Harmful Algal Blooms IN MALAYSIA :
Current status and Challenges

Po Teen LIM PhD
IOES, UM
Harmful Algal blooms In Malaysia

- Introduction
- Current Status
  - Paralytic shellfish poisoning (PSP)
  - Amnesic shellfish poisoning (ASP)
  - Benthic harmful dinoflagellates
  - Fish-killing harmful microalgae

- Challenges of HABs research and Monitoring
Harmful Algal Blooms

Blooms:
Increase of number of organisms in a certain volume of water as a consequence of biological, physical and chemical environmental condition, including those derived from organisms themselves.
Regular phytoplankton (microalgae) community

Some of them have an ability to grow very fast, i.e. one cell division in every 4-6 hours. One cell becomes more than thousand in 2-3 days.

Courtesy of Y Fukuyo
Toxic plankton community

Several toxic plankton occurs simultaneously. Cell numbers are not high.
Red tide plankton community

One drop of discolored water by *Cochlodinium polykrikoides* in the Gulf of Thailand *(Courtesy of Y Fukuyo)*
HAB: definition is difficult

Harmful Algal Bloom (HAB) is a generic term used to refer events where proliferations of microalgae in marine or brackish waters can cause
1. massive fish kills (often associated w/ RT),
2. toxin contamination in seafood (TAB), and
3. alternation of ecosystems in ways that humans perceive as harmful.

(GEOHAB, 2000)

Cell number causing HABs are very different between Red tides and Toxic Algal Blooms
Paralytic Shellfish Poisoning in Malaysia and its causative organism
1. Paralytic shellfish poisoning (PSP)

- Neurotoxin - **Saxitoxins (STXs)**
- Sodium channel blocker in mammalian nerve system

- Causative organisms of PSP – marine dinoflagellates
  - Pyrodininium bahamense var. compressum since 1970s;
  - Gymondinium catenatum,
  - Alexandrium spp.
Pyrodinium bahamense var. compressum

- PSP outbreak was first reported in the early 1970s.
- Morphology: chain forming, heavy thecated.
Related research...

- **Species discovery**: since 1970s
- **Toxin production**: Usup et al. 1994, 2006, Montojo et al. 2006
- **Genetics and Phylogeny**: Leaw et al. 2005
Usup et al. 2012 *Harmful Algae* 14:301-312

Phylogeny of *Pyrodinium bahamense*
Barcode of Pyrodinium bahamense

Usup et al. 2012 *Harmful Algae* 14:301-312

5.8S rRNA

5.8S-28S proximal stem
New Discovery…

First report of *Pyrodinium bahamense* in the Straits of Malacca
Biology, ecology and bloom dynamics of the toxic marine dinoflagellate *Pyrodinium bahamense*

Gires Usup\textsuperscript{a,*}, Asmat Ahmad\textsuperscript{a}, Kazumi Matsuoka\textsuperscript{b}, Po Teen Lim\textsuperscript{c}, Chui Pin Leaw\textsuperscript{d}

\textsuperscript{a}Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
\textsuperscript{b}Institute for East China Sea Research, Nagasaki University, 1-14 Bunkyo-machi, Nagasaki, Japan
\textsuperscript{c}Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
\textsuperscript{d}Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
<table>
<thead>
<tr>
<th></th>
<th>72</th>
<th>73</th>
<th>76</th>
<th>77</th>
<th>78</th>
<th>79</th>
<th>80</th>
<th>81</th>
<th>82</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Philippines</strong></td>
<td>7-8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td>2-4</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>1-3</td>
<td>10-11</td>
<td>1-5,8-11</td>
<td>2-6,12</td>
</tr>
<tr>
<td><strong>Brunei</strong></td>
<td>3-5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4-7,9-10</td>
<td>1-3,7</td>
<td>1-9</td>
<td>1-9</td>
<td>1-9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Papau New Geinea</strong></td>
<td>3-7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Florida</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Costa Rica</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>El Salvador</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Guatemala</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>93</th>
<th>94</th>
<th>95</th>
<th>96</th>
<th>97</th>
<th>98</th>
<th>99</th>
<th>00</th>
<th>01</th>
<th>02</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Philippines</strong></td>
<td>1-10</td>
<td>1-7,11-12</td>
<td>1-7,12</td>
<td>1-7</td>
<td>1-8,8-10</td>
<td>1-11</td>
<td>1-11</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td>1-5,7-12</td>
<td>1-4,7-12</td>
<td>1-6,8-12</td>
<td>3,8-12</td>
<td>1-3,8-12</td>
<td>1-8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Brunei</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7-8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7,8</td>
<td>3,8</td>
<td>8-9</td>
<td>10-12</td>
<td>7-8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Papau New Geinea</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Florida</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Costa Rica</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>El Salvador</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Guatemala</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1-12 denote month of January to December.

* Var. bahamense. 
Usup et al. 2012 *Harmful Algae* 14:301-312
Toxic *Alexandrium* species

- PSP outbreak was first reported in **1990s**.

*A. tamiyavanichii* from Sebatu, Malacca
Related research...

- **Species discovery**: Kodama et al. 1988, Balech 1994, Usup et al. 2002a, Lim et al. 2003
- **Genetics and Phylogeny**: Usup et al. 2002b, Leaw et al. 2005
New Discovery...

Alexandrium tamiyavanichii from Kuching, Malaysia

A. *tamiyavanichii* was found for the first time in Kuching, Sarawak (2011)
Alexandrium minutum from Malaysia

First incidence of paralytic shellfish poisoning on the east coast of Peninsular Malaysia

Lim, P.T.¹, C.P. Leaw² and G. Usup²

Marine Science into the New Millennium: New Perspectives & Challenges, Phang et al.(eds.), 2004
Toxin composition in contaminated shellfish

(Lim et al. 2007)

Changes of toxin compositions in benthic clam, *Polymesoda similis* after feeding with toxic *A. minutum*.
Dendrogram revealed distinct toxin profiles of Southeast Asian *A. minutum* from *A. minutum* from temperate waters.
Studies on the Morphology of Alexandrium species

Morphological variation of two *Alexandrium* species responsible for paralytic shellfish poisoning in Southeast Asia

Po-Teen Lim\(^1\)\(^*,\) Chui-Pin Leaw\(^1\) and Takehiko Ogata\(^1\)

Identification of *Alexandrium halim* (Dinophyceae) using EPI-microscopy

Po-Teen Lim *, Chui-Pin Leaw ** and Gires Usup **
Alexandrium taylori and A. peruvianum

First report of *Alexandrium taylori* and *Alexandrium peruvianum* (Dinophyceae) in Malaysia waters

Po Teen Lim\textsuperscript{a,b},*, Gires Usup\textsuperscript{c}, Chui Pin Leaw\textsuperscript{c}, Takehiko Ogata\textsuperscript{b}
Gymnodinium catenatum

- No PSP outbreak was reported thus far.
- Morphology: chain forming, unarmoured dinoflagellate.

G. catenatum was found for the first time in Santubong, Sarawak (2012)
Occurrences of PSP toxin producing dinoflagellates in Southeast Asia

Sources:
**Alexandrium**
Matsuoka et al., 1997
Yoshida et al., 2000
Usup et al., 2002
Bajarias et al., 2003
Nguyen et al., 2004
Lim et al., 2004
Lim et al., 2005

**Pyrodinium**
Ting and Wong, 1989
Usup et al., 1989, 2012
Furio and Gonzales, 2002

**Gymnodinium**
Fukuyo et al., 1993
Holmes et al., 2002
Mohammand-Nor et al., 2002
Potential microalgal species of Amnesic Shellfish Poisoning (ASP)
2. Amnesic shellfish Poisoning (ASP)

* Toxin: Domoic Acid (DA)
* No confirm ASP cases being reported in SE Asia.
* Contaminated shellfish were reported in Philippines (Bajarias et al. 2006) and Vietnam (Dao et al. 2009, Takata et al. 2009).
* Only *P. caciantha* from Vietnam was confirmed to be DA producer (Dao et al. 2009, 2014).
<table>
<thead>
<tr>
<th>Species</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Malaysia</td>
</tr>
<tr>
<td>Pseudo-nitzschia americana</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia brasiliana</td>
<td>+, b, d, h</td>
</tr>
<tr>
<td>Pseudo-nitzschia caciantha</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia calliantha**</td>
<td>+ b</td>
</tr>
<tr>
<td>Pseudo-nitzschia cuspidata</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia delicatissima**</td>
<td>+ b</td>
</tr>
<tr>
<td>Pseudo-nitzschia dolorosa</td>
<td>+ d</td>
</tr>
<tr>
<td>Pseudo-nitzschia fraudulenta**</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia cf. grani</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia heimii</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia inflatula</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia micropora</td>
<td>+ b</td>
</tr>
<tr>
<td>Pseudo-nitzschia multistriata**</td>
<td>+ b</td>
</tr>
<tr>
<td>Pseudo-nitzschia pungens</td>
<td>+ d, h</td>
</tr>
<tr>
<td>Pseudo-nitzschia pseudodelicatissima**</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia cf. sinica</td>
<td>-</td>
</tr>
<tr>
<td>Pseudo-nitzschia subpacifica</td>
<td>-</td>
</tr>
</tbody>
</table>

Sources:  
\(^a\) Bajarias et al., 2006;  \(^b\) Larsen & Nguyen, 2004;  \(^c\) Yap-Dejeto et al., 2008;  \(^d\) Lim, 2010;  \(^e\) Lundholm et al., 2002;  \(^f\) Priisholm et al., 2002;  \(^g\) Sidabutar et al. 2000;  \(^h\) Su, 2010  
** toxic species
New Discovery…

• >25 species of *Pseudo-nitzschia* found in Malaysia.
• Five new species was described.

▶ *Pseudo-nitzschia circumpora*

H.C. Lim, C.P. Leaw et P.T. Lim (Lim et al. 2012)
New Discovery...

- *Pseudo-nitzschia batesiana*
- *Pseudo-nitzschia fukuyoi*
- *Pseudo-nitzschia lundholmii*
New Discovery...

- *P. kodamae*

More species yet to be uncovered.
On a Local-scale Species Distribution...

**Pseudo-nitzschia**

*Sampling locations*

Teng et al. (2013) *Botanica Marina*
Pseudo-nitzschia (Bacillariophyceae) community structure in the eastern South China Sea:
An automated ribosomal intergenic spacer analysis (ARISA) of samples from SHIVA Expedition

Teng, et al. (In prep)

Distribution pattern and species richness of Pseudo-nitzschia spp.
Potential ASP risk in Malaysia
New Discovery...

- Invasive species found (?)

\[ P.\ turgidula: \text{cold water species} \]

\[ P.\ decipiens: \text{temperate species} \]
Interactive Key to species of *Pseudo-nitzschia*

This interactive key is designed to aid researchers in the field to identify the species of *Pseudo-nitzschia*. Each character is illustrated to ease *Pseudo-nitzschia* identification. Each taxon has hyperlinks to the taxa descriptions on morphology, distributions and relevant references.

The key was created in jI (Internet-accessible Interactive Identification) Interactive Key and Taxonomic Database software package (http://amperals.inha.illinois.edu/dkmtree/index.asp).

How to Use the Interactive Key

1. The main window presents the list of characters, with a drop-down box of a set of states. Some characters may have no state, numeric value should be entered (the range of valid values is indicated in parentheses).

2. As for Character List Sorting, the program allow sorting the characters in three ways:
   - **By Rank** - which will be sorted based on the best characters for ID (we set that in the database), the rank of the character is specified in parentheses, e.g. "poroid structure (I=18)".
   - **By Separating Power** - with this option, the rank is disregarded, and the program will calculate which characters better split taxa (and according to the program, this is recalculated after each step of ID).
Character state description with detailed micrographs
Pseudo-nitzschia americana (Hasle) Fryxell, 1993

Images

Autogenerated Description

Studied Material

References

Search on the Internet

No Map Legend ▼  Best Fit Map ▼  Update
### Micrographs of each species

<table>
<thead>
<tr>
<th>Images</th>
<th>Species</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="micrograph1.png" alt="Image" /></td>
<td><em>americanus</em> (Hasle) Fryxell, 1993</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph2.png" alt="Image" /></td>
<td><em>baltziana</em> Lim, Teng, Leav &amp; Lim, 2015</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph3.png" alt="Image" /></td>
<td><em>baltziana</em> Lundholm, Hasle &amp; Fryxell, 2002</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph4.png" alt="Image" /></td>
<td><em>caledonia</em> Lundholm, Moestrup &amp; Hasle, 2003</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph5.png" alt="Image" /></td>
<td><em>caledonia</em> Lundholm, Moestrup &amp; Hasle, 2003</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph6.png" alt="Image" /></td>
<td><em>circumpora</em> Lim, Leav &amp; Lim, 2012</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph7.png" alt="Image" /></td>
<td><em>depressa</em> Lundholm &amp; Moestrup, 2006</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph8.png" alt="Image" /></td>
<td><em>delicataforma</em> (Cleve) Hayden, 1928</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph9.png" alt="Image" /></td>
<td><em>doloresa</em> Lundholm &amp; Moestrup, 2006</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph10.png" alt="Image" /></td>
<td><em>futuyo</em> Lim, Teng, Leav &amp; Lim, 2013</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph11.png" alt="Image" /></td>
<td><em>hasiana</em> Lundholm, 2012</td>
<td></td>
</tr>
<tr>
<td><img src="micrograph12.png" alt="Image" /></td>
<td><em>infaba</em> (Hasle)Hasle, 1993</td>
<td></td>
</tr>
</tbody>
</table>
Functions in the “compare”
Research on benthic harmful dinoflagellates in Malaysia
3. Benthic harmful dinoflagellates and ciguatera

Five genera:

1. *Amphidinium*,
2. *Coolia*,
3. *Gambierdiscus*,
4. *Prorocentrum*, and
5. *Ostreopsis*

Share similar habitats and form assemblages.
Benthic epiphytic dinoflagellates

- Current known toxins:
  - Maitotoxin ~ *Gambierdiscus toxicus*
  - Palytoxin analogs ~ *Ostreopsis* spp.
  - Yessotoxin analogs ~ *Prorocentrum* spp., *Coolia monotis*
- Ovatoxin a, b, c, d, e, and f ~ *O. cf. ovata*

(Ciminiello et al. 2012)
Where can we find them?

- Epiphyte: Seaweeds, coral rubbles, sand, rocks etc.
- Water column

The seaweed *Carpophyllum plumosum* covered in *O. siamensis* in Northeastern New Zealand (Shears & Ross 2009)

Mat formed by *O. ovata* on rocks in Conero Riviera (Totti et al. 2010)
Related research...

- **Genetics**: Leaw et al. 2001, 2010
- **Toxins**: Holmes 1995, 1996, ?
- **Distribution**: ?
- **Habitat preference**: ?
New discovery...

MORPHOLOGY AND MOLECULAR CHARACTERIZATION OF A NEW SPECIES OF THECATE BENTHIC DINOFLAGELLATE, *COOLIA MALAYENSIS* SP. NOV. (DINOPHYCEAE) ¹

Chui-Pin Leaw²
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, Kota Samarahan, 94300 Sarawak, Malaysia

Po-Teen Lim
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Kota Samarahan, 94300 Sarawak, Malaysia

Kok-Wah Cheng, Boon-Koon Ng, and Gires Usup
Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Bangi, 43600 Selangor, Malaysia

¹ DOI: 10.1111/j.1529-8817.2009.00778.x
BENTHIC HARMFUL DINOFLAGELLATE ASSEMBLAGES IN A FRINGING REEF OF SAMPADI ISLAND, SARAWAK, MALAYSIA

Toh-Hii Tan¹, Po-Teen Lim², Aazani Mujahid³, Gires Usup³ and Chui-Pin Leaw¹
Black fiberglass screens (300 cm$^2$) were deployed underwater along a transect line by SCUBA diving. The screens were left for 24 h prior to collection.
Total cell densities observed on the screens ranged from $<10 - 100$ cells per $100 \text{ cm}^2$. 
An underwater video survey was conducted along the transect line, and the surface of sediments were photographed by SCUBA.

Habitat mapping and classification
BHAB species in the assemblages of Sampadi Island.

Cluster analysis using Bray-Curtis similarities revealed a degree of interaction between algal community (in a function of relative abundance) and benthic habitat condition.

Tan et al. (2013) Mar Res Indonesia
Red tide forming and Fish Kills
HAB events caused fish kill

- Caused millions losses in finfish mariculture.

- Fish kills due to mucus compound at gills; low oxygen level in water due to degradation of blooms; production of ammonia by certain dinoflagellate species.

(Source: Sinchew Daily, 2005)
Cochlodinium polykrikoides

- Chain forming dinoflagellate,
- commonly known for fish kills in the East Asia, China, Korea and Japan.
- In SE Asia, blooms were encountered in Sabah, Malaysia (Anton et al. 2008) and Palawan, Philippines (Azanza et al. 2008).

Cochlodinium bloom in Sabah

Courtesy of M. Iwataki
Prorocentrum minimum

Recent massive fish kills in Johor Strait
• Fish kill incident happened, started on Feb 11, 2014; became more serious on the following three subsequent days.
• It last for at least two weeks.
Cell compositions

Cell density of *Karlodinium* on 21\textsuperscript{st} February at West Johore Strait: 1-2.3 \times 10^6 cells L\(^{-1}\)

*K. veneficum* blooms in Chesapeake Bay, USA: 6 \times 10^7 cells L\(^{-1}\) (Deeds, 2003)
The unarmored dinoflagellates

*Karlodinium australe*

Cell length: 22.5 ± 2.1 µm

Cell width: 16.2 ± 1.9 µm

Nucleus: irregular-rounded, anterior

Chloroplast: >10 ribbon shape and irregularly distributed peripherally
Fish Necropsy
Challenges of HABs Monitoring
Monitoring

• To fulfill the requirement for seafood export
• To ensure seafood safety for local consumption
• To prevent damage to aquaculture

• Plankton monitoring:
• could be an early indicator of onset of shellfish poisoning incidents by monitor the abundance of toxin producers
• Early warning for aquaculturists/farm operators
• **Shellfish monitoring:**
• Monitoring of shellfish is required for management and shellfish safety issue
• Shellfish harvesting bans when PSP toxicity beyond 400MU/100g shellfish tissue (mouse bioassay)
Challenge 1: What to monitor?

- We need to know what to monitor on “regular basis” and for what “purpose”
  - Blooms forming species
  - Toxin producers

- Challenges:
  - Inadequate information on HABs distribution; frequently, causative species was found after occurrence of poisoning or fish kills incidences
  - Insufficient baseline data, mainly focused on selected areas with growing aquaculture industries
  - Lack of long term research and monitoring data
Species composition in Kuching, Sarawak (2008 to 2011)

*Pseudo-nitzschia* spp. (>20%)
Physical parameters of Santubong and Samariang
Macronutrients at Santubong and Samariang

WHAT ARE THE DRIVING FACTORS?
Challenge 2: What to monitor?

- Emerging new HABs species
- Introduction of invasive HABs species by Ballast water (planktonic cells or resting cysts).
- Increased frequency, expansion of HABs occurrence due to environmental changes (anthropogenic driven or naturally).
• HABs species have been recognized as one of the most unwanted species that has been introduced to various regions of the world via discharge of ships’ ballast water.

• IMO has established a guideline in 1991, and the international convention for the control and management of ship’s ballast water (WM) was adopted in 2004 (IMO, 2004).
Challenges 2: Lack of CRM

- For shellfish toxicity analyses, it required reference materials as standard
- Analytical Instruments: HPLC, LCMS/MS
- Assay: Radiolabelled Competitive receptor binding Assay (RBA), ELISA
- One of the challenges for monitoring agencies
High performance liquid chromatography  HPLC for PSP

• Isocratic post-column derivatization method (Oshima, 1995)
• Gradient post-column derivatization method (Lawrences, 2003)
• References toxin is needed for analysis
Challenge 2: Lack of awareness

- Inadequate “Best Management Practice” at aquaculture industries
- Deterioration of environmental condition lead to occurrence of algal blooms
- Land-based discharge leading to eutrophication promote formation of algal blooms
- Awareness program targeted aquaculturist is needed to carry out concurrently with monitoring/research program
Challenge 3: How to react?

- JKAM-Tecnical Working Group on HABs and Marine/Freshwater Biotoxins acts as the advisory body to issues related to HABs/shellfish poisoning events
- Lack of trained manpower in newly established Depart of Fisheries- Biosecurity Unit?
- Lack of structured training/capacity building program on HABs and Biotoxins-
- In house training activities for Department of Fisheries on yearly basis
Challenge 4: How to mitigate?

- HABs mitigation strategies varied by species, environmental condition etc.
- Early warning system such as Environmental Sample Processor (ESP) is known to be effective but costly.
- Water treatment system has been proposed as way to treat HABs, but not being tested yet locally?
Summary

• PSP remained the most important issue to address.

• Increased of fish kills incidences (damage to aquacultures has been widely reported recently).

• All stakeholders (Fisheries Dept, Biosecurity Unit, Aquaculture industries) need to work hand-in-hand to address these issues.

• Comprehensive monitoring program should be formulated based on purposes.
Acknowledgements

- **Research Associates:**
  - Dr Chui Pin LEAW
  - Dr Gires USUP
  - Dr Yasuwo FUKUYO
  - Dr Mitsunori IWATAKI
  - Dr Stephen S. BATES
  - Dr Hong Chang LIM

- **Graduate students:**
  - TH TAN, ST TENG, KS HII,
  - NF KON, LH YEK, SN TAN, R. M. RAZALI

- **Malaysian Government-MOSTI ScienceFund, KPT**
- **UNESCO IOC-WESTPAC**
- **JFIT**