HABs and shellfish intoxication in China sea

Jinhui Wang, Hao Guo, Mingyuan Zhu

SOA, P.R. China,
The HABs in China

The intoxication by consuming shellfish in China
19 red tide monitoring zone with biweekly sample were carried out since 2002.

East China sea: 10
There are 809 red tides recorded in China up to 2005, among them, the red tide during 2001 to 2005 is up to 453 which occupy 60% of total. There are 2 peak periods with the increasing tendency. Recently, stable around 80 times.
The red tide during 2001 ~ 2005

- Red tide sensitive zone

453 red tides were recorded in China during 2001~2005, the affected area cover 93,260 km². The most sensitive area is East China sea, the times and affected area of red tide occupied 61% and 72% of that in China separately; the notorious Zhejiang Coast (one part of East China sea) occupied 38% and 61% of that total in China separately.
Bohai sea, Yeallow sea, East China sea, South China sea

The occurrence comparison of red tide in different sea area
Peak month of red tide

Most red tides occurred on May or June during 2001~2005, the occurrence times and affected area of these 2 months occupied 62% and 83% of that in whole year.
seasonal variation of HAB occurrence times in China

seasonal variation of HAB affected area in China
The HAB events and affected area increase
2. 南海、东海和渤海3个赤潮高发区赤潮发生比较分析

red tide events variation during 1980~2005

- **Bohai sea**
- **East China sea**
- **South China sea**
Red tide events in different seas

Bohai sea, East China sea, South China sea
Red tide peak season

Bohai sea: 6-9
East China sea: 5-7
South China sea: 1-5

2001-2002年

Bohai sea
South China sea
East China sea
Regular Red tide caused species in China

- **Bohai sea:** *Noctiluca scintillans*、*Skeletonema costatum*、*Mesodinium rubrum*、*Phaeocystis sp*、*karenia mikimotoi*

- **East China sea:** *Noctiluca scintillans*、*Prorocentrum dentatum*、*Skeletonema costatum*、*karenia mikimotoi*、*Heterocapsa circularisquama*

- **East China sea:** *Skeletonema costatum*、*karenia mikimotoi*、*Phaeocystis sp*、*Trichodesmium sp*
## Red tide caused species

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<tr>
<th>Year</th>
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<td>Prorocentrum sp</td>
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<td>Pseudo-nitzschia pungens</td>
<td>Phaeocystis globosa</td>
<td>CYANOPHYTA</td>
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<td>Heterocapsa circularisquam</td>
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Prorocentrum dentatum

Before 1990s no records
Prorocentrum dentatum
= Prorocentrum donghaiese

Before 1990s no records
1996~1999, small scale red tide nearby the Changjiang anchoring sea area
**Prorocentrum dentatum**

*Prorocentrum donghaiense*

Before 1990s no records

1996~1999, small scale red tide nearby the Changjiang anchoring sea area

2000 May, 7000Km³
Changjiang Estuary to north Zhejiang Coast
Prorocentrum dentatum = Prorocentrum donghaiense

Before 1990s no records

1996~1999, small scale red tide nearby the Changjiang anchoring sea area

2000 May, 7000Km³ Changjiang Estuary to north Zhejiang Coast

2001~2003, south forward sparkle
Prorocentrum dentatum = Prorocentrum donghaiense

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Alexandrium

- Often coincide with the *prorocentrum* HABs, with maximum abundance of 100000 cell/L
1995 HAB in Hongkong and caused great loss,
1998 HAB along the coast of the South China Sea
2001 small scale in east China sea and caused aquaculture fish dead
2004 large scale HAB (5000 Km²) in Bohai sea, no dead fish.
2005 large scale HAB (7000 Km²) in east China sea, caused lots of aquaculture fish dead, estimated loss of RMB 19.7 billion Yuan.
1995 HAB in Hongkong and caused great loss, 1998 HAB along the coast of the South China Sea, 2001 small scale in east China sea and caused aquaculture fish dead. 2004 large scale HAB (5000 Km²) in Bohai sea, no dead fish. 2005 large scale HAB (7000 Km²) in east China sea, caused lots of aquaculture fish dead, estimated loss of RMB 19.7 billion Yuan.
Heterocapsa circularisquama caused great loss on shellfish aquaculture in Japan,

**Distribution**: mainly in Japan

When did it first find in China?

June 2003, HAB in Changjiang estuary, no harm found

June 2005, HAB in Changjiang estuary, caused some cultured mussel dead
Heterocapsa circularisquama
Among the 8 *Pseudo-nitzschia* species recorded to date on China coasts, namely *Pseudo-nitzschia cf. sinica*, *P. pungens*, *P. delicatissima*, *P. subpacific*, *P. Americana*, *P. multistriata*, *P. multiseries* and *P. pseudodelicatissima* (Qi Y 1994, Chen Jufan 2003, Zou, J.Z 1993, our research), the last four have been documented elsewhere in the world as DA producers, both in the field and in culture studies (Orsini L, 2002; Grethe R. Hasle, 2002)
Red tide in East China sea
About **435** red tides are recorded in East China sea since 1930s, which occupied about **54%** of total red tides in China.
The red tide affected area in East China Sea

![Graph showing the affected area in square kilometers and percentage over time.](image-url)

- **Square Kilometers**
  - 1970s: 0.6
  - 1980s: 0.0
  - 1990s: 7.9
  - 2000: 28.3
  - 2001: 7.0
  - 2002: 6.3
  - 2003: 8.9
  - 2004: 2.2
  - 2005: 1.0

- **Percentage**
  - Jan: 0.6
  - Feb: 0.0
  - Mar: 0.0
  - Apr: 7.9
  - May: 37.5
  - Jun: 28.3
  - Jul: 7.0
  - Aug: 6.3
  - Sep: 8.9
  - Oct: 2.2
  - Nov: 1.0
  - Dec: 0.3
Harmful Algal Bloom in East China Sea

43 HABs in East China sea were recorded which is about 10% of the red tides, the causing species include *Alexandrium tamarens, kerina mikimotoi, Heterocapsa circularisquama, Cochlodinium sp* and *kerina brevis*, in which *kerina mikimotoi*, *Heterocapsa circularisquama* had caused lots of harm to aquaculture recently. There are about 24 *kerina (Gymnodinium) sp.* bloom recorded in East China sea since 1980s, most of them have detrimental influence, the bloom of *kerina sp.* has the tendency of increase on frequency and spreading from south to north.
### Other Toxic Algae

- **DSP**
  - *Keria mikimotoi*
  - *Heteracapsa circularisquama*
  - *Heterosigma akashiwo*
  - *Gymnodinium sanguineum*
  - *Karinia brevis*
- **NSP**
  - *Alexandrium tamarense*
  - *Alexandrium catenella*
  - *Alexandrium minutum*
- **ASP**
  - *Pseudo-nitzschia multiseries*, *P. pungens*, *P. multistriata*
- **PSP**
  - *Dinophysis acuminata*, *Dinophysis caudata*, *Dinophysis fortii*, *Dinophysis rotundata*
  - *Gymnodinium sanguineum*
  - *Heterocapsa circularisquama*
  - *Dinophysis tamarense*
5 species of *Pseudo-nitzschia* were identified during the monitoring: *Pseudo-nitzschia multiseries, P. pungens, P. multistriata, P. americana* and *P. delicatissima*, 3 species (*P. multiseries, P. americana* and *P. delicatissima*) are first recorded in China and the *P. multistriata* is first recorded in Changjiang estuary.
The relative abundance (%) of *Psedudo-nitzschia sp*

<table>
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<tr>
<th>Salinity</th>
<th>Turbidity</th>
<th>P. pungens</th>
<th>P. multiseries</th>
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<th>P. sp.</th>
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图3-2 上海海域表层盐度分布示意图
The image shows a map with a gradient scale indicating salinity levels. The map is color-coded with different shades representing various salinity ranges, from 0 to 10, 10 to 1000, 1000 to 10000, 10000 to 100000, 100000 to 1000000, and 1000000 to 10000000 ind/m³. The map also highlights specific regions with concentrations marked by dots in pink, indicating NO₃ (Nitrate) levels. The map includes labels for different regions, such as Taiwan, P.R.China, and the surrounding oceanic areas.
Red tide in South China sea

1) tendency of red tide events

2) peak period: spring

1983-2005年各月平均发生赤潮的次数
139 red tide species found in south China sea, mainly diatom and dinoflagellate.

珠江口及其邻近海域1981—1992年各类赤潮生物发生赤潮次数的比例

各种赤潮生物引发赤潮的比例

珠江口及其邻近海域1981—1992年各类赤潮生物发生赤潮次数的比例

夜光藻 Noctiluca scintillans
裸甲藻 Gymnodinium spp.
其它甲藻 Other dinophceae
硅藻 Bacillariophyceae
其它 Other
Reason of HAB increase: Increase of Pollution

- **TIN**
- **TIP**
- **Oil**
- **Hg**
- **COD**
- **Pb**
Correlation of Inorganic Nitrogen and HABs in Bohai sea
黄河断流天数的增加使得渤海盐度升高

**Biomass of Predator decrease**

- 图表显示了不同年份（82-83和92-93）的浮游动物生物量变化。
- 生物量在50-150之间。
- **Feb**、**May**、**Aug**、**Oct**对应不同月份。

**decrease of runoff**

- 图表显示了1960年至2000年黄河流量（单位：百万方米）的变化。
- 流量在0-120之间波动。
- **Annual effluent of the Yellow River at Lijin Station**
The species number of plankton on August 2002

phytoplankton

zooplankton
The density of plankton (trawl sample) 2002 August

Phytoplankton

Zooplankton

Density intervals:
- 0 to 20
- 20 to 50
- 50 to 100
- 100 to 200
- 200 to 500
- 500 to 1000
- 1000 to 1500
- 4000 to 10000
- 10000 to 100000
- 100000 to 500000
- 500000 to 1000000
- 1000000 to 462500000

The density is visualized on a map of the region, with various concentrations indicated by different symbols and colors.
Reclamation for aquaculture
Marine aquaculture
The throughput of Shanghai Harbor in 2004 was 38 billion Ton which ranked first in the world; The container was 1.4551 billion TEU, which ranked third in the world.
AMONG THEN EXPORT CONTAINER IS ABOUT 45% OF TOTAL,

There are 1716 container vessel every month in shanghai harbor,

1 TEU weighs 24000 kg, so about 1.57 billion ton ballast water
was discharged in Changjiang estuary in 2004, which was about
1/59000 of the Total Changjiang freshwater in a year.
THE CONTAINER TRAFFIC IN SHANGHAI HARBOR
(2005.1~7)

7896000TEU
72% of the container trade with Korea, Japan, Singapore, America, Europe
## Nutrient and N/P

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<th>Sea</th>
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<td>1.198</td>
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从环境富营养化程度看，东海赤潮高发区最严重，渤海次之，南海除珠江口外较轻。
Increasing trend of N : P ratio in China’s inshore waters

- Bohai sea: 1.6–16 (ZG Yu 2001)
- Bohai: 0.3 in 1960, 1.0 in 1982, 4.8 in 1992, >11.5 in 1999.
- Jiaozhou Bay: 15.9 in 1960s, 37.8 in 1990s (JX Zhang 1997, Shen 2001)
- 浙江沿海: 平均 47 (金卫红 邵秀伟 2000)
- 大亚湾: 2.5 升高到 25
- 珠江口: >100, 最高 400 (Yin et al 2000, Yin et al 2001)
- 三亚湾: <5至>20 (王汉奎等 2002)
- 南沙海域: 时常低至<1 (林洪瑛 韩舞鹰 2001)
1. Si:N ratios, in addition to N:P ratios, play a significant role in promoting or depressing HAB.

2. The influences of Si:N ratios might be attributed to their impacts to diatoms growth. When the growth of diatoms is promoted, dinoflagellate-related HAB is depressed. When diatoms growth is depressed by low silicates, dinoflagellate-caused HABs are promoted.

3. The significance of Si:N (atomic) ratio implies that, other than discharges of domestic sewage and agricultural wastes, disturbance of Si input due to urbanization, soil erosion and river diversion can also be considered as a trigger for HABs dominated by dinoflagellates and microflagellates.
The potential toxic algae and biotoxin were often detected in China sea recently, but few reports about the poisoning events caused by HAB biotoxin. The death or loss of aquacultured and field fish/shellfish were often found recently during the red tide. The harmful algal bloom may affect the safety and economical development in the following paths in China sea: The advection of offshore toxic micro-algal blooms into growing areas and coast by current

Why *Cochlodinium* spp. have no problem in China?
The intoxication by consuming shellfish
Detect toxicity with MIST Alert
3 cases of shellfish intoxication were reported, with total 121 people intoxication, no dead.
Shellfish intoxication in Jiangsu Province

14 cases of shellfish intoxication were reported since 1991, with total 88 people intoxication, 11 dead.
These samples were analyzed with the help of Prof. Dr. Bernd Luckas in Friedrich-Schiller-University Jena.
What cause Nassarius spp. Containing TTX?
There is no shellfish intoxication reported, but several sea food intoxication is suspected as PSP intoxication.
Shellfish intoxication in Zhejiang Province

More than 150 cases of shellfish intoxication were reported since 1967, with total 1200 people intoxication 62 dead
The seasonal variation of shellfish intoxication in Zhoushan (1977~2000)

- Death people
- Intoxication people

The seasonal variation of shellfish intoxication in Ninghai (1978~2000)

- Death people
- Intoxication people besides death
More than 40 cases of shellfish intoxication were reported since 1986, with total 324 people intoxication, 13 dead.
Shellfish intoxication in Taiwan Province

About 4 cases of shellfish intoxication were reported since 1986, with total 89 people intoxication, 7 dead.
About 16 cases of shellfish intoxication were reported since 1984, with total 246 people intoxication, 21 dead.
Shellfish intoxication in other Province

About 5 cases of shellfish intoxication were reported in inland province include Heilongjiang, Anhui, Ningchuan, Sanxi, with total 140 people intoxication, 1 dead. The consumed shellfish include Scallop, oyster, snail and *Nassarius spp*

1 cases of shellfish intoxication were reported in Guangxi province in 2005, with total 1 people intoxication, 1 dead after consuming snail.

Several cases of shellfish intoxication were reported in Hong Kong Special Administrative Region since 1990s, but details on the number of patients affected and the clinical presentation are not available.
Since 1960s, poisoning incidents caused by the consumption of snail *Nassarius* spp. were reported in Coast of East China sea. After observation of the symptoms in the victims it was suspected that PSP toxins were involved, and the toxicity screening of the snail samples with mouse bioassay method for monitoring of PSP toxins gave numbers exceeding 10,000MU/100g tissue (wet weight). However, no PSP toxins were detected after analysis of snail samples using high performance liquid chromatography (HPLC) with postcolumn derivatization. The toxins in *Nassarius* spp. were finally identified as tetrodotoxin (TTX), after re-analysis of the samples using HPLC coupled with a mass detector. The derivatives of TTX in toxic snail samples were also analyzed, using HPLC coupled with a triple quadrupole mass detector (API 4000), in the mode of precursor ion scan and product ion scan. Two isomers of *trideoxyTTX*, two isomers of *TTX*, two isomers of *11-oxoTTX*, *anhydroTTX* and trace amounts of *deoxyTTX* were identified from the toxic snail samples.
Advice for future HAB work in China

- The coordination and cooperation between various agencies make the HAB monitor network run favourably;
- The optimized monitor scheme should assure that most of the data collected are validated, but not rich data with poor information;
- The HAB monitor network and subsided monitor centers have quality assurance program to make data reliable and accurate;
- The selection of the variables, sites, techniques and periods should have explicit purpose to elucidate specific information of HAB, and objectives should be clearly stated as definite goals for monitoring.
Capability building:

1. Algal identification and toxin detection training
   - many new unskilled crew, Comprehensive ecosystem
2. Develop realtime techniques (monitoring\forecast\mitigation)
3. Improve monitoring system
   - a large system but not high efficient
Thank you

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http://www.dhjczx.org/chichao/chichao.asp