following persons and research leaders for this research to have gained a spotlight, Dr. Bonifacio S. Villanueva, University President and his staff, CTU, Cebu.

**References**


Properties of Squid Ink. Unpublished Research. CSCST-Main Campus, CITE, Cebu City.

http://www.patentstorm.us/patents/description.htm

http://www.mhlw.go.jp

http://www.pectin-calamansi.html

http://www.asianfisheriessociety.org

http://www.indianshellac.com/printing-inks.htm

http://www.essayproof.net
Overview of the leiognathid species of Malaysia

Ying-Giat Seah¹, Gires Usup¹, Aziz Arshad² and Mazlan Abd Ghafar¹

¹Marine Ecosystem Research Centre, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
²Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

Corresponding author’s email: magfish05@yahoo.com

Abstract

The taxonomy of leiognathid species has changed drastically as a result of revisions carried out in recent years. During the same period, new species have also been described. In this study, a taxonomic review and update of leiognathid species present in Malaysian waters was carried out. Leiognathid specimens were collected from the coastal waters of Peninsular Malaysia. All specimens were examined for their internal and external morphological features and osteological features. The leiognathids of Malaysia reviewed here comprised at least 22 species. Malaysia thus has one of the richest assemblages of leiognathid species in the world. Equulites laterofenestra (Sparks and Chakrabarty, 2007), Leiognathus robustus (Sparks and Dunlap, 2004) and Nuchequula manussella (Chakrabarty and Sparks, 2007) are new records in Malaysian waters. Some previously described species from Malaysia were erroneously identified. These include specimens misidentified as Equulites rivulatus, Gazza achlamys and Nuchequula nuchalis. Equulites rivulatus and Gazza achlamys have been recorded in the Western Pacific but these species have not been encountered in Malaysia or in collections held in Malaysia.

Keywords: Leiognathidae, taxonomy, new record, Ponyfishes, Dubious taxa, Malaysian waters

Introduction

The taxonomy of leiognathids has changed dramatically in recent years. Several studies of leiognathids have been carried out based on morphology (Chakrabarty et al., 2008, 2010; Chakrabarty and Sparks, 2008; Kimura et al., 2000, 2003, 2005, 2008; Sparks, 2006a, 2006b; Sparks and Chakrabarty, 2007; Yamashita and Kimura, 2001), or phylogenetic analyses of morphological transformations (Chakrabarty and Sparks, 2007; Sparks, 2006a), or phylogenetic analyses of DNA sequences (Ikejima et al., 2004; Seah et al., 2008; Sparks and Dunlap, 2004; Sparks et al., 2005). These analyses have provided a better understanding of the leiognathids’ relationship at the generic and species levels. In addition, new species have also been described. In light of these developments, an update of the leiognathids present in Malaysian waters is needed.

Materials and Methods

Leiognathid collections were made at locations shown in Table 1. Observations of external and internal of morphological features and osteological features were made from fresh and cleared and stained specimens and X-ray photos. Cyanine blue 41 (Acros Organics, USA) was used to examine and count scales and sensory canals. All specimens were kept in the museum of Universiti Kebangsaan Malaysia.
Table 1. The location and date of samplings in Malaysia for this study.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perhentian Island, Terengganu</td>
<td>02.09.2006</td>
</tr>
<tr>
<td>N05° 59.863'E102° 46.623' - N06° 04.467'E102° 38.895'</td>
<td>03.09.2006</td>
</tr>
<tr>
<td>N06° 00.950'E102° 38.400' - N06° 02.227'E102° 42.119'</td>
<td>04.09.2006</td>
</tr>
<tr>
<td>N05° 50.440'E102° 47.240' - N05° 49.963'E102° 48.468'</td>
<td></td>
</tr>
<tr>
<td>Tinggi-Sibu Island, Johor</td>
<td>17.07.2007</td>
</tr>
<tr>
<td>N02° 13.830'E103° 59.280' - N02° 12.530'E103° 59.057'</td>
<td>18.07.2007</td>
</tr>
<tr>
<td>N02° 15.452'E103° 59.829' - N02° 13.314'E104° 00.099'</td>
<td></td>
</tr>
<tr>
<td>N02° 11.444'E104° 00.441' - N02° 10.945'E104° 02.121'</td>
<td>19.07.2007</td>
</tr>
<tr>
<td>Triom Island, Pahang</td>
<td>28.07.2008</td>
</tr>
<tr>
<td>N03° 02.000'E104° 05.490' - N03° 03.988'E104° 03.472'</td>
<td>29.07.2008</td>
</tr>
<tr>
<td>N03° 07.792'E104° 03.359' - N03° 02.886'E104° 05.020'</td>
<td></td>
</tr>
<tr>
<td>N02° 47.586'E104° 03.265' - N02° 44.262'E104° 03.721'</td>
<td></td>
</tr>
<tr>
<td>N02° 57.201'E104° 06.105' - N02° 57.773'E104° 12.464'</td>
<td></td>
</tr>
<tr>
<td>N02° 47.031'E104° 02.827' - N02° 44.131'E104° 03.476'</td>
<td></td>
</tr>
<tr>
<td>N02° 40.345'E104° 04.663' - N02° 43.286'E104° 03.532'</td>
<td></td>
</tr>
<tr>
<td>Tanjung Sepat Jetty, Selangor*</td>
<td></td>
</tr>
<tr>
<td>N02° 39.446'E101° 33.393'</td>
<td></td>
</tr>
<tr>
<td>Kuala Kedah Jetty, Kedah*</td>
<td></td>
</tr>
<tr>
<td>N06° 06.371'E100° 17.298'</td>
<td></td>
</tr>
<tr>
<td>Siti Khadijah Kota Bharu Market, Kelantan*</td>
<td>(N06° 07.808'E102° 14.356')</td>
</tr>
<tr>
<td>LKIM Cendering Jetty, Terengganu*</td>
<td></td>
</tr>
<tr>
<td>N05° 15.846'E103° 11.055'</td>
<td></td>
</tr>
<tr>
<td>Endau Mersing Jetty, Johor*</td>
<td></td>
</tr>
<tr>
<td>N02° 39.494'E103° 37.195'</td>
<td></td>
</tr>
</tbody>
</table>

*Collections were carried out on more than one occasion.

Results

Twenty species of leiognathids were caught in the current study. Several taxonomic designations of species known from Malaysia and frequently cited in the literature have been recognized as erroneous identifications and their current status were reviewed and corrected (Table 2).

Table 2. The status of leiognathid species listed in several references from Malaysia and conclusions drawn from the present study.

<table>
<thead>
<tr>
<th>Species</th>
<th>This study</th>
<th>Mansor et al., 1998</th>
<th>Kong., 1998</th>
<th>Mohsin and Ambak, 1996</th>
<th>Tan et al., 1996</th>
<th>Atan et al., 2010</th>
<th>Ambak et al., 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurigequula fasciata</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aurigequula longispinis</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equulites elongatus</td>
<td>x</td>
<td>E. stercorarius</td>
<td>x E. stercorarius</td>
<td>x E. stercorarius</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equulites laterofenestra</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equulites leuciscus</td>
<td>x</td>
<td>E. laterofenestra</td>
<td>x E. laterofenestra</td>
<td>c</td>
<td>x E. laterofenestra</td>
<td>x E. leuciscus</td>
<td>x E. stercorarius</td>
</tr>
<tr>
<td>Equulites rivulatus</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equulites stercorarius</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eubleekeria jonesi</td>
<td>+</td>
<td>x E. jonesi</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gazza achiamsys</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gazza minuta</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gazza rhombica</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karalla daura</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus berbis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus brevisrostris</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus equulus</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus lineolatus</td>
<td>+</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus robustus</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leiognathus smithursti</td>
<td>+</td>
<td>A. longispinis</td>
<td>x A. longispinis</td>
<td>x A. longispinis</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

? Collections were carried out on more than one occasion.
Discussion

Four species of leiognathids have been concluded to be dubious taxa, namely *Leiognathus berbis* (=likely *Equulites leuciscus*, see Chakrabarty et al., 2010), *Leiognathus brevirostris* (=a junior synonym of *Photopectoralis bindus*, see Chakrabarty and Sparks, 2007) *Leiognathus lineolatus* (=nomen dubium, see Sparks, 2006a) and *Leiognathus smithursti* (=a junior synonym of *Aurigequula longispinis*, see Sparks 2006b). The species described and photographed as *L. brevirostris* in Atan et al. (2010) and Ambak et al. (2010) is in fact *Nuchequula gerreoides*. Atan et al. (2010) recorded *L. berbis* and *L. lineolatus* without photographs and thus no further verification of identification can be done.

Atan et al. (2010) and Ambak et al. (2010) recorded the occurrence of *Equulites rivulatus* from Malaysia. However, photographic evidence indicated that the specimens are *Equulites leuciscus* and *Equulites stercorarius* respectively. *E. rivulatus* is easily distinguished from other congeners by the presence of an expansive transparent rectangular lateral flank patch for males, and large round blotches on the upper flank and thick horizontal bars along the lateral line and slightly above the midline of the flank in both sexes (Ikejima et al., 2008). This species has been reported to occur in the Western Pacific but without any given specific distribution (Eschmeyer, 2010). It has not been encountered in Malaysia or in collections held in Malaysia. Mohsin and Ambak (1996) and Atan et al. (2010) recorded *Gazza achlamys* from Malaysia. This species has also not been encountered in Malaysia or collections held in Malaysia. Mohsin and Ambak (1996) mentioned no specific distribution for this species but reported it existed in the South China Sea, while Atan et al. (2010) provided no photograph. Woodland et al. (2001) reported that this species do not exist in Malaysian waters except possibly in the northern part of Sabah. Since no sampling was carried out in East Malaysia, these records remain to be verified. Atan et al. (2010) and Ambak et al. (2010) recorded *Nuchequula nuchalis* from Malaysia. However, this species was reported to occur only in the waters of China, Japan, Taiwan and Korea (Kimura et al., 2008). The species photographed as *N. nuchalis* in both references is actually *Nuchequula mannusella*.

Several books that are often referred to as reference guides by the local communities contained numerous misinformation. The inaccurately represented species illustrations and scientific names have contributed to frequent misidentifications. The taxonomy of leiognathids was reviewed and correctly assigned in the present study. The data available showed that Malaysia harbours one of the richest assemblages of leiognathid species in the world with at least 22 species representing all the genera currently recognized.

Acknowledgements

This work was supported by the Malaysia government through grants UKM-GUP-ASPL-08-
Seah Ying Giat was a recipient of a National Science Fellowship. The work reported here was part of a PhD research (ygseah).

References


Sparks, J.S., 2006b. Leiognathus longispinis (Valenciennes in Cuvier and Valenciennes, 1835), a senior synonym of Leiognathus smithursti (Ramsay and Ogilby, 1886) (Teleostei: Leiognathidae).


Research on season, places and gears for collection of grass eels migrating into estuaries in Quang Binh and Phu Yen, Vietnam and technical nursery in artificial conditions

Nguyen Quang Linh*, Vo Duc Nghia, Tran Quang Khanh Van, Ha Thi Hue, Nguyen Duy Quynh Tram, Tran Dinh Minh, Nguyen Duc Thanh, Kieu Thi Huyen and Ho Viet Lam

Faculty of Fisheries, Hue University of Agriculture and Forestry, Hue University
102, Phung Hung, Hue City, Vietnam
Corresponding author’s email: nqlinh2001@gmail.com

Abstract

Actual study of eels in the world and Vietnam showed that eels have different types: *A. japonica*, *A. borneensis*, *A. marmorata* và *A. bicolar pacifica*; The methods of collection grass eels from sea immigrate into estuaries in Central Vietnam were studied and conducted in different seasonals, places, times and were collected by different gears in coastal communities. The results were conducted grass eels immigrated to estuaries from September to February in Quang Binh, North Central Vietnam and from December to April in Phu Yen, South Central Vietnam. Depend on conditions of ocean and tides, temperature, salinity and exchanges between freshwater and marine water. Grass eels were collected at weight, 0.11–0.12 g/head and can be nursery by different feedstuffs for growth up-to 50 g for aquaculture farming. Feeds were fed to grass eels as moina, earthworm and water filariasis for first stage with weight 0.11–0.12 g/head, water filariasis was showed a best result for growth and survival rates, mixed live-food, earthworm and commercial feed for second stage with weight 5–6 g/head, earthworm was showed a best result of growth and survival rates.

Keywords: eel, season, immigration, nursery, collection

Introduction

There are 16 species of eels on worldwide and 6 species under the genus Anguilla eels and distribution in many parts of the world (Vimhelm, 1979). In Vietnam, scientists have studied and have identified four species of eels are: *Anguilla japonica*, *Anguilla borneensis*, *Anguilla bicolar marmorata* and *Pacifica*, which is popular Football (*Anguilla marmorata*) and eels Ebony (*Anguilla bicolar Pacifica*) (Hoang and Vo, 1995). Quang Binh has mainly two common species (eels and eel ebony flower) (Pham Binh Quyen, 2001). Eel has wide adaptability with the variation of salinity and temperature. They can live in salt water, brackish and fresh water. Withstand temperatures of eels from 1-38°C, which is the appropriate temperature 25-27°C. Eels preferred darkness and fear the light of day so they often find areas where low light as the cave, to get dirt bright, dark beef to make them new prey and move to another place. Dissolved oxygen content appropriate for the growth of fish from 2-12 mg/litre. Eel species are migratory reproductive behaviour especially compared to other species. Growth in freshwater fish to mature age, sexual maturity, migrate to the sea to breed. In the process of migration, development of gonads, maturity and reproduce in deep waters. Fertilized eggs, embryos hatch into larvae develop as willow leaves, living phytoplankton in the ocean. Grass eels freshwater stream migration upstream rivers, streams and reservoirs of fresh water to survive until adults. When the adult fish migrate deep into the sea to lay eggs. Source current fish are harvested from outside the natural estuary or coastal areas. In Central Vietnam, many eels in the natural distribution from Quang Binh to Phu Yen. The research aims in findings the seasons, time, places and fishing gears to collect grass eels from sea into estuaries, and also making of a nursery technology for feeding and management of grass eels in artificial conditions for aquaculture farms.
Materials and Methods

There are 5 river estuaries in coastal region of Quang Binh (North Central Vietnam) and 2 river estuaries in Phu Yen (South Central Vietnam) were investigated and collected grass eels to migrate from sea to continents via estuaries. With 3 steps of methods to observe by survey on coastal fishery communities of 7 estuaries of 45 fishermen each, with 15 core fishermen, they often use different gears to collect eels to sell into local markets.

The research was designed for collection of grass eels migration from sea into estuaries at three points of each estuary, with two periods of time on daily, from 16.00 h to 23 h and 2.00 h to 5.00 h AM following day, from side of river left, right hand and middle river, more attach places, whereas water changes between marine and fresh water as under the dykes. We started from August to April in two provinces: Quang Binh from August to February and Phu Yen from October to April. The different gears were used for collection of eels as: Traditional bottom nets, bottom China nets, rackets, drift-nets.

Based on the different ecological river zone, we have located the different times and point places for collection, with major objectives to collect grass eels in successful archives during two years of research periods by two seasons.

The nursery experiments were designed for two phase treatments, first treatment nursery for small size of grass eels body length 51,03 ± 1,326 (mm) and weight (0,11 ± 0,018 g per head) into 9 composite tanks, each group with 3 tanks, each tank was delivered stocking density 0.3 kg/m³of tanks. Three different feeds (moina, earthworm and water filariasis) were fed to grass eels of 10% of body liveweight, feeding one time at 20.00 h daily, the purpose grass eels can find their food and eat. Second phase was allocated into 9 netting rackets in ponds with density 300 per netting racket and fish size, three were three different feeds (mixed livefood, earthworm and commercial feed) that were fed up to 7% body live weight and up to 60 days. Feeding is also one time at 20.00 h daily.

Results

The research has done on based coastal fishery communities and 305 times of collection and located fishing gears in 7 places of two provinces. Table 1 conducted that fishermen used more groups of traditional bottom nets, bottom China nets (42.7%), while grill-net and casting nets only 2.7%. In Central Vietnam, especially young fishermen like to use new models of fishing gears and they got more fish and more species as China bottom nets. Grass eels are from sea to estuaries and go upstream for stay, they have short time to stock around estuaries.

<table>
<thead>
<tr>
<th>Table 1. Different gears used for collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of fishing gears</td>
</tr>
<tr>
<td>Fishing net, frame, drag net</td>
</tr>
<tr>
<td>Traditional bottom nets, China</td>
</tr>
<tr>
<td>bottom nets</td>
</tr>
<tr>
<td>Drift-net, rackets, pull nets</td>
</tr>
<tr>
<td>Grill-net, casting net</td>
</tr>
<tr>
<td>Fishing</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Phu Yen province (South Central Vietnam)
When fishermen used different gears for catching and collection of eels in different body sizes, Table 2 conducted that traditional and china bottom got more eels than other fishing gears (56.92%).

**Table 2.** Relationships between different fishing gears and catching body size of eels.

<table>
<thead>
<tr>
<th>Name of fishing gears</th>
<th>Frequencies</th>
<th>Body size (g)</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1 – 5</td>
<td>5 – 99</td>
<td>100 – 199</td>
<td>200 – 299</td>
</tr>
<tr>
<td>Fishing net, frame, drag net</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Traditional bottom nets, China bottom nets</td>
<td>25</td>
<td>22</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Drift-net, rackets, pull nets</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Grill-net, casting net</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fishing</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>32</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

The research have done for whole years of two years, from May 2008 until May 2010, different seasons in years, we can expect migration of grass eels from sea into continents, however, based on hatchery season in the sea by research works of Atsushi (1991); Fukube et al. (1980) the *Anguilla marmorata* can immigration from sea to East Asia from May to August into Indonesia and from August to April into Vietnam coastal zones. Herewith, Table 3 showed that eels mainly immigrate into estuaries from September to January in the year of Quang Binh and from December to April of Phu Yen.

**Table 3.** Seasonal collection of grass eels to migrate into estuaries.

<table>
<thead>
<tr>
<th>Season and time</th>
<th>Frequency</th>
<th>%</th>
<th>0.1 - 0.5</th>
<th>&lt; 5 g</th>
<th>&gt; 5 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major season: September to January</td>
<td>56</td>
<td>50.00</td>
<td>10.00</td>
<td>10.53</td>
<td>77.20</td>
</tr>
<tr>
<td>February to April</td>
<td>51</td>
<td>45.54</td>
<td>51.85</td>
<td>10.15</td>
<td>38.00</td>
</tr>
<tr>
<td>May to September</td>
<td>5</td>
<td>4.46</td>
<td>80.00</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of presented eels</td>
<td>112/305</td>
<td>36.72</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.** Point places and time for collections in experimental designs.

<table>
<thead>
<tr>
<th>River estuaries, places, time</th>
<th>Quang Binh</th>
<th>Phu Yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far from river side of 15 m, right</td>
<td>small nets, netting racket</td>
<td>small nets, netting racket</td>
</tr>
<tr>
<td>Far from river side of 15 m, left</td>
<td>Smooth nets, rackets</td>
<td>Smooth nets, rackets</td>
</tr>
<tr>
<td>Middle of river</td>
<td>Bottom nets</td>
<td>Bottom nets</td>
</tr>
<tr>
<td>Under dykes (2 m from side)</td>
<td>Smooth nets, drag-net</td>
<td>Smooth nets, drag-net</td>
</tr>
</tbody>
</table>

The results were conducted for nursery in composite tanks that was showed in Table 5. Results in the Table 6 shows, lots of fish in the experiment have on growth. However, the use of different foods for differences in weight gain (P <0.05). Lots of fish in the experiment were fed by worms cinnamon for a highest increase weigh: 53.5 ± 1.52 g / fish, followed by
fish fed formulated feed worms combined with cinnamon: 46, 2 ± 1.55 g / fish, and then to a lot of experimental feeding processed food: 39.1 ± 1.61 g / fish.

Table 5. Different growing variables with different feeds.

<table>
<thead>
<tr>
<th>Variables X ± SD</th>
<th>Water filariasis</th>
<th>Moina</th>
<th>Earth worm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbd (mm)</td>
<td>51.60 ± 1.02</td>
<td>51.467 ± 1.358</td>
<td>51.467 ± 1.356</td>
</tr>
<tr>
<td>Lst (mm)</td>
<td>72.53 ± 1.01a</td>
<td>65.267 ± 1.351b</td>
<td>68.933 ± 1.461c</td>
</tr>
<tr>
<td>Wbd (g)</td>
<td>0.12 ± 0.012</td>
<td>0.121 ± 0.0141</td>
<td>0.126 ± 0.0143</td>
</tr>
<tr>
<td>Wst (g)</td>
<td>6.9 ± 0.02a</td>
<td>6.15 ± 0.01b</td>
<td>6.18 ± 0.02c</td>
</tr>
<tr>
<td>DWG (g/day)</td>
<td>0.12 ± 0.006a</td>
<td>0.09 ± 0.005b</td>
<td>0.10 ± 0.006c</td>
</tr>
<tr>
<td>Survival rate (%)</td>
<td>62.56 ± 2.52a</td>
<td>42.55 ± 3.71b</td>
<td>51.28 ± 2.78c</td>
</tr>
</tbody>
</table>

a # b # c in a row, with P < 0.05.

Table 6. Effects of different feeds on growth and survival rates of eels during 60 days.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Feeds</th>
<th>Commercial feed</th>
<th>Mixed live food</th>
<th>Earth worm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight (g)</td>
<td>6.3± 0.42</td>
<td>5.4 ± 0.44</td>
<td>5.2± 0.43</td>
<td></td>
</tr>
<tr>
<td>Final weight (g)</td>
<td>39.1 ± 1.61</td>
<td>46.2 ± 1.55</td>
<td>53.5±1.52</td>
<td></td>
</tr>
<tr>
<td>Survival rate (%)</td>
<td>57.25 ± 3.75a</td>
<td>62.25 ± 2.56b</td>
<td>77.25 ± 4.21c</td>
<td></td>
</tr>
</tbody>
</table>

a # b # c in a row, with P < 0.05.

Discussion

Season appeared like eels in river estuaries of Central Vietnam in the rainy season and two different waves and water changes, from September to November in the year mainly large eel grass, this type into the estuaries before and live to fish migration flood season. From December to April next year, like small eels appear scattered (grass eels), often appear when the fish into the dark days from 20th-30th of months (Lunar Calendar), appear at 22.00 h PM to 4.00 h AM, in the areas of exchange between sea water and fresh water poured in, the salinity is about 15 -18 ‰. Collection places in foot dam removal and river-wing doors, 15 m from shore between the rivers. There are many types of fishing gear to exploit the larger eels from 50 grams or more is China's Lu, bottom, eel fishermen exploit the same type of effect size is less than 5 grams is a big racket, smooth nets and smaller than, fine mesh bottom. Small size can eel hatching success with fresh food as moina, filariasis and cinnamon worms, feed the worms only have the best results. However, low life rate 62.56% only. Food items such as worms cinnamon, mixed and used to run self-similar large eels> 50 grams in earthen ponds have good speed growth, worm eels cinnamon is more popular than home-made food industrial and food and fresh homemade food.

References

Coral associated fishes in St. Martin’s Island of the Bay of Bengal, Bangladesh

M. Maruf Hossain¹, D.Sultana¹ and R. Ormond²

¹Institute of Marine Science and Fisheries (IMSF), University of Chittagong
Chittagong-4331, Bangladesh
²Save Our Seas Foundation, Edinburgh (UK) Office, Edinburgh EH30 9WN, UK

Corresponding author’s email: marufctgu@yahoo.com

Introduction

Corals reefs are some most productive ecosystem on earth and are certainly the most productive and species rich environments in the oceans. Without question, coral reefs have by far the highest diversity of ichthyofauna of any marine or fresh water ecosystem (Hallacher, 2003). St. Martin’s Island is the only coral belonging island in Bangladesh rich in biodiversity. In addition to coral species, it supports a large number of other organisms, such as coral associated fishes, molluscs, crustaceans, echinoderms, bryozoans, algae, seaweed, sea grass etc. However, there is no information or in depth study on corals or its associated fishes, their abundance, habitat, biology and taxonomy from the St. Martin’s island except a report by Tomasik (1997). However, present study in January, 2008 is an attempt to have first hand knowledge on the coral associated fishes at St. Martin’s.

Materials and Methods

This study was conducted in January 2008. Five sampling sites were chosen randomly after preliminary survey and study was done by scuba diving survey in all 5 sites, which were distributed around coast of St. Martin’s near 200-250m from intertidal zone towards the sea. Duration of each dive was 60—75 min. Photographs of fish samples were collected by underwater video camera and information of each fish samples was collected during stay under water in waterproof slate. Geographical positions of each site were recorded using a Global Positioning System (GPS). Fish communities were characterized by “DACFOR” scale. For further confirmation of taxonomic classification of fishes, samples were collected by hook, long line, hand net, rock gill net and traps around the sampling sites. Literatures used for identification included Lieske and Myers (2001), De Bruin et al. (1995), Debelius (1993), Munro (1982) and Vincent (1978).

Results and Discussion

During the study and scuba diving survey of the shallow coral deposits and its associated area of 5 diving sites of St. Martin’s Island reveal a total of 37 species of fishes under 25 genera and 18 families within 3 orders. Among them 17 were ornamental fish, 8 ornamental and food fishes and 12 considered as food fishes. The most abundant reef associated fishes were snapper (Lutjanidae) and grouper (Serranidae) which are commercially important food fishes and some also have ornamental value. Dominant ornamental fish groups were butterfly fish (Chaetodontidae), wrasses (Labridae) and damselfish (Pomacentridae). Less diversity and rare groups were Moorish idol (Zanclidae), surgeonfish (Acanthuridae), angelfish (Pomacanthidae), sweet lips (Haemulidae) and emperor fish (Lethrinidae). The present study shows a low diversity of fishes in the island. The reason may be the study did not cover deeper portion of the island. Coles and Tarr (1990) reported that Arabian Gulf...
showed a pronounced increase in abundance and diversity of fishes from nearshore to offshore locations with increasing depth. Ormond et al. (2006) have similar finding during study of coral associated fish in Belochistan coast, Pakistan.

Distributions of fishes were not observed uniform in all sites. Highest diversity of fishes were recorded at dive site 4 (Cheradia) with total of 28 species. On the other hand, lowest fish diversity was found at site 1 (St. Martin’s bazar), which was only 10 species. The lower diversity of fishes may be due to some natural factors like presence of predatory fishes or scarcity of foods and also have some anthropogenic factors and threats because in this site degraded environment and human interferences was observed. All human activities like tourism, construction activities, and household activities are occurring adjacent to this area and are threatened by higher sedimentation rate than others site. Hossain and Islam (2006) and later Sultana (2008) reported lower transparency (65 cm) and degradation of other environmental parameters from St. Martin’s Bazar (site 1), compare to higher transparency (310 cm) and better environmental conditions at Cheradia (site 4).

Conclusions

These coral associated fishes are generally used as aquarium fishes for their colourful appearance and ornamentation. They have also commercial importance for human consumption as food fish, which shows culture possibility for good economic return. This study certainly helpful for conservation and management of the coral resources at St. Martin’s but also a baseline information on coral associated fish from this part of S-E Asia.

Acknowledgements

Authors particularly indebted to DelPHE/British Council HE Research Link programme for supporting this North-South research link programme.

References

Oral: Session 3C
Aquaculture
Indicators for sustainability analysis of world shrimp aquaculture production

Md Arif Chowdhury* and Khairun Yahya

Centre for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia (USM), 11800 Pulau Pinang, Malaysia

Corresponding author’s email: arifail@yahoo.com, arif@usm.my

Abstract

The study was performed in order to have an idea about world brackish water shrimp aquaculture production and the stability of the production. The study also tried to identify the indicators which are responsible for sustainable production. In last 20 years, brackish water shrimp aquaculture production has increased by 6.7 times in weight and 3.5 times in value, increasing the world production from 620,739 tones in 1989 to 3,396,010 tones in 2008. The world top ten shrimp producers in 2008 were China (37.3%), followed by Thailand (14.9%), Vietnam (12.0%), Indonesia (11.2%), Ecuador (4.4%), Mexico (3.8%), India (2.6%), Bangladesh (2.0%), Brazil (1.9%) and Myanmar (1.4%). In 2006, the global shrimp export was 3,244,871 tones with value of US$ 14.13 billion. It has been increased by 3.5 times in weight and 3 times in value during 1986 to 2006. Based on present issues and sustainability principles a total of 12 indicators were selected under three subsystems; environmental, economical and social sustainability. Production stability is one of the best indicators for sustainability analysis of shrimp aquaculture. The major shrimp producing countries including Thailand, China, Indonesia are involved with “Boom and Bust Cycle” of shrimp production with struggling process due to environmental pollution and frequent occurrence of viral disease and international market price fluctuations.

Keywords: sustainability, shrimp aquaculture, indicators and world production

Introduction

The world shrimp aquaculture has expanded rapidly after 1980s considering its profitability, generation of employment and foreign export earnings. This accelerate development has created negative environmental impacts such as habitat destruction, pressure on fisheries resources, land salinization, pathogen intensity and nutrient pollution and fallen the shrimp industry under threat of sustainability. The term and concept of sustainability in agricultural filed has received much attention since the late 1980s, when it became a part of the long-term perspective on economic growth (Franceschi and Kahn, 2003). Sustainable aquaculture is a means to profitable production, efficiency of natural resources, best aquatic environmental practices without compromising the overall ecological integrity of ecosystems. The objective of this study is to analyze the sustainability context of world shrimp aquaculture production through identifying the sustainability indicators.

Materials and Methods

The study was performed by using data and information related to world shrimp aquaculture status and environmental impacts available in journals, reports and conference proceedings. The statistical database software Fishstat Plus (FAO, 2010) was used to analyze world production trend.
Results and Discussion

In last 20 years brackish water shrimp aquaculture production has increased by 6.7 times in weight and 3.5 times in value, increasing the world production from 620,739 tones in 1989 to 3,396,010 tones in 2008 with estimated value of US$3.85 billion and US$14.29 billion, respectively. Farmed shrimp now contributes more than 50% to the world total supply of shrimp, and this share is growing up. Capture shrimp production was 3,259,915 tones in 2007 and keeping steady in last few production years. More than 69 countries in the world are involved in shrimp aquaculture production though ten producers contribute more than 92% of the world production. The world top ten shrimp producers in 2008 were China (37.3%), followed by Thailand (14.9%), Vietnam (12.0%), Indonesia (11.2%), Ecuador (4.4%), Mexico (3.8%), India (2.6%), Bangladesh (2.0%), Brazil (1.9%), and Myanmar (1.4%). According to FAO (2010), China production had increased significantly since 1988 with 199,418 tons and reached into incredible production 1,268,074 tons in 2008 including few worst years during 1993 to 1997, due to international market fall, disease and implementation of inland shrimp culture ban. The main farmed species are whiteleg shrimp (*Penaeus vannamei*), giant tiger prawn (*P. monodon*), and banana prawn (*P. merguiensis* and *P. indicus*). Due to disease problem in tiger shrimp production farmers have shifted culture species into whiteleg shrimp after 2001, presently more than 80% of farmed shrimp production comes from whiteleg shrimp.

Around 82 countries across the world are involved with shrimp and shrimp product imports of which leading importers include USA, Japan, Canada, UK, Australia, Germany and other EU countries. In 2006, the global shrimp export was 3,244,871 tones with value of US$ 14.13 billion. It has been increased by 3.5 times in weight and 3 times in value during 1986 to 2006. The average shrimp price has dropped from 6.22 US$/kg in 1996 to 4.36 US$/kg in 2006, the problem of price declining seems to be associated with increased production of *P. vannamei*.

Based on present issues and sustainability principles a total of 12 indicators were selected under three subsystems; environmental, economical and social sustainability (Figure 1). Production stability is one of the best indicators for sustainability analysis. Scientists (Chowdhury et al., 2006; Tiwari and Paudel, 2008) use this indicator for agricultural sustainability analysis in developing countries. The major shrimp producing countries including Thailand, China, Indonesia are involved with “Boom and Bust Cycle” of shrimp production with struggling process due to environmental pollution and frequent occurrence of viral disease. Medium shrimp producing countries like Bangladesh, Myanmar and India are involved with less intensive culture methods and stabile production having minimum environmental impact.

![Shrimp aquaculture sustainability indicators](image-url)

**Figure 1.** Sustainability indicators of shrimp aquaculture.

Economic

i) productivity

ii) profitability

Environmental

i) effluent quality

ii) soil quality

Social

i) food security

ii) employment and equity
Conclusions

World shrimp aquaculture production has been increased significantly over the last decades, though productions in many countries are not stable due to diseases, natural calamities and international market fluctuations. After critical analysis and review all indicators It is concluded that shrimp aquaculture are now criticized on environmental pollution and conflicts with other coastal resource uses and fallen under threat of sustainability.

References


Integrated aquaculture system: Shrimp co-cultured with seaweed

M.H. Gan$^{1,2}$, M.K. Choy$^1$, Z.F. Chai$^3$, S. Faizah$^1$ and A. Siti Aishah @ C.A. Orosco$^2$

$^1$Institute of Tropical Aquaculture, Universiti Malaysia Terengganu
21030 Kuala Terengganu, Malaysia

$^2$Department of Marine Science, Faculty of Maritime Studies and Marine Science
Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia

$^3$Department of Food Science, Faculty of Agrotechnology and Food Science
Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia

Corresponding author’s email: mh_gan@yahoo.com

Abstract

The aquaculture industry is plays an important role in the Malaysian agriculture sector. Land based aquaculture such as earth ponds and hatcheries are mainly located near coastal region, mangrove forests and estuaries. New era of modern aquaculture bring towards sustainable development, therefore, a feasible system is an ideal approach for coastal ecosystem conservation and rehabilitation. In this study, seaweed was shown to be an effective biofilter that removes dissolved nutrients in all our designed systems. Concentration for total ammonia was below 4µmol L$^{-1}$. Orthophosphate was below 10µmol L$^{-1}$ during the first two weeks and gradually increased until the end of the experiment. The highest relative growth rate was obtained in system C with 100g stocking biomass. Application of alternately changing seaweed between system C and stocking tank advanced the nutrient removal and relative growth rate of seaweed throughout culture period. Relative growth rate of shrimp was performed comparable to those found in literature. From this study, seaweed based integrated system is established as good aquaculture practice and responsible to natural environment health.

Keywords: dissolved nutrients, Gracilaria edulis, Litopenaeus vannamei, relative growth rate

Introduction

In recent decades, there has been a rapid expansion of finfish and shrimp aquaculture. Most of these aquaculture activities are carried out near estuaries and mangrove swamps, using both semi-intensive or intensive open seawater culture system and inland culture system. A common problem for these systems is the increasing nutrient input from artificial feeds and feces from culturing species. when such nutrient rich effluent are discharged directly into the environment without undergoing proper treatment, coastal areas will be at risk from increased eutrophication and ecological imbalance (Marinho-Soriano, 2007).

Waste discharged from shrimp aquaculture is the highest among aquaculture species which is 77-94% (Troell et al., 2003). This waste percentage includes both nitrogen and phosphorus whereby results in nutrification that can cause various local environmental concern. Nevertheless, this effluent nutrient is essential for seaweed growth (Lobban and Harrison, 1994). Many studies have shown that seaweed has the ability to reduce dissolved nutrient from the discharge of shrimp (Lombardi et al., 2006; Marinho-Soriano et al., 2009; Nelson et al., 2001) and fish (Hayashi et al., 2008; Schuenhoff et al., 2003; Troell et al., 1997; Neori et al., 1996).

Practicing integrated aquaculture can reduce coastal exploitation due to aquaculture farming. Seaweed in an integrated aquaculture system that acts as an effective biofilter to remediate excessive nutrient before waste discharge is considered to be a low cost
treatment. At the same time, aquaculturist can gain both direct and indirect benefits through improved water quality. The aim of this study is to design an integrated aquaculture system that is by co-culturing tropical seaweed with shrimp to improve water quality without the need of changing the system’s water.

Materials and Methods

Experiments were carried out in the marine hatchery of Universiti Malaysia Terengganu (UMT). Three re-circulating systems were designed to hold different volumes of water; A (5956m³), B (7702m³) and C (203156m³). Water was not changed throughout the entire experiment. To maintain the maximum water level, filtered seawater was added ad libitum into each system. To prevent epiphytism, nursery netting was applied in system A and B throughout experiment while only from second until third week for system C.

*Gracilaria edulis* (agarophyte) was collected from Middle Bank, Penang, Peninsular Malaysia. Seaweeds were cleaned and acclimatized for one week. Fresh seaweeds were then weighed accordingly and placed in plastic basket (50x40x30cm) before being transferred into designated system. System A and B each contains triplicates of 200g fresh seaweeds while system C contains six replicates of stocking biomass with different weight (100g, 150g, and 200g). At the same time, six replicates of stocking biomass similar to system C were kept in the stocking tank. Seaweeds in system C were alternately changed with seaweeds from stocking tank after every fresh weight measurement.

White leg shrimps, *Litopenaeus vannamei* were acclimatized for one week before experiment started. Average shrimps size of 3.03±0.26g (system A and B) and 5.92±0.22g (system C) with stocking density of 100 pcs. m⁻², 87 pcs. m⁻² and 28 pcs. m⁻² were placed in system A, B and C, respectively. Shrimps were fed with the amount of 5% of their body weight, four times daily. Hydrological parameters such as temperature, salinity, specific conductivity (SPC), total dissolved solid (TDS), dissolved oxygen (DO) and pH were recorded twice daily. Nutrient analysis including total ammonia and phosphate was conducted daily. RGR of seaweeds and shrimps were measured during the first week and subsequently every two weeks until the end of experiment. Thirty shrimps from each system were randomly selected and weighed. The quantity of feed given was then adjusted according to the new recorded weight. RGR (% day⁻¹) of shrimps and seaweeds were calculated with the following formula: RGR (% day⁻¹) = [ln(final weight)-ln(initial weight)/time]

Results

<table>
<thead>
<tr>
<th>System</th>
<th>Temp. (°C)</th>
<th>SPC (ms/cm)</th>
<th>TDS (g/L)</th>
<th>Salinity (%)</th>
<th>DO (%)</th>
<th>DO (mg/L)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28.26-30.41</td>
<td>41.82-43.70</td>
<td>25.66-25.75</td>
<td>80.64-81.55</td>
<td>5.32-5.47</td>
<td>5.32-5.47</td>
<td>8.16-8.27</td>
</tr>
<tr>
<td>B</td>
<td>28.12-30.27</td>
<td>37.60-39.03</td>
<td>23.05-23.10</td>
<td>78.90-81.29</td>
<td>5.43-5.44</td>
<td>5.43-5.44</td>
<td>8.23-8.25</td>
</tr>
<tr>
<td>C</td>
<td>28.48-28.91</td>
<td>39.54-40.53</td>
<td>24.40-24.40</td>
<td>73.24-74.41</td>
<td>4.98-5.03</td>
<td>4.98-5.03</td>
<td>8.32-9.33</td>
</tr>
<tr>
<td>Stocking Tank</td>
<td>27.40-29.21</td>
<td>51.09-53.23</td>
<td>31.98-32.09</td>
<td>84.98-87.77</td>
<td>5.69-5.83</td>
<td>5.69-5.83</td>
<td>8.68-8.74</td>
</tr>
</tbody>
</table>
Table 2. RGR (% day\(^{-1}\)) of shrimp and seaweed at week 1, 3, 5, 7, 9 and 10.

<table>
<thead>
<tr>
<th>System</th>
<th>Week</th>
<th>Seaweed</th>
<th>Shrimp</th>
<th>Survival rate (%)</th>
<th>FCR 100g</th>
<th>FCR 150g</th>
<th>FCR 200g</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>-</td>
<td>1.50</td>
<td>3.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-</td>
<td>0.71</td>
<td>3.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-</td>
<td>0.49</td>
<td>0.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>-</td>
<td>0.60</td>
<td>1.77, 92.73, 2.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>-</td>
<td>-0.11</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>-</td>
<td>-0.86</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>-</td>
<td>2.37</td>
<td>3.26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-</td>
<td>1.14</td>
<td>3.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-</td>
<td>1.28</td>
<td>1.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>-</td>
<td>0.61</td>
<td>1.59, 79.20, 2.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>-</td>
<td>-0.10</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>-</td>
<td>-0.05</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>4.65 (1.16*)</td>
<td>3.98 (1.19*)</td>
<td>2.36 (1.38*)</td>
<td>3.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.25 (0.57*)</td>
<td>2.11 (0.56*)</td>
<td>0.96 (0.97*)</td>
<td>2.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3.02 (0.51*)</td>
<td>2.73 (-0.03*)</td>
<td>1.81 (0.61*)</td>
<td>2.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2.14 (1.30*)</td>
<td>1.97 (1.06*)</td>
<td>1.33 (0.39*)</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>1.51 (1.59*)</td>
<td>0.99 (1.22*)</td>
<td>0.59 (0.59*)</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>-0.97 (-0.33*)</td>
<td>-0.90 (-0.41*)</td>
<td>-0.78 (-0.81*)</td>
<td>1.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.12±1.73m</td>
<td>1.64±1.54m</td>
<td>1.24±0.96m</td>
<td>2.06±1.17m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.73±0.92m*)</td>
<td>(0.62±0.67m*)</td>
<td>(0.41±0.67m*)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RGR (% day\(^{-1}\)) of seaweed kept in stocking tank with seawater changed once after every fresh weight measurement. FCR: Feed conversion ratio. m = mean ± standard deviation.

Figure 1. Concentration of total ammonia for system A, B, C and stocking tank throughout experiment.
Discussion

Growth rate of seaweed in system C decreased in the third week (Table 2), due to the nursery netting which was set up in the second and third week. Consequently, efficiency of ammonia removal from day 7 to day 13 were also affected (Figure 1) during this period. This proves that seaweed needs light (Lobban and Harrison, 1994; Demetrotopoulos and Langdon, 2004) and nutrient for its growth (Neori et al., 2004). Effluent from shrimp cultivation has proven to be a good source of nutrients for seaweed (Phang et al., 1996). Low light source for system A and B decelerate seaweed growth since nursery netting was covered throughout the experiment for epiphytism prevention. Excess phosphorus was removed in much smaller proportions than nitrogen. This was also shown by Neori et al. (2004). As a result, concentration of orthophosphate increased gradually in all system (Figure 2). Changing alternately between seaweeds in system C and stocking tank induced nutrient removal and increased RGR for G. edulis. Maximum RGR in present study for G. edulis reached 4.65% day\(^{-1}\) with a mean of 2.12±1.73 % day\(^{-1}\). This result is comparable to 5.10% day\(^{-1}\) in indoor and outdoor culture tank (Gerung et al., 1999). Increasing stocking density decreases nitrogen uptake efficiency of Gracilaria (Matos et al., 2006). Hence, RGR for 200g of G. edulis was the lowest among the different stocking biomass.

Generally, RGR of shrimp in all system performed better compared to Lombardi et al. (2006). Although the stocking density and shrimp size varies for each system, there is however no significant differences between the mean RGR and survival rate for shrimp. In addition, the hydrological parameters in the experiment were shown to be at an as optimal range for tropical aquaculture (Table 1).

Conclusions

This experiment has shown the effectiveness of seaweed as a biofilter in the designed systems. This seaweed based integrated aquaculture system can be practiced in inland farming especially in Malaysia. Integrated aquaculture can take place in coastal waters or in ponds and can be highly intensified. Therefore, modern integrated system in general, and seaweed-based system in particular, are bound to play a major role in sustainable expansion of coastal aquaculture industry.

Acknowledgements

This project is fully funded by Institute of Tropical Aquaculture (AKUATROP), Universiti Malaysia Terengganu. Authors would also like to thank to Mohd. Irwan b. Hussin, Muhamad Zuri b. Sayuddi @ Abdul Hadi and Ab Azim b. Ab Wahab for their assistance in the project. Special appreciation is extended to Ms. Teo Woon Li who was helping to review this manuscript.
References


Gametogenesis of green mussel *Perna viridis* in the coastal waters of Malacca, Malaysia

Said Al-Barwani¹, Aziz Arshad²,³, S.M. Nurul Amin³ and Siti Shapor Siraj²

¹Department of Marine Science and Fisheries, College of Agricultural and Marine Sciences
Sultan Qaboos University, Seeb, Muscat, Oman
²Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia
³Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: sharthi@squ.edu.om

Abstract

Studies on gametogenesis, sizes at sexual differentiation and first maturity of *Perna viridis* from Sebatu, Malacca were performed using histological sections. More than 300 specimens of *P. viridis* between 14.96 and 113.52 mm total shell length were histologically prepared and analyzed. No gonadal development was observed in individuals smaller than 17 mm. Sexual differentiations began at 18 mm with incipient acini formation. Specimens larger than 20 mm had well-developed gonads at different stages of maturation. Active gametogenesis was recorded throughout the study period, with all stages of development usually occurring simultaneously within the same sample population. A clear fall in gonadal index (GI) was observed in the months of January and February, during which most of the females were clearly spent. Their acini were almost empty except for some residual ova, and most of the surface area of the lumen of the acini was covered with masses of cellular debris. A second fall in GI with less intense spawning was observed again during the months of September and October. Gamete release between sexes was fairly synchronized, and no differences in GI were observed between the male and female. The histological male: female ratio was 1:1. Two hermaphroditic specimens were recorded during the months of June and September. The occurrence of male and female gametes was on only one side of the mantle in both specimens. Gonadal index results showed that spawning event in *P. viridis* was year round, except during the months of May until August in the study area where the occurrence was low.

Keywords: reproduction, histology, Gonadal Index, hermaphrodite

Introduction

In many temperate mussel species gametogenesis starts in winter fuelled by reserves of protein, lipid and carbohydrate accumulated over summer and autumn (Seed, 1969; Seed and Suchanek, 1992). Typically, maturity reaches a peak in late winter, which is followed by spawning during spring-summer. Villalba (1995) reported gametogenesis activities in *Mytilus galloprovincialis* progressing in autumn and early winter, using reserves stored during the previous months. According to Sivalingam (1977), spawning of *Perna viridis* in Malaysia is closely related to the monsoon seasons and occurs twice a year during March-April and October-November. It is most prevalent during southwest monsoon rainfall (Stephen and Shetty, 1981). However, green mussels located in the Straits of Johore, Malaysia (Tham et al., 1973; Choo, 1974) and Quezon, Philippines (Walter, 1982) exhibit continuous breeding throughout the year.

The objective of this study is to classify the different gonad developmental stages via histological examination to determine the reproductive cycle of *P. viridis* in Sebatu, Malacca, Malaysia. From the histological analysis, the sex ratio and evidence of hermaphroditism in *P. viridis* are also described.
Materials and Methods

Twenty individuals of both sexes were sub-sampled from monthly samples collected from Malacca. The gonads were fixed in 10 % buffered formalin for 48 hours and then post-fixed in 70% alcohol. The gonads were sectioned at 5 to 7 µm thickness and were stained using Haematoxylin and Eosin following standard histological procedures (Bancroft and Stevens, 1996).

Results

In the determination of gonadal index (GI), over 300 individuals were histologically prepared and analyzed. In the months of January 2004, more than 70% and 80% of male and female respectively were in spawning condition. This situation persisted until the month of April. A clear fall in gonadal index was observed in the months of February and March, during which a peak spent condition. Redevelopment was quickly restored in the months of May and June. Active spawning or time of first maturity of *P. viridis* was observed in a 19.6 and 22.3 mm male and female, respectively.

Hermaphroditism

Two hermaphrodite specimens were recorded during the month of June and September, 2004 from the coastal waters of Sebatu, Malacca. The histological appearance of a section of the gonad showed sperm and ova to be in different acini (Figure 1).

![Figure 1](image)

**Figure 1.** (A) General appearance of male; (B) Female; (C) Hermaphrodite of *P. viridis*. (D) Monograph of a hermaphroditic individual showing sperm and ova in different acini. Mag. x 10; scale bar 100 µm

A correlation analysis test (Table 1) was performed between GI and the different physico-chemical parameter, however, no significant correlation was found except a negative relation with salinity (*r* = 0.02; *n* = 12; *p* < 0.05).
Table 1. Correlation analysis of GI of *P. viridis* with different physico-chemical parameters of Sebatu, Malacca, Malaysia.

<table>
<thead>
<tr>
<th></th>
<th>Temp (°C)</th>
<th>DO (ml/l)</th>
<th>pH</th>
<th>Salinity (ppt)</th>
<th>Chlo-a (mg/L)</th>
<th>TSS (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.49</td>
<td>-0.22</td>
<td>0.20</td>
<td>-0.66</td>
<td>-0.05</td>
<td>-0.18</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.11</td>
<td>0.50</td>
<td>0.54</td>
<td>0.02*</td>
<td>0.87</td>
<td>0.58</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed).

**Discussion**

*P. viridis* from Sebatu showed continuous spawning activity all year round, with gametogenesis progressing rapidly till the end of the year with major spawning taking place in January and February. Active gametogenesis was recorded throughout the study period, with all stages of development usually occurring simultaneously within the same sample population. Similar observations were made for *P. viridis* at Quezon, the Philippines by Walter (1982), who also found that these mussels undergo gametogenesis throughout the year with no repetitive peaks during his two-year study. A second less intense spawning peak was noted during the months of September and October. Sivalingam (1977) recorded a similar observation for a population of *P. viridis* at Penang, Malaysia. Some authors reported a single spawning event (Mohan and Kalyani, 1989; Narasimham, 1980), while other reported more than one event (Rajagopal et al., 1998).

**References**


Absence of postzygotic isolating mechanisms: Evidence from experimental hybridization between two reef margin species of tropical sea urchins (genus *Echinometra*)

Md. Aminur Rahman¹ and Tsuyoshi Uehara²

¹Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia 43400 UPM Serdang, Selangor, Malaysia
²Department of Chemistry, Biology and Marine Science, Faculty of Science, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan

Corresponding author’s email: aminur1963@gmail.com

Abstract

Two species of tropical sea urchins, *Echinometra* sp. C (Ec) and *Echinometra oblonga* (Eo) occur sympatrically along the coast of Okinawa Island, southern Japan and the hybridization between them were examined through a series of cross-fertilization experiments. At limited sperm concentration, where conspecific crosses reached near 100% fertilization; both heterospecific crosses showed higher fertilization rates (81-85%). The compatibility of gametes demonstrated that if gamete recognition molecules are involved in fertilization in these species, they are not strongly species specific. Larval survival, metamorphosis, and adult survivals of hybrid groups were nearly identical to either of their parent. Hybrids resulting from crosses in both directions were developed normally through larval and juvenile stages to sexually mature adults, indicating that neither gametic incompatibility nor hybrid inviability appeared to ensure reproductive isolation between these species. In adults, Ec x Ec were largest in live weight, followed by Eo x Ec, Ec x Eo, while Eo x Eo was the smallest. Other growth parameters (test sizes and gonad index) also followed the same trends as live weight. Colour patterns of the hybrids were maternally inherited, whereas other characters such as spine length, tubefoot and gonad spicules, and gamete sizes were intermediate. Adult F₁ hybrids were completely fertile and exhibited high fertilization rates in backcrosses, minimizing the possibility that hybrid infertility is a postzygotic isolating mechanism. On the other hand, intensive field surveys failed to find individuals with such hybrid characteristics, suggesting the absence of natural hybridization. This strongly suggests that reproductive isolation is achieved by prezygotic isolating mechanism(s). Of these mechanisms, habitat segregation, gamete competition, differences in spawning times, gametic incompatibility or other genetic and non-genetic factors appear to be important in maintaining species integrity of these species.

Keywords: fertilization, hybridization, *Echinometra*, reproductive isolation, speciation

Introduction

Detailed studies on morphology, ecology, mtDNA and gamete compatibility have shown that 4 biological species of *Echinometra* exist in the Indo-West Pacific, distinguished as *Echinometra* A, B, C and D. (Uehara et al., 1990; Nishihira et al., 1991; Metz and Palumbi, 1996; Rahman et al., 2001; 2004; 2005). Mitrochondrial DNA sequence data show that the *Echinometra* in the central and west Pacific diverged over the past 1-3 million years (Palumbi, 1996). *Echinometra* sp. B is now recognized as *E. mathaei* (Arakaki et al., 1998), while *Echinometra* sp. D belongs in the *E. oblonga* complex, composed of three cryptic species (Arakaki and Uehara, 1999). The other two, *Echinometra* spp. A and C, have yet to be named.

For sympatric marine invertebrates, that broadcast their gametes into water column, gametic incompatibility, may be particularly important for maintaining reproductive isolation (Palumbi and Metz, 1991; Rahman et al. 2001; 2004). On the other hand, post-zygotic mechanisms
such as the production of nonviable larvae and unfertile adults could also lead to and maintain reproductive isolation (Knowlton, 1993).

Two reef margin species, *Echinometra* sp. C (Ec) and *E. oblonga* (Eo) show distinct differences in adult morphologies and habitat preference (Table 1). The reproductive seasons of these two species overlap and gametes are reciprocally compatible (Uehera et al., 1990). Here we determine how these two species maintain their genetic identity in the field through detailed hybridization trails and phenotypic determination of their distinct traits.

**Table 1.** *Echinometra* sp. A (Ea) and *E. oblonga* (Eo). Summary of characters relevant to their identification and reproductive isolation.

<table>
<thead>
<tr>
<th>Character</th>
<th><em>Echinometra</em> sp. C (Ec)</th>
<th><em>Echinometra oblonga</em> (Eo)</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>Burrows on the reef margin, narrower range of distribution</td>
<td>Deep burrows along narrow reef margin, slightly below Ec</td>
<td>2</td>
</tr>
<tr>
<td>Bathymetric range</td>
<td>Intertidal, above MLWS</td>
<td>Intertidal, above MLWS</td>
<td>2</td>
</tr>
<tr>
<td>Salinity and thermo-tolerance</td>
<td>Higher tolerance to sudden temperature and salinity changes</td>
<td>Lower tolerance to sudden temperature and salinity changes</td>
<td>1</td>
</tr>
<tr>
<td>Body size</td>
<td>Moderate among <em>Echinometra</em></td>
<td>Smallest among <em>Echinometra</em></td>
<td>3</td>
</tr>
<tr>
<td>Colour</td>
<td>Colour highly variable, spines mostly green, brownish-black, basal translucent, white ring</td>
<td>Entirely black test and spines, basal ring of spine unclear</td>
<td>3</td>
</tr>
<tr>
<td>Spicules: a. Tubefoot</td>
<td>Triradiate</td>
<td>Triradiate, bihamate, and triradiate-bihamate</td>
<td>3</td>
</tr>
<tr>
<td>Spicules: b. Gonad</td>
<td>Triradiate, spindle, and bihamate</td>
<td>Triradiate, spindle, bihamate, and spindle-triradiate</td>
<td>3</td>
</tr>
<tr>
<td>Breeding season</td>
<td>April-December (maximum around late September)</td>
<td>May-September (maximum around mid September)</td>
<td>2</td>
</tr>
</tbody>
</table>

Sources: 1) Arakaki and Uehara (1991); 2) Nishihira et al. (1991); 3) This study.

**Materials and Methods**

Mature adults of Ec and Eo were collected from Sunabe coast of Okinawa Island (26°07' N; 127°46' E) during their natural breeding season and maintained in aquaria at the University of the Ryukyus, Okinawa. Gametes were obtained from each sea urchin with the injection of 0.5 M KCl solution into the coelomic cavity. Eggs were collected in sterilized filtered seawater (SFSW). “Dry” sperm were pipetted off the genital pores.

Cross-fertilization of the two *Echinometra* spp. was carried out following the protocols described in Rahman et al. (2001; 2005). The conspecific and heterospecific crosses produced feeding larvae in approximately 48 h post-fertilization. They were then reared in glass bottles and fed with *Chaetoceros gracillus* until attaining metamorphic competence within 22-24 days post-fertilization. Induction of metamorphosis was performed on coralline red algal stone in the petri dish containing FSW. The juveniles urchins were reared in plastic aquaria with flow-through seawater. Dead coral with encrusting coralline algae was supplied as food. The cultures were continued for 1 year by which time they attained sexual maturity. All the gametes were then reciprocally backcrossed to determine gametic compatibility among hybrids and conspecifics. Detailed morphological characteristics were recorded from one-year-old hybrids and their conspecifics including colour patterns of spines and test, sizes of test, spicules in tubefoot and gonad, and gamete sizes. Statistical analyses of data were performed by one-way analysis of variance followed by Tukey’s multiple comparison tests.
To examine the occurrence of natural hybridization, field surveys were conducted along the Sunabe and the west coast of Sesoko Island, Okinawa, where Ec and Eo occur sympatrically. About 400 suspected to be hybrid on the basis of colour patterns, were collected and compared to the lab-reared hybrids with respect to above morphological determinants.

Results and Discussion

Fertilization success of conspecific and heterospecific crosses was highly dependent on sperm concentrations (Figure 1). Fertilization rates in heterospecific crosses (Ec x Eo and Eo x Ec) at higher sperm concentrations were 100%. At limited sperm concentration (1.0 x 10^6 sperm/ml), where conspecific crosses reached near 100% fertilization, mean fertilization rates in Ec x Eo (85.3%) and Eo x Ee (81.8%) were significantly (P < 0.05) lower than those in either conspecific cross. Under lower sperm concentrations, heterospecific crosses showed similar trends but progressively lower fertilization rates compared to those in conspecific crosses. These impediments to fertilization in either heterospecific cross indicate the presence of protein-binding system for gamete recognition. Incompatibility of bindin might eventually lead to reproductive isolation, as proposed by Metz et al. (1994). Furthermore, the Ec-Eo crosses had higher fertilization rates in F1 backcrosses (Table 2) than those in other Echinometra spp. (Rahman et al., 2001; 2004). The higher fertilization rate may be due to the higher genetic similarity between Ec and Eo. In other words, they show high divergence in their bindins. However, the lack of gamete incompatibility between the two species suggests that the observed differences in bindin do not significantly affect gamete interactions.

Survival (%) of competent larvae of Ec x Eo and Eo x Ec hybrids was slightly lower but the values were not significantly different (P > 0.05) from larvae of conspecific crosses and among themselves (Table 2). The metamorphosis rate also followed the same trends as survival. The mean live weight and gonad index of 1-year-old Ec x Ec were significantly (P < 0.05) higher than those gained by Eo x Eo, while both reciprocal hybrids were intermediate. Survival was highest in Eo x Eo followed by Ec x Ec, Eo x Ec and Ec x Eo in that order. Neither reciprocal hybrid showed significant differences in survival from their parental siblings. Growth and survival indicated hybrids were viable but showed intermediate to either parental cross.

<table>
<thead>
<tr>
<th>Egg from</th>
<th>Ec x Ec</th>
<th>Ec x Eo</th>
<th>Eo x Ec</th>
<th>Eo x Eo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sperm from</td>
<td>98.7±1.5</td>
<td>93.3±1.3</td>
<td>91.8 ±1.6</td>
<td>81.0±3.8</td>
</tr>
<tr>
<td>Ec x Ec</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ec x Eo</td>
<td>85.8±2.4</td>
<td>97.7±1.1</td>
<td>91.3 ±2.2</td>
<td>83.0±2.4</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eo x Ec</td>
<td>81.2±3.0</td>
<td>93.2±2.0</td>
<td>95.2 ±2.3</td>
<td>78.8±3.4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Larval, juvenile and adult performances of Ec x Ec, Eo x Eo and their reciprocal hybrids. Six replicate experiments were conducted in each cross; mean ± SD.

<table>
<thead>
<tr>
<th>Performances</th>
<th>Ec x Ec</th>
<th>Ec x Eo</th>
<th>Eo x Ec</th>
<th>Eo x Eo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Larva and Juvenile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survival (%)</td>
<td>78.50 ± 2.08a</td>
<td>76.63 ± 1.98a</td>
<td>77.08 ± 2.22a</td>
<td>79.30 ± 2.02a</td>
</tr>
<tr>
<td>Metamorphosis (%)</td>
<td>88.33 ± 5.16a</td>
<td>85.83 ± 4.92a</td>
<td>86.67 ± 4.08a</td>
<td>89.16 ± 5.85a</td>
</tr>
<tr>
<td>Recovery (%)</td>
<td>76.63 ± 1.98a</td>
<td>88.33 ± 5.16a</td>
<td>77.08 ± 2.22a</td>
<td>79.30 ± 2.02a</td>
</tr>
<tr>
<td><strong>Adult</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet weight (g)</td>
<td>9.21 ± 0.83a</td>
<td>6.59 ± 0.42b</td>
<td>6.77 ± 0.45b</td>
<td>5.02 ± 0.50c</td>
</tr>
<tr>
<td>Gonad index (%)</td>
<td>14.52 ± 0.70a</td>
<td>11.41 ± 0.40b</td>
<td>11.68 ± 0.35b</td>
<td>10.19 ± 0.45c</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>86.67 ± 3.34a</td>
<td>83.33 ± 3.34a</td>
<td>84.45 ± 3.35a</td>
<td>87.78 ± 1.92a</td>
</tr>
</tbody>
</table>

Values in the same row having the same superscripts are not significantly different (P > 0.05).

Phenotypic colour patterns of both hybrids, for instance, tended to be maternally inherited. On the other hand, other characters, such as test sizes and spine lengths, spicule morphology of tubefoot and gonad, and gamete sizes tended to be intermediate (Table 3).

Table 3. Summarization of Phenotypic characteristics of hybrids produced experimentally through cross-fertilization between Echinometra sp. C (Ec) and Echinometra oblonga (Eo).

<table>
<thead>
<tr>
<th>Distinctive features</th>
<th>Ec x Ec</th>
<th>Eo x Ec</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body colour</strong></td>
<td>Ec-like</td>
<td>Eo-like</td>
</tr>
<tr>
<td>a. Aboral and oral</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Test characteristics</strong></td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>a. Length, width and height</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spines</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Length</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>b. Spine and base ring colour</td>
<td>Ec-like</td>
<td>Eo-like</td>
</tr>
<tr>
<td><strong>Spicules</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Tubefoot and gonad</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td><strong>Gametes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Sperm-head and egg sizes</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

We searched for the distinctive phenotypes in the field, and although suggestive colour morphs were found, but none were identified as hybrids. Because the lab-reared hybrids are fully fertile, there is almost certainly some kind of effective mechanism(s) separating them that does not involve hybrid viability and fertility. Of these mechanisms, habitat segregation, gamete competition, differences in spawning times, gametic incompatibility or other factors appear to be important in maintaining reproductive isolation and speciation in these species.

References


Biofloc technology (BFT) - The futuristic technology for replacing animal protein in aquafeeds and improving the ecological sustainability of aquaculture systems

B. Madhusoodana Kurup* and K.K. Prajith
Aquaculture Laboratory, School of Industrial Fisheries
Cochin University of Science and Technology
Cochin-682016 INDIA
Corresponding author's email: madhukurup@hotmail.com

Introduction

High quality protein is an essential ingredient for the shrimp to attain faster growth and achieve the harvestable size with in optimum period. Feeding in shrimp farming is very expensive and accounting for more than 55% of the recurring cost of farming. On the other hand, 60-70% of the shrimp protein supplied to shrimp farms are remaining unconsumed and the high quality protein is being subsequently converted in to nitrite nitrogen, TAN, etc. Protein rich feed is a major source of ammoniacal nitrogen in the pond besides, shrimp excretion of the Ammonium N further aggravates the accumulation of these inorganic products in the pond bottom. Shrimps exposed to such inorganic nitrogenous products are subjected to stress and strain and therefore the chances of outbreak of shrimp diseases are very high in these farms. Accumulation of such toxic materials in the pond bottom will also aggravate the level of pollution not only inside the pond but also in the external environment due to release of water having high concentration of inorganic nitrogenous products such as ammonia, nitrite-N. etc. (Avinimelech, 1994).

The biofloc technology utilizes the co-culture of heterotrophic bacteria and algae grown in flocs under controlled conditions within the culture pond. Thus microbial biomass is grown on unconsumed feed, fish excreta, inorganic nitrogenous products resulting in a removal of these unwanted components from the water. The major driving force is the intensive growth of heterotrophic bacteria which consume organic carbon (Schryver, 2008). A biofloc consist of a heterogonous mixture of microorganisms (floc formers and filamentous bacteria), particles, colloids, Organic polymers, cations and dead cells and can reach more than 1000 µm in size. Typical flocs are irregular by shape, have a broad distribution of particle sizes, are fine easily compressible, highly porous and are permeable to fluid. The development of biofloc technology is achieved through sequence of motivation, principles and suitable operative technologies. It always aspires for a zero or minimal water exchange, targeted to achieve maximal biosecurity in the pond and minimize external environmental effect of shrimp culture.

Materials and methods

This paper is prepared based on the results of the studies carried out in School of Industrial Fisheries, Cochin University of Science and Technology and also based on the secondary data collected from literature. The results of the pioneer studies on the application biofloc system in the extensive shrimp farming system conducted at the aquaculture laboratory, School of Industrial Fisheries, Cochin University of Science and Technology, India has been presented. Avinimelech (199; 1999; 2005; 2007) standardized the quantity of Carbohydrate source required and the explained the mechanism behind this technology. The results of Hari et al. (2004; 2005) on-farm trial to control carbon/nitrogen ratio (C/N ratio) by addition of carbohydrate to the water column in extensive types of shrimp culture systems is also
examined. Varghese (2007) optimized of protein percentage in the shrimp feed by the application of biofloc technology and the results are given in the present review. Indoor experiments were conducted to optimize the protein percentage in the shrimp feed by the control of C / N ratio in the extensive shrimp culture system. The effectiveness of biofloc technology in larval rearing of the Giant Fresh Water Prawn was evaluated and the quantity of carbohydrate addition has been optimised (Kurup and Saritha, 2010; Saritha, 2010). Results on efficiency of biofloctechology in the grow out system of giant freshwater prawns *Macrobrachium rosenbergii* (de man) was also reviewed( Kurup and Prajith, 2010). Studies conducted on the use of biofloc as replacement of fish meal is also reviewed and incorporated (Addison et al., 2010 ; Ju et al., 2008; Ballester et al., 2010).

**Results and Discussion**

**Biofloc manipulation through C/N ratio optimization**
According to Avnimelech (1999) the quantity of carbohydrate added was calculated following eq (1) and assuming that the added carbohydrate contains minimum 50 % carbon, the carbohydrate addition needed (∆ CH) to reduce total ammonia nitrogen concentration by 1 g nitrogen/ m3 is 20 g /m3.

$$\Delta CH = \Delta N / 0.05 \quad \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

It can be assumed that ammonium flux into water, $\Delta NH_4^+$ directly by excretion or indirectly by microbial degradation of feed residues, is roughly 50 % of the feed nitrogen

$$\Delta N = \text{Quantity of feed} \times \% \text{ N in feed} \times \% \text{N excretion} \quad \ldots \ldots \ldots \ldots \ldots \ldots (2)$$

The amount of carbohydrate addition needed to assimilate the ammonium flux into microbial protein is calculated using eqs. (1) and (2):

$$\Delta CH = \text{Quantity of feed} \times \% \text{ N in feed} \times \% \text{ N excretion}/0.05$$

Variables in the above equation are (1) Quantity of feed and (2) % Nitrogen in feed (Calculated from crude protein content of the feed).

**Application of Biofloc technology in the extensive shrimp farming system**
Hari et al. (2004,2006) and Johny and Kurup ( 2006) conducted on-farm trails to prove the viability of carbohydrate addition in an extensive shrimp farming system of *Penaeus monodon* in improving sustainability, reducing feed cost and growth performance when fed with a low protein feed. 25% dietary protein with carbohydrate (P25 + CH) and 40% dietary protein (P40) were compared in earthen ponds each having 250 m² area. The stocking density was maintained @ 6 post larvae (PL 20) of *Penaeus monodon* m⁻² (0.016 ± 0.01 g). Tapioca flour was used as carbohydrate source which was directly applied to the water column after the first feeding during the day. Total ammonia nitrogen (TAN) concentration in water and sediment in treatment P25 + CH was significantly lower ($P<0.05$) when compared to P40. Highest THB value was observed in the treatment P25 + CH (57.04 x 10⁵ cfu ml⁻¹) due to the addition of carbohydrate. Low protein diet with addition of carbohydrate to the water column showed a significant effect ($P<0.05$) in the shrimp yield in P25 + CH when compared to P40 and the values were 64.4 and 44.8 g m⁻² respectively. Chlorophyll-a showed significant increase ($P<0.05$) during the culture period and the value ranged from 9.7 – 45.1 µg l⁻¹. The variables PER, FCE, ADG and NPV were higher in the treatment P25 + CH and it was significantly different ($P<0.05$) from P40. Survival of shrimp was not affected ($P>0.05$) by the treatment and it was 35.5% and 42.2% in P40 and P25 + CH respectively. Total variable cost was much higher in treatment P40 (IRS. 97, 420.0/-) when compared to P25 + CH (IRS. 73, 302.0/-). Cost of feed and carbohydrate source for P25 + CH was lower than P40 since the latter is costly due to high protein content. Total revenue from the harvested shrimp (ha⁻¹) was 54% higher in treatment P25 + CH than in P40 due to the combined effect of better yield and higher price of shrimp due to their precarious size. Net profit from the P25 + CH was IRS. 1,14,292.0/- which was significantly higher than P40 (IRS. 20,422.0/-). The benefit cost ratio was significantly ($P<0.05$) higher in treatment P25 + CH (1.4) than to P40 (0.2). By applying the technology, the farming can become more economically viable due to the reduction of dietary protein level by the addition of
carbohydrate to the water column. Farming on the basis of this technology is very useful in improving the ecological sustainability of extensive shrimp farming system. The technology would benefit the extensive farming practices by increasing production; reducing feed cost and production of low level of inorganic nitrogen in the pond and furthermore, low discharge of nutrients into the environment.

**Optimization shrimp protein requirement in favour of carbohydrate addition**

Hari et al. (2005; 2006) and Johny and Kurup (2005) assessed the optimal dietary protein level was for the addition of carbohydrate in *Penaeus monodon*, with a view to know whether the addition of carbohydrate will helps in increasing the shrimp production and reducing the feed cost. Two dietary protein levels 25% and 40% (P25 and P40) with or without carbohydrate source addition (P25 + CH and P 40 + CH) were compared at a stocking density @ 6 post larvae (PL 20) of *Penaeus monodon* m⁻² (0.357 ± 0.01 g). The quantity of carbohydrate was calculated following Avnimelech (1999); i.e. 390 g and 620 g tapioca flour kg⁻¹ of the 25% and 40% diet fed, respectively. The addition of carbohydrate source was found useful in significantly (P<0.05) reducing the total ammonia nitrogen (TAN) in the water and sediment. Protein level in the diet had a significant effect (P<0.05) in the inorganic nitrogen concentration in the sediment. Treatment P40 showed higher (P<0.05) water TAN, nitrite-N and nitrate-N level, while it was lowest in the treatment P25 + CH. Total heterotrophic bacterial (THB) population both in the water column and sediment increased (P<0.05) during the period. Lower specific growth rate (SGR) and higher feed conversion ratio (FCR) were recorded in P25 treatment when compared to other treatments. Higher shrimp yield was recorded in P25 + CH when compared to P40. Survival of shrimp was not effected by the treatments. The results revealed that the demand for dietary protein level 40% can be lowered to 25% in favour of carbohydrate addition to the water column without compromising shrimp production. Furthermore, addition of carbohydrate was useful in reducing toxic inorganic nitrogen levels in the pond as well as effluents.

**Application of Biofloc Technology for the larviculture of Macrobrachium rosenbergii**

The biofloc technology has been found very useful for improving both the ecological and economic sustainability in shrimp aquaculture. The technology helped in reduction of inorganic nitrogenous products in the farms and also reducing the protein content of the feed substantially. The modified static green water system of seed production of *Macrobrachium rosenbergii* faces the problem of elevated levels of metabolites like ammonia and nitrite. The present study was conducted to evaluate the effectiveness of biofloc technology in larval rearing of the Giant Fresh Water Prawn when the quantity of carbohydrate addition is optimized to assimilate the toxic metabolites generated and consequently converting them into bacterial flocs. Five levels of carbohydrate (0.01, 0.02, 0.03, 0.04 and 0.05 g/l) were added to the larval rearing tanks and the water quality and post larval production were estimated. Larvae were fed with *Artemia* nauplii from the second day of hatching and with egg custard of required size (0.06 g/l) from fifth larval stage onwards. Total ammonia nitrogen and nitrite nitrogen (NO₂⁻ -N) were found to be significantly low, whereas total heterotrophic bacteria (THB) were found to be higher in carbohydrate added tanks when compared to the control.

The study revealed that the addition of carbohydrate was found to be very effective and useful in reducing the toxic nitrogenous compounds in static hatchery systems resulting in higher production in a shorter period. The addition of carbohydrate has been optimized at the rate of 0.03 g/l of the rearing water which resulted in the average survival of post larvae @58.56% which is the ever highest reported survival percentage in the modified static green water system.

**Biofloc as alternative protein source for replacing animal protein in aquafeeds**

The results of Ju et al. (2008) suggest that inclusion of the floc material in shrimp diets could enhance the shrimp growth. They observed enhanced growth when compared with that of the control (P<0.05) the diet preference and pellet stability study were also positive. Shrimp
preferred the experimental diets over commercial diet and the feed stability was same as that of commercial diet. Addison et al. (2010) by evaluating the nutrient values of the semi-purified experimental diets insight into what components of biofloc will probably not and those that may be responsible for the enhanced growth seen when biofloc is consumed either directly or included as ingredients in feeds by marine shrimp. Result of the experiment by Kuhn et al. (2010) is that Experimental diets were varied greatly and notable independent variables included complete replacement of soybean protein, two-thirds replacement of fishmeal, and no fish oil. Biofloc inclusion always increased growth rates and ranged from a low average increase of 4% to a high average of 67% over the control diets; the latter percent increase was significant at P < 0.01. Based on the results of our studies, it seems that biofloc technology represents a promising option for sustainability of the aquaculture industry.45 days experimental trial of Ballester et al. (2010) concluded that shrimps fed with a protein percentage of 35% which are maintained in biofloc ponds showed maximum growth parameters. It was significantly greater when compare to the feed with 25, 30, 40 and 45% of crude protein. Logan (2010) Presented the possibilities of commercializing the biofloc feeds in recent World aquaculture Society conference (WAS 2010) held at California, the product is expected to available in market by September 2011 as the trade name Obron SCP ingredient.

Conclusions

Biofloc technology is a technique which is economically and ecologically friendly that ensure the sustainable aquaculture without affecting the production so farmers can adopt this technique with out further discussions. In other words this technology is very important in environmental management aspects. Pollutant from the aquaculture systems can reduce by the application of biofloc technology and by adopting this technique it is possible to culture animals in small embankments with the production of less toxic effluent. The information on the nutrient value, quality and quantity of biofloc would greatly increase the ability to prepare cost effective biofloc ingredients to increase the sustainable production of marine shrimp and other aquatic species.

References


Johny T Varghese and B. Madhusoodana Kurup 2005, Effect of Carbohydrate addition in the culture of Penaeus monodon (Fabricius) having varying stocking density, Sustainfish,16-18, March 2005, Cochin India.


Kuhn, D, Addison Lawrence, Gregory Boardman, Susmita Patnaik, Lori Marsh, George Flick. 2010. Sustainable biofloc technology: Using bioreactors to treat aquacultural effluent while producing biofloc for shrimp feed. World Aquaculture 2010 - Meeting Abstract. San Diego, California.


Varghese, J.T, Carbon/Nitrogen ration optimization and periphyton development on the production and sustainability of penaeus monodon (Fabricus) in extensive culture system. PhD Thesis, Cochin Cochin University of Science and Technology, Cochin-INDIA.
Poster Papers:
Coastal and Riverine Interactions
Sedimentology of the Redang Island coral reefs environment

Nor Antonina Abdullah¹, Noor Azhar Mohamed Shazili², Norhayati Mohd. Tahir³ and Siti Zauyah Darus⁴

¹Marine Science Department, Faculty of Maritime Studies and Marine Science University Malaysia Terengganu, Mengabang Telipot, 21030 Kuala Terengganu, Malaysia
²Institute of Oceanography, Universiti Malaysia Terengganu Mengabang Telipot, 21030 Kuala Terengganu, Malaysia
³Research and Management Centre, Universiti Malaysia Terengganu Mengabang Telipot, 21030 Kuala Terengganu, Malaysia
⁴Land Management Department, Faculty of Agriculture, Universiti Putra Malaysia 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: antonina@umt.edu.my

Abstract

A study on the sedimentology of the Redang Island coral reefs environment was conducted. Sediments were collected on board UNIPERTAMA VII during the pre and post monsoon seasons. Twenty and seven sediments samples were collected using a Smith McIntyre grab on board UNIPERTAMA VII and put in labelled plastic bags then brought back to the laboratory for analysis. The sediments were analyzed for their sedimentological characteristics (mean size, skewness, standard deviation and kurtosis) using dry sieving method. Results showed that the highest mean size value of the sediments during the pre and post monsoons seasons are 2.14 Φ and 2.37 Φ, respectively and the lowest are -0.40 Φ and -0.10 Φ, respectively. Based on the results, sediments can be classified as medium sand (34%), poorly sorted (67%), strongly negative skewed (36%) and extremely leptokurtic (56%) during the pre monsoon season, while during the post monsoon season sediments can be classified as medium sand (38%), poorly sorted (73%), strongly negative skewed (41%) and very leptokurtic (62%). Results revealed that the sediments in the whole study area are relatively coarse. No relationship was observed between mean size and other sedimentological characteristics ($R^2 = 0.05$ pre-monsoon, $R^2 = 0.0017$ post monsoon) with seasons.

Keywords: sedimentology, Redang Island, coral reefs, sediment

Introduction

Marine sediments occur in a broad range of sizes and types. Most sediment is classified either by the size of particles, the description of components, the process of formation or some combination of these three. The ultimate aim of this classification is to understand the processes and relationships of sediments with time. Sedimentology encompasses the study of particle size such as; sand, silt and clay (mud) and the processes that deposit them. The coast of Terengganu consists of number of islands that are surrounded by coral reefs. One of the islands is the Redang Island, which is found as rich in habitat, and species, besides, has unique and diverse marine and coastal ecosystems such as mangroves, coastal forests, sandy beaches, mudflats and coral reefs.

Information on characteristics of sediments in the South China Sea particularly Terengganu off Redang island is very scarce. For example, grain size studies are limited only to those reported R. Yaakob (1985). Generally, the bottom sediments are reported to be finer during the post-monsoon season. This paper was conducted to determine the sediment characteristics and the effects of the northeast monsoon in the study area.
Materials and Methods

The sediments were collected at Redang island. All sediment samples were collected using a Smith McIntyre Grab on board UNIPERTAMA VII vessel. The samples were kept in labelled polyethylene plastic bags and brought back to the laboratory for analysis. Sediments were removed from the freezer then air dried at room temperature until fully air dried. After air drying for a week, 100 g of samples were weighed for sedimentological characteristics analyses. Dry sieving method was applied to determine the mean size, sorting, skewness and kurtosis of the sediments. Thirteen sieves were used and these were arranged consecutively finer downward at 0.5 phi interval as follows: 4000 μm, 2800 μm, 2000 μm, 1400 μm, 1000 μm, 710 μm, 500 μm, 355 μm, 250 μm, 180 μm, 125 μm, 90 μm, and 63 μm. The sieves and samples were shaken for 15 minutes. Samples retained in each mesh were accurately weighed and the data were processed to obtain the moment’s statistical methods. Calculation of the sedimentological characteristics (mean size, sorting, skewness and kurtosis) were as follows:

Mean size; \( \phi = \frac{\sum f_m}{n} \)

Sorting; \( S = \frac{\sum f \cdot (m - X)^2}{100} \)

Skewness; \( Sk = \frac{\sum f \cdot (m - X)^3}{100 \sigma^3} \)

Kurtosis; \( K = \frac{\sum f \cdot (m - X)^4}{100 \sigma^4} \)

Where:
- \( f = \) percentage weight of each grade of particle size;
- \( m = \) median of each particle size in \( \phi \);
- \( n = \) total number of the samples in 100 when \( f = \% \).

Figure 1 shows the sampling stations of the study area.

![Figure 1. Sampling stations of the study area.](image-url)
Results and Discussion

Table 1. The value of the sedimentological characteristics obtained during both seasons.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Pre-monsoon</th>
<th>Post-monsoon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVR</td>
<td>MAX</td>
</tr>
<tr>
<td>Mean Size</td>
<td>1.16</td>
<td>2.54</td>
</tr>
<tr>
<td>Sorting</td>
<td>1.05</td>
<td>1.43</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.20</td>
<td>0.99</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.43</td>
<td>9.86</td>
</tr>
</tbody>
</table>

Results showed that the average mean size obtained is 1.16 $\phi$ which is classified as coarse sand during both monsoon seasons (Table 1). This is in conjunction with the results obtained Nor Antonina (2001). The coarseness of the sediments in the study area might be due to the dominant rock existing in the study area which is granite. For sorting, the range is between 0.81 $\phi$ and 0.61 $\phi$ which is more or less the same for both seasons which indicates that the sediments are moderately sorted (Table 1). Good sorting which is an indication of small standard deviation on the other hand is produced by the action of energy which transport and deposit only a limited range of grain size. For skewness, results showed that sediments are strongly negatively skewed for both monsoon seasons where the phi scale indicate an excess of coarser grain and could of fine particles (Nor Antonina, 2001). Generally, the average values on the sedimentological characteristics are almost the same for both seasons indicating that the particle size is not influenced by monsoon.

Conclusions

The study area is a part of the South China Sea which is located at the East Coast of Peninsular Malaysia off Terengganu. In this area, the dominant rock is granite and upon weathering of this rock, quartz is being released thereby, the sediments are coarse grains. With this, it can be concluded that the sediments in the whole study area are coarse. No relationship was observed between mean size and the other sedimentological characteristics ($R^2=0.05$ pre-monsoon; $R^2=0.0017$ post monsoon) between seasons.

Acknowledgements

The authors wish to acknowledge the University for allowing us to conduct this study and also the Fisheries Department for giving us permit to collect the sediments surrounding the island.

References


Coastal water quality in near shore development area at Sepang coastline

Leow Wai Mun and Rozainah Mohamad Zakaria*

Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia

Corresponding author’s email: rozainah@um.edu.my

Abstract
Coastal zone area plays an important role in ecological and economical factors to the human being. A development of a resort in Sepang coastline has modified the coastal shoreline and its coastal water quality that may have severe impact to the coastal and surrounding environment. In this research, coastal water quality parameter was determined to detect any changes. They were salinity, total dissolved solid (TDS), pH, temperature, conductivity and dissolved oxygen (DO). The measurements were taken on monthly basis in situ for six months at the development area and another replicate at the adjacent area as the control data. T-test were used to determine any significant different between the two areas. Results indicated that salinity of the coastal water in near shore development area was ranged from 23-26 ppt, much lower than the surrounding salinity which ranged from 27-29 ppt. The readings for pH, TDS, temperature, conductivity and DO were recorded as (mean ±S.D.) 7.19±0.52, 19.33±1.12ppt, 28.02±1.19°C, 37.60±1.35mS, 2.85±0.10mg/L respectively in development area compare to adjacent area which are 7.09±0.02, 21.46±0.18ppt, 27.93±1.20°C, 43.12±0.68mS, 3.32±0.18mg/L respectively. However, t-test showed that the result were significantly different between both study site. The results indicated that development construction in Sepang coastline has changed the coastal water quality.

Keywords: coastal development, water quality, mangrove, Sepang

Introduction
Coastal length in Malaysia is estimated at 4809km and 29% of it is facing erosion (Chan et al., 1993). In 2002, the state of Selangor recorded 224,220 ha of forested areas that include terrestrial forest, peat swamp forest and mangrove forest (JPSM, 2002). Mangrove forest commences from Sepang rivermouth to Bagan Lalang to the south, it moves towards north to Morib passing Klang before finally to Kuala Bernam. Coastal zone of Malaysia has some very special advantages as a source of income to the country. These advantages are social-economic and environmental significant. Coastal area supports human population and is also the center of economic activities such as fisheries, agriculture, urbanization, tourism, and gas and oil exploitation. (Shahrizaila, 1993). Such benefit has led the government or private sector to develop on the coastal zone. Eventually coastal area environment will be modified. Coastal zone activities such as near shore or off shore development, agricultural, urbanization, or industrialization always give changes on coastal water and sediment quality. Pollutants from the anthropogenic activities can flow to the coastal water by river or surface runoff and hence affecting the water and sediment quality. West coast of Peninsular Malaysia is highly polluted due to the highly industrialized areas that are concentrated here and most of the riverine systems flow into coastal area and thus become important source of heavy metal contamination in this area. (Yap et al., 2002).

Objectives:
1. To determine the coastal water quality in developing and adjacent areas.
2. To compare the significance of water quality between developing and adjacent areas.
**Study area**

Figure 1 shows the location of the study area which is situated in the southern part of the Selangor state, under the Sepang district. A new resort project was constructed in this area. Surrounding of the development area is a mangrove area and fishing villages. There is also influx of fresh water from two rivers including Sg Sepang around the development area.

![Figure 1](image)

*Figure 1. An arrow showing the study site at Bagan Lalang, Sepang Selangor.*

**Materials and Methods**

The sampling points were located at near shore development area and adjacent area. Each sampling point was replicated three times for more accurate results. The measurement was measured on monthly basis from July 2009 until December 2009. The parameters measured were salinity, pH, temperature, Dissolved oxygen, conductivity and total dissolved solid by using YSI multiparameter model IQ170. The parameters were measured \textit{in-situ} during high tide. Mean of parameters was calculated in each replicate. Standard deviation was also performed to show how much variation there was from the mean. T-test was calculated to determine any significant difference between the two areas by SPSS software.

**Results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Near shore development area</th>
<th>Control area</th>
<th>Chong et al. (2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>24.22 ± 1.23ppt</td>
<td>27.83±0.39ppt</td>
<td>30.25±1.36ppt</td>
</tr>
<tr>
<td>Conductivity</td>
<td>37.60 ± 1.35mS</td>
<td>43.12 ± 0.68mS</td>
<td>n.a.</td>
</tr>
<tr>
<td>TDS</td>
<td>19.33 ± 1.12ppt</td>
<td>21.46 ± 0.18ppt</td>
<td>n.a.</td>
</tr>
<tr>
<td>Temperature</td>
<td>28.02 ± 1.19°C</td>
<td>27.93 ± 1.20°C</td>
<td>30.04 ± 0.62°C</td>
</tr>
<tr>
<td>pH</td>
<td>6.84 ± 0.10</td>
<td>7.09 ± 0.02</td>
<td>8.06 ± 0.17</td>
</tr>
<tr>
<td>DO</td>
<td>2.85 ± 0.10mg/L</td>
<td>3.32 ± 0.18mg/L</td>
<td>5.38 ± 0.86mg/L</td>
</tr>
</tbody>
</table>

(n.a. not available)

Table 1 shows the data for water quality between study site at nearshore development area and the control site which is a nearby natural mangrove forest, and compared with established data by Chong et al. (2005) in the Klang Strait. There are significant different
between both sites in terms of salinity (t=6.45, df=10, p<0.05), conductivity (t=8.41, df=10, p<0.05), Dissolved oxygen (t=5.23, df=10, p<0.05), Total dissolved solid (t=4.33, df=10, p<0.05) and pH (t=5.66, df=10, p<0.05). However there is no significant different in temperature for both sites (t=0.129, df=10, p>0.10).

Discussion

The salinity, conductivity, dissolved oxygen, total dissolved solid, pH in control area are much higher than in developing area. All the parameters are fluctuating on monthly basis due to the dynamic of coastal water changing very fast. From the results above, for near shore developing area, the salinity of the coastal water is much lower than the control area. Near shore developing area has a lower salinity concentration can be due to the influx of fresh water from anthropogenic activities, such as during the construction work or surface water runoff. Dissolved oxygen in both areas is less than minimum requirement for aquatic organisms that is 4mg/L (Baker, 1980).

The coastal water quality changes can impact the mangrove and some aquatic species because they require some specific salinity to survive. The temperature in both areas falls in the range of 25.8-29.5°C, which area the typical temperature of tropical water. The temperature in both areas does not show any significant different because the water surface in both areas receive the same amount of sunlight. T test results show that almost all parameters in developing area are significantly different from control area. This difference in parameters indicates that there are changes in water quality in developing area.

Conclusion

The experiment showed that there are significant changes in water quality between development area and the control area.

Acknowledgements

The authors would like to thank University of Malaya for technical and laboratory assistance.

References


A case of fish kill in cages related to dredging activity

Toh-Thye Chuah

Fisheries Research Institute Batu Maung
11960 Batu Maung, Penang, Malaysia
Corresponding author's email: chuahtt@rocketmail.com

Introduction

A study was made to investigate a fish kill in two floating cage farms at Dinding River on 8 October 2008 (Figure 1). It was reported that dredging activity might be the cause of the 2-million ringgit loss of fish to the 3 cage operators in the river on 7 Oct (Kosmo, 8/10/08; Harian Metro, 8/10/08).

Materials and Methods

Water parameter both inside and outside the cages were checked in situ with YSI6920. Plankton samples were taken with a 20um-mesh net and Lugol-fixed for lab examination. Water at 30-cm depth were sampled with Kemmerer’s sampler for nutrient level using Hach DREL2800 and Biochemical Oxygen Demand (BOD) by WTW OxiTop in lab. Some water were sent to an accredited lab for analysis of heavy metals and pesticides. One bottle of water sample collected immediately when fish showed signs of stress on 6 Oct was received from an affected operator. One tail of moribound Johny snapper Lutjanus johnii was dissected and sampled for disease diagnosis.

Results

Water quality and nutrient contents in the cage culture area seemed normal except for the high level of sulphide and ammonia (Table 1).

Table 1. Water quality data.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cage 1 Inside cage</th>
<th>Cage 1 Outside cage</th>
<th>Cage 2 Inside cage</th>
<th>Cage 2 Outside cage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp °C</td>
<td>30.98 29.86</td>
<td>31.04 29.27</td>
<td>31.08 30.97</td>
<td>30.97 29.38</td>
</tr>
<tr>
<td>DO ppm</td>
<td>5.26 5.48</td>
<td>5.03 5.72</td>
<td>4.92 5.32</td>
<td>5.12 5.47</td>
</tr>
<tr>
<td>pH</td>
<td>6.03 5.89</td>
<td>7.23 7.10</td>
<td>7.34 7.31</td>
<td>7.36 7.29</td>
</tr>
<tr>
<td>Secchi Disc m</td>
<td>2.1 -</td>
<td>2.0 -</td>
<td>2.1 -</td>
<td>2.0 -</td>
</tr>
<tr>
<td>Conductivity</td>
<td>46.78 46.90</td>
<td>46.88 47.22</td>
<td>46.85 47.01</td>
<td>43.76 46.76</td>
</tr>
<tr>
<td>Iron mg/l</td>
<td>0.01 0.02</td>
<td>0.01 0.02</td>
<td>0.01 0.03</td>
<td>0.01 0.01</td>
</tr>
<tr>
<td>Sulfide mg/l</td>
<td>3 1</td>
<td>1 4</td>
<td>2 2</td>
<td>11 3</td>
</tr>
<tr>
<td>Ammonia mg/l</td>
<td>0.34 0.44</td>
<td>0.29 0.29</td>
<td>0.69 0.37</td>
<td>0.31 0.39</td>
</tr>
<tr>
<td>Nitrite mg/l</td>
<td>0.013 0.011</td>
<td>0.012 0.014</td>
<td>0.013 0.012</td>
<td>0.013 0.015</td>
</tr>
<tr>
<td>BOD mg/l</td>
<td>15.1 (sampled 6.10.08)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis of heavy metals and pesticides in the dead tiger grouper *Epinephelus fuscoguttatus* had higher levels of arsenic, copper, iron, lead and zinc compared to the water (Table 2).

**Table 2. Analyses of heavy metals in water and fish.**

<table>
<thead>
<tr>
<th>Heavy metals</th>
<th>Concentrations in mg/l</th>
<th>Water</th>
<th>Tiger grouper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>&lt; 0.01</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Boron (B)</td>
<td>4.8</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.12</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Chromium Hexavalent</td>
<td>&lt;0.01</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Chromium Trivalent</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>&lt; 0.1</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.34</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>&lt; 0.1</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.02</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td></td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>&lt; 0.08</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Tin (Sn)</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.03</td>
<td>5.3</td>
<td></td>
</tr>
</tbody>
</table>

No pesticide was detected from water and fish (Table 3).

**Table 3. Analyses of pesticides from water and fish.**

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Concentrations in mg/l</th>
<th>Water</th>
<th>Tiger grouper</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDT</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>BHC</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>DDE</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Endrin</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Lindane</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Chlordane</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Aldrin</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>TDE</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Ethion</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Diazion</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Malathion</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Paradichlorobenzene</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Dacthal</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Simazine</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Atrazine</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>Diuron</td>
<td>Not detected</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
</tbody>
</table>

*Not detected denotes less than 0.001 mg/l*
Plankton analysis revealed no bloom of toxic algae present and the dominant species was *Cylindrotheca closterium* found outside the cages. Disease diagnosis reported no serious infection of pathogenic parasites nor bacteria in the Johny snapper being examined.

**Discussion**

Dredging activity does result in deteriorated water quality as it disturbs the underlying sediments in the process of deepening the riverbed (Figure 2). Toxic compounds could be churned up and noxious gases like methane and hydrogen sulphide released during dredging. The turbid water itself could threaten living organisms in vicinity under prolonged and severe conditions (Wilbur, 1971; Wilber and Clark, 2001). Fish cultured in cages would suffer the most as they received the full impact in its netted confinement. Thus dredging is supposed to be regulated strictly to minimize potential negative consequences.

The pattern of fish mortality in this instance had strong implications that irregular dredging activity could be the cause of it, with support from the following observations:

1) Multiple species of fish (Figures 3, 4 and 5: *E. fuscoguttatus, L. johnii, L. malabaricus, Lates calcarifer, Trachinotus blochii*) of various sizes (1-month juveniles to 7-month adult fish) were dead within a day. Fish killed by disease would generally spread over several days or weeks. The moribund snapper seemed healthy with no obvious sign of disease symptom upon examination.
2) All dead fish exhibited distinct sign of stress with mouth and operculum wide-opened (Figure 6). This exaggerated death appearance seemed to suggest suffocation most probably due to depletion of dissolved oxygen because of some drastic chemical absorption or as a result of some abiotic intoxication. The oily film on the water surface and the oily fish body indicated some exogenous compounds might have been released by the dredging process.

3) It was alleged that irregular dredging activities were carried out during low tides on 6 Oct. The cage operator through the District Fisheries Assistant had notified the party concerned about the stress the fish were experiencing as they surfaced to gasp for air or oxygen. The violation on dredging regulation and rejection of request to stop the dredging immediately might have jeopardized the whole stock of fish which finally succumbed under prolonged and severe stressful conditions.

4) The high BOD level (15.1 mg/l vs < 3.0 mg/l) from the water sampled on 6 Oct. indicated gross pollution (Leong, 1984). Chemical compounds released during dredging could utilize available oxygen and caused the fish to die of asphyxiation. The higher levels of sulphide (1.0-11.0 mg/l vs safe level of <0.002 mg/l) and ammonia (0.29-0.69 mg/l vs <0.02 mg/l) in water were also toxic to the fish especially if they were already under great stress.

5) The accumulated levels of arsenic, copper, iron, lead and zinc detected in the dead tiger grouper were not particularly high as to kill off the fish with immediate effect.
6) As all the 22 types of pesticides were below detectable level of 0.001 mg/l, pollution from pesticides seemed not likely though the cages were nearby oil palm estates.

7) Toxic algal bloom was ruled out as no profuse growth of toxic algae were observed under the microscope even though the latest bloom of *Ceratium furca* occurred in April and coloured some areas of the Dinding River reddish on the surface. They had subsided and replaced by the common *Cylindrotheca closterium* by this time.

**Conclusions**

By logical elimination and reasoning, the dredging activity during low tides could have played a very critical role in relation to the total fish kill at the two cage farms, which were about 200 m away in the same tributary of the Dinding River as there was no other unusual event or activity going on during that period of time.

**Acknowledgements**

The assistance from the Manjung Fisheries District Office and the National Fish Health Research Centre during the investigation are much appreciated.

**References**


Poster Papers:
Marine Biodiversity and
Resource Management
Evaluation on the genetic relationship of Malaysian grouper using molecular marker

Abdul Muhaimin Ahmad1*, Mariana Nor Shamsudin1,2 and Noraznita Sharifuddin1

1Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia 43400 UPM Serdang, Selangor, Malaysia
2Department of Medical Microbiology and Parasitology, Faculty of Medicine and Health Sciences, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: muhaimin5057@gmail.com

Abstract

Grouper is classified into 14 genera from the subfamily Epinephelinea, and there are at least 449 grouper species from the Serranidea family. The Malaysian grouper, Epinephelus fuscoguttatus and Epinephelus coioides, get a lot of attention from fishermen for culture because of their high value market demand. Grouper can generally be found in tropical and subtropical waters, but in Malaysia wild grouper can rarely be found except in Langkawi and Sabahan waters. The genus Epinephelus is usually differentiated based on phenotypic identification of colour patterns and a suite of morphologic characters. However, these characters often show intraspecific sequence variation in a portion of the gene encoding for cytochrome b and mitochondrial ribosomal 16s rRNA of the Malaysian grouper Epinephelus fuscoguttatus and Epinephelus coioides, which are among grouper species of considerable economic value in tropical and subtropical regions, and particularly in south-east Asia. Besides that, intraspecific sequence variations can also be viewed using random amplified polymorphic DNA (RAPD) analysis. The RAPD fingerprints generated in Epinephelus fuscoguttatus and Epinephelus coioides with several primers were found to be consistent, reproducible, and yielded species-specific diagnostic markers in this study. Using the polymerase chain reaction, phylogenetically informative nucleotide positions were found in a 2400-base pair cytochrome b sequence and 1400-base pair mitochondrial ribosomal 16s rRNA sequence. A RAPD loci are in the size range of approximately 300 bp-3000 bp was produced. Although on the basis of their morphology these two species are considered different species, our results show that the genetic relationship between Epinephelus fuscoguttatus and Epinephelus coioides has similarity in their extensive genetic divergence.

Keywords: grouper, Epinephelus, RAPD, mitochondrial ribosomal 16s rRNA, cytochrome b, species-specific markers

Introduction

Genetic variability, besides being important for checking evolution, can be used as instrument of inquiry in diverse areas, for example, to verify the affinities and the limits between species, to detect forms of reproduction and familiar structure, to evaluate levels of migration and dispersion in populations and for the identification of species threatened with extinction. The basic data for this study are the called molecular markers, which are genetic loci that present some variability, different rates of evolution between genus Epinephelus.

The genus Epinephelus is usually differentiated based on phenotypic identification. However, these characters often show intraspecific sequence variation in a portion of the gene encoding for cytochrome b and mitochondrial ribosomal 16s rRNA of the Malaysian grouper Epinephelus fuscoguttatus and Epinephelus coioides. Usually mitochondrial ribosomal 16s rRNA is universal primer for species identification and not specified to certain gene.
A particularly diverse region is the cytochrome b coding region. Cytochrome b is one of nine to ten proteins that compose the complex II of the mitochondrial oxidative phosphorylation system (Hatefi, 1985). Consequently, cytochrome b sequences have been obtained from many taxonomy (Irwin et al., 1991) and used extensively for phylogenetic study. The RAPD fingerprinting technique has been developed for genetic mapping, fingerprinting, and is widely used in inter- and intraspecific population polymorphism analyses of different organisms.

**Materials and Methods**

**DNA extraction**
A total of nucleic acid is extract from fish tissue were using commercial kits that have been provided.

**Mitochondrial ribosomal 16srRNA and Cytochrome b gene**
PCR was carried out in total volume 25ul containing MgCl2, dNTPs, Taq polymerase, dH2O, Buffer A and primer (16srRNA and cytp b gene). Thermal cycle for PCR is containing 30cycle of denaturation, annealing, elongation and end elongation temperature. The PCR products were stored at 4°C. Run gel electrophoresis for result view and further with DNA sequencing method.

**RAPD fingerprinting**
PCR was carried out in a total reaction volume of 25uL containing 10 to 15 ng template DNA, 10 mM Tris-HCl (pH 9.0), 1.5 mM MgCl2, 50 mM KCl, 0.2 mM each of dATP, dCTP, dGTP, and dTTP, 10 pM primer, and 1 U Taq DNA polymerase. PCR was performed using thermal cycler for an initial denaturation of 30 seconds at 94°C, followed by 45 cycles, each consisting of 30 seconds at 94°C (denaturation), 30 seconds at 36°C (annealing), and 120 seconds at 72°C (extension). A final extension was carried out at the same temperature for 7 minutes and followed by pausing file at 4°C until they could be used or stored. PCR products were stored at 4°C in a refrigerator. Run gel electrophoresis 1.5% agarose gel for result viewing.

**Results and Discussion**

**Mitochondrial ribosomal 16srRNA and Cytochrome b primer**
The size band for 16srRNA was 610bp while for cyt b gene was 1400bp according to 1kb base pair marker. Based on Figure 1, K for 1kb marker, C- for negative control while C for *Epinephelus coioides* and M for *Epinephelus fuscoguttatus*.

![Figure 1. Gel electrophoresis picture for 16srRNA and cyt b gene.](image-url)
**DNA sequencing**
Based on Blast NCBI, for Mitochondrial Ribosomal 16srRNA primer has confirmed *Epinephelus fuscoguttatus* 16S ribosomal RNA gene, partial sequence of mitochondria where length is 619 base pair. For cyt b gene, 1141 base pair was detected as *Epinephelus fuscoguttatus* cytochrome b (cytb) gene.

**RAPD fingerprinting**
Based on Figure 2, C for *Epinephelus coioides* and M for *Epinephelus fuscoguttatus* has showing similar band pattern. This maybe inter species relationship between 2 species has showing. The size range of approximately 300 bp-3000 bp was produced.

![Figure 2. Gel electrophoresis picture for RAPD fingerprinting of 2 species.](image)

**Conclusions**
Relationship between 2 species is shown based on taxonomy and RAPD fingerprinting. Evolution of genetic variety can be viewed through RAPD fingerprinting and cyt b gene.

**References**


Biodiversity and adaptability in artificial environment of two sea cucumber species

Abdoulie Ceesay* and Mariana Nor Shamsudin

Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: sheikhbamba@yahoo.co.uk

Abstract

Sea cucumber species differ in the manner they respond to adverse or challenging environmental conditions. Thus, to culture them in an artificial environment would require the necessary investigation to better understand and define their environmental needs and be able to determine the environmental factors that help to support their survival outside their natural habitats. Two species of sea cucumber found at Port Dickson, *Stichopus japonicus* and *Holothuria leucospilota*, which are the major species at the site, were investigated to determine their biodiversity. We collected data on them with the help of GPS and YSI data collecting instruments. Data obtained on the two species showed that the temperature tolerance for *Stichopus japonicus* was found to be between 31 – 32°C and that of *Holothuria leucospilota* was 30 – 31°C. Salinity was found to range from 30.00 – 31.00 part per thousand (ppt) for *S. japonicus* and 30.00 – 31.00 ppt for *H. leucospilota*. The optimum values for pH obtained for the two species *S. japonicus* and *H. leucospilota* ranged from 7.80 – 8.40 and 8.00 – 8.60, respectively. Genomic DNA of the sea cucumbers were extracted and amplified using the 16S primer, and showed the amplified DNA for *Holothuria leucospilota* to be approximately 550bp and that of *Stichopus japonicus* to be 600bp. The sequenced PCR product analyzed using Basic Local Alignment Search Tool (BLAST) Version 2.01G for rapid searching of nucleotide and protein databases identified *Holothuria leucospilota* as another species.

Keywords: biodiversity, *Stichopus japonicus*, sea cucumber, 16S primer, BLAST, *Holothuria leucospilota*

Introduction

Sea cucumbers are organisms belonging to the phylum Echinodermata from the class holothuriodea composed of five genera. They are ocean dwellers even though some are found in shallow waters, while some live in the deep ocean. They live on or near the ocean floor and are often buried beneath it (National Geographic). They are widely distributed in all regions of the oceans worldwide. To date, as many as 1430-1500 species and new species identified each year have been recorded among the six valid orders of Apodida, Aspidochirotida, Elasipodida, Molpadiida, Dendrochirotida and Dactylochirotida (Bruckner, 2006; Kamarul et al., 2009). Holothurians have a long history of consumption by the oriental people, mostly Chinese and Japanese (Bruckner, 2006). Being a source of food and medicine to many has resulted in their being harvested heavily in many communities with tonnes leaving the ocean annually (Pawson et al., 2010). This situation led some species to the point of extinction. However, some institutions and communities have embarked on aquaculture, breeding, and protecting of the endangered species from disappearing (Bruckner, 2006). In Malaysia, approximately 50 species from three orders and seven genera have been recorded while 34 species still require further identification (Kamarudin et al., 2009). Sea cucumbers can be found near the shore beneath rocks, muddy or sandy areas, and some in coral reef areas in different parts of Malaysia. Two sea cucumber species, *Stichopus japonicus* and *Holothuria leucospilota*, found around the coastline in Port Dickson are among the sea cucumber species recorded in Malaysia, with *H. leucospilota* being the commonest species (Kamarudin et al., 2009). These two species were sampled
from their various habitats at low tide and cultured in the laboratory. Total DNA was extracted from muscle tissues and intestines, using the 16S primer for partial characterization of the mitochondrial genomic DNA. This was followed by sequencing of their genomes for identification. This study aimed to use DNA sequencing to identify the two species of sea cucumber and also to highlight some of the factors that support the survival of one species over the other in an artificial environment.

**Materials and Methods**

**Sampling of sea cucumbers**
The samples were collected at low tide at a depth of 30cm – 100cm in two sites: a coral reef site in Teluk Kemang for *H. leucospilota*, and beneath rocks, muddy, or sandy areas near the shore at Port Dickson behind Costa Rica Hotel for *S. japonicus*. The species were collected within three quadrants each measuring 5m x 20m. YSI was used to read salinity, temperature and pH measurements and the GPS used for determining the location of the species at the sites. The sea cucumber species collected from each quadrant was counted and then stored in sea water in ice cooled containers with battery aerators to provide oxygen. They were then carried to the lab in this condition before being transferred to the aquarium.

**Culture in aquarium**
The two sea cucumber species were cultured in two separate aquariums of the same size. We used fresh water and added sodium chloride to culture each species in the aquarium. Some sand, stones, and a few corals were placed in the aquariums to mimic their natural environment. The species were left to move about in the aquarium without interference. *S. japonicus* was cultured in fresh water with salinity at 27.00ppt and left in that condition for two days. *H. leucospilota* on the other hand was cultured in a salinity level of 27.00ppt, below its optimum salinity level of 30.00ppt, and left in such a condition for two days. The salinity was adjusted to normal on the third day when they showed signs of stress. However, their conditions were monitored both in the morning and in the afternoon. Observations made on each species were recorded on a daily basis.

**Total genomic DNA Extraction**
DNA extraction was carried out using Epicenter’s DNA and RNA extraction kit according to the manufacturer’s instructions. To summarize, the samples were mixed with the kit’s tissue and cell lysis buffer containing proteinase K and incubated at 65°C for 15 mins, vortexing every 5 mins. Samples were then placed on ice for 3-5 mins, added with MPC protein, and centrifuged for 10 mins at 4°C at 8500 rpm/min. The supernatant was collected and the pellet discarded. Ice cold 99% isopropanol was added and the tube was inverted gently 35 times. The samples were centrifuged as above to pellet total nucleic acid. The isopropanol was then carefully poured off without dislodging the nucleic acid pellet. The pellet was rinsed twice with 70% ethanol, and all traces of ethanol were removed before resuspending the total nucleic acid in 35ul TE buffer. The qualitative and quantitative yield of DNA was determined by biophotometric measurements.

**Polymerase chain reaction**
PCR was carried out in a thermocycler and the sample preparations were carried out in a laminar flow in an aseptic condition. The component of the PCR reaction include ddH₂O, magnesium chloride (MgCl₂), deoxyribonucleotide triphosphate (dNTPS), Buffer A, 16S primer (forward and reverse), DNA template and Taq Polymerase. The total volume of the reaction mixture in each tube was 25ul.

PCR cycling parameters comprised of initial denaturation at 95°C for 5 mins, followed by 29 cycles of denaturation at 95°C for 45 secs, annealing at 55°C for 90 sec, and elongation at 72°C for 90 secs, and a final elongation step at 72°C for 7mins (Kamarul et al., 2010).
Purified PCR products in suspension forms were prepared prior to sending the samples for commercial sequencing to Repfon Glamor SDN BHD.

Analysis of amplified PCR product by agarose gel electrophoresis
0.84 grams (1.4%) of agar and 6ul of g bred (Promega) was prepared in 60ml of 1X TBE buffer. A 1kb DNA standard ladder (300 – 10000bp) and Hypper Ladder-IV (100 – 1000bp) were used for size separation reference. The gel was run at 70V for 90mins. Upon completion, the gel was removed and viewed under the UV light.

Results
Data collected at the sampling sites for the two sea cucumber species showed that S. japonicus are found in a salinity range of 30.00 – 31.00 part per thousand (ppt) whilst Holothuria leucospilota were found in 30.00 – 31.00 ppt salinity. Temperature values for S. japonicus ranges from approximately 31 – 32°C and 30 – 31°C for Holothuria leucospilota. The pH readings ranged from 7.80 – 8.40 and 8.00 – 8.60 for S. japonicus and H. leucospilota, respectively. The salinity mean value for both species is 31.00ppt. Mean values in temperature for the two species are 32°C and 31°C respectively. The mean pH value for S. japonicus is 8.00 and for H. leucospilota is 8.13.

The two species, S. japonicus and H. leucospilota, cultured outside their natural habitats showed some marked differences based on their ability to adapt to changes outside their natural environment. Observations showed that after 2 days of culture in fresh water S. japonicus started to reduce in size getting smaller and smaller and on the third day of culture all the species eviscerated their internal organs and eventually died. H. leucospilota on the other hand showed a little bit of stress on the first day when salinity was reduced to 27.00ppt instead of their normal salinity tolerance of 30.00 ppt. However, when the salinity value was normalized the species continued to thrive in the aquarium with the same number of organisms for 6 weeks.

The PCR result showed the amplified fragment from body tissue and intestines of S. japonicus to be approximately 600bp and 550bp from body tissue of H. leucospilota.

Discussion
The process of establishing data on sea cucumbers in Malaysia, especially biodiversity data, is very challenging because little or nothing is recorded for the very many species of sea cucumbers (Kamarul et al., 2009).However, the data collected on S. japonicus and H. leucospilota based on their salinity, temperature, and pH optimum ranges are partly in line with the data recorded by FAO Corporate Document Repository for S. japonicus in China. They reported 27 – 35ppt as the optimum salinity tolerant limit for S. japonicas (FAO Corporate Document Repository). Comparing this with the salinity value obtained for H. leucospilota there is no significant difference in the optimum salinity limit for the two species.

However, the temperature tolerant values obtained for this study’s S. japonicus is significantly different from the optimal temperature tolerance values recorded by FAO Corporate Repository Document for S. japonicus in China. The optimal temperature tolerance range they recorded was from 5 – 15°C. The data stated that when water temperatures fall below 3°C and above 17°C, the feeding habits of the species decline sharply, and as it rises to 24°C they enter the phase of aestivation. These values are far below the 31 – 32°C and 30 – 31°C recorded for S. japonicus and H. leucospilota respectively. This difference in optimal temperature tolerance could be due to the difference in geographical regions of the Stichopus species, China and Malaysia. Besides, water temperature plays a part in this case since S. japonicus, according to the study in China, was found to be a cold water species (FAO Corporate Repository Document) and in
Malaysia water temperatures may not fall below 15°C more so to 5°C. These data provided here need not necessarily be conclusive, and further studies still need to be done on these two species.

**Acknowledgements**

Special thanks to the laboratory of Marine and Aquaculture, Institute of Bioscience, UPM, The Islamic Development Bank Group (IDB), and University of The Gambia (UTG) for their unflinching support and valuable advice.

**References**


Biodiversity and cultivation of sea star, *Astropecten indicus* at Kuala Perlis, Perlis

Ahmad Fakhrurrazi Mokhtar* and Mariana Nor Shamsudin

Laboratory of Marine Science and Aquaculture (MARSLAB), Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author's email: mariana@medic.upm.edu.my

Abstract

Biodiversity is needed to give information about how a particular species plays its role in certain habitat. To culture sea stars in a suitable artificial environmental condition, we need to investigate and have a better understanding of their natural habitat. Sea stars that were found and quite abundant in Kuala Perlis were of the species, *Astropecten indicus*. GPS and YSI data had been used to determine and measure physical parameters of the sea water. Lift-net had been used to catch the sea stars and culture them in aquarium of lab condition. The genomic DNA of sea star was extracted and amplified using the 16S primers and the size of DNA fragment was 600 bp. Basic Local Alignment Search Tool (BLAST) Version 2.0 was used to analyse sequenced PCR product for confirmation of the species based on the nucleotide and protein databases provided.

Keywords: culture, artificial, lift-net, 16S primers, databases

Introduction

Asteroidea is one of the classes in Phylum Echinodermata, which is the second largest group of deusterostomes after chordates. Asteroidea is more generally related as starfish and sea star. A sea star commonly exhibit radial symmetry that typically has five arms; however, some species have more and some species have less (Zulfigar et al., 2008). Its habitat is mostly at coastal areas and found as living benthos. They usually feed on mussels, small fishes and dead organisms. Fisherman at Kuala Perlis, Perlis stated that when the number of mussels decreases, the number of sea stars will increase. The sea stars were usually accidentally caught together with mussels. The fishermen usually threw the sea stars back into the sea because they are of no commercial value. Consequently, this will increase the number of sea stars in the sea water, resulting in the need to study the population and distribution of these sea stars known as *Astropecten indicus* Doderlein, 1888. Nowadays, marine aquariums are becoming more popular. The sea star can be used as an ornament because of the small size of this creature which can easily be put inside an aquarium. We can keep the sea stars for a long time and also do further research on this invertebrate. The small aquarium can be set up to put these small animals. Other marine animals or plants including corals can be put inside the aquarium to make it more diverse and colourful. Thus, these will decorate the aquarium. Therefore, by using these sea stars will increase the use of this abundant species beneficially as ornaments, as well as maintaining their population in the sea. This paper is aimed to provide an overview of the species of sea stars that are found in Kuala Perlis and to culture these sea stars in the lab with nearly exact environmental condition as their natural habitat. DNA sequencing is also aimed to be done to identify and confirm the species of these sea stars.
Materials and Methods

Sea stars, *Astropecten indicus* (Figure 1) were collected at the coastal area of Kuala Perlis (N 06°18.477', E 100°09.400') at the end of May 2010 by using Malay lift-net (pukat tangkol). The lift-net had been placed on the substrate in the water at depth 3m and left for about 1 hour. After that, it was lifted rapidly to the surface and the number of sea stars in the net had been counted. Bait (dead fish) had been used to attract the sea stars into the net (English et al., 1997). The environmental parameters had been taken by using YSI 556. The sea stars were put in a bucket with lid and then aerated by using a battery aerator. They were then sent to the laboratory and transferred into a small aquarium (30cm x 30cm x 45cm). The aquarium has sand and seawater. The seawater was changed once a week. After 1 month, artificial seawater was added to replace the previous natural seawater. The salinity of the water was 30ppt. The sea stars were fed with dead fishes. DNA extractions from the body tissue of the sea star were done by using Epicentre DNA and RNA Extraction Kit and proceed to polymerase chain reaction (PCR). Purified PCR products in suspension form were prepared to send for sequencing and the process was done by Repfon Glamor Sdn. Bhd. The sequenced PCR product was analysed by using BLAST.

Results

The number of sea stars that had been caught was counted per lift. The environmental parameters for seawater of the coastal area of Kuala Perlis are on Table 1. At the sampling site, 114 sea stars were caught for 6 lifts. For each lift, the average number of sea stars caught was 19. The distance between one lift to another lift was about 8m.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>31</td>
</tr>
<tr>
<td>Salinity (g/L)</td>
<td>30.53</td>
</tr>
<tr>
<td>DO (%)</td>
<td>115.00</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>7.21</td>
</tr>
<tr>
<td>pH</td>
<td>7.55</td>
</tr>
</tbody>
</table>

Table 1. Environmental parameters for seawater of coastal area of Kuala Perlis.

To culture and conserve the sea stars, they had been put in a small aquarium with sand and good aeration (Figure 2). At early cultivation, seawater taken from the sampling site had been used in the laboratory. The aquarium was put in room temperature. All 114 sea stars with sizes ranging from 5 cm to 8 cm can be put in one aquarium. Initially, they were given food such as pellet but were not consumed. After replacing the food with very small dead fish, the sea stars swallowed wholly inside its mouth. The sea stars remain alive after replacing the seawater with artificial seawater in the aquarium. The conditions from environmental parameters at the sampling site were closely followed.

The PCR result showed the amplified fragment from the body tissue of *Astropecten indicus* to be approximately 600 bp and confirmed the species from the sequencing by using BLAST analysis.
Discussion

In this study, *Astropecten indicus* is the only species found in the coastal area of Kuala Perlis and quite abundant in the area. It can be recognized by its small size, pale colour with upper and lower plates fringed with small spines. Molecular genetic analysis confirmed that the species of the sea star is *Astropecten indicus*. The lift-net used can only catch the sea stars but cannot be used to measure exact quantitative per area. After one month in natural seawater, the sea stars remain alive when replaced with artificial seawater in the aquarium. This shows that the sea stars can still live in artificial seawater by following the physical parameters of the natural habitat. They are not very sensitive to environmental changes even though they showed a little bit of stress at early stage. They still can adapt to a new environment. The sea stars can also live even though food was not given in a week. We still need further research on this invertebrate as suitable ornamental or household pet. We can keep the sea stars in the laboratory for other observation with proper handling.

Acknowledgements

Special thanks to all personnel in Laboratory of Marine Science and Aquaculture (MARSLAB), Institute of Bioscience, UPM and Fisheries Development Authority of Malaysia (Perlis) for their support, valuable advice and cooperation.

References


Zooplankton community structure in riverine coastal ecosystem, Kota Marudu, Sabah during dry season

Marinni Khir¹ and Fatimah Md. Yusoff¹,²

¹Department of Biology, Faculty of Science, Universiti Putra Malaysia
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

²Institute of Bioscience, Universiti Putra Malaysia
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

Corresponding author’s email: fatimah@ibs.upm.edu.my

Abstract

This study was undertaken to determine the community structure of zooplankton in riverine coastal ecosystems in Kota Marudu, Sabah during the dry season. The samples were collected from 15 stations covering four different rivers, estuary and marine zone. Eleven different zooplankton groups dominated by copepods were recorded in the study area. Copepods contributed the highest percentage (72.50%) among the zooplankton in all the stations, followed by bivalve larvae (11.21%), barnacle larvae (6.70%), and lowest being the protozoan (0.02%). The highest zooplankton density (357553 ± 328487 ind/m³) and diversity (H’=1.893 ± 0.581) was observed in Sungai Selaping, whereas, the lowest zooplankton density (29591 ± 1585 ind/m³) and diversity (H’=0.95694±0.14066) were observed in Sungai Langkorn. These differences might be due to the influences of fresh and sea water influx in both locations. In addition, the amount of nutrient available in the locations may also be an important factor. Multi dimensional scaling (MDS) analysis based on zooplankton abundance showed two distinct groups. The first group consisted of the river stations and the other consisted of the estuarine and marine stations. The result of this study revealed a distinct separation zooplankton population between the riverine and coastal ecosystems.

Keywords: copepods, salinity gradient, abundance, diversity, density

Introduction

Zooplankton serves as the key link between phytoplankton and the higher consumers such as shellfish, birds and mammals (Diebel, 2001). Zooplankton is one of the most important groups of organisms in the aquatic ecosystem. Zooplankton growth and distribution are dependent on abiotic and biotic parameters which is why they are usually viewed as high potential bio-indicator (Zannatul-Ferdous and Muktadir, 2009; Beyst et al., 2001; Escribano and Hidalgo, 2000; Christou, 1998). The differences in the environmental factors such as salinity, temperature and pH between the sea and freshwater ecosystems lead to differences in species diversity. According to Silva et al. (2009), salinity variation and other environmental factors including nutrients play vital roles where they can influence the composition and distribution of species in the aquatic ecosystem.

Materials and Methods

Study area

The study was carried out at Kota Marudu, Sabah, Malaysia which is situated at 6°30’-7°00’ North and 116°46’-117°07’ East, at the northernmost point of Sabah. Fifteen sampling stations (four river stations, five estuaries stations and six sea stations) were established in the area (Figure 1).
Field sampling and laboratory procedures

Samples were collected during dry season (wherein the saline and brackish swamps are partially dry out) of 2009. Zooplankton samples were collected using plankton net (100µm mesh size) towed vertically from the deepest depth at every station. Samples were preserved with 10% buffered formalin. Identification and enumeration were done under the dissecting microscope for large zooplankton and inverted microscope for smaller zooplankton. Zooplankton were identified to the lowest taxon possible. Density is reported as individuals per m³.

Results

Eleven different zooplankton groups dominated by copepods were recorded in the study area. Copepods contributed the highest percentage (72.50%) among the zooplankton in all the stations, followed by bivalve larvae (11.21%), barnacle larvae (6.70%), and lowest being the protozoan (0.00%) (Figure 2a). In terms of density, Sungai Selaping marked the highest density with 357553 ± 328487 ind/m³, while Sungai Lankon has the lowest zooplankton density (29591 ± 1585 ind/m³) (Figure 2b). The species richness was highest in marine stations (1.71 ± 0.077), whereas, the diversity index (1.893 ± 0.581) and species evenness (0.706 ± 0.208) were highest in Sungai Selaping (Figure 3). However, the differences in the indices were not significant (p>0.05). Multi dimensional scaling analysis based on zooplankton density showed two main groups at 60% similarity. The first group consisted of zooplankton population from the river stations while the second group consisted of zooplankton population from estuary and marine stations (Figure 4).

Figure 2(a). Percentages of different zooplankton group; 2(b). Total density of zooplankton in the riverine-coastal ecosystems in Kota Marudu, Sabah.
Discussion

In the present study, the copepods (calanoids and cyclopoids) were the most abundant zooplankton group observed. Generally, among the zooplankton, copepods were the most numerous taking more than 50% of the total zooplankton populations (Rezai, 2002; Johan, 2001; Matias-Peralta, 2010; Safura, 2010). Among the non-copepod portion of the zooplankton, bivalve larvae and barnacle larvae recorded the highest percentage. This finding was similar to that of Hirst et al. (1999) who reported that for the non-copepod component, barnacles larvae usually found as one of the major group within the meroplankton community structure. Meanwhile, the variations in zooplankton composition which was observed in this study was mainly due to the differences in salinity in different stations. According to Silva et al. (2009) salinity is the main factors in addition to temperature, pH and nutrients were responsible for the changes in zooplankton community structure. Likewise, Derry et al. (2003) reported that in addition to salinity, other factors may significantly alter the structure of zooplankton communities such as ion composition, food availability (Toumi et al., 2005) and predation pressure (Williams, 1998).

References


Zooplankton abundance and distribution along Perak River estuary during northeast monsoon season

Nur Zulikha Zakariya1* and Fatimah Md. Yusoff1,2

1Department of Biology, Faculty of Science
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

2Laboratory of Marine Science and Aquaculture, Institute of Bioscience
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: fatimah@ibs.upm.edu.my

Abstract

This study was undertaken to determine the abundance and distribution of zooplankton along Perak River estuarine system during Northeast (NE) monsoon. Four sampling stations were selected along the salinity gradient covering stations in the upstream to 1 km off the coastal area. The zooplankton samples were collected by vertical tow using conical plankton net (100 µm mesh size). The zooplankton samples were identified to the lowest possible taxa. A total of 12 zooplankton taxa dominated by copepods (> 50% of total zooplankton count) were identified followed by the protozoans mainly from the genus Tintinopsis throughout the season. Changes in the zooplankton community were observed in different stations, wherein the upstream, estuarine and marine stations were dominated by rotifers, protozoans and copepods, respectively. Cladocerans and rotifers were present only in the upstream, whereas, copepods were distributed in all the stations. Highest mean zooplankton density (25.6 x 10³ ± 3473.4 individuals m⁻³) was recorded in the marine stations followed by estuary station and lowest in the upstream station (17.36 x 10³ ± 2158.9 individuals m⁻³). However there was no significant difference between the three stations (P>0.05). Zooplankton density showed a distinct pattern of abundance where low densities were recorded during the beginning and increasing towards the end of the monsoon season. Multidimensional scaling (MDS) analysis based on zooplankton abundance revealed that the upstream station was a distinct ecosystem compared to the others. In general, the zooplankton community structure in terms of composition and abundance change with salinity gradient.

Keyword: Salinity gradient, estuarine system, community structure

Introduction

Tropical estuaries are complex productive ecosystems (Correll, 1978). This transitional zone between freshwater and marine ecosystem, serve as habitats of some zooplankton that have high tolerance and can survive in the brackish water of estuaries. In Malaysia, information on zooplankton in estuarine system is lacking, although zooplankton plays important roles as the link between primary producer and higher trophic levels. Study of zooplankton community was done at Perak River estuary during the NE monsoon to investigate the changes in zooplankton community along the salinity gradient of this particular river. Perak River situated on the north part of peninsular Malaysia. Serving as natural boundary between two states, Perak River was the second largest river in peninsular Malaysia. Perak River was chosen as the study sites because of its unique characteristic where sometimes its salinity can be very low even in the river mouth, and constant throughout the water column. This can be crucial because salinity was one of the main factor that determine the composition of zooplankton in that particular area (Rezai, 2005). This study become important as many fisheries activity were carried out within this area, namely recreational fishing and jellyfish fishing.
Materials and Methods

The samples were collected from four stations along the Perak River estuary. Station 1 was located in the upstream, two stations in the estuary and the last station in the river mouth. The samplings were done during Northeast Monsoon starting from November 2009 until February 2010. The samples were collected in vertical hauls using conical plankton net (100µm mesh size with cod end) from the deepest depth of each station to the surface. The sample were fix immediately with 4-5% formalin (buffered with sodium tetraborate to pH 8-8.2) on boat. Then, the zooplankton samples were brought back to laboratory for identification and enumeration using Bogorov counting chamber under dissecting microscope.

Results

A total of 12 groups of zooplankton were found along the Perak River Estuary. Copepoda was the most dominant group (consist of 24 species from 12 genera) throughout the sampling (Figure 2) contributing up to 86.9% from the zooplankton sample and followed by protozoans (10.0%). The rest of other zooplankton groups were only contributed less than 1% of the total zooplankton population. The highest zooplankton density (Figure 3) was recorded in the marine station (25.6 x 10^3 ± 3473.4 individuals m^-3) while the lowest was recorded in the upstream station 17.36 x 10^3 ± 2158.9 individuals m^-3). Multi dimensional scaling based on zooplankton abundance showed three major groups at 50% similarities (Figure 4). The first group was only consist of the zooplankton collected in the upstream station whereas the remaining two groups were consist of the combination of the zooplankton collected in both estuary and marine stations.

Figure 1. Map of the sampling location in Perak River Estuary showing the sampling stations (marked with stars).

Figure 2. Percentages of major zooplankton groups during northeast monsoon season in Perak River Estuary, Malaysia.
Discussion

In this study, the lowest zooplankton density was recorded in the upstream station and highest in the sea. In the contrary, Prabath (2005) found highest zooplankton densities in the Langat River estuarine stations and lowest in the marine stations. This might be due to the influence of saline or freshwater into that particular station that causes the high nutrient availability. Rezai (2004) and Wickstead (1958) stated that a variety of physical, chemical and biological factors including salinity may affect the density of some zooplankton. Multi dimensional scaling analysis based on zooplankton abundance in Perak River shows that the zooplankton community was distinctly different in the upstream station. Cladocerans and rotifers were only found in the upstream station, while copepods were found in all stations, even though only copepod naupli and copepodite stage were found in the upstream station. The marine and estuarine stations were grouped together probably due to the tidal factor. The freshwater flush from the large Perak River might have cause the marine station to have similar zooplankton composition as the estuary.
References


Spatial and temporal distribution of phytoplankton along salinity gradient during northeast monsoon season in Perak River estuary, Malaysia

NurSuhayati Abu Seman and Fatimah Md. Yusoff

1Laboratory of Marine Science and Aquaculture, Institute of Bioscience Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

2Department of Biology, Faculty of Science Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author's email: fatimah@ibs.upm.edu.my

Abstract

The phytoplankton distribution was studied along the salinity gradient in Perak river estuarine system during northeast monsoon (from November 2009 to February 2010). Four stations along the salinity gradient were established. The phytoplankton comprised of six main families namely, Bacillariophyceae (diatoms), Chlorophyceae (green algae), Cyanobacteria (blue-green algae), Chrysophyceae (golden-brown algae), Euglenophyceae (euglenoids) and Pyrrophyceae (dinoflagellates). A total of 94 species of phytoplankton were recorded from all the stations throughout the season, with green algae and diatoms dominating the upstream and the marine, respectively. On the other hand, the estuarine stations were dominated by both green algae and diatoms. The marine station have the highest (p<0.05) species density during the season compared to other stations with a mean total density of 190.6±27.4 cells/mL, whereas the lowest (p<0.05) density (73.8±11 cells/mL) were found in the upstream station. Multidimensional scaling analysis based on the phytoplankton densities revealed two distinct groups. The first group consisted of the phytoplankton from marine station, whereas the other group consisted of the phytoplankton from estuarine and upstream stations. Generally, phytoplankton distribution in Perak River estuary follows the same pattern as other estuaries in tropical countries.

Keywords: upstream, estuarine, marine, dominant species, means density

Introduction

Phytoplankton is a very important primary producer for the aquatic ecosystem (Lalli and Parsons, 1993). Generally, most marine and freshwater organisms depend on phytoplankton which serves as a base for the food chain (Townsend et al., 2000; Miller, 2005). The distribution of phytoplankton population is largely limited to the photic zone, where the energy production of phytoplankton by photosynthesis matches their energy destruction by respiration. (Fogg and Thake, 1987). The degree of salinity gradient stability in the water bodies was reported to be a primary factor to the growth and diversity of phytoplankton communities (Leyland and Brown, 2000). Marine phytoplankton is adapted to high salinity and usually cannot survive in freshwater. However some marine or freshwater species have evolved a tolerance to the different salinity fluctuations and therefore they can survive in the brackish water of estuaries.

Materials and Methods

Study site

The study was carried out at Perak River estuary up to 1km off the coastal area. The origin of Perak River is from Titiwangsa Mountain while the river mouth is at Hilir Perak, whereas
the coastal area is along the Malacca Straits. The length of the Perak River is about 760 km, with water flowing from the mountainous Perak-Kelantan-Thailand border of the Belum Forest Reserve. The salinity distribution in the Perak River estuarine system is affected by the interactions of fresh and salt water, tidal energy as well as wind influence.

Sample collection
Sample collection was carried out during the northeast monsoon season from November 2009 until February 2010. The four stations represent the upstream (Station 1), estuarine (Stations 2 and 3) and marine zone (Station 4) (Figure 1). Water samples were collected at 1m depth interval using 5 L Niskin water sampler. Samples were preserved in Lugol’s Iodine for phytoplankton identification and quantification. In the laboratory, samples were sedimented and concentrated to a working volume of 100 mL. Enumerations of the phytoplankton were done under Leitz Diavert inverted microscope following Uthermohl (1958). Random non-overlapping fields were examined until at least 150 units of the dominant species were counted. The phytoplankton density was calculated in terms of number of cells per millilitre of water.

Results
Generally, there are six main family of phytoplankton in Perak Estuary. These were Bacillariophyceae (diatoms), Chlorophyceae (green algae), Cyanobacteria (blue-green algae), Chrysophyceae (golden-brown algae) Euglenophyceae (euglenoids) and Pyrrophyceae (dinoflagellates). A total of 94 species of phytoplankton were recorded from all the stations throughout the season wherein 55 species were found in the marine station. Among the phytoplankton, diatoms have the most number of species (53) followed by green algae (24), blue-green algae (7), euglenoids (6), dinoflagellates (3) and chrysophytes (1). Throughout the season and from all the stations, diatoms dominated taking up 63% of the total phytoplankton populations, followed by green algae (20%), cyanobacteria (9%), euglenoids (6%) and 1% for both chrysophytes and dinoflagellates (Figure 2).

Among the stations, marine station has the highest total mean density (p<0.05) of phytoplankton (190.6±27.4 cells/mL) followed by estuarine stations (128.8±14 cells/mL) and upstream station (73.8±11 cells/mL) (Figure 3a). Phytoplankton density was highest during the month of January with mean total density of 154.3±24.7 cells/mL, whereas the lowest density was recorded in December with mean total density of 106.2±16.1 cells/mL. However, there was no significant difference between month (p>0.05) (Figure 3b).

The MDS analysis based on phytoplankton density revealed two distinct groups at 45% similarity. The first group consisted of phytoplankton from marine station while the other group consisted of phytoplankton from both estuarine and upstream stations (Figure 4).
Figure 2. Percentages of different phytoplankton groups during northeast monsoon along the salinity gradient in Perak River estuary, Malaysia.

Figure 3. (a) Mean density of phytoplankton in different sampling stations during northeast monsoon along the salinity gradient; (b) mean density of phytoplankton in different months during northeast monsoon season in Perak River estuary, Malaysia. Different letters denotes significant differences (p<0.05).

Figure 4. Multi-dimensional scaling (MDS) based on phytoplankton species abundance during northeast monsoon season along Perak River estuary, Malaysia.

Discussion

Similar to many freshwater ecosystems, green algae were found to dominate the upstream station. On the other hand, diatoms dominated the estuarine and marine zone. A total of 94 species of phytoplankton were recorded from all the stations throughout the season wherein
55 species were found in the marine station. Likewise, marine station recorded the highest density of phytoplankton compared to estuarine and upstream zone perhaps due the higher nutrient availability in the sea than in the upstream. Meanwhile, estuarine stations phytoplankton species both from freshwater and marine stations were observed. Due to frequent flushing and mixing of freshwater and marine waters in the sampling area, many species from upstream and marine zone have adapted to the estuarine condition. In addition, nutrient concentrations may also contribute as important factor influencing the rate of phytoplankton growth (Spies and Parsons, 1985). Generally, the phytoplankton composition and distribution in Perak river estuary follows the pattern of other estuaries in tropical countries (Costa et al., 2009).

References


The root profile of *Avicennia alba* in Carey Island, Selangor

Noraziera Mohd Fadhi, Normaniza O. and Rozainah Mohd Zakaria*

*Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia*

*Corresponding author’s email: rozainah@um.edu.my*

**Abstract**

Rapid development in coastal areas may lead to coastal erosion. The shear strength of the mangrove vegetation’s root system helps to reduce coastal erosion by holding or anchoring the soil and forms a binding network within the soil layer. In this study, *Avicennia alba* was determined for its correlation of its root properties (soil shear strength, root volume, root order) against its height and biomass. Four cohort of plant’s height were used; 10 – 30 cm, 31 – 50 cm, 51 – 70 cm, and 71 – 90 cm. The results indicated that the root properties values were positively correlated with the plants’ height and biomass. It also showed that *Avicennia alba* have the average shear strength around 31 kPa to 36 kPa on the muddy area. Root order and root volume is increasing with the increasing of shear strength value. The higher root order is 11 and the lowest is 1 which related to the magnitude of the root. Total plant fresh weight also positively correlated with the shear strength value. The significant increment of soil shear strength with the presence of this species may imply that A. alba has the potential to act against coastal erosion.
Poster Papers:
Environmental Stressors
Effect of elevated water temperature at a coastal power plant on phytoplankton assemblages

A.H. Muhammad Adlan*, W.O. Wan Maznah1,2 and Khairun Yahya1,2

1School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia
2Center for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia, 11800 Penang, Malaysia

Corresponding author’s email: wmaznah@usm.my

Abstract

A study on the phytoplankton community structure in the coastal waters adjacent to a thermal power plant was carried out monthly between September 2009 and April 2010. The objectives of the study were to determine the changes in the composition and abundance of phytoplankton in the coastal waters adjacent to the power plant as well as to relate its abundance with elevated water temperature. The phytoplankton samples were collected at surface water at three sampling stations adjacent to the power plant using 35μm mesh-sized plankton net. Three sampling stations were designated which include the outlet and inlet points and also a station at the open-sea which represented a reference area. The highest mean water temperature at the outlet point was 36.70 ± 0.96°C, followed by inlet point with 30.6 ± 1.56°C, and open-sea with 30.4 ± 0.78°C respectively. Four phytoplankton’s group was identified during the study and Bacillariophyta (constituting up to 97.42%) was the major phytoplankton’s group followed by Chlorophyta (1.76%), Cyanobacteria (0.50%), and Dinomastigota (0.32%). The inlet point recorded slightly higher mean total abundance of phytoplankton (60704.17 ± 135378.78 Cells/m³) followed by the open-sea (36604.18 ± 65755.47 Cells/m³, and outfall point (28717.63 ± 40972.68 Cells/m³). Phytoplankton abundance was not significantly different among the sampling stations (Sig. = 0.763, p>0.05) and showed insignificant positive correlation with water temperature (r = 0.087). This study showed that the thermal discharge slightly altered the total abundance of phytoplankton, but does not change the overall species composition. Phytoplankton was able to tolerate the thermal exposure by showing a small difference of total abundance between outlet and inlet points.

Keywords: phytoplankton, power plant, temperature, thermal effluent

Introduction

Coastal waters serves as a cooling fluid for electric power industry. A coal-fired power plants discharge large amount of heat to cooling water during the process of steam condensation. The water is drawn from an intake point in the water body near the power station. It is used to discharge the heat waste in the condensers and then released back into the water body through the outlet point. The temperature of the discharged effluent may be about 7 to 10ºC above the ambient water temperature. In this study, phytoplankton in the receiving water body (outlet point) was exposed to the thermal effluent and its composition and distribution may be compromised. Phytoplankton is sensitive to environmental changes such as high water temperature, thus influencing the community structure of the higher trophic levels in the marine ecosystem (Lo et al., 2004). As primary producers, phytoplankton is affected by warm water because higher water temperature increases their growth rates, resulting in a shorter lifespan and species overpopulation.

Materials and Methods

The study was carried out at Sultan Azlan Shah Power Station (SASPS), which was located at the west coast of Peninsular Malaysia (Figure 1).
The samples collection was conducted monthly from September 2009 to April 2010. Global Positioning System (GPS) was used to record the coordinate of each sampling stations. A total of 3 sampling stations adjacent to the power plant were established; these included the inlet point (4°08'27.83"N, 100°38'07.44"E), outlet point (4°09'14.28"N, 100°38'22.28"E), and open-sea (4°09'20.09"N, 100°37'08.69"E). The station at the open-sea represented a reference. Phytoplankton samples were collected at approximately 5 cm below the surface water at each sampling stations by filtering 40 litre of seawater through 35 µm mesh-sized plankton net. The phytoplankton samples were preserved using Lugol's solution. At the laboratory, the samples were identified and enumerated for each species present. Identification of phytoplankton was carried out by referring the taxonomic key from Tomas (1997) and Shamsudin (1990) while phytoplankton composition and enumeration were based on the methods recommended by Lobban et al. (1988). Water temperature at all sampling stations was measured in-situ. Statistical analysis was done to determine the spatial patterns of distribution and composition of phytoplankton species. Correlation between phytoplankton and water temperature was determined using the statistical program of Statistical Package for the Social Sciences (SPSS) version 15.0. The one-way ANOVA was used to analyze the significant difference of phytoplankton abundance between sampling stations. The Pearson’s correlation was used to analyze the correlation between phytoplankton abundance and water temperature.

Results

Four phytoplankton’s group was identified during the study period and Bacillariophyta (constituting up to 97.42%) was the major phytoplankton group followed by Chlorophyta (1.76%), Cyanobacteria (0.50%), and Dinomastigota (0.32%). The most common phytoplankton species at SASPS were Chaetoceros curvisetus, Oscillatoria corallinae, and Odontella sinensis. Higher mean total abundance of phytoplankton was recorded at the inlet point and open-sea with $60704.17 \pm 135378.78$ Cells/m³ and $36604.18 \pm 65755.47$ Cells/m³ respectively compared to the lower mean total abundance recorded at the outlet point with $28717.63 \pm 40972.68$ Cells/m³. On the hand, outlet point recorded the highest mean water
temperature with 36.70 ± 0.96°C, followed by Intake point with 30.6 ± 1.56°C, and open-sea with 30.4 ± 0.78°C respectively (Figure 2). One-way ANOVA analysis showed that there was no significant difference of phytoplankton abundance between sampling stations (Sig. = 0.763, p>0.05). Pearson’s Correlation analysis showed insignificant positive correlation between phytoplankton abundance and water temperature (r = 0.087).

![Figure 7](image)

**Figure 7.** Mean total abundance (Cells/m$^3$) of phytoplankton and mean water temperature (°C) at the coastal waters of SASPS.

**Discussion**

Mean total abundance of phytoplankton at all sampling stations was not varied. The highest mean total abundance of phytoplankton was recorded at the Intake point whereas the lowest was at the Outfall point. The circulation between surface water and bottom water at the Intake point remobilized the nutrients from sediments, thus enhancing the production of phytoplankton (Illus and Keskitalo, 2008). Furthermore, the location of the Intake point was approximately 1 km away from the Outfall point, thus reducing the effect of thermal stress on phytoplankton. Meanwhile, lower abundance of phytoplankton at the Outfall point was due to thermal stress. The thermal effluent caused the reduction of phytoplankton diversity and abundance (Choon, 2003).

As a conclusion, this study recorded highest mean total abundance of phytoplankton at the Intake point whereas the lowest was recorded at the outlet point. Phytoplankton was able to tolerate the thermal exposure by showing a small difference of total abundance between Outfall and Intake point.

**Acknowledgements**

The authors are grateful to the Centre for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia, and Tenaga Nasional Berhad Research (TNBR) for supporting this study.

**References**


Heavy metal concentrations in the medaka fish (*Oryzias javanicus*) as a new research organism collected from Linggi Estuary in the west coast of Peninsular Malaysia

Dariosh Khodadoust* and Ahmad Ismail

Department of Biology, Faculty of Science, Universiti Putra Malaysia
43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: dariosh_khodadoust@yahoo.com

Abstract

This study aimed to determine Cu, Cd, Zn, Pb and Ni concentrations in different tissues of Java Medaka (*Oryzias javanicus*) from the Linggi Estuary of Peninsular Malaysia. The Linggi River Basin is located in the south western part of the state of Negeri Sembilan, Peninsular Malaysia. Linggi River covered with mangrove and plant is a suitable place for living of Java Medaka. There are a lot of industrial and aquaculture activities such as oil palm mills, urbanization, and else around the river that all those activities were reported to elevate Heavy Metals in the environment. In the sampling stations the physicochemical parameters of water were: pH= 7- 7.2, Salinity= 7.1 – 7.4p.p.t, Temperature =29.3 – 30.5˚c and Conductivity = 13.54 – 13.94 ms. Concentrations of Cd, Cu, Pb, Zn and Ni was determined by using aqua-regia method. The concentrations of metals in the different parts of fish tissues, the highest concentration of Cu found is in digestive organs (17.78 µg/g⁻¹), for Cd in caudal muscle (2.32 µg/g⁻¹), for Ni in digestive organs (14.29 µg/g⁻¹), for Pb in the head (24.22 µg/g⁻¹) and for Zn in the head also (77.99 µg/g⁻¹). This preliminary study is helpful in establishing this fish species as potential biomonitor in the future for the ecotoxicology and environment health monitoring study.

Keywords: *Oryzias javanicus*; Cu, Cd, Pb, Ni and Zn; Linggi estuary; different tissues

Introduction

Created developments in industrial and agricultural sectors and promote human life in recent decades, application of heavy metals in different fields is inevitable. Heavy metals that have found their way into the environment in different methods such as extraction, melting process, fuel combustion materials, industrialization from various ways are transmitted to water environment such as descending climate, waste discharge, accidental leakage, ship discharge water balance, industrial, agricultural and household sewerage discharge (Karadede et al., 2003; Filiazi et al., 2003; Al-Yousof et al., 2000). Following transfer of pollutants to marine environment likely to occur fish absorb values of some heavy metals trough water or food chain (Chale, 2002). Age, length, weight, sex, nutritional habits, ecologic requirements, concentration of heavy metal in water environment, physicochemical properties of water (salinity, pH, hardness and temperature) are the important factors in the accumulation of heavy metals in different organs of a fish (Canli and Atli, 2003). Even seems the amount of fat tissue can also be an important factor to pollutants accumulates in different organs such as bone, brain, muscle, gills, gonads and liver (Farkas et al., 2003). Heavy metals in the marine environment are very stable and can be harmful to many marine organisms (Langston, 1990). So focusing on study of heavy metals in coastal environment and how to access them are important. One of potential biomonitors is Java Medaka fish (*Oryzias javanicus*) in the Linggi Estuary. The aim of this study is to determine the distribution of Cd, Cu, Zn, Pb and Ni in the Java Medaka fish (*Oryzias javanicus*) collected from Linggi Estuary.
Materials and Methods

Study area and method of sediment and medaka sampling
The Linggi Estuary Basin is located in the south western part of the state of Negeri Sembilan, Peninsular Malaysia (2°.23’N and 101°.58’ E). Our sites includes: Fishing Bridge as Station 1, Streams connected to the main river as Station 2, Main River as Station 3 and between mangroves as Station 4. Java medaka were sampled by using the small size mesh hand net, the fishes usually swim together in groups.

Medaka fish tissues digestion
Three replicates of each tissue (head, caudal muscle, digestive organs) of medaka fish were dissected, pooled and dried in oven and then digested. About 0.5 – 1.0 g dry fish sample was weight and digested in 5 ml concentrated nitric acid (AnalaR grade, BDH69%), later they were put into digestion block first at low temperature (40˚C) for one hour and then the temperature was increased to 140˚C for at least three hours (Ismail et al., 1999). The digested samples were then filtered through Whatman Paper No 1 filter papers into pill box and the prepared samples were determined by using an air – acetylene flame Atomic Absorption -Spectrophotometer (AAS) Perkin-Elmer Model Analyst 880.

Ecological parameters, quality control and statistical analysis
For measuring the ecology parameters we used YSL multi probe machine and to stay away from the possible contaminations, all laboratory equipments and all glassware used were acid-washed and were washed with phosphate-free soap and double rinsed with distilled water and left to dry in a room temperature. At first the metal determine procedural blanks were analyzed and also samples of standard solution were analyzed to check the metal recovery for every metal in every five samples, in order to check of the percentage of recovery of metals ranged from 108- 115%for Cd, 101-112% for Cu, 97-106% for Zn, 87-93% for Pb and 93-101 % for Ni. All statistical analysis was done using Statistical Package for the Social Science (SPSS) for Windows V- 16.0.

Results and Discussion

Table 1. Mean Cu, Cd, Zn, Pb and Ni concentration (µg/g⁻¹) in medaka fish different tissues.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Station</th>
<th>Head</th>
<th>Digestive organs</th>
<th>Caudal muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>Station 1 (n=24)</td>
<td>10.118±0.005</td>
<td>17.786±0.054</td>
<td>4.408±0.031</td>
</tr>
<tr>
<td></td>
<td>Station 2 (n=25)</td>
<td>8.854±0.031</td>
<td>16.127±0.026</td>
<td>4.973±0.028</td>
</tr>
<tr>
<td></td>
<td>Station 3 (n=25)</td>
<td>9.467±0.143</td>
<td>17.640±0.045</td>
<td>4.757±0.025</td>
</tr>
<tr>
<td></td>
<td>Station 4 (n=23)</td>
<td>9.586±0.185</td>
<td>16.656±0.044</td>
<td>4.561±0.044</td>
</tr>
<tr>
<td>Cd</td>
<td>Station 1 (n=24)</td>
<td>2.274±0.007</td>
<td>2.029±0.020</td>
<td>2.327±0.008</td>
</tr>
<tr>
<td></td>
<td>Station 2 (n=25)</td>
<td>2.281±0.005</td>
<td>2.027±0.019</td>
<td>2.147±0.005</td>
</tr>
<tr>
<td></td>
<td>Station 3 (n=25)</td>
<td>2.259±0.004</td>
<td>2.031±0.020</td>
<td>2.266±0.004</td>
</tr>
<tr>
<td></td>
<td>Station 4 (n=23)</td>
<td>2.268±0.006</td>
<td>2.026±0.019</td>
<td>2.237±0.029</td>
</tr>
<tr>
<td>Zn</td>
<td>Station 1 (n=24)</td>
<td>77.99±0.052</td>
<td>56.26±0.042</td>
<td>40.92±0.184</td>
</tr>
<tr>
<td></td>
<td>Station 2 (n=25)</td>
<td>74.14±0.026</td>
<td>54.55±0.069</td>
<td>52.87±0.052</td>
</tr>
<tr>
<td></td>
<td>Station 3 (n=25)</td>
<td>77.24±0.044</td>
<td>53.64±0.038</td>
<td>46.6±0.077</td>
</tr>
<tr>
<td></td>
<td>Station 4 (n=23)</td>
<td>76.58±0.378</td>
<td>59.87±0.058</td>
<td>49.65±0.069</td>
</tr>
<tr>
<td>Pb</td>
<td>Station 1 (n=24)</td>
<td>14.223±0.030</td>
<td>12.196±0.230</td>
<td>8.406±0.034</td>
</tr>
<tr>
<td></td>
<td>Station 2 (n=25)</td>
<td>13.724±0.033</td>
<td>13.03±0.037</td>
<td>8.382±0.020</td>
</tr>
<tr>
<td></td>
<td>Station 3 (n=25)</td>
<td>13.968±0.035</td>
<td>12.318±0.044</td>
<td>7.072±0.036</td>
</tr>
<tr>
<td></td>
<td>Station 4 (n=23)</td>
<td>14.006±0.042</td>
<td>12.797±0.042</td>
<td>7.357±0.032</td>
</tr>
<tr>
<td>Ni</td>
<td>Station 1 (n=24)</td>
<td>10.853±0.073</td>
<td>13.344±0.042</td>
<td>9.337±0.039</td>
</tr>
<tr>
<td></td>
<td>Station 2 (n=25)</td>
<td>11.298±0.026</td>
<td>14.296±0.053</td>
<td>9.665±0.053</td>
</tr>
<tr>
<td></td>
<td>Station 3 (n=25)</td>
<td>11.107±0.049</td>
<td>13.688±0.037</td>
<td>10.392±0.037</td>
</tr>
<tr>
<td></td>
<td>Station 4 (n=23)</td>
<td>11.618±0.036</td>
<td>13.926±0.040</td>
<td>9.973±0.040</td>
</tr>
</tbody>
</table>
The concentrations of five metals in medaka fish tissues are given in Table 1. The general pattern of average metal concentrations in the different tissues of the medaka fish from the Linggi Estuary follows the order from highest to the lowest were: Zn > Pb > Ni > Cu > Cd. Metal concentrations in the different tissue are between 2.02-2.32 for Cd, 4.40-17.78 for Cu, 40.22-77.99 for Zn, 17.07-24.22 for Pb and 9.33-14.29 for Ni (µg/g⁻¹) dry weight. Comparing mean concentration of different metals, the higher mean contents of Zn, Cd and pb were found in head and of Cu and Ni in digestive organs. The levels of metals in muscle were usually less than other parts. In the same study Yap et al. (2009) reported range of Cu and Zn 3.55-5.48 and 16.2-53.8 (µg/g⁻¹) wet weight respectively in medaka fish from the 5 site of Peninsular Malaysia. Higher levels of metals that were found in the digestive organs and head of Java Medaka fish from this study were also found in other fish species in the literature. Amundson et al. (1997) reported similar phenomenon for several fish species collected from the border region between Norway and Russia. Alam et al. (2002) found that heavy metals were lowest in muscles when compared to livers, intestines, kidneys and gonads of Cyprinus carpio. Karadede et al. (2004) also found higher levels of metals in gills than muscle in mullet and catfish. Target organs such as gills, gonads, kidney and livers and metabolically active tissues accumulate heavy metals of higher levels, as was observed in experimental and field studies (Karadede and Unlu, 2004; Yilmaz, 2003). Therefore, higher levels of metals found in the head are supported by those in the literature since it is a target organ to accumulate heavy metals in high levels. Head and gill is chosen as a target organ for assessing metal accumulation since the fish gills reflect the concentrations of metals in water where the fish species live. It is also well known that muscle is not an active tissue in absorbing metals and the contamination gradients of water, aquatic animals and sediment, as well as physic-chemical factors such as temperature and interacting agents (Goyer, 1991; Canli and Furness, 1995). Bioaccumulation of heavy metals by fish, together with underlying mechanisms, has been extensively studied in the field and experimental studies. In comparing with the other results of heavy metals in different fishes, Zn, Cu and Pb levels in Java medaka were higher than those found in Tilapia fish from Klang Jaya Pond of Malaysia and Cd level is lower than those found (Yap and Ismail, 2004).The other comparison which could be useful when metal levels of other marine organisms reported in Malaysia were compared with those found in Java medaka (Table 2).

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Samples</th>
<th>Cd</th>
<th>Cu</th>
<th>Pb</th>
<th>Zn</th>
<th>Ni</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Peninsular Malaysia</td>
<td>Six species of fisheries</td>
<td>0.03-0.05</td>
<td>NA</td>
<td>NA</td>
<td>1.56-5.93</td>
<td>NA</td>
<td>Babji et al. (1979)</td>
</tr>
<tr>
<td>2</td>
<td>Peninsular Malaysia</td>
<td>Five species of fishes</td>
<td>0.04-0.07</td>
<td>NA</td>
<td>NA</td>
<td>5.36-11.1</td>
<td>NA</td>
<td>Babji et al. (1988)</td>
</tr>
<tr>
<td>3</td>
<td>Klang, Malaysia</td>
<td>Six species of fish</td>
<td>0.04-0.098</td>
<td>NA</td>
<td>2.9-15.4</td>
<td>NA</td>
<td>NA</td>
<td>Law &amp; Singh (1988)</td>
</tr>
<tr>
<td>4</td>
<td>India</td>
<td>Three molluscs</td>
<td>3.9-24.5</td>
<td>0.07-0.93</td>
<td>3.8-16.5</td>
<td>0.05-0.89</td>
<td>NA</td>
<td>Sivaperumal (2006)</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>23 species of fishes</td>
<td>0.02-0.132</td>
<td>0.17-14.7</td>
<td>0.23-0.68</td>
<td>0.6-39.2</td>
<td>0.03-0.69</td>
<td>Sivaperumal (2006)</td>
</tr>
<tr>
<td>6</td>
<td>Bagan La, Malaysia</td>
<td>Twenty fishes</td>
<td>0.04-0.18</td>
<td>0.44-2.23</td>
<td>0.53-23.8</td>
<td>NA</td>
<td>NA</td>
<td>Khatji &amp; Ismail (1992)</td>
</tr>
<tr>
<td>7</td>
<td>Bagan La, Malaysia</td>
<td>Five fishes</td>
<td>0.38-0.55</td>
<td>0.39-153</td>
<td>0.09-95.4</td>
<td>NA</td>
<td>NA</td>
<td>Ismail &amp; Saed (2000)</td>
</tr>
<tr>
<td>8</td>
<td>Almano River, USA</td>
<td>Tilapia</td>
<td>0.18</td>
<td>0.64</td>
<td>NA</td>
<td>12.2</td>
<td>NA</td>
<td>Riedel et al. (2002)</td>
</tr>
<tr>
<td>9</td>
<td>Southern Sri Lanka</td>
<td>Tilapia</td>
<td>0.0-0.2</td>
<td>0.3-1.2</td>
<td>NA</td>
<td>2.9-5.7</td>
<td>NA</td>
<td>Allinson et al. (2002)</td>
</tr>
<tr>
<td>10</td>
<td>The Golf of</td>
<td>Perna viridis</td>
<td>0.17-2.94</td>
<td>0.19-3.75</td>
<td>24.9-213</td>
<td>NA</td>
<td>NA</td>
<td>Ruangwises</td>
</tr>
</tbody>
</table>

Table 2. A comparison of reported concentration (µg/g) of heavy metals in different organisms.
Cd and Pb levels in Java medaka were higher than those found in *Perna viridis* from 9 different sites of Peninsular Malaysia, in other hand Zn and Cu levels are lower than those found (Yap and Ismail, 2003). Different concentrations of heavy metals in different tissues of fish can be because of variability of heavy metals to overcome in the field of metal links proteins such as metallothionein. Also, different metabolic activities and ecological needs of fish could be another important factor (Canli and Atli, 2003). Heavy metals are choosing based on their target organ metabolic activity of that organ. For this reason, find more metal accumulations in tissues such as liver, kidney and gills compared with muscle tissue with low metabolic activity (Filazi et al., 2003).

**Conclusions**

The present study indicated that metal distribution was found in *Oryzias javanicus*. In particular, different levels of heavy metals in the different tissues of *Oryzias javanicus* indicated that this fish could become a potential biomonitoring material of Cd and Cu while the remaining could become a potential biomonitoring organ of heavy metals. Further ecotoxicological and ecological studies are needed on this small species of fish in Malaysia.

**References**


Assessment of heavy metals in brown alga *Padina* sp. along the east coast of Peninsular Malaysia

Siti Mashitah Mohammad* and Nor Azhar Mohamed Shazili

Institute of Oceanography, Universiti Malaysia Terengganu
21030 Kuala Terengganu, Terengganu, Malaysia

Corresponding author’s email: siti_mashitah07@yahoo.com

Abstract

A study was done along the east coast of Peninsular Malaysia with 11 stations and *padina* sp., was chosen as biomonitor due to their widespread distribution. This research aims to evaluate levels for mercury (Hg), cadmium (Cd), lead (Pb), copper (Cu), zinc (Zn) and manganese (Mn), to define the general tendency for metals accumulation in *Padina* sp., correlations and to analyse the spatial variations of heavy metal content in seaweed. Samples were ground, homogenised and quantified by Inductively Coupled Plasma Mass Spectrometry (ICP-MS); Cd, Pb, Cu, Zn, Mn and total Hg by MA-2 Mercury Analyser. Accuracy was assessed by standard reference material (SRM) from National Institute of Standards and Technology (NIST-SRM) 1547 Peach Leaves. To accomplish the objectives, Spearman correlation and one-way ANOVA were performed. It is concluded that no significant variations amongst locations and most samples were in the same range of concentrations exception for Hg, Cd and Pb in Batu Layar, Zn in Teluk Cempedak and Mn in Chendering. The tendency of metals accumulation decreased in the sequence of Mn>Zn>Cu>Pb>Cd>Hg. The presented rank with high concentration of essential elements for metabolism and the partial exclusion of non-essential elements is comparable to other literatures. The mean level in these studied elements still in low concentration and below the safety limit stated by Malaysia Food Act, but continuous surveillance is a need to observe the trends of pollution and monitor the changes in the marine ecosystem.

Keywords: biomonitor, seaweed, safety limit

Introduction

Heavy metals are parts of the pollution components in our marine ecosystem. Among these innumerable contaminants, pollution by heavy metals has become a global phenomenon because of its toxicity, persistence for several decades in the aquatic environment, bioaccumulation and biomagnification in the food chain (Gochfeld, 2003). In order to evaluate the recent status of our pollution in marine ecosystems, there is a need to study their distribution and current concentration through biomonitor and in this study, using seaweed. Seaweeds are amongst the more suitable organisms for studies of heavy metal contamination in aquatic ecosystems. They have often been used as bioindicators for metal pollution in seawater because of their sessile nature, longevity, metal accumulation capacity and presence at sites prone to pollution (Chaudhuri et al., 2007).

The study was conducted along the East Coast of Peninsular Malaysia due to lack of research done at that area as only a small number of studies have provided data for the east coast (Shazili et al., 2006). The areas involved east Johor, Pahang and Terengganu except for in Kelantan due to its sandy type shores and the fact that no signs of seaweed were observed along its coastal areas. Rocky shore areas were chosen because their communities are sensitive to the effects of anthropogenic disturbance that cause pollution, which may play a vital role in the shaping of fauna and flora (Milazzo et al., 2004). All study areas were facing South China Sea, where it is expected that the majority of pollution is from land such as from large cities (sewage, industrial waste and hydrocarbons) and agricultural runoff like nutrients, pesticides and sediment (Liow, 1999). Oil and gas-related industries are
developing rapidly along the east coast of Malaysia with most of the development located in the states of Pahang and Terengganu, so there is a need to monitor the pollution status before the aquatic system along the East Coast will be severely contaminated by the heavy metals.

**Materials and Methods**

Sampling session had been done during May-June 2010 along the East Coast of Peninsular Malaysia with 11 sampling stations as in Figure 1. Samples were hand collected, washed and kept frozen in acid–cleaned plastic. Samples for analysis were digested in Merck concentrated acid and hydrogen peroxide by a Milestone closed vessel microwave digestion, prior to the ICP-MS multi elemental analysis, for Cd, Pb, Cu, Zn, and Mn. Raw samples detection was performed for Hg analysis, where samples were mixed up with additives and introduced into MA-2 Mercury Analyser which measured the concentration using cold vapour atomic absorption spectroscopy (CVAAS) inside. All the final results were blank subtracted in order to compensate for the possible elemental interference from the blank. The accuracy of this procedure was verified against the NIST-SRM 1547 Peach Leaves and the results were in good agreement with the certified value with the range was between 82% to 108%.

![Figure 1. Map of East Coast Peninsular Malaysia with the number of stations and their coordinates, where Johor (1-4), Pahang (5-6) and Terengganu (7-11).](image)

**Results**

**Heavy metals distribution**

Mean concentration of heavy metals in *Padina* sp. collected around rocky shore areas along the East Coast of Peninsular Malaysia were shown in Table 1 as below. Mean concentration in Johor covered 4 stations, 2 stations in Pahang and 5 stations in Terengganu. Mercury, cadmium and lead concentration were highest in Batu Layar, follow by copper in Sedili Kecil,
zinc in Teluk Cempedak and manganese in Chendering. The lowest heavy metals concentration stated in Cherating for Hg and Cd, in Tanjung Jara for Pb, in Kijal for Cu, in Bari Kecil for Zn and in Chendering for Mn. Manganese was the metal whose mean concentrations were highest, followed invariably by Zn, whereas Cu and Pb showed intermediate values. The rest, Hg and Cd consistently showed the lowest levels. The relative average abundance of heavy metals in the alga from the areas studied decreased in the order Mn>Zn>Cu>Pb>Cd>Hg.

Table 1. Concentration of heavy metals [(mean ± SD, min-max) in the brown alga, Padina sp.]

<table>
<thead>
<tr>
<th></th>
<th>Hg</th>
<th>Cd</th>
<th>Pb</th>
<th>Zn</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johor</td>
<td>0.04± 0.00 (0.04-0.05)</td>
<td>0.94 ± 0.06 (0.24-2.40)</td>
<td>3.64 ± 0.20 (2.39-5.98)</td>
<td>9.58 ± 1.41 (6.70-15.29)</td>
<td>32.30 ± 2.61 (19.80-44.35)</td>
</tr>
<tr>
<td><strong>Batu Layar</strong></td>
<td><strong>Batu Layar</strong></td>
<td><strong>Batu Layar</strong></td>
<td><strong>Batu Layar</strong></td>
<td><strong>Batu Layar</strong></td>
<td><strong>Batu Layar</strong></td>
</tr>
<tr>
<td>Pahang</td>
<td>0.03 ± 0.00 (0.02-0.03)</td>
<td>0.25 ± 0.03 (0.19-0.31)</td>
<td>3.17 ± 0.24 (2.75-3.58)</td>
<td>7.41 ± 0.75 (6.00-8.81)</td>
<td>77.39 ± 2.52 (21.15-133.63)</td>
</tr>
<tr>
<td><em>Cherating</em></td>
<td><em>Cherating</em></td>
<td><em>Cherating</em></td>
<td><em>Cherating</em></td>
<td><em>Cherating</em></td>
<td><em>Cherating</em></td>
</tr>
<tr>
<td>Terengganu</td>
<td>0.02 ± 0.00 (0.01-0.03)</td>
<td>0.34 ± 0.09 (0.20-0.51)</td>
<td>1.92 ± 0.47 (1.68-2.09)</td>
<td>6.05 ± 1.48 (5.25-10.84)</td>
<td>13.67 ± 1.45 (10.45-15.50)</td>
</tr>
</tbody>
</table>

** Highest in concentration
* Lowest in concentration

Statistical analysis
Spearman rank correlation and the analysis as referred in Table 2 showed significant positive correlations (p<0.01; p<0.05) for the metal pairs Pb-Hg, Pb-Zn, Hg-Cu, and Zn-Hg, with the most significant positive correlation (r=0.8091, p<0.01, n=11) corresponding to the Pb-Hg pair. Significant negative correlations showed from the metal pairs Hg-Mn, Pb-Mn and Zn-Mn, with the most significant negative correlation is Hg-Mn pair (r=-0.8000, p<0.01, n=11). ANOVA (one-way) clearly indicate that there were statistically insignificant (p>0.05) spatial variations in concentration of all heavy metals in Padina sp. collected from the East Coast of Peninsular Malaysia.

Table 2.  Spearman rank correlation for the metal concentrations in Padina sp. from the East Coast of Peninsular Malaysia.

<table>
<thead>
<tr>
<th>Padina sp.</th>
<th>Pb</th>
<th>Hg</th>
<th>Cu</th>
<th>Zn</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(+)Hg**, (+)Zn*, (+)Mn**</td>
<td>(+)Pb**, (+)Cu*, (+)Zn*, (-)Mn**</td>
<td>(+)Hg*</td>
<td>(+)Pb*, (+)Hg*, (-)Mn**</td>
<td>(+)Pb**, (-)Hg**, (-)Zn**</td>
</tr>
</tbody>
</table>

(+ Positive correlation; (-) Negative correlation; *p<0.05, **p<0.01

Discussion
The determined mean concentration of elements in Padina sp. showed the tendency of accumulation decreased in the sequence of Mn>Zn>Cu>Pb>Cd>Hg. This order follows the general sequence of the most abundant elements in seaweed where Fe>Mn>Zn>Cu, as these elements together with Co (in vitamin B12) may accumulate in algal tissues because...
they are important nutrients (Lobban and Harrison, 1994). The sequence also incomparable to literature data reported for the Gulf of Gdansk (Bojanowski, 1973) and other areas, e.g. the coast of Argentina (Zn>Cu>Pb>Cd) (Muse et al., 1999) and Aegean Sea (Zn,Mn)>(Pb,Cu)>Cd (Sawidis et al., 2001). The range of Hg, Cd, Pb, Cu and Zn concentration in wet weight with the 5.8 conversion factor for Padina sp. was still below the safety limit when compared with the permissible limit established by the Malaysia Food Act 1983.

Anova (One-Way) showed no significant variations amongst locations, and the result suggested that mean levels of Hg, Cd, Pb, Cu, Zn and Mn in Padina sp. reflected regional background levels, with the exception of Hg, Cd and Pb enrichment at Batu Layar, Johor. Batu Layar is an area that must be noted as important study area where the concentration of Hg, Cd and Pb elevated by 5, 12 and 4 magnitudes higher than the lowest. The metals analysed in this study (Hg, Cd and Pb) are included in the Dangerous Substances Directive (76/464/EEC), a list of substances originally published by the EEC in 1976, which were considered to be of particular concern in aquatic environments, due to their production volumes, persistence, bioaccumulation properties and toxicity (Crathorne et al., 2001). No localised source of contamination found around this vocational areas, suggested that the pollution must have derived through current transport from southeast areas, e.g. Teluk Ramunia, a developed area for Oil and Gas Fabrication Industries. Continuous monitoring need to be performs in order to observe the changes and trend of pollution by heavy metals spatially and temporally.

Acknowledgements

The author is indebted to Prof Dr. Noor Azhar Mohamed Shazili, a supervisor for this project with his support and guidance, family members and friends.

References


Liow, S.W. 1999. Heavy metals in marine molluscs and the barnacle, Tetracrita sp. along the rocky shores of the east and west coast of Peninsular Malaysia. Final year report, UPMT. 111pp.


Distributions of trace metals in rocky shore rock oyster *Saccostrea cucullata* along the east coast of Peninsular Malaysia

Mohd Fuad Miskon* and Noor Azhar Mohamed Shazili

*Institute of Oceanography, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia
Corresponding author's email: mohdfuadmiskon@yahoo.com

**Abstract**

This study aimed to investigate the distribution of selected metals in the soft tissue of rocky shore rock oyster, *Saccostrea cucullata* from different types of sampling sites along the east coast of Peninsular Malaysia as well as provide data for the east coast region which was scarce. Sites include Johor, Pahang and Terengganu while Kelantan was excluded because of no naturally rocky shore. Similar size oysters were chosen and analyzed at the laboratory individually and undergo closed microwave digestion system. Detection was carried out using Inductive Coupled Plasma Mass Spectrometer (ICPMS) Perkin ELMER ELAN 9000 system for Cd, Co, Cu, Zn, Mn and Pb. Hg was detected separately using MA-2 Mercury Analyzer. Data was presented based on dry weight basis (µg/g⁻¹). Results indicated that Tanjung Balau, Johor has the highest mean value of metal concentration compared with the other locations. Very high value of Pb has been discovered at Kampung Tanjung Batu (3.47 µg/g⁻¹) and Tanjung Gelang (4.38 µg/g⁻¹) in Pahang. Average distribution of metals indicated that Johor state has the highest concentration compared with Pahang and Terengganu for all metals except on Pb and Cu. Using conversion factor, analysis of metal concentration data of *S. cucullata* in this study shows that the values were still within the permissible limit by Malaysian Food Act 1983 and Food Regulations 1985 Fourteen Schedule. The results of trace metals recorded in *S. cucullata* collected from 14 sites along the east coast of Peninsular Malaysia serve as baseline data for future reference. Along with its wide distribution on rocky shore area along the east coast of peninsula, the present results supported the use of *S. cucullata* as a suitable biomonitoring agent for heavy metals in the east coast of Peninsular Malaysia.

**Keywords:** *Saccostrea cucullata*, east coast of Peninsular Malaysia, rocky shore

**Introduction**

According to Shazili et al. (2006), the information on the levels of heavy metals pollution in the Malaysian aquatic environment is scarce and limited to few studies or research. Most of the coastal resources, agriculture and economic activities and human population are concentrated on the west coast of Peninsular Malaysia, and as such, most of the studies on heavy metals have been focused in this area (Abdullah et al., 1999). Only a small number of studies have provided data for the east coast (Shazili et al., 2006).

Rocky shore had been an area of interest as studies of benthic communities show great potential for revealing the cumulative effects of disturbances on marine biota as benthic organisms can integrate the effects of long-term exposure to natural and anthropogenic disturbances. Use of benthic communities in marine pollution assessments are based on the concept that they reflect not only conditions at the time of sampling but also conditions to which the community was previously exposed. Upper sublittoral communities thriving in rocky shores are more affected than other benthic communities to urban and industrial effluents (Reish, 1987).

The use of bioindicators to study heavy metal pollution in the Malaysian environment has received much attention. Bivalves (*Perna viridis* and *Saccostrea* sp.) and gastropods (*Thais* sp.) were frequently used (Shazili et al., 2006). Rock oyster *S. cucullata* is one of cultured oyster that found in Malaysia (Malaysian Fisheries Department). From the survey, this filter
feeder species is found to have abundance distribution on the rocky shore area along the east coast region. The objective of this study is to investigate the distribution of heavy metal in *S. cucullata* at different rocky shore locations along the east coast of Peninsular Malaysia and provide metals data for the east coast region.

**Materials and Methods**

Surveys and samplings were conducted in May 2009. 14 sampling sites along the east coast of Peninsular Malaysia had been chose as it is accessible and will be involving various types of area such as industrial, recreational, vocational or undisturbed area contain bioindicator. The sampling sites covered the area of latitude-north between 05° 34' and 01° 21' and longitude-east between 104° 13' and 102° 51' from the southern to the northern end of east coast Peninsular Malaysia.

### Table 1. Sampling dates and descriptions of sampling sites in coastal waters off Peninsular Malaysia.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sampling Sites</th>
<th>Sampling Date</th>
<th>Coordinate</th>
<th>Sites Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sungai Rengit, Johor</td>
<td>21/5/2009</td>
<td>N 01° 21' E 104° 13'</td>
<td>Next to small port and urban area</td>
</tr>
<tr>
<td>2</td>
<td>Batu Layar, Johor</td>
<td>21/5/2009</td>
<td>N 01° 27' E 104° 16'</td>
<td>Undisturbed area near a small village</td>
</tr>
<tr>
<td>3</td>
<td>Tanjung Balau, Johor</td>
<td>21/5/2009</td>
<td>N 01° 37' E 104° 18'</td>
<td>Vacational area</td>
</tr>
<tr>
<td>4</td>
<td>Sedili Kechil, Johor</td>
<td>22/5/2009</td>
<td>N 01° 51' E 104° 09'</td>
<td>At the rivermouth</td>
</tr>
<tr>
<td>5</td>
<td>Mersing, Johor</td>
<td>22/5/2009</td>
<td>N 02° 26' E 103° 51'</td>
<td>Recreational area</td>
</tr>
<tr>
<td>6</td>
<td>Kampung Tanjung Batu, Pahang</td>
<td>22/5/2009</td>
<td>N 03° 12' E 103° 27'</td>
<td>Undisturbed area</td>
</tr>
<tr>
<td>7</td>
<td>Teluk Cempedak, Pahang</td>
<td>23/5/2009</td>
<td>N 03° 49' E 103° 22'</td>
<td>Vacational and recreational area</td>
</tr>
<tr>
<td>8</td>
<td>Tanjung Gelang, Pahang</td>
<td>23/5/2009</td>
<td>N 03° 58' E 103° 25'</td>
<td>Discharge area of waste from nearby industrial factory and industrial area</td>
</tr>
<tr>
<td>9</td>
<td>Cherating, Pahang</td>
<td>23/5/2009</td>
<td>N 04° 08' E 103° 24'</td>
<td>Recreational area</td>
</tr>
<tr>
<td>10</td>
<td>Kijal, Terengganu</td>
<td>7/6/2009</td>
<td>N 04° 19' E 103° 29'</td>
<td>Recreational area</td>
</tr>
<tr>
<td>11</td>
<td>Kemasik, Terengganu</td>
<td>7/6/2009</td>
<td>N 04° 25' E 103° 27'</td>
<td>Recreational area</td>
</tr>
<tr>
<td>12</td>
<td>Tanjung Jara, Terengganu</td>
<td>7/6/2009</td>
<td>N 04° 48' E 103° 25'</td>
<td>Vacational area</td>
</tr>
<tr>
<td>13</td>
<td>Chendering, Terengganu</td>
<td>7/6/2009</td>
<td>N 05° 16' E 103° 10'</td>
<td>Next to Chendering Fisheries Port</td>
</tr>
<tr>
<td>14</td>
<td>Bari Kecl, Terengganu</td>
<td>8/6/2009</td>
<td>N 05° 34' E 102° 51'</td>
<td>Undisturbed area</td>
</tr>
</tbody>
</table>

About 10 specimens rock oyster *S. cucullata* of relatively similar sizes were collected during low tide referring on the tides schedule by Malaysian Fisheries Department. Samples were placed within an ice chest during transportation to the laboratory. Samples were washed under running deionised water prior to preserve frozen at -20°C at the laboratory. After thawing at room temperature, samples were extracted from their shells. In order to evaluate the water content and conversion factor, wet weight of samples will be recorded. Extracted soft tissues were undergo freeze drying process (Labconco) before being weighed again for dry weight calculation. Freeze-dried soft tissues were homogenized using porcelain mortar or pestle. Grounded samples were stored in acid clean plastic bottles in a desiccator with Bendosen silica gel at room temperature.

0.3 gram of sample was accurately weighted in the Teflon vessel. After addition of concentrated nitric acid (HNO₃) "Merck", the vessels were inserted into the microwave oven and heating proceeded at 210°C for 30 minutes in Milestone ETHOS PLUS microwave.
digested. Digested samples were diluted to a certain volume with mili-Q water (18.2Ω). Analysis of heavy metals was carried out using ICPMS. The concentration of metals in samples was blank corrected and expressed as µg g⁻¹ dry weight. As for Hg, 50 mg of dried samples added with fixed additives in a boat introduced into Mercury Analyzer which measured by cold vapour atomic absorption spectroscopy (CVAAS) inside.

All the glassware and equipment used were washed with Decon90 before being immersed in 10% nitric acid (HNO₃) solution for at least 24 hours prior to sampling and laboratory analysis. The quality of method used was checked and confirmed in a separate comparative study of metals in a standard reference material, Lobster Hepatopancreas Tort-2 (National Research Council Canada). Recoveries were as follows: 93.2% for Hg, 95.19% for Cd, 101.47% for Co, 100.71% for Cu, 85.56% for Zn, 81.8% for Mn and 118.92% for Pb. For statistic information, ANOVA one-way and Pearson correlation (SPSS 12.0) was used.

Results

The concentrations of Hg, Cd, Co, Cu, Zn and Mn in the soft tissue of S. cucullata are presented in Table 2. The mean concentrations (µg/g dry weight) of Hg, Cd, Co, Cu, Zn, Mn and Pb in the oysters ranged from 0.08-0.53 µg/g, 0.99-4.37 µg/g, 0.08-0.42 µg/g, 84.12-256.38 µg/g, 350.55-5764.00 µg/g, 1.02-10.92 µg/g and 0.24-3.48 respectively.

Table 2. Concentration of metals (µg/g dry weight) in soft tissue of rock oyster S. cucullata (mean and standard deviation) along the east coast of Peninsular Malaysia.

<table>
<thead>
<tr>
<th>Sampling Sites</th>
<th>Hg</th>
<th>Cd</th>
<th>Co</th>
<th>Cu</th>
<th>Zn</th>
<th>Mn</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sg. Rengit</td>
<td>0.11±31.1</td>
<td>1.79±0.26</td>
<td>0.23±0.08</td>
<td>211.46±35.28</td>
<td>2472.53±365.34</td>
<td>10.92±7.17</td>
<td>1.19±0.17</td>
</tr>
<tr>
<td>Bt. Layar</td>
<td>0.18±52.4</td>
<td>2.49±0.36</td>
<td>0.08±0.02</td>
<td>226.18±47.70</td>
<td>973.00±40.07</td>
<td>4.39±7.28</td>
<td>0.98±1.31</td>
</tr>
<tr>
<td>Tg. Balau</td>
<td>0.53±50.1</td>
<td>2.24±0.13</td>
<td>0.42±0.05</td>
<td>256.38±12.71</td>
<td>5764.00±35.36</td>
<td>4.03±1.58</td>
<td>0.85±0.38</td>
</tr>
<tr>
<td>Sedili Kechil</td>
<td>0.26±35.7</td>
<td>4.37±0.71</td>
<td>0.29±0.05</td>
<td>212.44±29.28</td>
<td>4341.50±484.37</td>
<td>5.30±2.54</td>
<td>0.35±0.19</td>
</tr>
<tr>
<td>Mersing</td>
<td>0.14±17.8</td>
<td>2.84±0.39</td>
<td>0.20±0.05</td>
<td>166.12±54.50</td>
<td>951.70±12.96</td>
<td>5.12±2.31</td>
<td>1.02±0.22</td>
</tr>
<tr>
<td>Kg. Tg.</td>
<td>0.14±33.7</td>
<td>2.78±0.52</td>
<td>0.13±0.03</td>
<td>188.59±42.30</td>
<td>871.65±56.57</td>
<td>3.15±1.10</td>
<td>3.47±3.03</td>
</tr>
<tr>
<td>Batu</td>
<td>0.14±4.7</td>
<td>1.15±0.15</td>
<td>0.09±0.02</td>
<td>94.75±15.70</td>
<td>350.55±9.43</td>
<td>8.47±0.36</td>
<td>0.24±0.1</td>
</tr>
<tr>
<td>Cempedak</td>
<td>0.08±7.3</td>
<td>0.99±0.11</td>
<td>0.16±0.02</td>
<td>107.75±22.21</td>
<td>1449.72±83.67</td>
<td>2.84±1.62</td>
<td>4.38±0.96</td>
</tr>
<tr>
<td>Tg. Gelang</td>
<td>0.15±55.6</td>
<td>1.69±0.67</td>
<td>0.11±0.01</td>
<td>84.12±42.22</td>
<td>455.87±148.49</td>
<td>5.36±1.16</td>
<td>0.70±0.09</td>
</tr>
<tr>
<td>Cherating</td>
<td>0.14±54.2</td>
<td>1.42±0.41</td>
<td>0.09±0.01</td>
<td>156.54±32.49</td>
<td>1806.95±292.27</td>
<td>2.88±1.00</td>
<td>0.65±0.03</td>
</tr>
<tr>
<td>Kijal</td>
<td>0.14±14.5</td>
<td>1.21±0.47</td>
<td>0.13±0.01</td>
<td>119.32±80.04</td>
<td>936.12±15.32</td>
<td>3.95±2.94</td>
<td>0.64±0.25</td>
</tr>
<tr>
<td>Kemasik</td>
<td>0.23±58.37</td>
<td>2.45±0.65</td>
<td>0.10±0.02</td>
<td>194.78±36.38</td>
<td>1409.58±102.53</td>
<td>1.02±0.06</td>
<td>0.84±0.46</td>
</tr>
<tr>
<td>Tg. Jara</td>
<td>0.18±9.60</td>
<td>1.79±0.38</td>
<td>0.14±0.03</td>
<td>238.15±11.67</td>
<td>3121.95±388.91</td>
<td>2.88±0.35</td>
<td>0.82±0.18</td>
</tr>
<tr>
<td>Cherading</td>
<td>0.10±33.91</td>
<td>2.64±0.62</td>
<td>0.10±0.01</td>
<td>167.00±7.41</td>
<td>504.68±27.11</td>
<td>4.23±2.64</td>
<td>0.74±0.05</td>
</tr>
</tbody>
</table>

*High value of standard deviation derived as metals concentration was detected using replicates of individual oyster.

Based on the metals mean concentration, the highest concentration of Hg, Co, Cu and Zn are found in Tg. Balau population while Sedili Kechil, Sg. Rengit and Tg. Gelang have the highest concentration of Cd, Mn and Pb respectively. The lowest concentration varied among the sampling stations. The concentrations obtained were converted from dry weight to wet weight of soft tissue to obtain conversion factor of 5.2 for this study.

Discussion

High level of zinc concentration compare with the others appears as oysters are strong accumulators of zinc. Oysters accumulate high concentrations of zinc in detoxified granules (Amiard et al., 2008). This explains why the highest concentrations were determined by oysters in this study. Statistically, ANOVA one way shows a significant differences between
metal concentration for all sampling locations (p<0.05). Among the trace metals analyzed, Hg has high correlation with Co and Zn while Cu correlated moderately with Hg, Cd and Co. Specimens inhabiting Tg. Balau were characterised by the greatest concentrations of Hg, Co, Cu and Zn. This might be related to the anthropogenic factor influenced by the human activities besides naturally origins metal. Tg. Balau is a vacational area which run a resort and jetty activity with a lot of small fishing boats laid may also be a suspected as anthropogenic sources in the area. Cu leachate from the antifouling paints of boats and the semi-enclosed topography may aggregate the pollution problem. It is noteworthy as Pb concentration in Kg. Tg. Batu and Tg. Gelang shows clearly high values compare with the other locations. High values relate to the area at Tg. Gelang which locates at the mouth of industrial sewage. Discharges of effluents from the nearby domestic and industrial inputs flow through this area. While for Kg. Tg. Batu, pollution at this area was probably derived from the organic wastes discharged from the nearby fish culture at the north. Generally, the average distribution of metals indicated that sampling locations in Johor shows higher mean values than Pahang and Terengganu except for Cu and Pb. This probably contributed by the high urbanisation and industrial like port activity at the east coast region of Johor.

From the pattern of metal occurrence in the soft tissue of S. cucullata, the results of this present study were still comparable to those previously reported studies. According to Shazili et al. (1995), concentration of metals in Saccostrea sp. from several same sampling location also have the pattern of Zn>Cd>Cd>Pb or Zn>Cd>Pb>Cd (No data for Hg, Co and Mn). According to Malaysian Food Act 1983 and Food Regulations 1985 Fourteen Schedule, the permissible limit for human consumption is 0.5 mg/kg, 1 mg/kg and 2 mg/kg (wet weight basis) for Hg, Cd and Pb, respectively. Metal concentration data of S. cucullata in this study shows that the value is still within the permissible limit.

Conclusions

The results of heavy metals recorded in S. cucullata collected from 14 rocky shore sites along the east coast of Peninsular Malaysia serve as a baseline data for future reference. Since it is widely distributed in the east coast of peninsula, S. cucullata stands a potential biomonitoring agent of trace metals for this region. Work is now being conducted to investigate the distribution of rare earth elements (REEs) in the soft tissue of S. cucullata.

Acknowledgements

The authors wish to thank Prof. Dr. Noor Azhar Bin Mohamed Shazili and Dr. Faridah Mohammad who provided helpful assistance during research progress.

References

Shazili, N.A.M., Yunus, K., Shamsudin, A., Abdullah, N. and Rashid, M.K.A. 2006. Heavy metal pollution status in the Malaysian aquatic environment. Faculty of Science and Technology and Institute of Oceanography. College University of Science and Technology Malaysia. pp 137-144.
Impacts of the 2010 severe coral reef bleaching event on a coral reef restoration site in Trat Province, the Gulf of Thailand

Makamas Sutthacheep*, Chaipichit Saenghaisuk, Sittiporn Pengsakun and Thamasak Yeemin

Marine Biodiversity Research Group, Department of Biology, Faculty of Science, Ramkhamhaeng University, Huamark, Bangkok 10240, Thailand

Corresponding author’s email: msutthacheep@yahoo.com

Abstract

In summer of 2010, there was a severe coral reef bleaching phenomenon in the Gulf of Thailand. Coral reefs and coral restoration sites in Trat Province were among areas severely impacted. The bleaching and subsequent mortality of transplanted corals and juvenile coral colonies on a coral reef restoration site at Koh Kra, Trat Province, the Gulf of Thailand were examined. The coral reef restoration site was initiated in March 2007 by using a simple cement block model to provide artificial substrate for coral recruitment and attaching coral fragments collected from the reefs nearby. There were three species of coral recruits on the cement blocks, i.e., Porites lutea, Pocillopora damicornis and Pavona sp., with an average density 3.8 colonies/m². All Pavona sp. and P. damicornis recruits bleached while 23% of P. lutea recruits showed no sign of bleaching. Attached fragments of Acropora nobilis and A. florida grew well on the artificial substrates, with live coral cover increasing about 120 – 150% in three years. All transplanted A. nobilis and A. florida died after the severe coral bleaching phenomenon. The present study highlights the importance of choosing appropriate coral species for coral reef restoration projects and the role of coral recruitment on recovery of coral communities after the bleaching.

Keywords: bleaching, coral recruitment, restoration, Gulf of Thailand

Introduction

The first severe coral reef bleaching event in the Gulf of Thailand was reported in 1998 (Yeemin et al., 1998). There are approximately 75 km² of coral reefs in the Gulf of Thailand, which include 16 km² in Trat Province. During the last decade, several organizations have developed coral reef restoration projects in the Gulf of Thailand by applying various methods and techniques with a variety of objectives. In March – June 2010 there was a severe coral reef bleaching phenomenon in the Gulf of Thailand. This research aims to examine coral bleaching and subsequent mortality of transplanted corals and juvenile coral colonies on a coral reef restoration site at Koh Kra, Trat Province, the Gulf of Thailand.

Materials and Methods

In March 2007, a coral reef restoration project was developed at Koh Kra, Trat Province, the Gulf of Thailand. Simple concrete block clusters, 1 m (width) x 1.6 m (length) x 0.2 m (height) for each, were deployed at 2 – 5 m depth. The cement blocks provide available substrate for coral recruitment. We also attached fragments of A. nobilis and A. florida which were collected from nearby coral reefs to the cement blocks with underwater cement. Recruitment and subsequent growth and mortality of corals on the cement block were monitored regularly over 3 years. In 2010, the study site was visited during the coral bleaching event (March – July) for detailed study of bleaching and survival of corals and new recruits.
Results

The majority of coral recruits on cement blocks were *Porites lutea* (72%), *Pocillopora damicornis* (22%) and *Pavona* sp. (6%), with an average density 3.8 colonies/m$^2$. All *Pavona* sp. and *P. damicornis* recruits bleached while 23% of *P. lutea* recruits showed no sign of bleaching (Figure 1). After the bleaching event, all recruits of *P. lutea* and *Pavona* sp. have high potential for survival but all *P. damicornis* recruits had died. Fragments of *Acropora nobilis* and *A. florida* attached on the cement blocks grew well until the coral bleaching event in April 2010, with live coral cover increasing about 120% for the former and 150% for the latter (Figure 2). The survey in July 2010 showed that all transplanted *A. nobilis* and *A. florida* were completely dead.

![Figure 1. Bleached and unbleached juvenile coral colonies in the 2010 coral bleaching event.](image1.png)

![Figure 2. Coverage of transplanted corals on cement blocks during March 2007 – July 2010.](image2.png)
Discussion

The greater susceptibility of *A. nobilis*, *A. florida* and *P. damicornis* to bleaching than *P. lutea* and *Pavona* sp. has also been reported by other researchers (Brown and Suharsono, 1990; McClanahan, 2000; Edwards et. al, 2001). Yeemin et al. (2006) recommended that the long-term success of coral reef restoration projects should be ensured. For example, the projects have to select appropriate transplanted coral species for future environmental changes and sustainable uses. However, most coral reef restoration projects in Thailand seem to select the fast growing *Acropora* spp. as materials. Therefore, the majority of transplanted corals in the Gulf of Thailand were severely impacted by the 2010 coral bleaching event.

Juvenile corals are a significant component of the population dynamics of corals and reef resilience. Survival of coral recruits after bleaching is potentially significant contribution to post-bleaching recovery of coral reefs and it is urgently required for future research. It should be noted that densities of coral recruits on natural reefs in the Gulf of Thailand are also low (Yeemin et al., 2009) in comparison to other coral reef sites in the Pacific (Roth and Knowlton, 2009) thus recovery of the coral communities would require a long period of time (Sudara et al., 1994).

Acknowledgements

This research was supported by a grant for research promotion from the Thai Government to Ramkhamhaeng University in the fiscal year B.E. 2553. We are thankful to the staff of the Marine Biodiversity Research Group, Ramkhamhaeng University for their fieldwork assistance.

References


Particulate organic carbon and nitrogen in the Setiu estuary on the east coast of Malaysia

Toshihiro Ichikawa¹*, Lokman Husain², Rosnan Yaacob² and Masanori Sato¹

¹Faculty of Science, Kagoshima University
1-21-35, Korimoto, Kagoshima, 890-0065, Japan

²Universiti Malaysia Terengganu, Mengabang Telipot,
21030 Kuala Terengganu, Terengganu, Malaysia

Corresponding author’s email: ichikawa@sci.kagoshima-u.ac.jp

Abstract

Particulate organic carbon (POC) and nitrogen (PON) in the Setiu lagoon-estuary water were investigated in 2009. POC and PON concentrations in the 13 sampling stations ranged from 260 to 1478 µgCL⁻¹, and from 45 to 212 µgNL⁻¹ respectively. The average concentration of POC and PON were significantly higher than those of coastal and open waters of Malaysia. The C/N ratios in the Setiu lagoon estuary water 2.6 to15 (average 6). The C/N ratios observed in the present study were significantly lower than that of Kuala Terengganu coastal water (average 26). Chlorophyll concentration ranged from 0.4 to 5 µgL⁻¹.

Keywords: suspended particles, C/N ratios, chlorophyll

Introduction

Most of the organic matter in seawater originates from phytoplankton photosynthesis in the euphotic layer of the ocean. In coastal waters, rivers carry terrigenous organic matter into the seawater, and the re-suspension of sediments would further supply particulate organic matter in shallow water. The particulate organic matter in seawater is altered in size and chemical composition by biological and physical processes occurring in the marine ecosystem. The concentration of suspended organic matter has been as POC and PON because organic carbon and nitrogen are the most important elements composing the organic mater in marine environment. POC and PON concentrations are one of the important parameters for evaluation of the seawater environment. For example, POC and PON concentrations generally tend to increase with the progress of eutrophication and pollution. It is well known that water in various areas of the sea shows differences in POC and PON concentrations. The distribution of suspended organic matter in the Malaysian EEZ in the South China Sea has already been reported from the Matahari Expedition of 1985 to 1989 under the cooperative project between UPM and Kagoshima University (Ichikawa, 1986; Ichikawa and Kartini, 1987; Ichikawa and Law, 1988; Ichikawa, 1990). The distribution of POC in the Straits of Malacca in the Malaysian EEZ was studied during research cruises in 1998 and 1999 for UPM-JICA collaborative project (Ichikawa et al., 2002).

The Setiu estuary is one of the large estuaries on the Terengganu coast. Rosnan et al. (1995) reported grain-size distribution of sediment in the Setiu estuary. However, little is known about oceanographic study in the Setiu estuary. In the present paper, we report the characteristic distribution of POC and PON in the Setiu estuary in 2009.
Materials and Methods

The water samples were collected in the Setiu estuary on the Terengganu coast at 13 sampling stations in August 2009. The water samples were obtained with a water sampler and plastic bottle at two different depths, surface and near the bottom, in each sampling station. The water temperature, salinity, conductivity and dissolved oxygen were determined on board using a YSI Model 85 SCOOT Meter. The sample water was kept in a plastic bottle and was filtered at the shore laboratory in UMT. One hundred millilitre of water from each depth was filtered through a Whatman GF/F filter for chlorophyll determination. Three hundred millilitre of subsample water from each depth was filtered through a Whatman GF/F filter for collecting suspended particles. All the filters for analysis of suspended organic matter were combusted in advance at 450°C for three hours to eliminate organic matter contained in the filter. The filter samples were brought back to the laboratory of Kagoshima University and were kept in a deep freezer. Chlorophyll was determined by a fluorometric method using Turner Design fluorometer. POC and PON retained on the filter were analyzed by a Perkin Elmer 2400 Elemental Analyzer. The dried filters for POC and PON analysis were exposed to vapour of hydrochloric acid for several hours to remove inorganic carbon.

Results and Discussion

The POC and PON concentrations in the Setiu estuary showed regional variation. The POC and PON concentration ranged from 260 to 1478 μgCL⁻¹ and from 45 to 212 μgNL⁻¹ respectively in the 13 sampling stations. There was not a significant difference between surface layer and the layer near to the bottom. The average POC and PON concentrations in the surface water were 696 μgCL⁻¹ and 119 μgNL⁻¹. For the bottom water, the average value of POC and PON showed 701μgCL⁻¹ and 125 μgNL⁻¹. The general level of POC and PON concentrations was significantly higher than that of coastal and continental shelf water in Malaysia. For example, Ichikawa et al. (1999) reported the average POC and PON values in the coastal water of Kuala Terengganu were 182 μgCL⁻¹ and 7 μgNL⁻¹. Ichikawa et al. (2002) summarized comparison of mean POC concentration in the Straits of Malacca with other areas in the Malaysian EEZ. The POC concentration in the Setiu estuary was higher than that of the highest value (325 μgCL⁻¹) observed in the Straits of Malacca. There are various sources of suspended matter in natural waters. The organic matter in coastal and estuary waters is derived from a variety of plants, including phytoplankton, and materials of terrestrial origin. The relative importance of suspended organic particles in the Setiu estuary cannot be estimated precisely. The chlorophyll concentration in the observed area varied 0.5 to 8.9 μgL⁻¹. The average value of chlorophyll for surface water and bottom water was 2.3 μgL⁻¹ and 2.1 μgL⁻¹ respectively. If we assume phytoplankton carbon to chlorophyll ratio as 50, calculated living phytoplankton carbon would be only 16 % of measured POC. The most of organic matter in the Setiu estuary may be derived from phytoplankton, detritus, terrestrial input, re-suspension of the sediment, and macroscopic aquatic vegetation.

The C/N ratio of suspended particles is also used to describe nature of organic matter. The average C/N ratio of marine phytoplankton and zooplankton is close to 6 (Redfield et al., 1963). The observed average C/N ratio in the present study ranged between 2.6 and 15, and the average C/N ratio (6) was the same as marine plankton. Ichikawa et al. (1999) reported the C/N ratios in the Kuala Terengganu coastal water were remarkably high (average 26). This result indicates that suspended organic matter in the Terengganu coastal water is characterized as nitrogen depleted particles. It can be implied that nitrogen rich particles occurred in the Setiu estuary would be utilized as a food source for filter feeder in the aquatic food chain.

Acknowledgements

We wish to express our thanks to Heiwa Nakajima Foundation for financial assistance for this study. We also thank science officers in UPM for their help for field trip.
References


Dissolved organic matter release by an axenic culture of *Emiliania huxleyi*

Suhaimi Suratman\(^1,2,*\), Keith Weston\(^1\), Tim Jickells\(^1\), Rosie Chance\(^1,3\) and Tom Bell\(^1\)

\(^1\)School of Environmental Sciences, University of East Anglia, Norwich, Norfolk NR4 7TJ, UK  
\(^2\)Environmental Research Group, Department of Chemical Sciences, University Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia  
\(^3\)Department of Chemistry, University of York, Heslington, York YO10 5DD, UK  

*Corresponding author’s email: miman@umt.edu.my*

**Abstract**

Measurements of the release of dissolved organic nitrogen (DON) and carbon (DOC) were carried out on an axenic batch culture of the coccolithophorid *Emiliania huxleyi*. This unicellular marine alga was cultured using a media with nitrate as the sole N source and the changes of DON and DOC concentrations measured over 14 days. Results showed that there was a significant release of DON, i.e. 7.6 µM N day\(^{-1}\) during mid-exponential growth phase (days 5–7). The highest release of DOC was also recorded in the same growth phase and accounted for 24.0 µM C day\(^{-1}\).

**Keywords:** dissolved organic nitrogen, dissolved organic carbon, axenic culture, *Emiliania huxleyi*

**Introduction**

Dissolved organic matter (DOM) cycling has been studied in marine waters worldwide with higher concentrations of DOM generally measured during phytoplankton bloom periods (Suratman, 2007). DOM is usually measured by assessing one of its constituent parts, i.e. DOC, DON or dissolved organic phosphorous (DOP). Its production is important due to its potential to drive primary production in marine systems when inorganic nutrients, typically nitrate, are depleted (Suratman, 2007). However, it is unclear whether DOM from phytoplankton is released from healthy cells during phytoplankton growth, or only from dead and decaying phytoplankton (Sharp, 1977; Collos et al., 1992). The aim of this experiment was therefore to determine if DON and DOC release occurs from healthy cells and also to quantify any such release. *Emiliania huxleyi* was selected because it is widespread throughout the world’s oceans forming large shelf sea and open ocean blooms (Winter et al., 1994), but is underrepresented in culture studies of DOM.

**Materials and Methods**

The experiment was carried out with axenic cultures of the warm water strain CCMP 373 of *E. huxleyi*. In brief, an experimental stock culture of *E. huxleyi* was grown in f/20 culture media (Guillard, 1975) prepared using seawater from the open Atlantic Ocean. The seawater was filtered through a 0.2 µm cellulose acetate filter (Sartorius USA) and autoclaved prior to addition of sterile nutrient stock solutions. Nitrate was the sole N source, with an initial concentration of ~100 µM in all flasks. The stock culture was kept under 14:10 hours light–dark cycle, at a temperature of 15°C, with light intensities of 40–50 µmol photon m\(^{-2}\) s\(^{-1}\). Flasks containing 1 L of growth medium were inoculated with a fixed volume (~50 mL) of stock culture in the exponential growth phase. Control flasks were prepared without the inoculation step. DON and DOC concentrations were determined at t = 0, 5, 7 and 14 days. For DON and DOC determinations, aliquots of 15 mL were taken and filtered through a 0.2 µm filter. The filtration was carried out using a syringe filter under gentle, hand-applied pressure.
Samples were then analysed by high temperature catalytic oxidation (HTCO) with a Thermalox (UK) TOC/TN analyser (temperature: 680±10°C; catalyst: 0.5% Pt/Al₂O₃) for NOₓ and CO₂ detection, produced from total dissolved N (TDN) and DOC compounds respectively (Hansell et al., 1993). The precision of analysis for TDN and DOC was < 5%. Nitrate was analysed using a Scalar (The Netherlands) San Plus Autoanalyser according to the method of Kirkwood (1996) with an analytical error < 5% relative to Ocean Scientific International (UK) standards. Ammonium was measured using a Jasco fluorometer (UK) according to the method of Holmes et al. (1999) with a precision of analysis < 5%. DON was calculated as the difference between TDN and dissolved inorganic N (DIN), i.e. nitrate and ammonium. Chl-a was determined according to the method of Parsons et al. (1984). In addition, cell counts were made using a Beckman (USA) Coulter Multi-sizer III electronic particle counter. DAPI staining combined with epifluorescence microscopy (Sherr et al., 1993) was used to confirm that bacteria were absent from all the experimental cultures and the control on day 7 of the experiment.

**Results and Discussion**

The growth cycle of *E. huxleyi* was followed using 2 indices of biomass: cell counts and chl-a concentrations (Figures 1a, b). No algal or bacterial growth was observed in the control flask. There was a steady decrease of DON concentrations for the control sample (Figure 1c) suggesting depletion of DON due to abiotic processes such as adsorption onto bottle walls. The DOC concentrations in the control culture remained constant (259 ± 6 µM) throughout the experiment (Figure 1d). Nitrate concentrations decreased steadily throughout the culture period, falling below the detection limit (<0.1 µM) on day 14. The decreasing nitrate corresponded to an increase of the algal biomass, as indicated by the increasing cell counts and chl-a concentrations. This is due to the conversion of nitrate to particulate organic matter. The DON variations showed a significant difference (ANOVA test, P<0.05) compared to the control with an increase of DON mean concentrations from 3.1 µM to 33.5 µM before decreasing to 16.8 µM at the end of the experiments. Similar to DON, there was a significant difference (ANOVA test, P<0.05) in DOC concentrations between cultures and the control. In general, DOC mean concentrations were highest at the beginning (310 µM) and the end (356 µM) of the experiments and lowest during the mid-exponential growth phase (253 µM). The high DOC concentrations found in the cultures at the beginning of the experiments are thought to be due to organic carbon in the *E. huxleyi* stock culture used to inoculate the experimental flasks, as the initial DOC concentrations in the control are lower. The decrease of DON concentrations at the end of the experiments suggested phytoplankton DON uptake after nitrate was depleted. Ammonium (results not shown) remained low (<5 µM) throughout the experimental period in the cultures. The release or depletion rates of DOM were calculated as the net change in concentration over the selected period in days, normalized to average cell count (Table 1). In general, higher release rates of DON by *E. huxleyi* were detected during the early and mid-exponential growth. However, a contrasting trend was observed for DOC with higher rates of release at the middle and end of exponential growth.

These results clearly indicate that there was an increase of DON and DOC concentrations with time, with the highest concentrations of DON (33.5 µM) and DOC (356 µM) seen during the middle and late exponential growth phase respectively. Since the cultures were axenic, DOM was produced directly by release from phytoplankton. Furthermore, increases in DOM were not accompanied by any marked decrease in cell numbers suggesting that this increase was mainly due to release of catabolised N compounds rather than from cell death. The DOM release results presented can be compared with other studies, which have also observed a similar trend of DOM release in cultures (Newell et al., 1972; Myklestad et al., 1989; Collos et al., 1992; Aluwihare and Repeta, 1999).
There is no general agreement on which phase of growth exhibits the highest rates of DOM release. Some studies have observed highest release rates in the stationary phase during the decomposition of the algal cells (Newell et al., 1972; Conover, 1975), while others have shown that they occur during the exponential growth phase (Myklestad et al., 1989; Collos et al., 1992; Aluwihare and Repeta, 1999). The present study indicates high release rates of DOM were found during the early and mid-exponential growth, consistent with the hypothesis that healthy living cells contribute to DOM release. However, it should be noted that the relatively short-term experiments (<14 days) in this study mean that the later stages of growth cannot be considered.

Although this culture study used significantly higher nitrate concentrations (~100 mM) than generally found in the marine environment, blooms of *E. huxleyi* are potentially an important source of DOC and DON. This release was also shown to be decoupled during the growth of *E. huxleyi* as has been implied by field studies (Painter et al., 2007) and may have important large scale biogeochemical implications (Arrigo, 2005).
References


Anthropogenic activities deteriorates the water quality of St. Martin’s Coral Island, Bangladesh

M. Maruf Hossain* and D. Sultana
Institute of Marine Science and Fisheries (IMSF), University of Chittagong
Chittagong - 4331, Bangladesh
Corresponding author’s email: marufctgu@yahoo.com

Introduction

St. Martin's Island is a small continental island in the Bay of Bengal, some 50 km to the south of Teknaf Peninsula, Bangladesh. The island is an area of about 8 sq. km. and the population is about 6 thousands. St. Martin’s Island endowed with vast marine and land resources having global biodiversity significance. The island is a good example of co-occurrence of corals, algae, seaweeds, grasses and mangroves. Like other niche ecosystems, coral reefs are highly prone to environmental perturbations. Thus, variation in water quality has a remarkable effect on the distribution and diversity of corals and associated plants and animals. At present no coastal zone management unit exists in St. Martin’s Island to know what is the sources of pollutants, how much nutrients are entering the coastal water, what is the existing level, and the effects of natural variations or management of them.

None is using currently available state of the art technology, which would allow continuous real-time measurements of water quality to locate every source of pollution, their magnitude and changes. Developments of these tools are essential to placing coastal zone management on a scientific basis and optimizing useful production in the lands and waters of St. Martin’s, the only coral belonging island of the Bay of Bengal, Bangladesh, the very point of sustainable development. The present research work is an attempt to get an overview on the water quality of status of the coastal area of St. Martin’s island, Bangladesh.

Materials and Methods

An investigation on the status of ‘aquatic pollution’ in St. Martin’s island in Bay of Bengal, Bangladesh was done in December 2007 and the present findings based on the result of that investigation. Water samples were collected for analysis on November, 2007 and January, 2008 and analysis were done following standard procedures. The sampling sites were distributed around coast of St. Martin’s approx.180-200 yards from inter-tidal zone towards the sea. Geographical positions of each station were determined using a Global Positioning System (GPS).

Results and Discussion

The result of the study revealed the deterioration of water quality around St. Martin’s island. Station 1 and Station 2, the two main busy and populated area, the degradation of water quality is more pronounced, indicated by higher values of nutrients, turbidity, TSS, TDS and lower value of water transparency, D.O compared to other remote sampling stations (St.4-7). The health hazard bacteria, like SPC, T. Coliform, Faecal Coliform in site 1 and 2, also exceeded the safe level.
However, the intensification of water quality deterioration in the above mentioned sites might be related to the dense human population, increased tourism activities, unplanned development and constructions (hotels, motels, jetty, ferry service, boat anchoring etc.), market, agricultural practices, untreated human wastes and garbage.

In addition to above factors, natural phenomena like cyclones, storm surges, heavy fresh water run off during monsoon (rainy season) along with silt and sediment load, as well as other anthropogenic activities, like over-exploitation of coastal fishery resources and uses of destructive fishing gears, excessive extraction of corals, sea weeds, algae, discharge of non-biodegradable toxic (e.g. plastic, black hydrocarbon (PAHs)) and biodegradable (e.g. untreated sewage matters) wastes etc. are all threats and environmental stressors to the St. Martin’s coral ecosystem and its biodiversity.

Conclusions

This study emphasizes the importance on long-term year round study on specific water quality parameters, especially in monsoon (rainy season) and to assess its impact on the health of corals and its biodiversity. This information is needed for sustainable management of MPA and conservation of coral community in St. Martin’s island.

Acknowledgements

Authors would like to say sincere thanks for supporting this piece of research work under a project entitled, “Conservation of Biodiversity, Marine Park Establishment and Ecotourism Project at St. Martin’s Island”, Ministry of Environment and Forest (MOEF), Government of Bangladesh.
Comparison of mitotic index in Nay Band and Asaloye coral reefs (Northern part of Persian Gulf, Iran)

M. Boloki1*, S.M.B. Nabavi1,2 and M. Haghighat2

1Department of the Environment, P.O. Box: 5181, Tehran, Iran
2Khorrarmshahr University of Marine Science and Technology, Marine Biology Department
P. O. Box 669, Khorrarmshahr, Khuzestan, Iran
Corresponding author’s email: lahijanjan@yahoo.com

Abstract

Coral reefs which are one of the most significant marine ecosystems have symbiosis with zooxanthellae for their growth and survival. Today zooxanthellae and coral symbiosis is in the danger of anthropogenic and global climate changes. A better understanding of the mitosis cycle of the cell in symbiotic algae leads to a quantitative assessment of stress in corals and a clear presentation of the effect of the relationship between mitotic division and pollutants. To conduct this study in the first investigation, the best concentration of live coral reefs was selected by using Manta Tow survey. Sampling was conducted from dominant species of the region (Porites sp.) in one year during 3 seasons - warm, cold and temperate - in Nay Band and Asaloye (Northern part of the Persian Gulf). By extracting zooxanthellae with airbrush machine, counting the dividing zooxanthellae under microscope and forming a simple proportion to the total counted zooxanthellae mitotic index was obtained. By comparing the mitotic index in both regions we come to the conclusion that Nay Band corals which are far away from stresses caused by anthropogenic activities have higher mitotic index than Asaloye corals which are under the impact of anthropogenic activities.

Keywords: mitotic index, coral reefs, Nay Band, Asaloye

Introduction

Coral reefs, which constitute some of the largest ecological structures on earth, result from interactions between symbiotic organisms composed of dinoflagellate algae (zooxanthellae) and scleractinian corals (Dustan, 1999; Stone et al., 1999). Garces(1992) reported that coral reef has a big value to the coastal ecosystem in ecology and economic aspect. According to media reports, anecdotal accounts from scuba divers and published work of marine scientists from diverse locations around the world, increasing populations of humans have been damaging coral reefs at an unprecedented rate (Luchavez and Alcala, 1988; Wilkinson et al., 1993; Munro and Munro, 1994; Grigg and Birkeland, 1997). These stressors can drive coral reef degradation directly, through increased coral mortality, or indirectly, by increasing susceptibility to coral diseases (Harvell et al., 2002) and decreasing population replenishment via recruitment (Hughes and Tanner, 2000). To date, the majority of damage to coral reefs around the world including Persian Gulf and Iranian waters has been through direct anthropogenic stress (Alcala and Gomez, 1987; Brown, 1987; Dahl and Salvat, 1988; Grigg and Dollar, 1990; Kenchington and Hudson, 1988; Kinsey, 1988; Pauly and Chua, 1988; Salvat, 1987). The major causes of damage are excessive pollution from domestic, industrial and agricultural waste and over exploitation. A better understanding of the mitosis cycle of the cell in symbiotic algae leads to a quantitative assessment of stress in corals and a clear presentation of the effect of the relationship between mitotic division and pollutants (Brown, 1988).
Materials and Methods

Study areas
We chose two sampling regions in Nay-Band Bay: 1- Nay Band (27°24´34˝ North and 52°35´24˝ East) 2- Asaloye (27°26´49˝ North and 52°35´33˝ East). Sampling was conducted from dominant species of the regions (Porites sp.) during a year and three seasons, cold, warm and temperate. The first phase was in beginning of February 2008, the second in end of April 2008 and the third in end of August 2008.

Coral tissues were stripped from the skeletons under dim light with filtered seawater using an airbrush gun. The mitotic index was calculated as the percentage of doublet cells out of the total cell count in the sample (Wilkerson et al., 1983). Mitotic index were determined by direct examination under a phase contrast microscope at 450× magnification, and counted using a Neubauer ruling hemocytometer (Cervino et al., 2004).

Results and Discussion

Table 1 shows the mean mitotic index (%) in Nay Band and Asaloye in the three seasons. The maximum mitotic index of zooxanthellae was 3.27±0.44 in warm season in Nay Band and the minimum was 0.06±0.03 in the temperate season in Asaloye.

Table 1. Mean mitotic Index ± standard error in Porites sp. (µg/cm²).

<table>
<thead>
<tr>
<th>Station</th>
<th>Nay Band</th>
<th>Asaloye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>2.44±0.25</td>
<td>1.59±0.15</td>
</tr>
<tr>
<td>Temperate</td>
<td>0.36±0.06</td>
<td>0.06±0.03</td>
</tr>
<tr>
<td>Warm</td>
<td>3.27±0.44</td>
<td>2.17±0.31</td>
</tr>
<tr>
<td>Mean</td>
<td>2.02</td>
<td>1.27</td>
</tr>
</tbody>
</table>

Figure 1 show that mean mitotic index in both regions has a significant difference between cold and warm seasons with temperate season. The comparison of these two regions show that mean mitotic index in all the three season is significantly different.

A better understanding of the mitosis cycle of the cell in symbiotic algae leads to a quantitative assessment of stress in corals and a clear presentation of the effect of the relationship between mitotic division and pollutants (Brown, 1988).

Assessing changes in the zooxanthellae division frequency (measured by the number of cells appearing as doublets, MI) has been suggested as a potential means of assessing stress in corals (Brown, 1988).
By comparing the mitotic index in both regions, we conclude that Nay Band corals, which are far away from stresses caused by anthropogenic activities, have higher mitotic index than Asaloye corals, which are under the impact of anthropogenic activities.

Cervino et al. (2004) describe a similar outcome in corals affected by Yellow-Band disease. Compared with healthy tissue, diseased coral samples had a 50% decrease in algal density and an 80% decrease in mitotic index. Also we observed a significant difference of 30%-80% in mitotic index in Asaloye as compared with Nay Band.

References


Reclamation effects on meiofauna community:  
Case study - Fahaheel area, Kuwait

Eiman Khaliefa*, Saied Al-Qadi, Aisha Al-Kandari, Jamila Al-Saffar  
and Mishari Al-Kandari

Environment Public Authority - Kuwait  
P.O. Box: 224395 Safat 13104

Corresponding author’s email: eimanmoh@hotmail.com

Abstract

This paper aims to investigate the effect of reclamation on meiofauna community. Meiofauna is an important part of the food chain, considered as bio-indicators for the changes and pollutants in the intertidal zone as they inhabit the sediment, which accumulate the pollutants. Fahaheel area was chosen to investigate this case since it was monitored monthly before, during and after the reclamation. This study compares Meiofauna status in 1996-1997, before the construction started and 1999-2000 during and after the construction. Three core samples were taken from each transect, perpendicular to the intertidal zone. Samples preserved in formalin and Rose Bengal dye. Samples were sieved using 63 and 500 micron. The result of the study showed significant density increase in Foraminifera, Bivalves, Nematodes, Ostracods, Turbellaria, Copepods and Ciliates. There was also a decline in Gastropods, while Polychaetes were not affected significantly by the change. Due to physical parameters, total organic matter (TOM) increase was observed after the reclamation. The conclusion of the study indicates that the construction caused disturbances in the accumulated organic matter in the area, which comprises the source of nutrition for the organisms and that caused enrichment to Meiofauna organisms in general except Polychaetes, which were insensitive to organic matter enrichment in this case.

Keywords: Kuwait, meiofauna, reclamation, Polychaetes, TOM
Hemolytic toxin in *Karlodinium* spp. from Kuwaiti waters

Muna M. Husain

*Environment Public Authority - Regional Centre of Marine Mortality*
*Al Surrah P.O.Box 221, 45703 Kuwait*

*Corresponding author’s email: munahusain@yahoo.com*

**Abstract**

Red tides of *Karlodinium*, recently identified as a novel species of dinoflagellate, have frequently caused mass mortality of several species of bivalves and fishes worldwide. We found that the cell-free ethanol extract prepared from *karlodinium* caused hemolysis of rabbit erythrocytes and demonstrated cytotoxic effects in HeLa cells and on the microzooplankton rotifer (*B. plicatilis*) in a dose- and time-dependent manner. Interestingly, the hemolytic activity and cytotoxic effects of the extract were completely dependent on the presence of light. When the experiments were conducted in the dark, no hemolysis was observed even at very high concentration of the extract. These results suggest that *Karlodinium* has photosensitizing hemolytic toxin, which can be easily extracted into ethanol. This may be the first report documenting the occurrence of photosensitizing hemolytic toxin in marine phytoplankton species.
Analysis and control of pollution sources of aquaculture
in Taihu Lake Basin in China

Yimin Zhang* and Yue-Xiang Gao

Nanjing Institute of Environment of Science of MEP
Nanjing 210042, P.R. China

Corresponding author’s email: zhangymzym@163.com

Abstract

Nonpoint pollution sources (NPS) cause great public concern with the lake or sea eutrophication increasing. The aquaculture pollution is one of important NPS, and contributes some to the water pollution under different conditions. So, the first Chinese National Census Sources of Pollution (2010) is carried out. The research of aquaculture pollution efficient is part of the work. The main fresh aquaculture pattern includes cage aquaculture, pen culture and so on. Pollutants come from lot of feed input, the metabolic and decomposition of aquatic organism, medicine of prevention and cure for diseases with high density, hooker pollution and sewage. Aquatic feed rich in nitrogen and phosphorus overplus, and high-density culture lead to water pollution.

Discharge coefficients of aquaculture to different waters, culture and species are determined usually by three methods, which are monitoring, the material balance, and experience factor method. Four pilot sites are selected in the Taihu lake basin for the study of discharge coefficient of aquaculture. The crab coefficient is respectively determined of TN, TP, Cu, Zn with fish or no. The pollution load of aquaculture is calculated in Taihu lake basin.

It is very important considering the food chain and food web in the ecological system in the aquaculture. The ecological aquaculture can make use of the substance (feed) mostly, and decrease the nutrient in the water, that is, reduce the aquaculture discharge effectively. Measures are taken of pollution control to restrict the area of aquaculture, adopt the ecological culture pattern and blend with many species with appropriate density so as to utilize the feeds to the maximum. The adequate marine product and less pollution produced are realized.

Keywords: non point pollution, aquaculture, discharge coefficient, pollution control
Poster Papers: Fisheries and Aquaculture
Improvement of grouper cultivation by domestication system

Ainatul Hakimah Zakaria

Laboratory of Marine Science and Aquaculture, Institute of Bioscience
Universiti Putra Malaysia, 43000 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: ainatul@hotmail.com

Abstract

Domestication system involved an indoor culture system designed to be used inside the building, utilizing limited space and accessible at relatively low cost in term of technologies and the capital cost. The system is suitable for nursery of fingerlings. Urban backyard system make life easier by providing ease in operation and management, require less man power, and easily adapted to culture a range of different species. The culture conditions can be controlled include temperature, salinity, DO and the pH. The system is designed to assist users with minimum background and skills in aquaculture to set-up and culture their own fish cultivation system with ease and less manpower. Fingerlings of brown marbled grouper, *Epinephelus fuscoguttatus* is used as culturing model in this study as groupers have high demand in the market. The trade for local grouper fishery is affected by lack of seed supply due to inefficient culturing practice. Therefore, the present domestication system can offer a simple cultivation alternative to fulfill domestic needs. Grouper make up over 16 per cent by weight and 30 per cent by value of total marine finfish produced by aquaculture in Malaysia. The fingerlings of brown marbled grouper, *E. fuscoguttatus* were cultured in fiber tanks supplied with artificial seawater with physical water parameters maintained as such, temperature, salinity, pH and DO. The fishes were enhanced with formulated diet and determined for the growth as well as proximate analysis, to ensure efficacy of system. A convincing result indicating good growth rate and nutritional values was observed in the fish cultivated using the designed module. Domestication system is an effective technique or system to culture grouper as long as basics needed for grouper culturing are supplied and maintained.

*Keywords: domestication, grouper, Epinephelus fuscoguttatus, proximate analysis*
Contrasting marine and freshwater sea bass in promoting recreational fisheries: Muscle cellularity and flesh quality

C. Girish Palaniyappan*, Mariana Nor Shamsudin, Norfarrah Mohamed Alipiah and Md. Shater Zakaria

Laboratory of Marine Science (MARSLAB), Institute of Bioscience
Universiti Putra Malaysia, 43000 UPM Serdang, Selangor, Malaysia
Corresponding author’s email: girish.indya@gmail.com

Abstract

Rearing environment was used to monitor survival, optimal feeding frequency for muscle growth patterns of sea bass fry to the commercial size (350 g, 30 cm). At this moment, the white muscle cellularity, proximate composition and organoleptic parameters of the fillet were analysed to evaluate the influence of environment on the structure and quality of the commercial product. An experiment was conducted in freshwater and seawater environment to determine the optimal feeding frequency for growth, effective feed conversion, survival and size variation in Asian seabass fry reared in the net cages on freshwater pond. White muscle cellularity was evaluated by means of the following parameters: number and diameter of muscle fibres, as well as the muscle fibre size distribution, throughout the total cross-section of the flesh. To ascertain the flesh quality, several physico-chemical parameters (moisture, protein, total fat, fatty acids, hydroxyproline, collagen and pH) were analyzed, and textural mechanical properties (hardness, springiness, chewiness, cohesiveness, gumminess) were determined objectively with a texturometer. This study infers that the Asian seabass fry can achieve maximum growth, survival and better feed conversion when they are adapted to freshwater net cage rearing. The findings also have practical significance towards establishing Asian seabass seed rearing in freshwater and will directly benefit the nursery operators.

Introduction

Commercial fishing has repeatedly been identified as a major causal factor for global declines in fish stocks. Recently, recreational fisheries have also been considered as having the potential to contribute to fisheries declines. Commercial and recreational fishing are both important sources of protein, and contribute substantial economic benefits to local and national economies (Hilborn et al., 2003). Recreational fisheries are usually considered those where fishing is conducted by individuals for sport and leisure, with a possible secondary objective of catching fish for personal consumption (Pitcher and Hollingworth, 2002). Adaptation of seabass from brackish water to freshwater is an attractive alternative for fish enthusiasts.

Muscle tissue is the main edible portion of fish and responsible of their nutritional value. Fish axial muscle is segmentally arranged into myotomes, with two main fibre types grouped into two muscle layers: the superficial (red muscle) and deep (white muscle) layers (Veggetti et al., 1990). Also, an intermediate, thin layer (pink muscle) is usually present between them (Mascarello et al., 1986). Fish muscle growth commonly occurs by two possible mechanisms: hypertrophy and hyperplasia of muscle fibres. Hypertrophic growth occurs throughout post-embryonic life until muscle fibres reach a functional maximum diameter (Egginton and Johnston, 1982). White muscle cellularity is an important determinant of the textural characteristics of the flesh (Hurling et al., 1996). Several studies have found a relationship between muscle fibre size and the firmness of the flesh (Hurling et al., 1996), which also influence on the taste and processing characteristics of the flesh (Johnston, 1999). This has already been demonstrated for the Atlantic salmon (Salmo salar, L.) where the firmness of smoked fillet and colour measured by Roche SalmoFank were positively correlated with the muscle fibre density (Johnston et
al., 2000a). Flesh quality is a complex set of characters involving intrinsic factors such as texture, chemical composition, colour, fat content (Fauconneau et al., 1995), and is heavily influenced by extrinsic factors such as pre- and post-slaughter handling procedures (Gjerdrem, 1997). However, optimum feeding frequency and rate vary depending on the fish species, size and rearing system (Cho et al., 2003). Although several studies have been conducted to determine the optimum feeding frequency for growth, survival, feed intake, body composition etc. in different fish species at their early life stages (Wang et al., 2009), lack of information exists in this regard for Asian seabass fry reared in freshwater pond net cages.

**Materials and Methods**

**Fish samples and growth conditions**
Fifteen sea bass were studied: Each five samples, 100 Seawater sea bass were maintained in rectangular tanks (30x30x45cm), 100 freshwater seabass were maintained in rectangular tanks (30x30x45cm) and 50 specimens on the experimental cages were fixed in the freshwater pond at the both sides of a catwalk kept 0.2 m height above the water surface. Twelve nylon net (mesh size=0.71×0.45 mm) cages of size 10×10×1.2 m (length×breadth×height) respectively. Seabass larvae were reared in rectangular tanks (2.5 m³) until a weight of 30 g and grow out subsequently in freshwater cages in pond until commercial size (app. 350 g).

**Physico-chemical analysis**
The flesh fillet of freshwater and seawater sea bass were homogenised separately in an Omni-mixer to obtain a homogeneous sample for the physico-chemical analysis. Fish homogenate was analyzed for moisture, crude protein, total fat and ash content according to AOAC methods (AOAC, 1999). Flesh pH was determined after mixing 10 g of sample with 50 ml of distilled water, measuring the pH value with a Crisson pH-meter (micro-pH 2000 Crison).

**Muscle sample processing for morphometrical studies**
A whole cross-section sample of the trunk musculature (0.5 cm thickness) was removed at the level of the fourth ray of the dorsal fin of each specimen. These cross-sections were used to estimate the total area of white muscle by drawing it on acetate paper. Subsequently, the left half of each one of these samples was trimmed into 6–7 muscle blocks of approximately equal size. Blocks were covered with tissue freezing medium (Jung), frozen in 2-methylbutane (_80 8C), snap frozen over liquid nitrogen, and then stored in a _65 8C freezer until sectioning. Sections of 8 Am thickness were obtained in a cryostat (Leica CM 1850), and then stained with Haematoxylin/Eosin. All muscle cellularity parameters were measured in the white muscle since it comprises the major edible part of the myotome. Morphometric analysis was carried out by means of an image analysis system device (Qwin, Leica) connected to a light photomicroscope (Leitz Dialux 20). The whole white muscle cross-sectional area (mm2) and diameters of a minimum of 600 white muscle fibres/fish were measured. These values were then used to calculate the white muscle fibre density (muscle fibre number/ mm2) for each fish. The total white muscle fibre number was estimated from values of muscle fibre density and the cross-sectional area of white muscle (Johnston et al., 2000b).

**Textural parameters**
Textural parameters were measured in the dorsal muscle of the fish fillet using a Texturometer mod.1011 (Instron) using a 25-kg load cell, a 5- mm spherical probe and test speed of 1 mm/s. Three measurements were made for each sample in dorsal muscle perpendicularly to the muscle fibres orientation. The distance, maximum force and maximum shear force values obtained from the texture profile curve of each sample were used to calculate the independent mechanical parameters (springiness, hardness and
cohesiveness), and two dependent parameters (chewiness and gumminess) following the methodology described by Friedman et al. (1962).

**Results**

**Growth performance and survival**
Survival was unaffected by salinity throughout experimental period it was greater than 90% in low salinities. Also, no differences in feeding behaviour or appetite were observed. However, salinity did have a statistically significant effect on growth, with fish reared at 28ppt having significantly smaller TL and BW than the fish reared at 15 or 0 ppt, whereas there were no differences between fish reared above 20 or 28 ppt salinity. There was large variation in the FCR between 0ppt to higher salinity, which could not be explained by the experimental design.

![Figure 1.](image1.png)

**Figure 1.** The growth parameters show better quality on fresh water adaptation.

![Figure 2.](image2.png)

**Figure 2.** The final survival of fry ranges from 67% to 90%.

**Flesh quality: Proximate composition**
Proximate composition shows the high value of protein in fresh water than sea water and other compositions such fat, fibre, carbohydrate and moisture don’t have variations shows the physico-chemical differences in sea bass. The freshwater group showed a higher content of protein, and a lower fat and fibre contents. Total fat content was higher in seawater group than in freshwater fish, with no significant muscle cellularity differences between them. The flesh pH values were 6.44 in freshwater and 6.75 in seawater specimens.

![Figure 3.](image3.png)

**Figure 3.** Proximate composition shows the high value of protein in freshwater.
Conclusions

The Asian seabass fry can achieve maximum growth, survival and better feed conversion when they are adapted to freshwater net cage rearing. The findings also have practical significance towards establishing Asian seabass seed rearing in freshwater and will directly benefit the nursery operators. Fresh water adaptation of seabass has proven to be a potential alternative in seabass fish farming. Growth conditions can be controlled and optimized, and more attention can be given to improving the fish immunity and health for better survival and yield.
Growth of *Holothuria scabra* in nursery, fed with formulated feed and soft sediment

Zaiduddin Ilias¹, Che Utama Che Musa¹, Zainoddin Jamari¹ and Ong Chin Cheng²

¹National Prawn Fry Research Centre (NAPFRE), Department of Fisheries Malaysia, Kampung Pulau Sayak, 08600 Kota Kuala Muda, Kedah, Malaysia

²Positive Ocean Sendirian Berhad

Corresponding author’s email: zaiali01@yahoo.com

Abstract

*Holothuria scabra* is a potential mariculture species, which can be introduced as a component in polyculture with fish or shrimp in ponds. This study was carried out to determine the possibility of nursing this species to size between 10-40g before being released into ponds or sea pen for grow out. Feeding was one of the main concerns in culturing marine organism, as cheap and affordable feed source is getting scarce. *H. scabra* juveniles were fed with a mixture of mashed *Gracillaria* sp., mix copepod, *Isochrysis* and silt from the sea whereas another group was treated with the same algae mixture but without silt collected from the sea. For control treatment, the juveniles were kept in the sandy bottom similar to the first and second group. All the samples were measured weight and length every seven days to determine the effect of feeding. The result showed that the feed without adding silt from the sea gave a stable growth compared to the second feed. For the stocking density study, the result showed that the growth rate of the sea cucumber increased and reached a plateau after the fourth months at an average weight of 17g. The stocking density were between 300-400 pieces/5 ton or per 5 m² surface area. Results showed that at different stocking density, the growth was better at the first four months of the activity but slowed down after the fourth month on reaching 6kg overall weight. Extra sediment was not needed for the juvenile to grow.
Growth and survival rate of hatchery breed *Tridacna derasa* in an ocean nursery in Boheydulang Island, Semporna, Sabah, Malaysia

Nasrulhakim Maidin* and Abdul Jalil Mapait

Sabah Parks, Tun Sakaran Marine Park Complex
P.O Box 163, 91307 Semporna, Sabah, Malaysia

Corresponding author’s email: nasrulhm@gmail.com

**Introduction**

Giant Clam Hatchery located in Boheydulang Island in Tun Sakaran Marine Park, Semporna and fully functional in the year of 2007. This Hatchery is a collaborative work between Marine Research Unit of Sabah Parks and Semporna Island Darwin Project. The main goal of this hatchery is to produce young stock of *Tridacna derasa* for re-seeding the reefs in Tun Sakaran Marine Park. This species are currently badly over-exploited or locally extinct. This will provide benefits both for biodiversity conservation and for public awareness and education. For this research purpose, the main objectives are as below:

1) To measure the growth rate of *Tridacna derasa*.
2) To measure the survival rate of *Tridacna derasa*.

**Map**

![Map of Tun Sakaran Marine Park](image)

*Figure 1.* The location of the ocean nursery; Ribbon Reef (RR) and Boheydulang Reef (BR).

**Materials and Methods**

1) Selection of cage placement in the open sea of RR and BR.
2) Relocating the *Tridacna derasa* juvenile to the benthic cages; 4 cages at RR and 5 cages at BR.
3) Monthly data collection (January-August 2010); growth and survival data measurement recorded.
4) Weekly monitoring for cleaning and removing any possible predatory.
Results

Growth rate of *Tridacna derasa* is shown in Table 1; the growth rate for the juvenile is between 0.49-0.55 cm/month.

Table 1. Growth rate of *Tridacna derasa*.

![Chart Title](image)

<table>
<thead>
<tr>
<th>Months</th>
<th>BR</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>3.58</td>
<td>3.21</td>
</tr>
<tr>
<td>Feb</td>
<td>4.18</td>
<td>3.33</td>
</tr>
<tr>
<td>Mac</td>
<td>4.63</td>
<td>4.25</td>
</tr>
<tr>
<td>Apr</td>
<td>5.11</td>
<td>5.03</td>
</tr>
<tr>
<td>Mei</td>
<td>6.34</td>
<td>6.06</td>
</tr>
<tr>
<td>Jun</td>
<td>6.41</td>
<td>6.22</td>
</tr>
<tr>
<td>July</td>
<td>7.43</td>
<td>7.35</td>
</tr>
<tr>
<td>Aug</td>
<td>8.63</td>
<td>8.36</td>
</tr>
</tbody>
</table>

Survival rate of the *Tridacna derasa* in this study was high as shown in Table 2; BR = 86.4% & RR = 99.1%.

Table 2. Survival rate of the *Tridacna derasa*.

![Chart Title](image)

<table>
<thead>
<tr>
<th>Months</th>
<th>BR</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Feb</td>
<td>86.9</td>
<td>99.7</td>
</tr>
<tr>
<td>Mac</td>
<td>99.8</td>
<td>99.7</td>
</tr>
<tr>
<td>Apr</td>
<td>99.7</td>
<td>100</td>
</tr>
<tr>
<td>Mei</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Jun</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>July</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Aug</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Conclusions

High growth and survival rate of the *Tridacna derasa* may be attributed by the regular monthly cleaning of cages and clams. A higher mortality in BR during the first month may be due to transport stress and overcrowding. Based on the growth rate of the species, it is best to stock them at around 100 ind. in each concrete plat of 0.5 m x 0.5 m and reduce the number to 30 ind. once their shell size reached 6-9 cm.
Size, frequency, distribution and length-weight relationship of long-spined sea urchin, *Diadema setosum* in Malaysia

Md. Aminur Rahman1, S.M. Nurul Amin1, Perumal Kuppan1, Aziz Arshad1,2, Mariana Nor Shamsudin1,3 and Fatimah Md. Yusoff1,4

1Laboratory of Marine Science and Aquaculture, Institute of Bioscience Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

2Faculty of Agriculture, 3Faculty of Medicine and Health Sciences, 4Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Corresponding author’s email: aminur1963@gmail.com

Abstract

Size frequency distribution and relative growth pattern of the long-spined sea urchin, *Diadema setosum* were estimated from the Pulau Pangkor (4°23.58' N; 100°54.50' E), Peninsular Malaysia. Mean length of *D. setosum* was estimated at 58.73 mm and the mean weight was 94.59 g. Total 101 specimens were examined; among them 52 were males and 49 were females. The overall ratio of males to females was 1:0.94. The logarithmic form of length-weight relationship of *D. setosum* was Log W = -1.9011 + 2.181 Log TL. The exponential form of equation obtained for the length-weight relation was W = 0.0126*TL2.181. The value of regression co-efficient ($r^2$) estimated for the species was 0.93.

Keywords: population growth, *Diadema setosum*, Peninsular Malaysia

Introduction

*Diadema setosum* (Leske. 1778) (Echinometra: Echinoidea: Diadematidae), is one of the regular echinoids widely distributed in the Indo-West Pacific Ocean, where it occurs from the Red Sea (Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea), and the east coast of Africa, to Japan and Australia (Lessios et al., 2001). It has distinctively long black spines and five white-spot on their aboral side. The orange ring around their anal cone completes the special visual features of this species. It is an omnivorous scavenger and detritus feeder, ingesting loose substrate and scraping films off hard surfaces.

Eight species of sea urchins have been recorded in Malaysia’s coral reef community: *Diadema setosum*, *Echinometra mathaei*, *Astropyga radiata*, *Toxopneustes pileolus*, *Echinothrix calamaris*, *Echinothrix diadema* and *Parasalenia gratiosa* (Kee Alfian, pers. Commu.). Among them, *D. setosum* is one of the most conspicuous and abundant species in the Straits of Malacca and South China Sea (Affendi and Kee Alfian, pers. Commu). Its distribution and abundance were studied on the natural reefs, artificial reefs, and marine park jetty in Pulau Tioman of Pahang (Wei et al., 2008). A marine research project undertaken by the Institute of Biological Sciences of Universiti Malaya found huge numbers of *D. setosum* scattered over the seabed and burrowed deep into reefs in Pulau Pangkor of Perak. Their densities in the surrounding islands of Pulau Pangkor ranged from “medium” at Pulau Mentangor (16 urchins/100m$^2$), “high” at Pulau Giam (23 urchins/m$^2$) and “phenomenally high” at Pulau Dua (222 urchins/100 m$^2$) (Rosman unpub. data).

The cryptic species is commonly observed around reefs and shallow rocky habitats (1-6 m depth), where it hides in crevices and under overhangs by day, and forages at night, at a distance of a few meters away from its daytime hideout. *Diadema* spp. has a wide range of diet, which includes algae, coral polyps and encrusting animals (Grignard et al., 1996). In the
Gulf of Suez, gametogenesis begins in April-May, when the water temperature rises above 25°C, and spawning takes place between June and September.

Sea urchins are used as raw material to produce foodstuff, in particular, the product of processing gonads known as “Sea urchin Roe or Uni” and are considered a prized delicacy in Asia, Mediterranean countries, and Western Hemisphere countries such as Barbados and Chile (Lawrence et al., 1997). Gonads of sea urchins have long been a luxury food in Japan (Shimabukuro, 1991). Although, *D. setosum* has not yet been used as commercially edible species in Malaysia, it has been reported that in Sabah, an indigenous tribe known as ‘Bajau Laut’ eats sea urchin roe with rice. The body of sea urchins, known as test, is cleaned and the roes removed. The clean test is then filled with rice and roe and after adding spices, the concoctions are steamed and then serve to the guests and customers (Kee Alfin, pers. Commu.). Sea urchin gonads are also rich in valuable bioactive compounds, such as polyunsaturated fatty acids (PUFAs) and β-carotene. PUFAs, especially eicosapentaenoic acid (EPA, C20:5 (n-3)) and docosahexaenoic acid (DHA C22:6 (n-3)), have significant preventive effects on arrhythmia, cardiovascular diseases and cancer (Pulz and Gross, 2004). On the other hand, the high levels of AA (arachidonic acid) and EPA recently detected in *D. setosum* supported the development of aquaculture of this urchin (Chen et al., 2009), since PUFAs are important for human nutrition (Lawrence, 2007). Sea urchin research is quite new in Malaysia. However, very few systematic works have been done on the abundance and distribution patterns of *D. setosum* in Peninsular Malaysia but no published information on their growth patterns are available. Due to the pharmaceutical values of sea urchin gonads, it is very important to understand the population growth patterns of *D. setosum*. Therefore, the present study has been undertaken on length-weight relationships and population growth of *D. setosum* in the Pulau Pangkor, Peninsular Malaysia.

**Materials and Methods**

One hundred one live specimens of *D. setosum* were collected from the intertidal reef of Pulau Pangkor (4°23.58’ N; 100°54.50’ E) during their natural breeding season in May-August, 2010. The collected specimens (Figure 1) were transported to the Institute of Bioscience at UPM and maintained in well aerated sea water tank before use for the experiment. Each individual was then measured to the nearest 0.05 mm total length (TL) using vernier caliper and weighed to nearest 0.01 g (total weight).

**Figure 1.** Sexually matured adults of *D. setosum* collected from the intertidal reef at Pulau Pangkor of Perak: aboral view (left); oral view (right).

The length-weight relationship was calculated using the equation $W = aL^b$ (Pauly, 1984), and logarithmically transformed into: $\log W = \log a + b \log L$, where $W$ is the weight of the urchin in g, $L$ is the total length of the urchin measured in mm, $a$ is the intercept and $b$ is the slope (growth co-efficient, i.e., relative growth rate). The parameters $a$ and $b$ of L-W relationships were estimated by linear regression analysis (least-squares method) on log-transformed data. The coefficient of determination ($r^2$) was used as an indicator of the quality
of the linear regression (Scherrer, 1984). To estimate the population structure, the length-frequency data of *D. setosum* were analyzed by using the SPSS Version 15.0.

**Results and Discussion**

**Size, frequency, distribution**
The mean length and weight of *D. setosum* was 58.73 ± 0.51 mm and 94.59 ± 1.82 g respectively. The length range was between 42.30 and 71.60 mm (Figure 2), whereas weight range was between 43.72 and 138.75 g (Figure 3).

**Length-weight relationship**
Length-weight relationship of *D. setosum* was established as Log *W* = -1.9011 + 2.181*Log TL* (*r²* = 0.93), in exponential form the equation was *W* = 0.0126* L^{2.181} (*r²* = 0.93). The calculated growth coefficient (b) was 2.181 and the constant (a) was 0.0126. The length–weight relationship curves are presented in logarithmic scale (Figure 4) as well as observed values (Figure 5).

Information on the length-weight relationships (LWR) of *D. setosum* is very limited. Relative growth studies are widely used, especially for heavily resistant crustaceans, such as lobsters and crabs, because of their hard integument and possibility of rapid changes during the ontogenesis (Ragonese et al., 1997). LWR can be useful in studies of gonad development,
rate of feeding, metamorphosis, maturity and well being of the fish population (Le-Cren, 1951; Bolger and Connolly, 1989). A characteristic of the length-weight relationship in fishes and invertebrates is that the value of the exponent (b) is 3 when growth in weight is isometric (without changing shape). If b value is different from 3, weight growth is said to be allometric (body changes shape as it grows larger). Allometric growth may be negative (b < 3) or positive (b > 3). The present estimated exponent (b = 2.181) is less than isometric value. Therefore, negative allometric growth was found for D. setosum in natural condition. This means that body weight does not increase as proportionally with the body length.

References


Microbial flora densities of *Perna viridis* distributed in the cities of Mandaue and Lapulapu Markets, Cebu Province

Corazon P. Macachor*, Cecilio S. Baga and Bonifacio S. Villanueva

Cebu Technological University, R. Palma St., Cebu City, Philippines
Corresponding author's email: cora_macachor@yahoo.com

Abstract

The microbial flora densities and presence or absence of pathogenic organisms of *Perna viridis* distributed in the Cities of Mandaue and Lapulapu markets was investigated using the procedure suggested by AOAC. *Perna viridis* taken from the Cities of Mandaue and Lapulapu markets had the highest mean bacterial load of $8.56 \times 10^3$ cfu/g, and $8.18 \times 10^3$ cfu/g, respectively. The bacterial loads from the two markets were lower than the tolerable limits ($10^4 - 10^6$ cfu/g). However, green mussels *Perna viridis* obtained from the two markets were safe for human consumption since the pathogenic organisms particularly *E. coli* and *Salmonella* were not detected after confirmatory tests conducted.

Introduction

Bivalves such as *Perna* are mostly cultured in coastal and estuarine areas, hence may have been exposed to industrial waste and sewerage discharges. The presence of bacterial and viral pathogens are usually the consequence of sewage pollution. The pollution level is often closely related to freshwater discharge from land. This makes it, in some cases, mandatory to develop guidelines to restrict mussels harvesting following periods of heavy rainfall. Contamination with bacterial and viral pathogens presents a major risk to consumers, especially if the mussels are eaten raw or only lightly cooked. Viral infection from eating oysters that led to infective hepatitis has been documented. The lack of awareness of the possible linkage between human fatalities and the consumption of mussels might be the primary reason that so far, no report exists on bacterial diseases transmitted through consumption of any of the *Perna* species. However, BFAR authorities is recently banning *Perna* from Masbate and Samar areas.

This study investigates the following specific objectives:

1) To determine the plate count densities of microbial flora present in *Perna viridis* distributed in the Cities of Mandaue and Lapulapu markets; and

2) To evaluate the potential hazard of the microbial flora densities present in *Perna viridis* distributed in the two markets.

Materials and Methods

**Study sites**

Microbial analysis was done at the Regional Fisheries Laboratory, Bureau of Fisheries and Aquatic Resources, Arellano Blvd., Cebu City from September 1 to 30, 2005. The sampling of mussel sites were the two markets situated in Mandaue City and Lapulapu City.

The mussel samples (Figure 1) weighing one kg each from the two fish markets were brought to the microbiology laboratory for microbial analysis. The sizes of mussels were measured based on length and width prior to deshelling. The total plate count (TPC) or the most probable number (MPN) of bacteria was analyzed based on the procedure suggested by Lim (1999).
Unit of analysis
The unit of analysis in this study was the mussel samples weighing one kg each from the two markets of Mandaue City and Lapulapu City, brought to the microbiology laboratory for microbial analysis. The variables investigated were the species, plate count and potential hazards.

Figure 1. The *Perna viridis* used in the study.

*Perna viridis* samples, approximately 150-200 g in weight, taken from the markets of Mandaue City and Lapulapu City were analyzed. Each shell was aseptically sliced in half and kept in a sterile petri dish. Tests were done in triplicate using test tubes and incubated at room temperature. The isolation and detection of the pathogenic organisms followed after bacterial enumeration. The confirmatory tests of the presence of *E. coli* were done based on the procedure suggested by Lim (1999).

Results and Discussion

The commercial samples of *Perna viridis* distributed in the two markets were subjected to the enumeration of aerobic plate count and detection of pathogenic organisms like *E. coli*.

Based on the laboratory results analyzed by BFAR 7, Figure 2 showed that Lapulapu had a higher bacterial load compared to Mandaue, with $8.56 \times 10^3$ cfu/g and $7.44 \times 10^3$ cfu/g, respectively. The bacterial species were gram negative bacteria which resembles like the strain of *E. coli*.

Figure 2. The total aerobic plate count of bacteria from green mussels, *Perna viridis* in cfu/g distributed in the two markets per two trials of analyses.
In addition, the higher mean bacterial load of green mussels suggest its mussel sources of the 2 markets which was from mildly polluted areas (Lutz, 1980). The minimum standards set by public health agencies (National Shellfish Sanitation Program, 1965), for total aerobic viable count was less or equal $5 \times 10^5$ cells/ml of shucked meat. The results of the three trials indicated that all the supermarkets evaluated met the standards.

Likewise, the *Perna viridis* bacterial load taken from Lapulapu and Mandaue meet the microbiological standards because the bacterial loads were lower than the $2.5 \times 10^6$ cfu/g, threshold which is safe for human consumption. It was in the presumptive test that *E. coli* was detected. However, in the confirmation tests, those bacteria were no longer detected.

**Conclusions**

After a thorough analysis of the laboratory results and based on the findings gathered from this study, the following conclusions were formulated:
1) The species, *Perna viridis* from the markets of Lapulapu City and Lapulapu City have comparable aerobic plate counts of bacteria i.e, $8.56 \times 10^3$, and $8.18 \times 10^3$ cfu/g, respectively.
2) There was no potential hazard on *Perna viridis* taken from the 2 markets, since the laboratory results meets the Bureau of Food and Drug (BFAD) microbiological food standards, thus it needs to maintain the proper handling of the product. The different markets must observe efficient handling techniques during marketing of *Perna viridis*. The 2 markets maintained the low temperature environment of the *Perna viridis*, thus the product was considered safe for human consumption. They must see to it that the source of *Perna viridis* must not be taken from the polluted waters so that it must be free from pathogenic organisms particularly *Escherichia coli*.

**References**


Population dynamics of *Acetes serrulatus* (Krøyer 1859) from the coastal waters of Pontian, Johor, Peninsular Malaysia

Siew-Yong Oh\(^1\), Aziz Arshad\(^{1,2}\), Japar Sidik Bujang\(^3\) and Nor Azwady Abd Aziz\(^3\)

\(^1\)Laboratory of Marine Science and Aquaculture, Institute of Bioscience
\(^2\)Department of Aquaculture, Faculty of Agriculture
\(^3\)Department of Biology, Faculty of Science

Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

Corresponding author’s email: thisipromiseu17@yahoo.com

Abstract

Shrimps of the genus *Acetes* Milne-Edwards, 1980 are ecologically and commercially important. Locally known as ‘udang geragau’ or ‘udang baring’, it is fished and utilized as food or feed in Malaysia. With annual landing of 13,797 metric tons in 2007, almost all products can be seen at market as dried shrimp, shrimp cracker, shrimp paste (‘belacan’) and pickled shrimp (‘cincalok’).

Monthly samples of *Acetes serrulatus* (Krøyer 1859) were collected between April 2008 to April 2009 from Pontian, west coast of Johor, Peninsular Malaysia. Population parameters such as asymptotic length ($L_m$), growth coefficient ($K$), natural mortality ($M$), fishing mortality ($F$) and exploitation level ($E$) of *A. serrulatus* were estimated using length-frequency data and FISAT software.

The asymptotic length ($L_m$) and growth coefficient ($K$) was estimated as 27.83 mm and 1.30 per year for males while 28.88 mm and 1.20 per year for females. The growth performance index ($\phi'$) was estimated as 3.00 for both sexes. The recruitment pattern was continuous throughout the year.

For males, total mortality ($Z$) was estimated as 4.56 per year while fishing ($F$) and natural ($M$) mortality was estimated at 1.64 and 2.92 per year, respectively. Exploitation rate ($E$) of 0.64 was obtained. For females, $Z$ and $M$ was estimated as 4.94 per year and 1.67 per year. Thus, $F$ was obtained as 3.27 per year with $E$ of 0.66 per year. Higher fishing mortality indicated there is high fishing pressure on the stock.

The exploitation rate ($E$) with an estimated average of 0.65 (>0.50) indicated that *A. serrulatus* was slightly over exploited in the study area. High exploitation rate also implies that any further restrained in fishing effort might drive the stock down. Therefore, management measures such as decreasing the allowable mesh size or operation of nonbreeding season are desirable for the fishery of *A. serrulatus* in the study area.