Dinophysis spp: The abundance, distribution and the toxicity of DSP in East China sea

Jinhui Wang, Yutao Qin, Caicai Liu, Xiangshen Chen, Ren Xu

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Outline

- The overview of *Dinophysis* spp in East China Sea
- The contamination of DSP in shellfish
According to simple morphological characters (such as size, shape, ± horns or spines, sulcal lists and supporting ribs, presence/absence of chloroplasts), More than 200 species of *Dinophysis* (and *Phalacroma*) are differentiated,

Only 11 species of *Dinophysis* are toxic or suspected toxic, However, several of these species are common.
The potentially toxic *Dinophysis spp.* in East China sea

- **Dinophysis acuminata**
  - widely distributed in temperate waters, found in all the coast of China
  - potential producer of OA and DTX-toxins

- **Dinophysis caudata**
  - widely distributed in warm temperate – tropical waters, found in South China sea and East China Sea
  - toxicity demonstrated in samples from the Philippines

- **Dinophysis fortii**
  - widely distributed in warm temperate and subtropical? Waters, found in Bohai and East China sea
  - potential producer of OA and DTX-toxins, perhaps the most noxious of the toxic *Dinophysis*

- **Dinophysis rotundata**
  - widely distributed in cold and temperate waters, found in Changjiang estuary
  - potential toxin producer

Photo by Jinhui Wang
The Dinophysis spp. in East China sea

<table>
<thead>
<tr>
<th>Sampling time</th>
<th>Phytoplankton species</th>
<th>Red tide caused species</th>
<th>Potential ly toxic species</th>
<th>Potentially DSP caused species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dinophysis caudata (20,11%)</td>
</tr>
<tr>
<td>1997.11</td>
<td>85</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998.05</td>
<td></td>
<td>6</td>
<td>Dinophysis caudata (5,1%)</td>
<td>Dinophysis caudata (1000,2%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dinophysis acuminata (21%)</td>
<td>Dinophysis caudata (1000,7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dinophysis fortii (18,1%)</td>
<td>Dinophysis fortii (625,14%)</td>
</tr>
<tr>
<td>1999.08</td>
<td></td>
<td>2</td>
<td>Dinophysis caudata (8,20%)</td>
<td>Dinophysis acuminata</td>
</tr>
<tr>
<td>2000.05</td>
<td></td>
<td>3</td>
<td>Dinophysis caudata (40,16%)</td>
<td>Dinophysis caudata (1200,2%)</td>
</tr>
<tr>
<td>2001.08</td>
<td></td>
<td>2</td>
<td>Dinophysis caudata (1600,14%)</td>
<td></td>
</tr>
<tr>
<td>2002.08</td>
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<td>3</td>
<td>Dinophysis caudata (24,21%)</td>
<td>Dinophysis caudata</td>
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<tr>
<td>2003.05</td>
<td>85</td>
<td>29</td>
<td>Dinophysis caudata (800,8%)</td>
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<tr>
<td>2003.06</td>
<td>102</td>
<td>40</td>
<td>Dinophysis fortii (500,3%)</td>
<td>Dinophysis fortii (1160,13%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dinophysis caudata (625,26%)</td>
<td></td>
</tr>
<tr>
<td>2003.08</td>
<td>141</td>
<td>50</td>
<td>Dinophysis fortii (500,8%)</td>
<td>Dinophysis caudata (800,5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dinophysis caudata (750,17%)</td>
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</tr>
</tbody>
</table>

* refers to the Algae (the average abundance, unit: cell per litre; The occurrence frequency

The Dinophysis caudata can be found in all season in East China sea, other species (D. fortii, D. acuminata, D. rotunda) only found in bloom season (May-August)
### Algae and Dinophysis fortii

<table>
<thead>
<tr>
<th>Items</th>
<th>N</th>
<th>mean</th>
<th>Pearson Correlation</th>
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<tbody>
<tr>
<td>Temperature</td>
<td>17</td>
<td>23.89</td>
<td>0.481</td>
</tr>
<tr>
<td>Salinity</td>
<td>17</td>
<td>22.19</td>
<td>0.059</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>17</td>
<td>8.29</td>
<td>0.436</td>
</tr>
<tr>
<td>pH</td>
<td>17</td>
<td>8.33</td>
<td>0.019</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>17</td>
<td>1.06</td>
<td>0.219</td>
</tr>
<tr>
<td>NO₃ (μmol/L)</td>
<td>17</td>
<td>0.10</td>
<td>-0.352</td>
</tr>
<tr>
<td>NO₂ (μmol/L)</td>
<td>17</td>
<td>0.24</td>
<td>-0.228</td>
</tr>
<tr>
<td>PO₄ (μmol/L)</td>
<td>17</td>
<td>5.11</td>
<td>-0.330</td>
</tr>
<tr>
<td>NH₄ (μmol/L)</td>
<td>17</td>
<td>1.33</td>
<td>-0.079</td>
</tr>
</tbody>
</table>
The *Dinophysis spp* include *D. Caudata*, *D. Acuminata*, *D. fortii*

The abundance of total *Dinophysis spp* range from 100~70000 cell/L

DSP was detected in Mussel by MBA (Dai hong 2005)
The distribution comparison of *Dinophysis spp* in China Coast

<table>
<thead>
<tr>
<th></th>
<th>Bohai</th>
<th>Yellow sea</th>
<th>East China Sea</th>
<th>South China sea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>D. fortii,</em></td>
<td><em>D. fortii,</em></td>
<td><em>D. caudata</em></td>
<td><em>D. caudata</em></td>
</tr>
<tr>
<td></td>
<td><em>D. acuminata</em></td>
<td><em>D. acuminata</em></td>
<td><em>D. fortii,</em></td>
<td><em>D. fortii,</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>D. acuminata</em></td>
<td><em>D. acuminata</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>D. rotunda</em></td>
<td><em>D. Mitra</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>D. miles</em></td>
</tr>
</tbody>
</table>
The HAB of *Dinophysis spp* in China

1998.09.22, the bloom of *Dinophysis fortii* (223 cell/L) and *Ceratium furca* (1250000 cell/L) in Bohai sea caused great loss, the affected area was near 3000km².

During several HABs on 1997~1998 in South China sea, the *Dinophysis Caudata* was one of the dominant species.

45 days after bloom in Bohai sea, the shellfish in bloom area and nearby sea area was sampled for detection for OA(ug/g).

<table>
<thead>
<tr>
<th>Time</th>
<th>sample</th>
<th>Gonade</th>
<th>tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.07</td>
<td>Mussel</td>
<td>24.42</td>
<td>5.15</td>
</tr>
<tr>
<td>11.07</td>
<td>scallop</td>
<td>16.83</td>
<td>1.69</td>
</tr>
<tr>
<td>11.07</td>
<td>clam</td>
<td>8.64</td>
<td>0.42</td>
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<tr>
<td>11.07</td>
<td>clam</td>
<td>0.86</td>
<td>0.08</td>
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</tbody>
</table>

Cite from Liu Ning 1999
<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>shellfish</th>
<th>content (ng/g)</th>
<th>Detection Rate</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995.06~08</td>
<td>Dalian</td>
<td>Mussel</td>
<td></td>
<td>77%</td>
<td>Wang J Y, 1996</td>
</tr>
<tr>
<td>1999.11</td>
<td>Shangdong Zhejiang</td>
<td>37 samples</td>
<td>1.01~174.95</td>
<td>35%</td>
<td>YUAN Qi, 2002</td>
</tr>
<tr>
<td>1999.01~02</td>
<td>Zhejiang</td>
<td>Clam, scallop, hectaric moon shell</td>
<td>31.7 (15.75—218.95)</td>
<td>45%</td>
<td>YUAN Qi, 2002</td>
</tr>
<tr>
<td>2001-2004</td>
<td>South China sea</td>
<td>Scallop mussel</td>
<td></td>
<td></td>
<td>WU Shi-wei, 2005</td>
</tr>
<tr>
<td>2005</td>
<td>Protein Phosphatase Inhibition Assay</td>
<td>Mussel</td>
<td>1.21μg OA eq./kg</td>
<td></td>
<td>Ai-Feng Li, 2006</td>
</tr>
</tbody>
</table>

Of the 27 shellfish samples, 1 sample exceeded the critical limit (200 ng/g).
The biotoxin contamination in shellfish
Consuming habit

- The output of shellfish in 2002 is about 1.132 million ton in China, the consuming shellfish in Shanghai is about 30,000 ton which occupied 2.6% that in China.

- About 600,000 ton sea food is consumed in Shanghai every year in which shellfish occupied about 5%.

- About 99% of seafood is sold through wholesale market in Shanghai, very little shellfish will be transferred directly from producer to customer or restaurant.
### More than 40 shellfish sold in Wholesale market

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Name in Latin</th>
<th>Trivial name</th>
<th>Time occurred</th>
<th>Scientific name</th>
<th>Name in Latin</th>
<th>Trivial name</th>
<th>Time occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>扁玉螺</td>
<td><em>Polynices didyma</em></td>
<td>heptic moon shell</td>
<td>Whole year</td>
<td>方斑东风螺</td>
<td><em>Babylonia areolata</em></td>
<td>Areola babylon</td>
<td>6</td>
</tr>
<tr>
<td>波纹巴非蛤</td>
<td><em>Paphia undulata</em></td>
<td>Venus clam</td>
<td>Whole year</td>
<td>瓜螺</td>
<td><em>Cymbium melo</em></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>大竹蛏</td>
<td><em>Solen grandis</em></td>
<td>Razor clam</td>
<td>Whole year</td>
<td>管角螺</td>
<td><em>Hemifusus tuba</em></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>菲律宾蛤仔</td>
<td><em>Ruditapes philippinarum</em></td>
<td>Venus clam</td>
<td>Whole year</td>
<td>泥东风螺</td>
<td><em>Babylonia lutosa</em></td>
<td>lutose babylon</td>
<td>6</td>
</tr>
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<td>毛蚶</td>
<td><em>Scapharca subcrenata</em></td>
<td>Blood clam</td>
<td>Whole year</td>
<td>大沽全海笋</td>
<td><em>Barnea fragilis</em></td>
<td></td>
<td>10,11,12,1,2,3</td>
</tr>
<tr>
<td>牡蛎</td>
<td><em>Ostrea rivularis</em></td>
<td>Oyster</td>
<td>Whole year</td>
<td>紫石房蛤</td>
<td><em>Saxidomrs purpuratus</em></td>
<td></td>
<td>3,6,12</td>
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<tr>
<td>日本镜蛤</td>
<td><em>Dosinia troscheli</em></td>
<td>Whole year</td>
<td></td>
<td>青蛤</td>
<td><em>Cyclina sinensis</em></td>
<td></td>
<td>5–10</td>
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<tr>
<td>美娜蛤</td>
<td><em>Meretrix meretrix</em></td>
<td>Hard clam</td>
<td>Whole year</td>
<td>沙海螂</td>
<td><em>Mya arenaria</em></td>
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<td>5–10,1</td>
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<tr>
<td>桂江珧</td>
<td><em>Pinna pectinate</em></td>
<td>Comb pen shell</td>
<td>Whole year</td>
<td>缭蛤</td>
<td><em>Sinonovacula consticta</em></td>
<td>Clam</td>
<td>5–11,1–2</td>
</tr>
<tr>
<td>皱红螺</td>
<td><em>Rapania bezoar</em></td>
<td>Periwinkle</td>
<td>Whole year</td>
<td>棕带仙女蛤</td>
<td><em>Callista eucymata</em></td>
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<td>5–8</td>
</tr>
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<td>菊蛤</td>
<td><em>Mytilus edulis</em></td>
<td>Mussel</td>
<td>Whole year</td>
<td>半扭蚶</td>
<td><em>Trisidos semitorta</em></td>
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<td>5–9</td>
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<td>等边浅蛤</td>
<td><em>Gomphina veneriformis</em></td>
<td></td>
<td>6–9</td>
<td>杂色蛤仔</td>
<td><em>Venerupis variegata</em></td>
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<td>焦河篮蛤</td>
<td><em>Potamocorbula ustulata</em></td>
<td></td>
<td>6–9</td>
<td>总角截蛏</td>
<td><em>Solecurtus divaricatus</em></td>
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</tbody>
</table>
According to biotoxin assay result of 421 shellfish sample (44 species) during 2002 and 2005. ASP was not detected in all sample, 19 species of shellfish such as *Cyclina sinensis*, *Meretrix meretrix*, *Protothaca jedoensis* and *Solen grandis* etc are free of biotoxin (PSP, DSP, ASP).

PSP was detected in 5 species of shellfish including Ark shell (*Scapharca broughtonii*), Scallop (*Argopectens irradias*), heptic moon shell (*Polynices didyma*), *Gomphina veneriformis* and mussel (*Mytilus edulis*) with the detection rate of 41.7%, 35.6%, 34.6%, 12.5% and 5.7% separately, and toxicity of 195.4 Mu/100g, 239.5 Mu/100g, 195.4 Mu/100g, 187.21 Mu/100G and 180.79 Mu/100g tissues, the concentrations of the PSP toxins of these shellfish ranged as 20.1µg/100g (4.4~42µg/100g), 25.5~78.5µg/100g and 38.3µg/100g (15.5~49.6µg/100g) separately, the main components were gonyautoxins 2/3 (GTX2/3) and gonyautoxins 1/4 (GTX1/4).
DSP was detected in 25 species of shellfish, the detection rate of 10 species of shellfish ranged from 8 to 26%, including Comb pen shell (*Pinna pectinate*), Scallop (*Argopectens irradians*), heptic moon shell (*Polynices didyma*), mussel (*Mytilus edulis, Perna viridis*), Venus clam (*Paphia undulata, Ruditapes philippinarum*), Oyster (*Ostrea rivularis*), Periwinkle (*Rapana bezoar*) and Blood clam (*Scapharca subcrenata*), the toxicity ranged from 5 to 10 Mu/100g, and half of the sample detected okadaic acid with the concentration ranged from 0.007 to 1.255 μg/100g; The detection rate of 15 species of shellfish sell in holiday and harvesting period was higher than that sell in whole year, the former almost come from natural growth such as *Moerella iridescens, Solecurtus divaricatus, Trisidos semitorta*, crenulated miter (*Pterygia crenulata*) etc, and most of the latter come from aquaculture. The toxicity ranged from 5 to 15 Mu/100g with the concentration of okadaic acid ranged from 0.36 4.94 μg/100g;
Among 44 samples in June 2005, 21 samples were positive by Mouse bioassay, but only 8 samples were positive by HPLC. TTX but no OA was detected in heptic moon shell.

Table 2. DSP toxins in shellfish from Shanghai markets by MBA and HPLC

<table>
<thead>
<tr>
<th>Shellfish</th>
<th>Sample amount</th>
<th>Species</th>
<th>Market name</th>
<th>MBA</th>
<th>HPLC (μg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastropod</td>
<td>3/9</td>
<td>Babylonina areolata, Ampullarum crossean</td>
<td>Tongchuan</td>
<td>+</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. lutosa, Macra veneriformis, Melvetrix</td>
<td>Tongchuan</td>
<td>+</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>meretrix</td>
<td>Fuxi</td>
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<td>Tegillarca granosa, Sanguinoilaria olivacea</td>
<td>Shiliupu</td>
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<tr>
<td>Clam</td>
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<td>Paphia euglypta, Paphia undulata</td>
<td>Shiliupu</td>
<td>+</td>
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<td></td>
<td>Melvetrix meretrix</td>
<td>Shiliupu</td>
<td>+</td>
<td>ND</td>
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<tr>
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<td></td>
<td>Gomphina veneriformis</td>
<td>Shiliupu</td>
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<td>Cyclina sinensis, Paphia undulata</td>
<td>Henda</td>
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<tr>
<td>Mussel</td>
<td>2/4</td>
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<td>diversicus, Solenidae minima</td>
<td>Henda</td>
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<tr>
<td>Razor clam</td>
<td>3/5</td>
<td>Tongchuan</td>
<td>Henda</td>
<td>+</td>
<td>ND</td>
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<tr>
<td>Scallop</td>
<td>1/1</td>
<td>Argopecten irradians</td>
<td>Henda</td>
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ND: beyond the detection limit

Cite from Wang JH 2006

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## The Shellfish Susceptible to DSP in China

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<tr>
<td><em>Paphia euglypta</em></td>
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<tr>
<td><em>Tegillarca granosa</em></td>
<td>50%</td>
</tr>
<tr>
<td><em>Gomphina veneriformis</em></td>
<td>38%</td>
</tr>
<tr>
<td><em>Sanguinolaria olivacea</em></td>
<td>33%</td>
</tr>
<tr>
<td><em>Ark shell</em></td>
<td>50%</td>
</tr>
<tr>
<td><em>Blood clam</em></td>
<td>31%</td>
</tr>
<tr>
<td><em>Scapharca subcrenata</em></td>
<td>31%</td>
</tr>
<tr>
<td><em>Mussel</em></td>
<td>26%</td>
</tr>
<tr>
<td><em>Mytilus edulis</em></td>
<td>26%</td>
</tr>
<tr>
<td><em>Venus clam</em></td>
<td>38%</td>
</tr>
<tr>
<td><em>Paphia undulata</em></td>
<td>33%</td>
</tr>
<tr>
<td><em>Gomphina veneriformis</em></td>
<td>33%</td>
</tr>
<tr>
<td><em>Periwinkle</em></td>
<td>20%</td>
</tr>
<tr>
<td><em>Rapana bezoar</em></td>
<td>20%</td>
</tr>
<tr>
<td><em>Trisidos semitorta</em></td>
<td>20%</td>
</tr>
<tr>
<td><em>heptic moon shell</em></td>
<td>19%</td>
</tr>
<tr>
<td><em>Polynices didyma</em></td>
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</tr>
<tr>
<td><em>Mactra quadrangularis</em></td>
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<td><em>Oyster</em></td>
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</tr>
<tr>
<td><em>Ostrea rivularis</em></td>
<td>17%</td>
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<tr>
<td><em>Venus clam</em></td>
<td>14%</td>
</tr>
<tr>
<td><em>Ruditapes philippinarum</em></td>
<td>14%</td>
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<tr>
<td><em>Moerella iridescent</em></td>
<td>12%</td>
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<tr>
<td><em>Comb pen shell</em></td>
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<tr>
<td><em>Pinna pectinate</em></td>
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腹泻性贝毒（DSP）

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<tr>
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</tr>
<tr>
<td>7</td>
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</tr>
<tr>
<td>8</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>9</td>
<td>40%</td>
<td>40%</td>
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<tr>
<td>10</td>
<td>50%</td>
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<tr>
<td>11</td>
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<tr>
<td>6</td>
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图示了2005年和2006年不同月份的检测率变化。
Monthly detection rate of DSP in some susceptible shellfish

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<th>6</th>
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<th>9</th>
<th>10</th>
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<td>0.14</td>
<td>0.25</td>
<td>0.29</td>
<td>0.13</td>
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<td>0.2</td>
<td>0.33</td>
<td>0.14</td>
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<td>0</td>
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<td>Sensitive season</td>
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<tr>
<td>2002</td>
<td>31</td>
<td>10% 9%</td>
<td>5~8月</td>
<td>heptic moon shell, Periwinkle, scallop, snail(Thais luteostoma)</td>
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<tr>
<td>2003</td>
<td>26</td>
<td>20% 30%</td>
<td>5~10月</td>
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<tr>
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<td>90</td>
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<td>2005</td>
<td>177</td>
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<tr>
<td>Year</td>
<td>Number of Sample</td>
<td>Detection Rate</td>
<td>Sensitive Season</td>
<td>Sensitive Species</td>
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<td>3%</td>
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<tr>
<td>2005</td>
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<td>19%</td>
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<td>5~8</td>
<td>mussel 、 snail(Thais luteostoma) 、 Periwinkle 、 scallop、albone</td>
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</table>
The correlation of HAB occurrence and biotoxin detection rate in shellfish
Up to now, no DSP intoxication were recorded, but it may be really not a contentious fact due to lack of clinical Knowledge and the light intoxication characteristic.
Cochlodinium spp in China

*Cochlodinium polykrikoides* was found in East China Sea, but with low abundance.

It was also found in South China sea (during the bloom of *Karenia mikimotoi*, *Cochlodinium polykrikoides* was recorded in Zhujiang estuary in April 1998).

In 1990, Toxic dinoflagellate red tide by a *Cochlodinium sp.* along the coast of Fujian, China / Qi, Du (Fujian Fish. Res. Inst., 7 Haishan Rd., Xiamen 361012), Huang, Yijian, Wang, Xiaofeng // ProcC-PHYTOPLANKTON BLOOMS IN THE SEA. Smayda, T.J.; Shimizu, Y. eds. AMSTERDAM NETHERLANDS ELSEVIER 1993. -1993. 3-235〜238

The HAB of *Cochlodinium sp.* on 1990 caused a direct economic loss of RMB 2 million in which both field fish and cultured fish suffered.
图6 调查海域主要流系示意图
Thank you

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Tel/Fax : 86 21-58671443
http://www.dhjczx.org/chichao/chichao.asp