Fish killing *Heterosigma akshiwo* blooms in Chinese coastal waters

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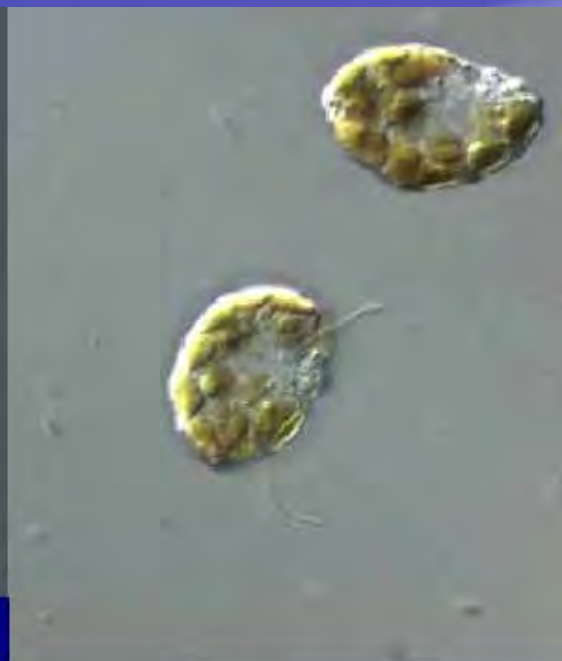
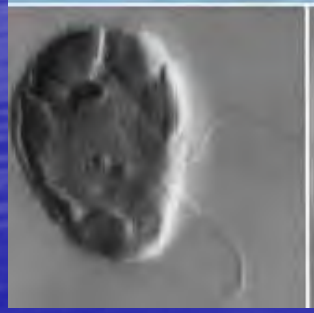
Points:

- **Brief introduction of causative species**
- **Bloom distribution and decadal change**
- **Harmful effects**
- **Summary**

Causative species		Bloom information and impacts
Raphidophytes	*Chattonella marina* Hara et Chihara	fish kill, bloom in BS, YS and SCS
	***Heterosigma akashiwo* Hada**	fish kill, bloom in BS, ECS and SCS
Prymnesiophytes	*Phaeocystis globosa* Scherffel	hemolytic toxins, bloom in BS, ECS and SCS
Diatom	*Pseudo-nitzschia pseudodelicatissima* (Hasle) Hasle	ASP, bloom in ECS and SCS
	Pseudo-nitzschia pungens (Grunow ex P.T.Cleve) Hasle	bloom in YS, ECS and SCS
	Pseudo-nitzschia seriata (Cleve) H. Peragallo	bloom in ECS and SCS
Cyanobacteria	*Microcystis aeruginosa* Kützing	bloom in SCS
	Trichodesmium erythraeum Ehrenberg et Gomont	bloom in SCS, ECS
	Trichodesmium thiebautii Gomont	bloom in ECS
	Trichodesmium hildebrandtii Gomont	bloom in SCS, ECS
Pelagophyte	*Aureococcus anophagefferens* Hargraves et Sieburth	bloom in BS



Morphology

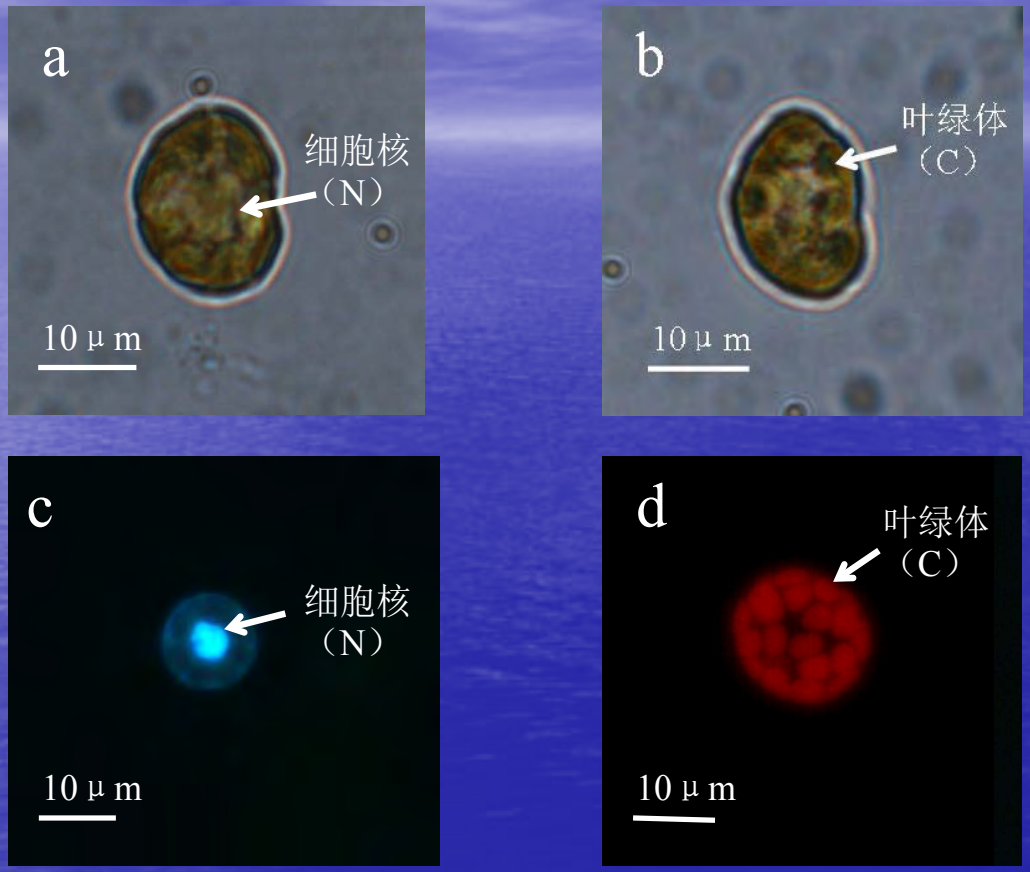


Heterosigma akashiwo
(Hada) Hada

Photomicrographs
by Yoshiaki Hara

WESTPAC-HAB
IOC Harmful Algal Bloom Programme
T0007

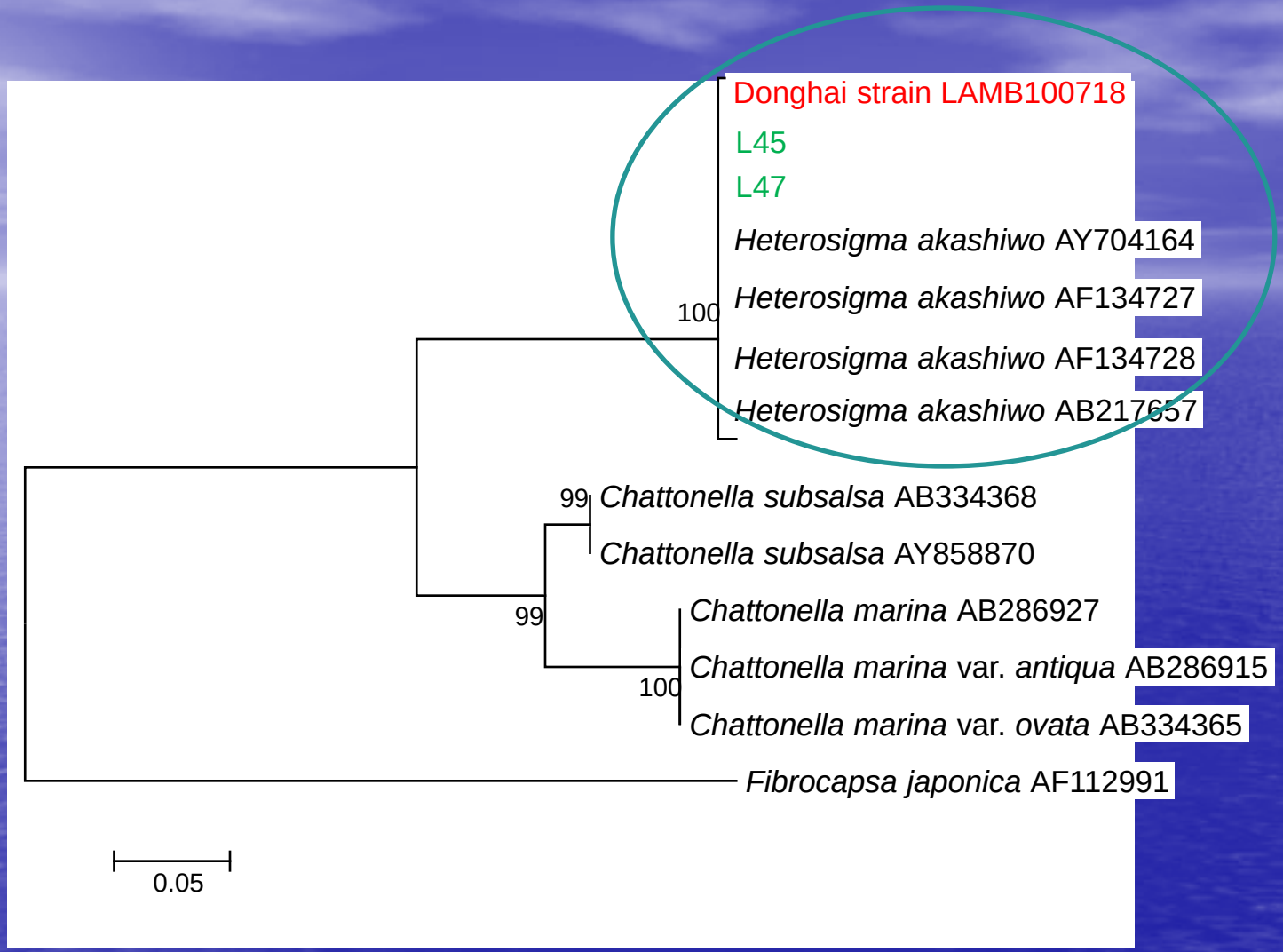
Tomas 2007


a
细胞核
（N）
10μm
b
叶绿体
（C）
10μm
c
细胞核
（N）
10μm
d
叶绿体
（C）
10μm

Morphological measurement of LAMB100718 and other strains of *Heterosigma akashiwo* as well as *Olisthodiscus luteus*

Species	Strain no.	size L/μm	size W/μm	Chloroplast
ECS strain	**LAMB100718**	**12~20**	**7~13**	**9~22**
Heterosigma akashiwo	BGN 666	11~20	9~12	10~19
	Kesen-numa	12~18	8~12	6~19
	GKB 666	11~22	10~13	9~22
	Ondo	10~19	10~15	11~25
Olisthodiscus luteus	CCAP 934/1	11~24	10~14	8~20
	UTEX 200	12~22	10~15	10~20
	—	12~20	8~14	7~25
	Tanigawa	13~18	10~14	7~16

（Hara et al. 1987; He et al. 2011）



Phylogenetic trees based on the ITS–rDNA sequences.

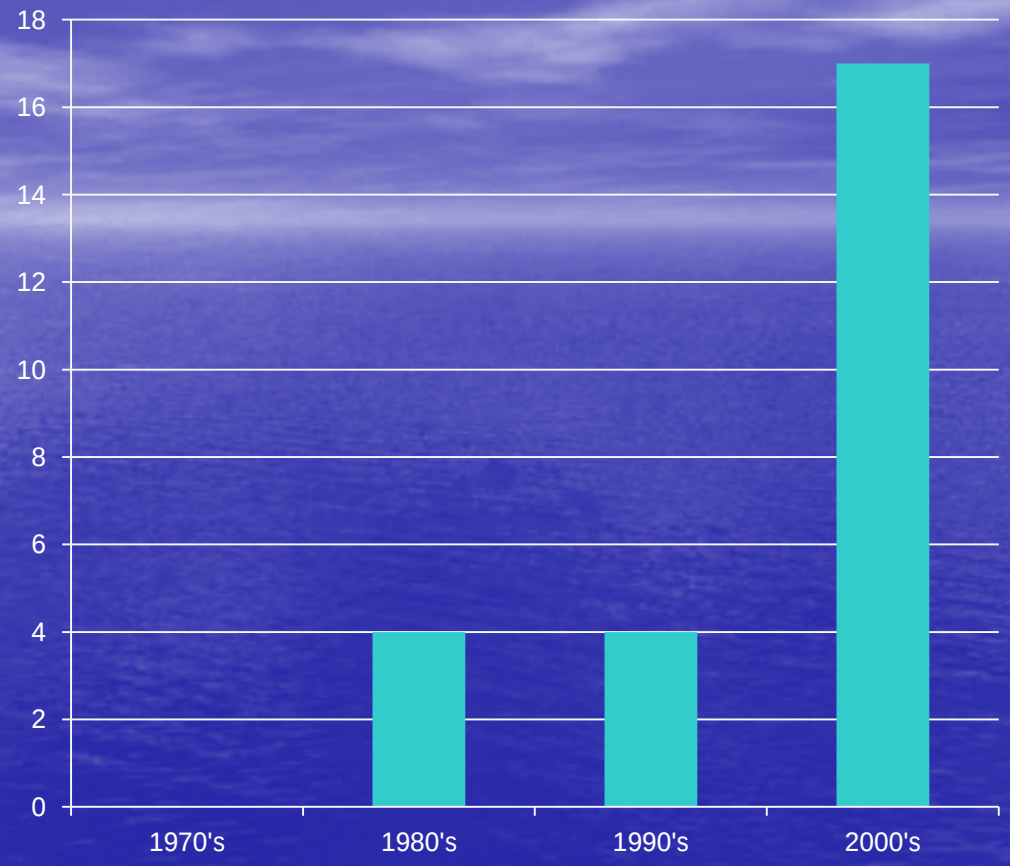
Pairwise distance matrix of Jukes-Cantor based on rDNA-ITS

种类名称	1	2	3	4	5	6	7	8	9	10	11
ECS (LAMB100718) (L45, L47)											
赤潮异弯藻*H.akashiwo* (AB217657)	0.002										
H.Akashiwo (AF134727)	0.002	0.000									
H.Akashiwo (AF134728)	0.002	0.000	0.000								
H.Akashiwo (AY704164)	0.004	0.002	0.002	0.002							
盐生卡盾藻*C. subsalsa* (AB334368)	0.206	0.203	0.203	0.203	0.205						
C. subsalsa (AY858870)	0.208	0.201	0.201	0.201	0.208	0.000					
海洋卡盾藻*C. marina* (AB286927)	0.227	0.208	0.208	0.208	0.228	0.087	0.086				
古老卡盾藻*C .antiqua* (AB286915)	0.227	0.208	0.208	0.208	0.228	0.087	0.086	0.000			
卵状卡盾藻C. ovata（AB334365)	0.237	0.231	0.231	0.231	0.234	0.087	0.089	0.000	0.000		
F. japonica (AF112991)	0.681	0.742	0.742	0.742	0.693	0.675	0.687	0.745	0.745	0.643	
F. japonica (AF152603)	0.681	0.742	0.742	0.742	0.693	0.675	0.687	0.745	0.745	0.643	0.002

Points:

- Brief introduction of causative species
- **Bloom distribution and decadal change**
- Harmful effects
- Summary

- ***H. akashiwo*** **bloom was first recorded in Dalian Bay of China in 1985. Since then, fourty bloom events of *Heterosigma akashiwo* have been registered and expanded to other China coastal waters.**



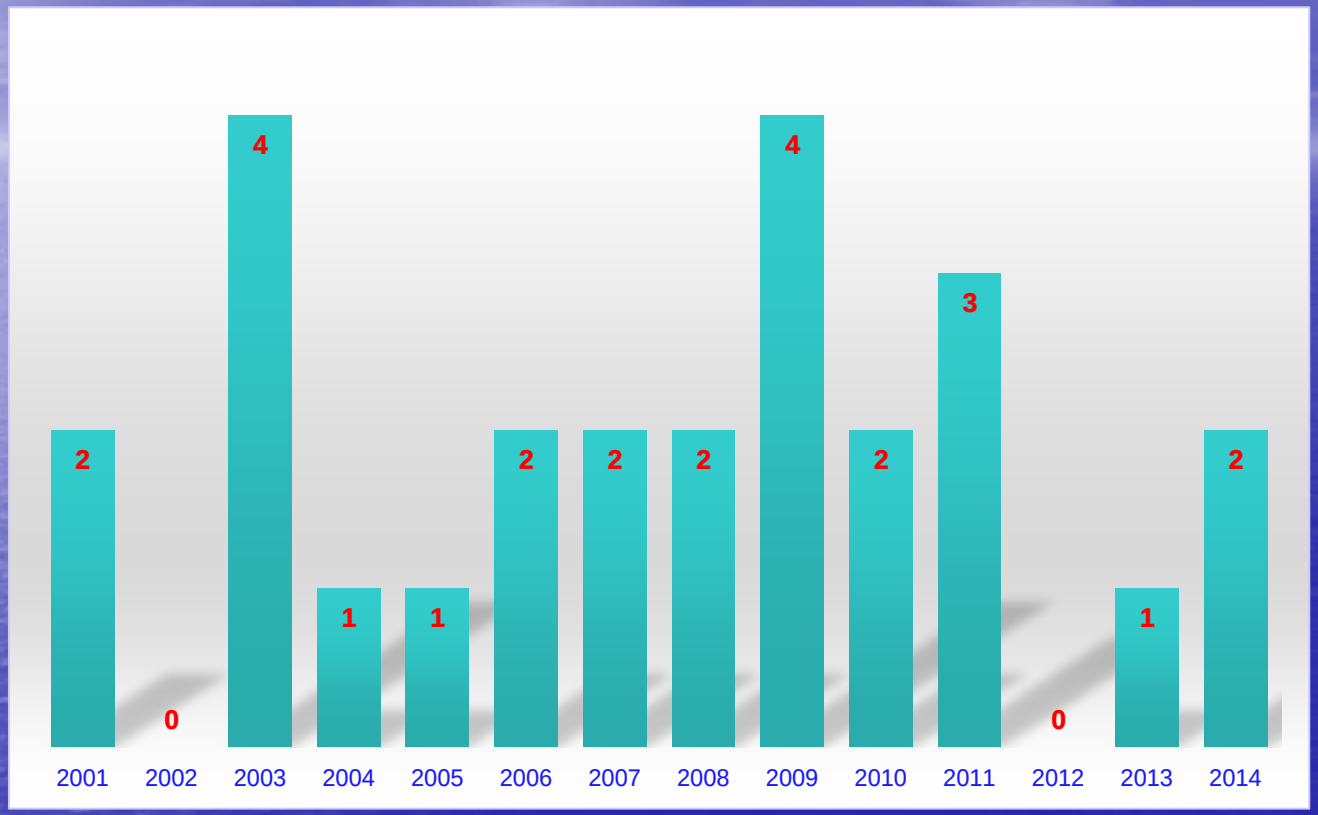
Decadal pattern of *Heterosigma akashiwo* bloom events in China coastal waters.

Seasonal pattern of Heterosigma blooms in different sea area:

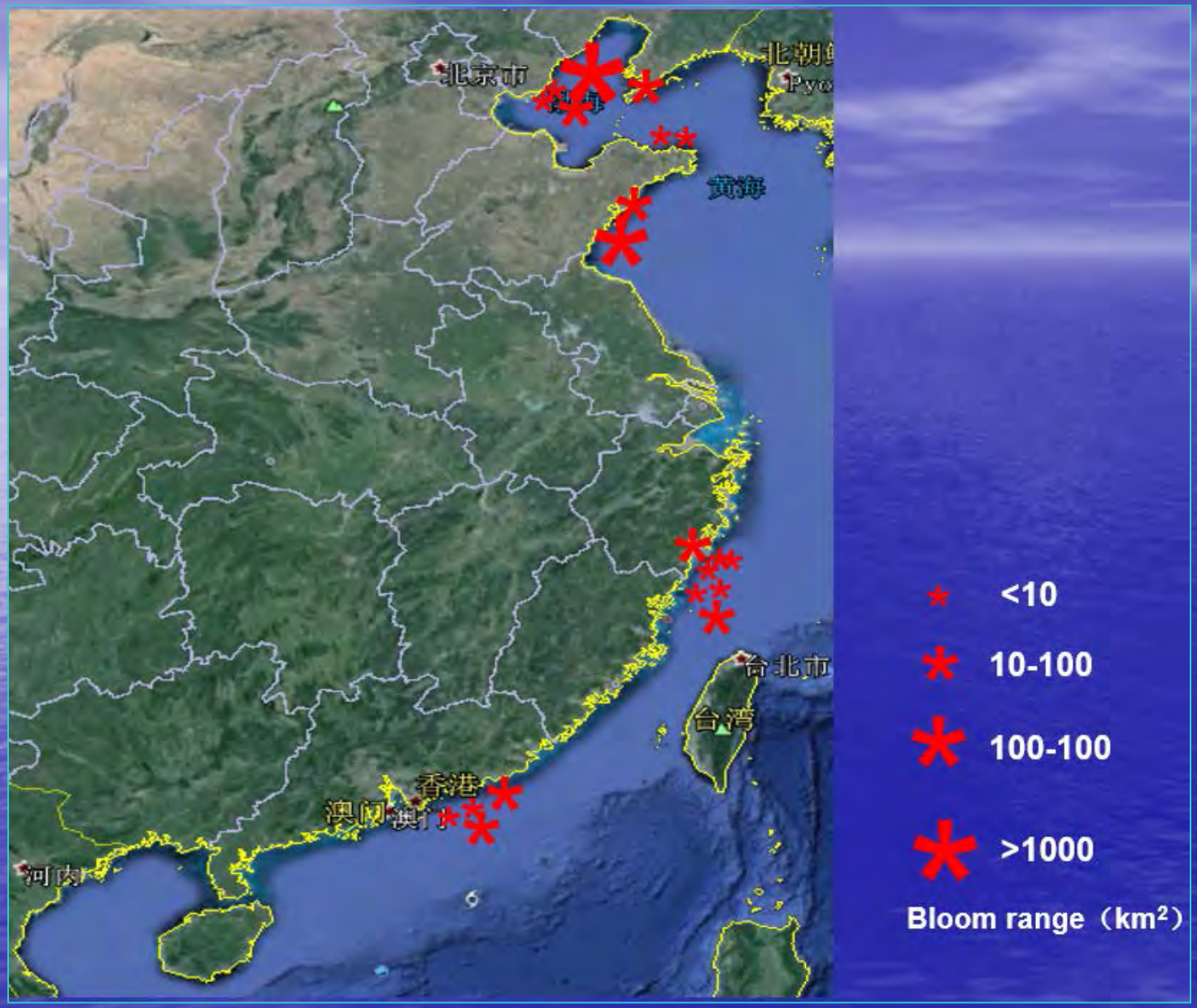
South China Sea: Feb. Mar. Apr. Sept.

East China Sea: May, June

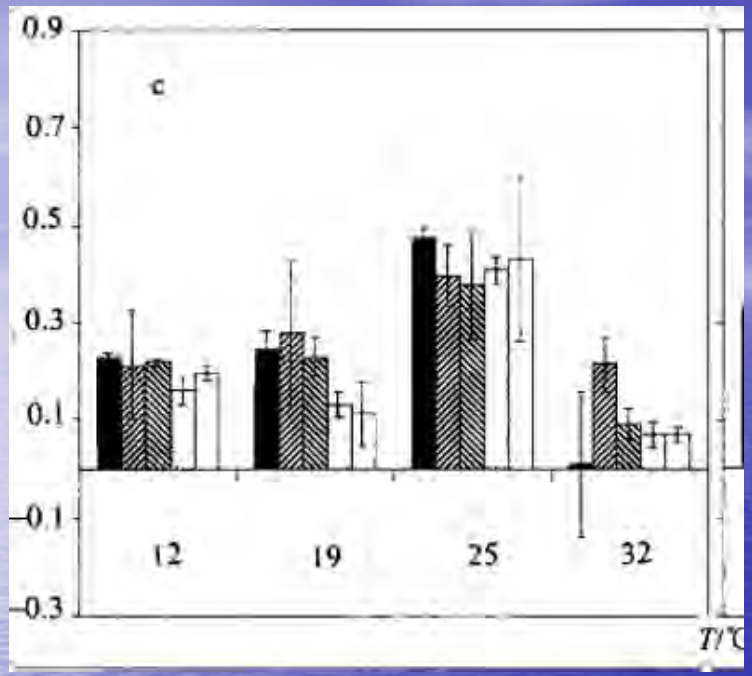
Bohai Sea and Yellow Sea: May-August

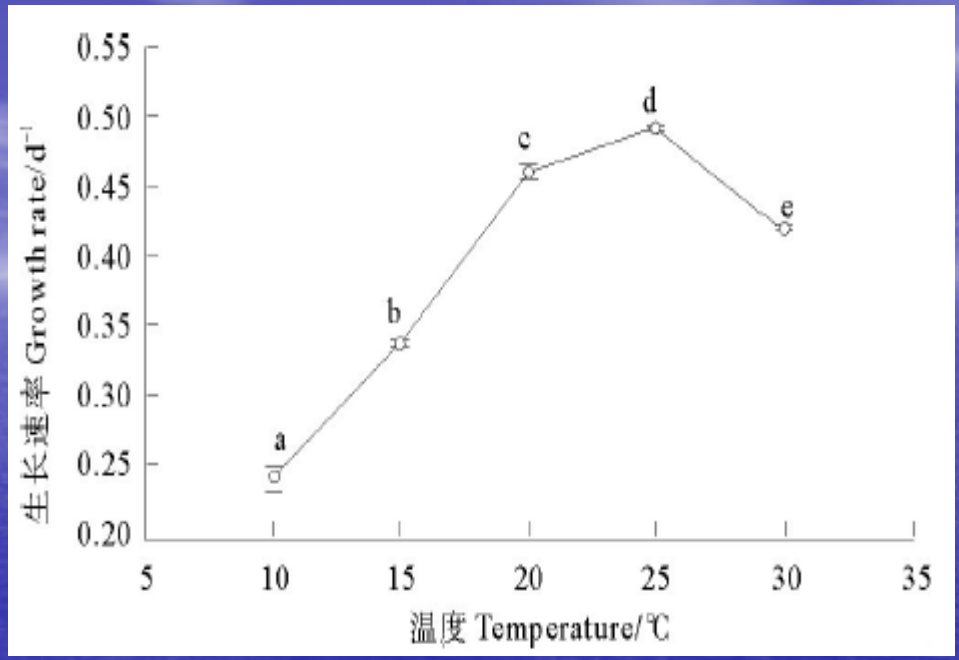


Bloom frequency of *Hetersigma akashiwo* from 2001 to 2014



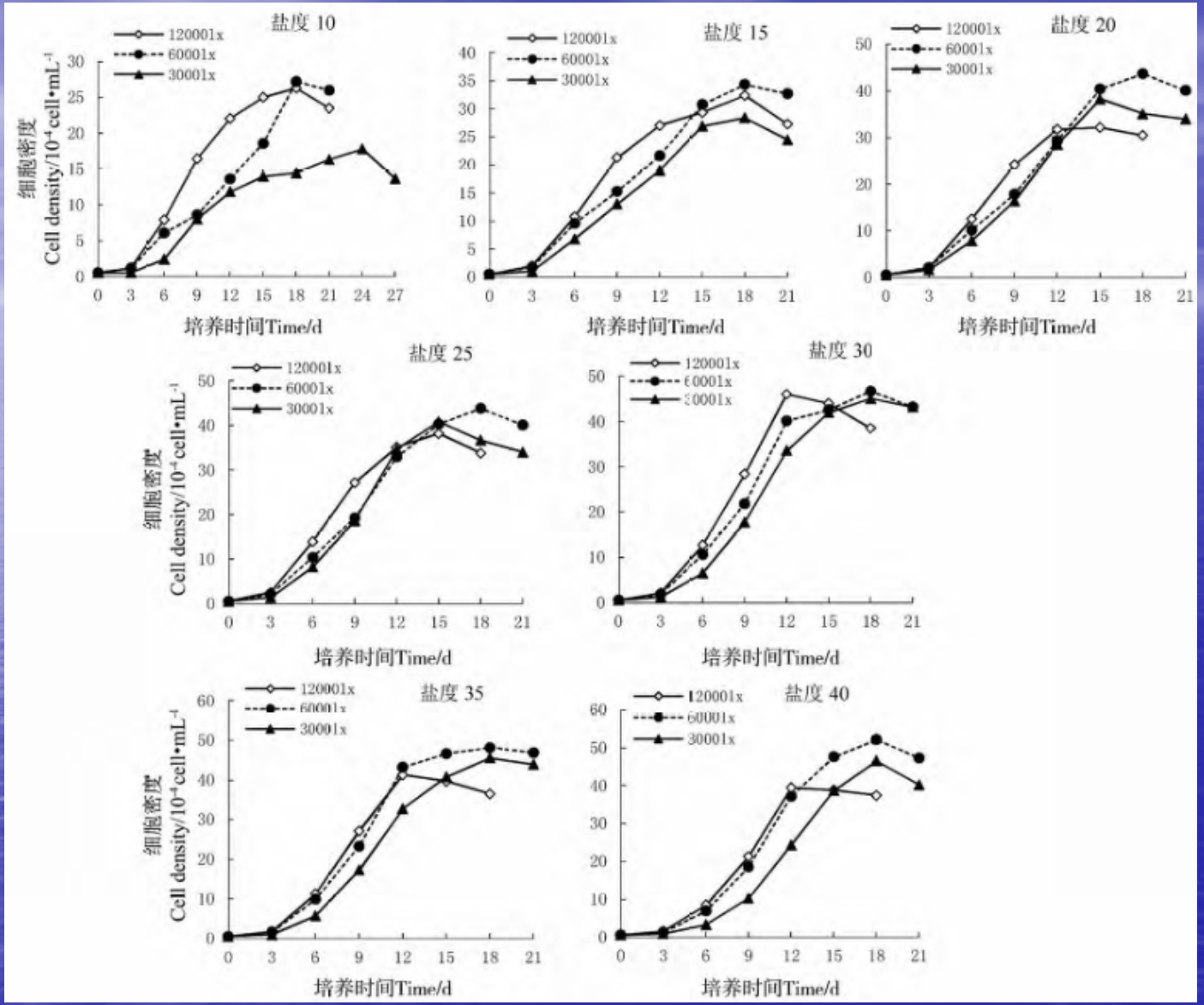
Bloom range of *Hetersigma akashiwo* since 2001





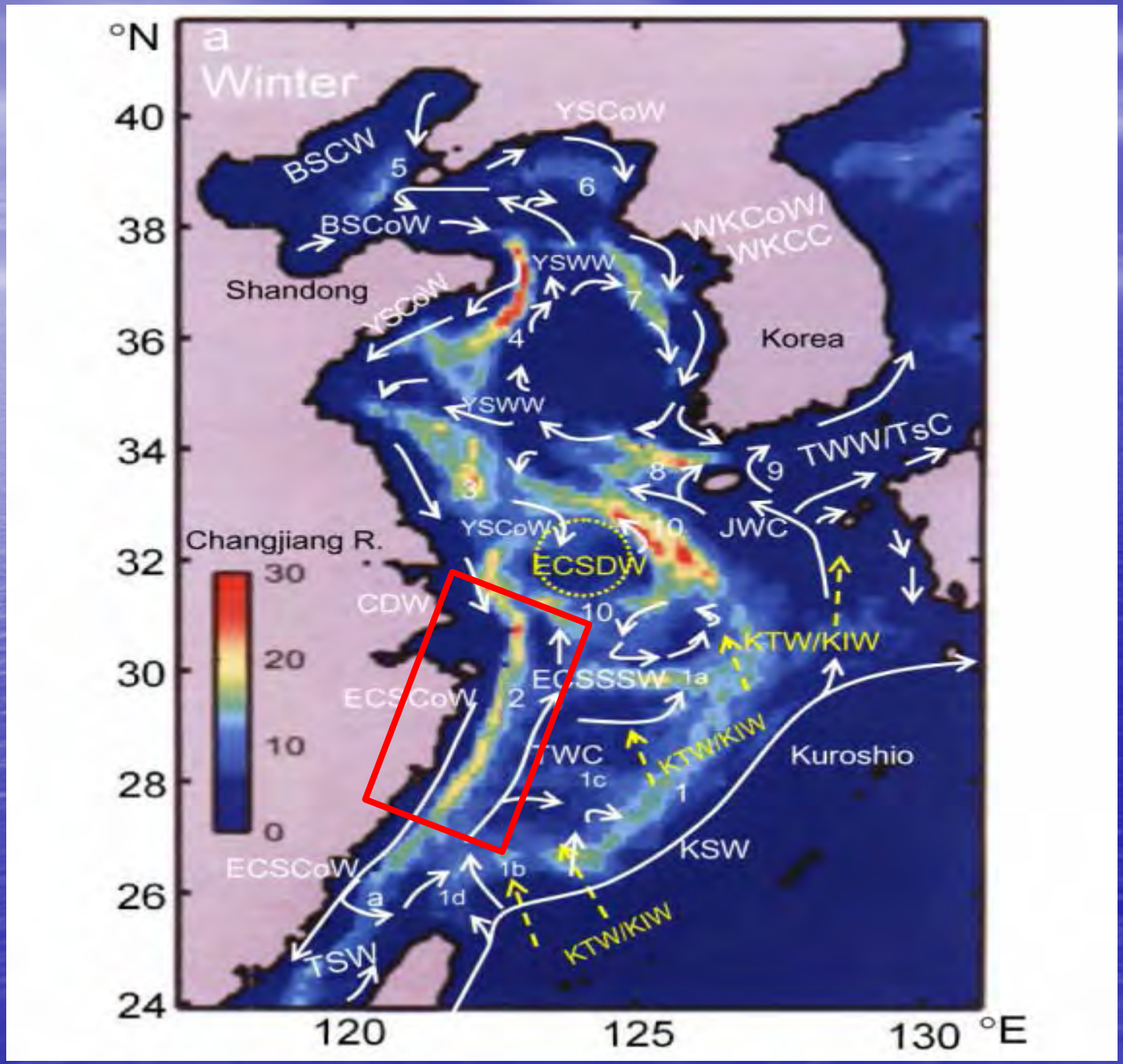
Temperatures ranging from 10℃ to 30℃ was suitable for the normal growth of *Heterosigma akashiwo* (Jiaozhou Bay Strain). The highest growth rate was observed at 25℃, which was considered as the optimum for the growth of *H. akashiwo*

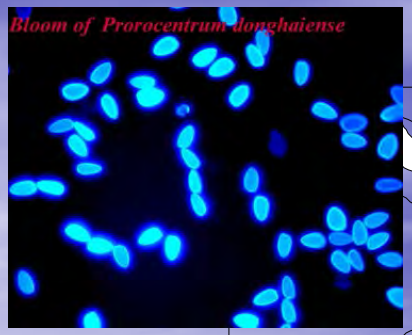
Yan et al., 2002; Wang et al., 2015

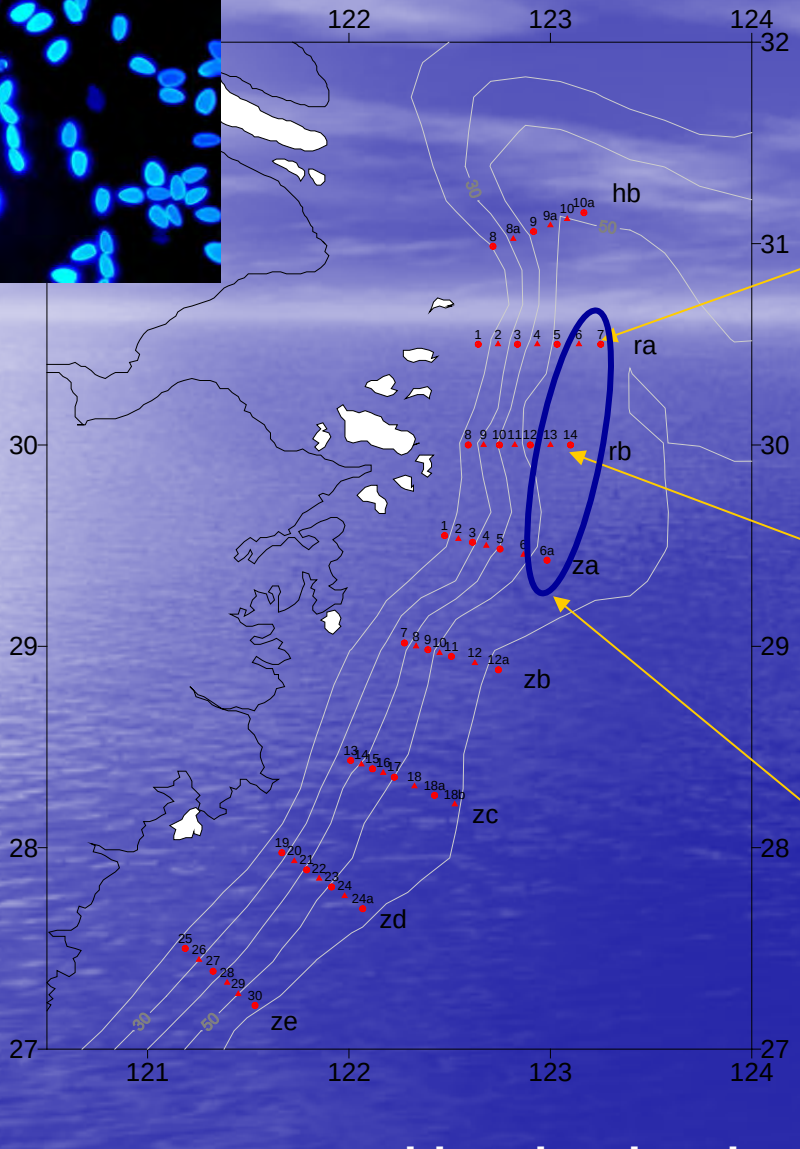


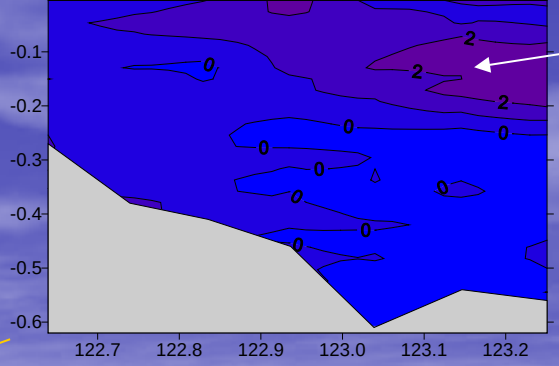
H.akashiwo is adapted to wide salinity, it can grow in the salinity ranging from 10 to 40 psu, low salinity is better for its growth Liu et al., 2015

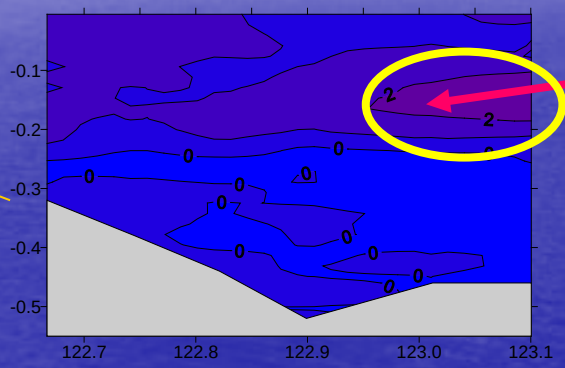
Transect profiles of *Heterosigama akashiwo* in the ECS

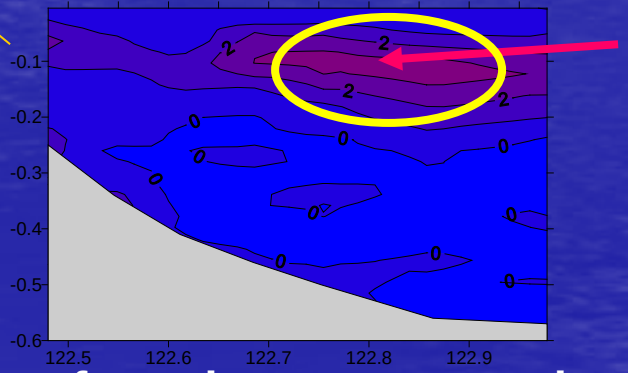

a
Winter
°N
40
38
36
34
32
30
28
26
24
120
125
130
°E
BSCW
BSCoW
YSCoW
WKCoW/
WKCC
YSWW
YSCoW
Shandong
Korea
YSWW
TWW/TsC
JWC
YSCoW
ECSDW
Changjiang R.
30
20
10
0
CDW
KTW/KIW
ECSSSW
ECSCoW
TWC
KTW/KIW
Kuroshio
KSW
ECSCoW
TSW
KTW/KIW
5
6
4
7
3
8
9
10
10
2
1a
1c
1
1b
1d
a











These zones are considered as incubators for subsequent massive blooms

“Pelagic seed banks”

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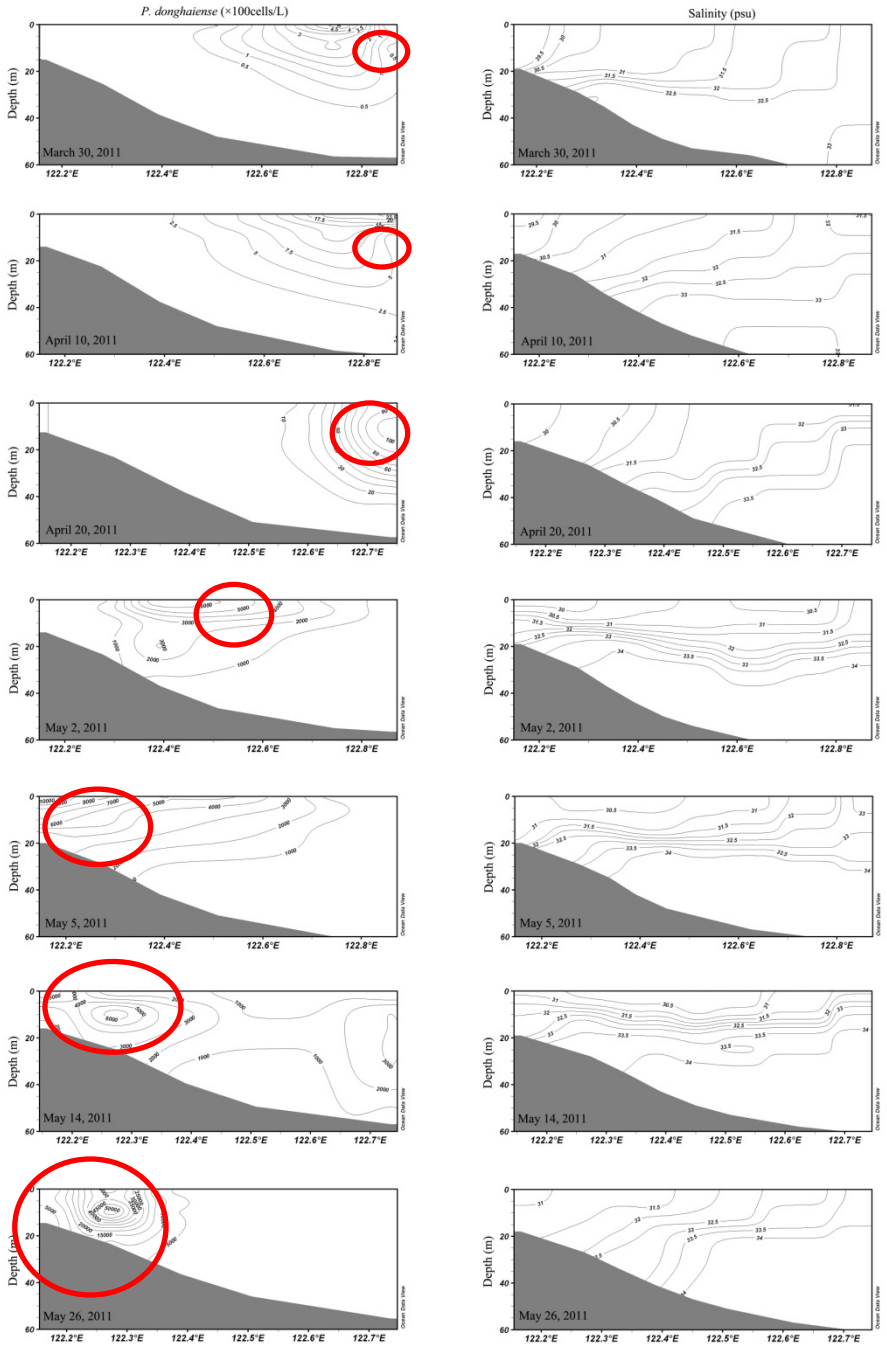
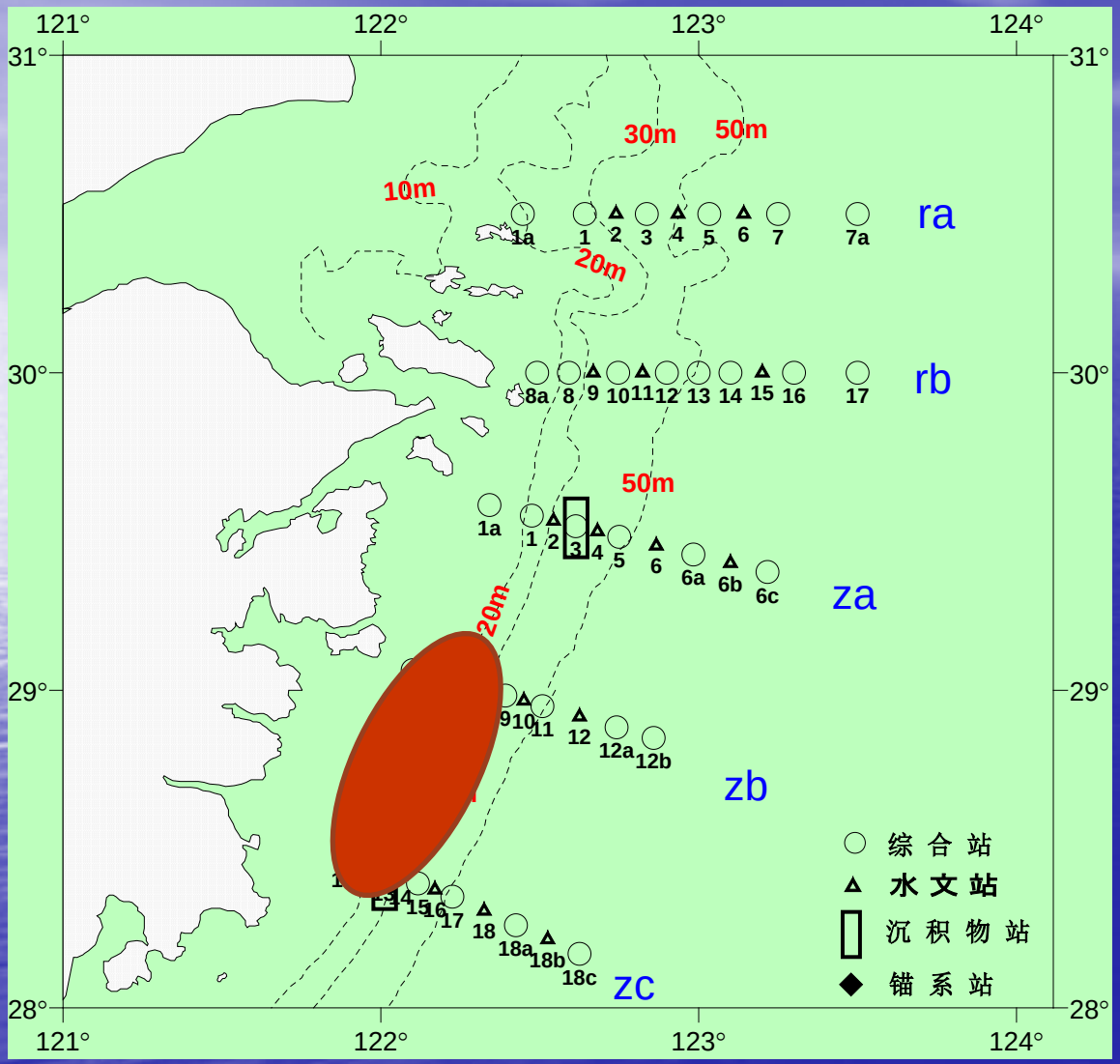
The Correlation between *Prorocentrum donghaiense* Blooms and the Taiwan Warm Current in the East China Sea - Evidence for the “Pelagic Seed Bank” Hypothesis

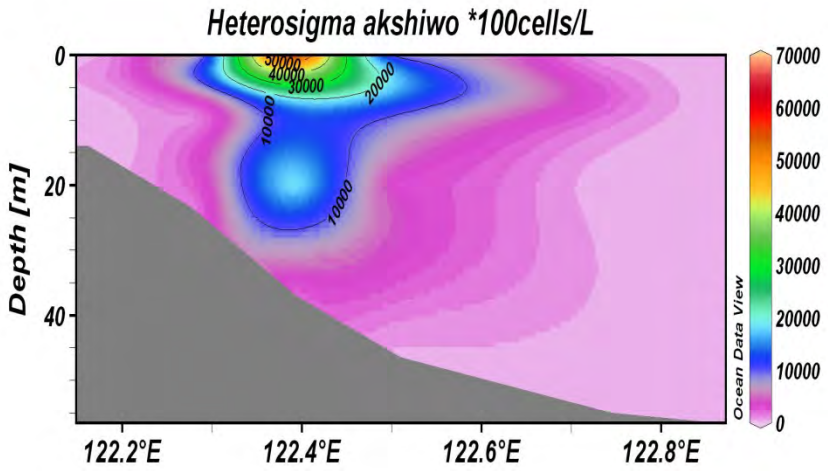
Xinfeng Dai, Douding Lu*, Weibing Guan, Ping Xia, Hongxia Wang, Piaoxia He, Dongsheng Zhang

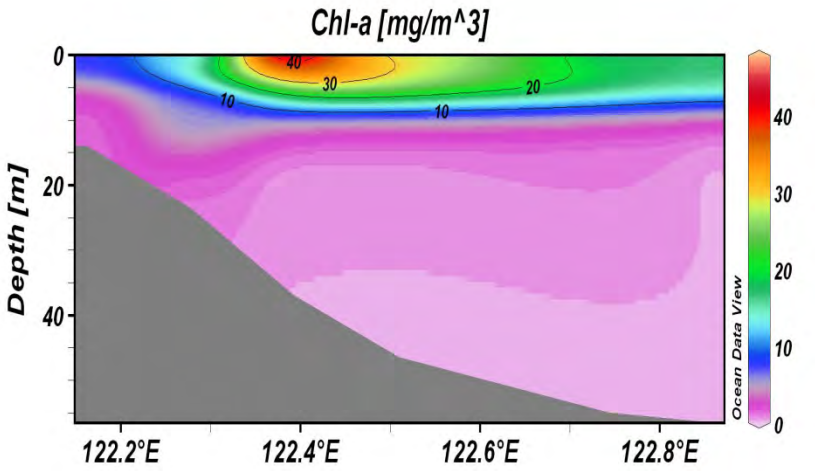


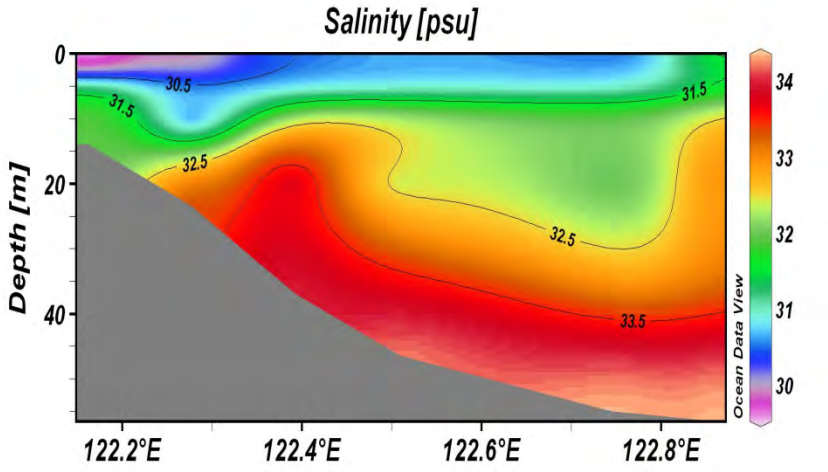
Vertical profiles of *P. donghaiense* abundance (left panels) and salinity (right panels) on the transect zb at time series in 2011

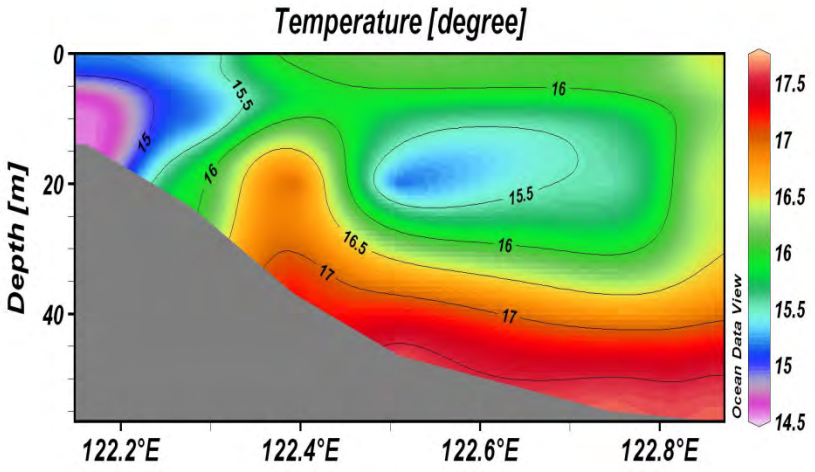

121°
122°
123°
124°
31°
30°
29°
28°
30m
50m
10m
20m
ra
rb
za
zb
zc
1a
1
2
3
4
5
6
7
7a
8a
8
9
10
11
12
13
14
15
16
17
6a
6b
6c
12a
12b
18
18a
18b
18c
综 合 站
水 文 站
沉 积 物 站
锚 系 站

（In May 2011）

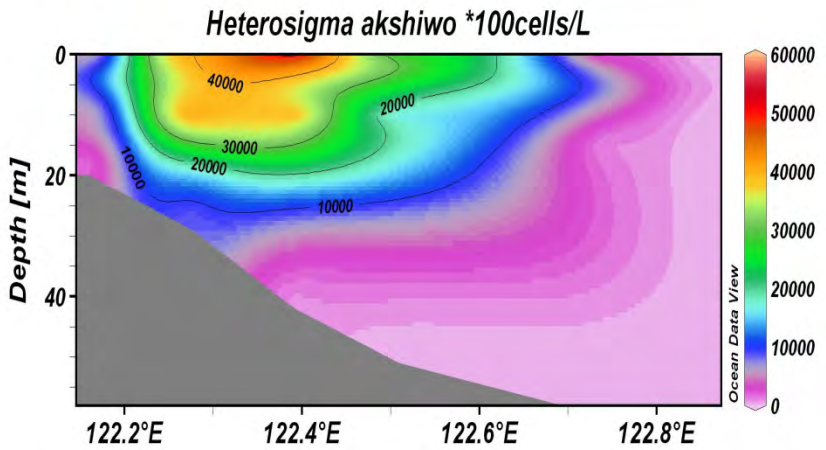


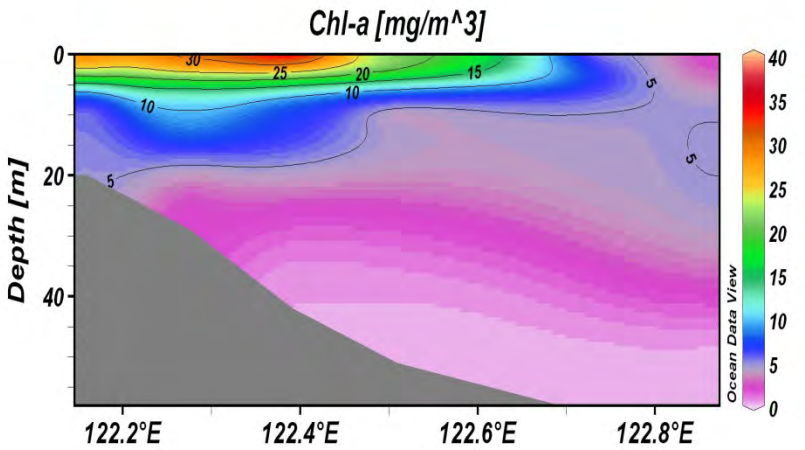


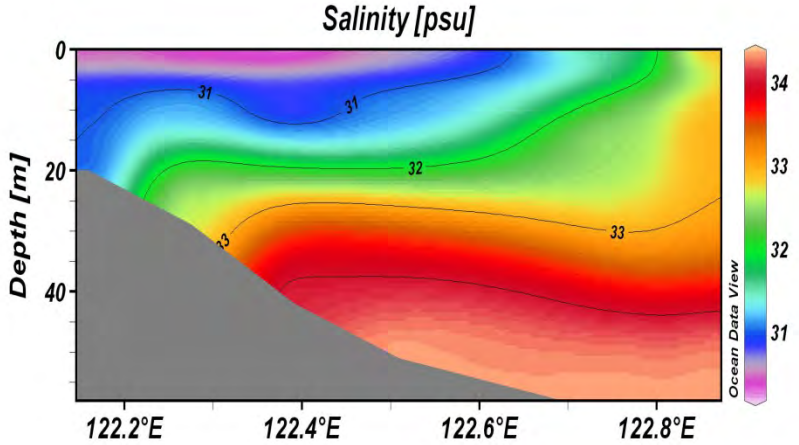


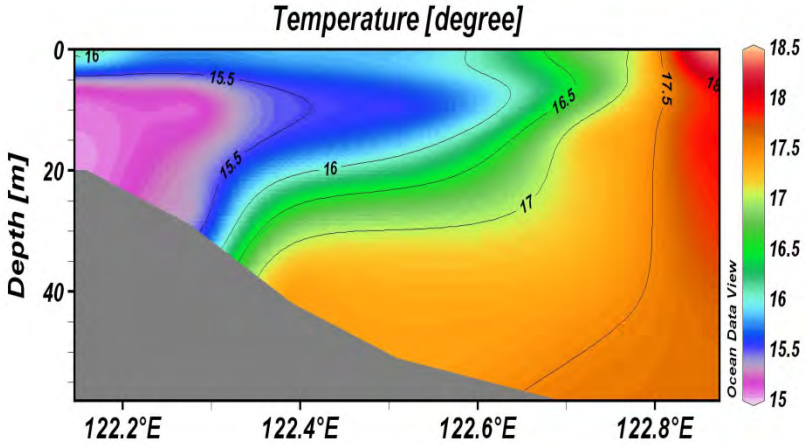


Transect ZB on May 2

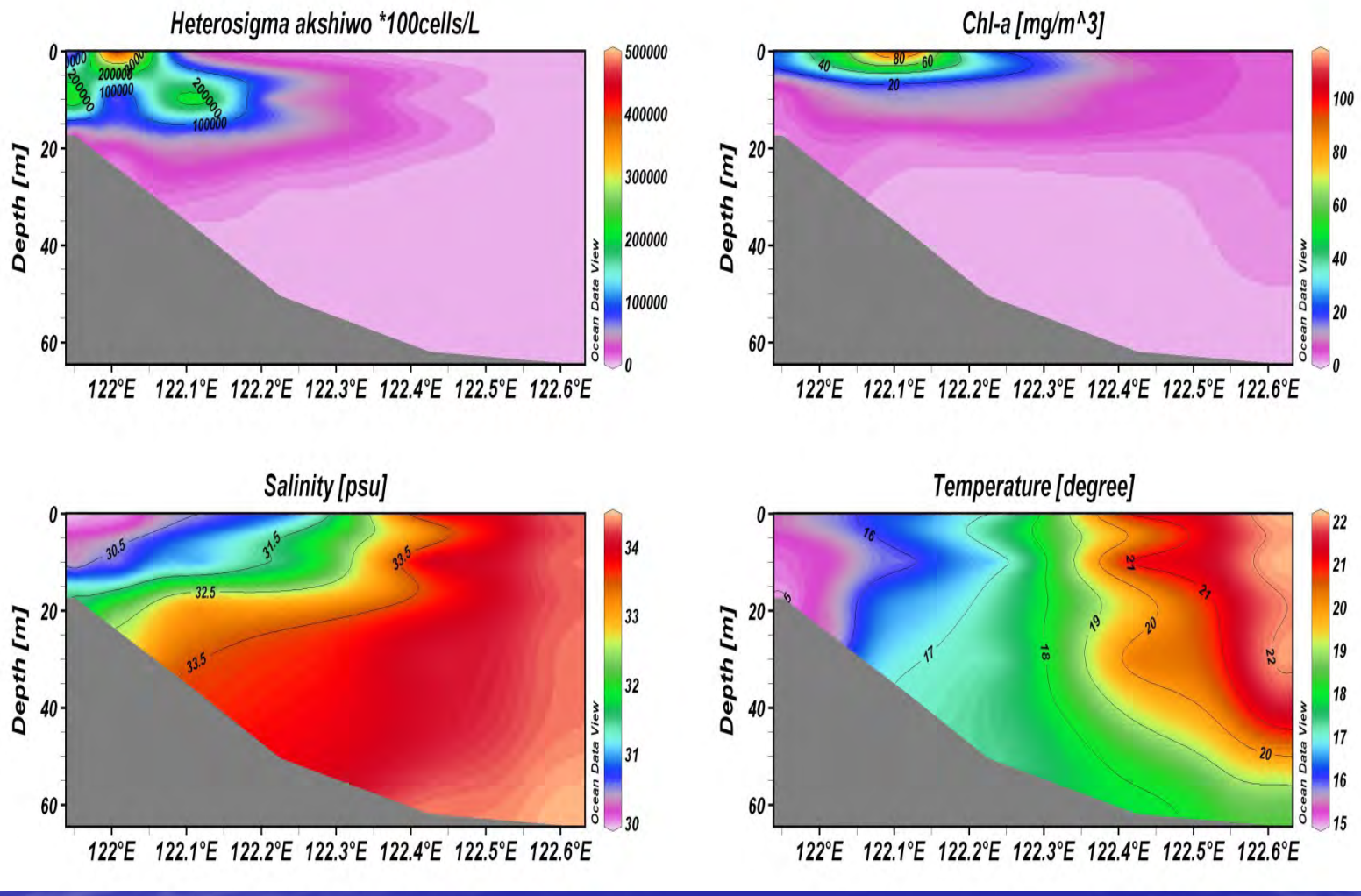








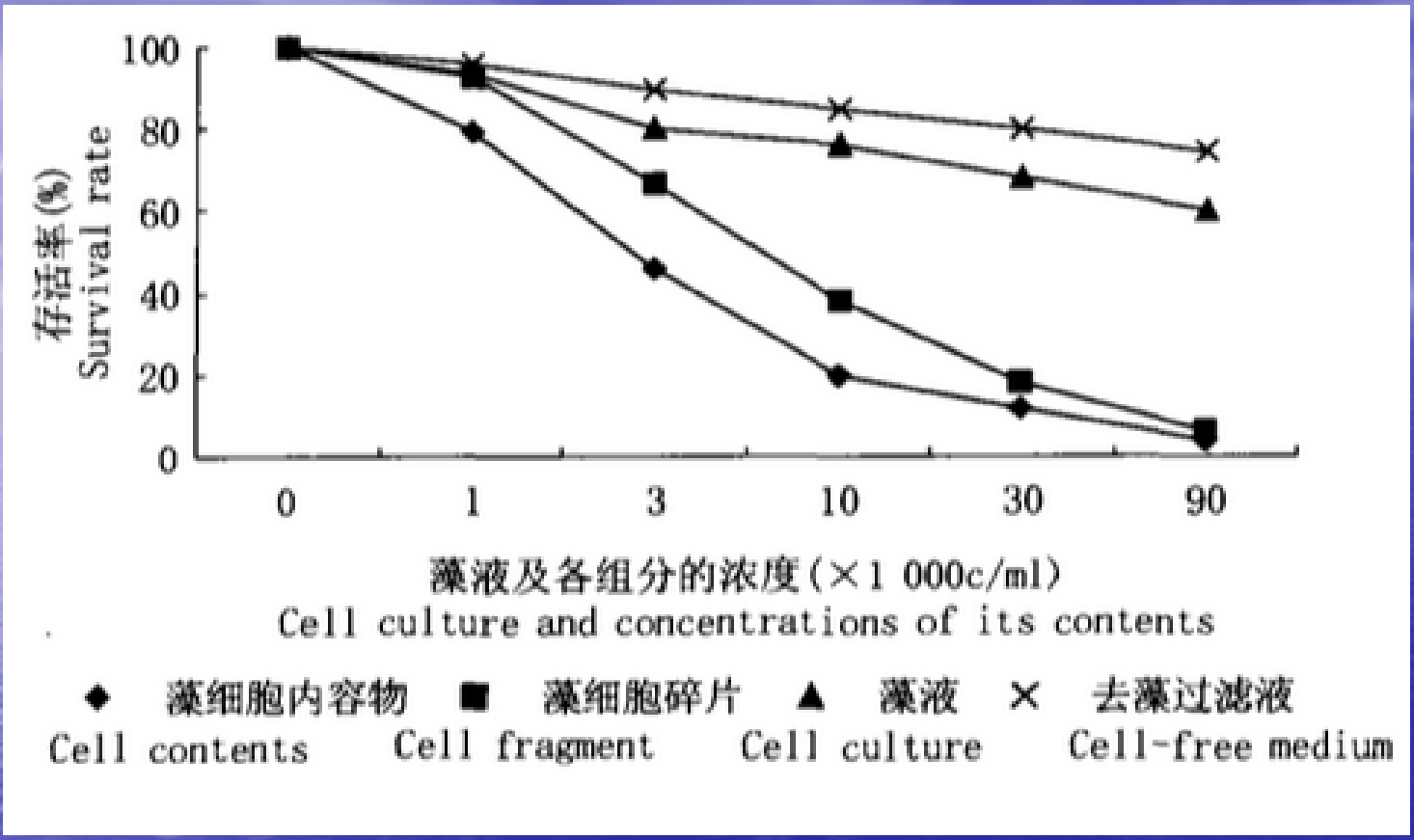
Transect ZB on May 7



Transect Zc on May 6

Points:

- Brief introduction of causative species
- Bloom distribution and decadal change
- **Harmful effects**
- Summary



Survival rate of juvenile *Engraulis japonicus* of during exposure to different fractions of the *Heterosihgma akashiwo* for 96h

(LIANG Zhongxiu et al., 2004)

The toxicity of *H. akashiwo* to *Sparus macrocephalu* juveniles was positively correlated to the cell density. The median lethal concentration （LC_{50} ） was 2.3 ×10^5 cells/ml after 12h exposure (Table1).

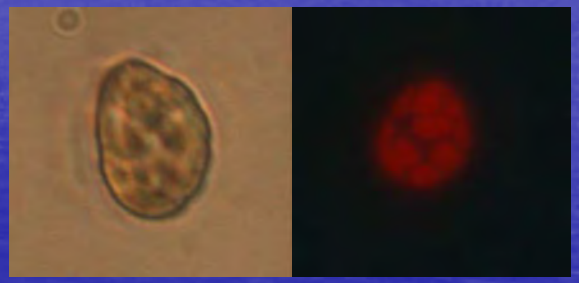
Tab.1 mortality of S. macrocephalu juvenile during 0-24h

Cell density (×10^4 cells/ml)	Average mortality of *S. macrocephalu* juveniles/ (%)			
	0h	6h	12h	24h
0	0	0	0	0
7	0	0	20	90
14	0	0	30	95
20	0	0	35	95
27	0	30	45	100

From ZHOU Chengxu et al., 2008

Summery :

- Fourty bloom events of Heterosigma akashiwo have been registered and bloom frequency has increased along China coastal waters. This species has mainly formed blooms in the Bohai Sea and the Yellow Sea and recently expanded to other China coastal waters.



- Seasonal pattern in different sea area:

  South China Sea: Feb. Mar. Apr. Sept.

  East China Sea: May, June

  Bohai Sea and Yellow Sea: May-August

- The bloom patterns in ECS were much related with stratified water system in the East China Sea in the spring. The process of H.A bloom seems different from massive *Prorocentrum* blooms.
- Decadal pattern suggest that there might be more H. akashiwo blooms in coming years in the ECS.

Thank you