

The largest scale macroalgae blooms in the Yellow Sea, China

Original sea area and Blooming mechanism

Jianheng Zhang, Yuanzi Huo, Kefeng Yu, Ren Xu, Peimin He*

Institute of Marine Sciences, Shanghai Ocean University

College of Fisheries and Life Sciences, Shanghai Ocean University

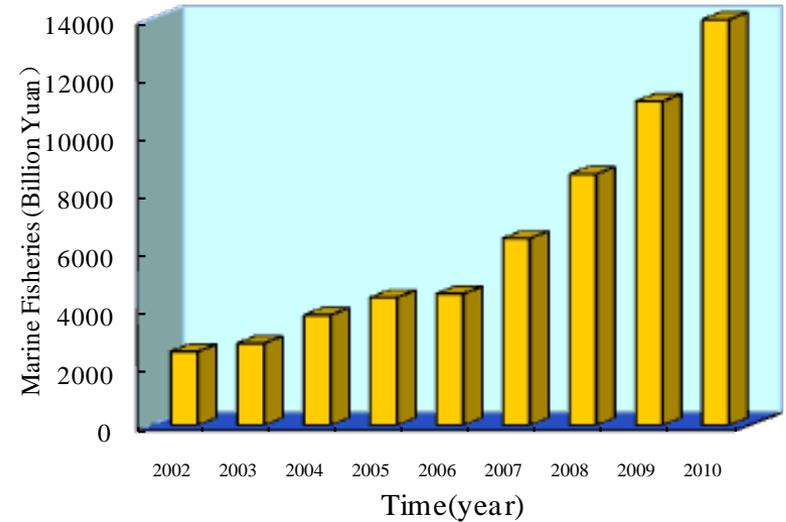
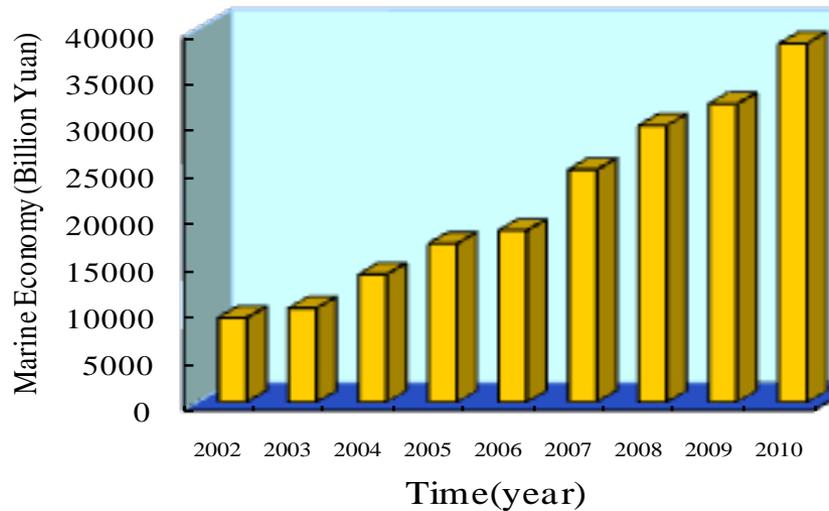
East China Sea Environmental Monitoring Center of State Oceanic Administration

Charles Yarish, Jang kyun kim

Department of Marine Sciences, University of Connecticut

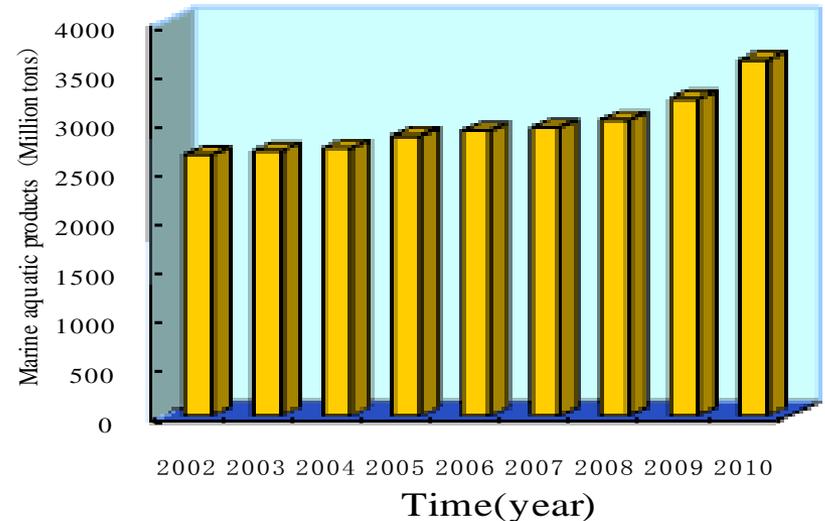
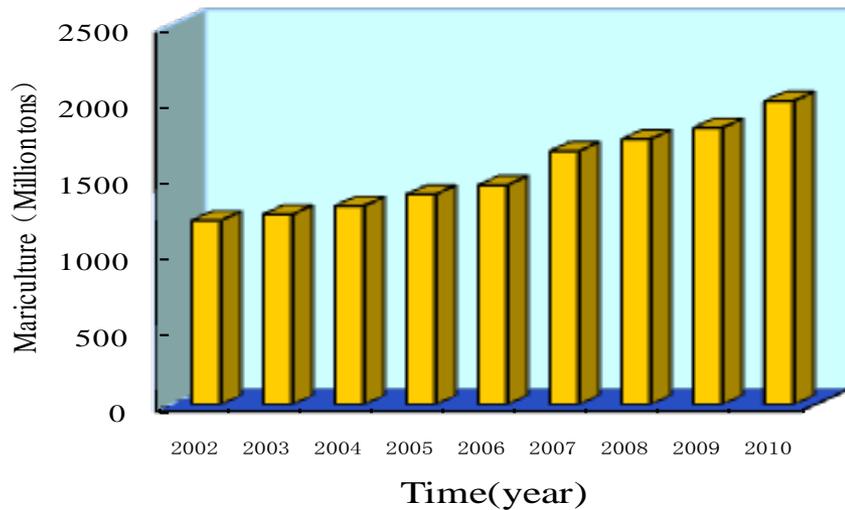
Department of Ecology and Evolutionary Biology, University of Connecticut

Rapid development of marine economy in China



Marine Economy Total production value

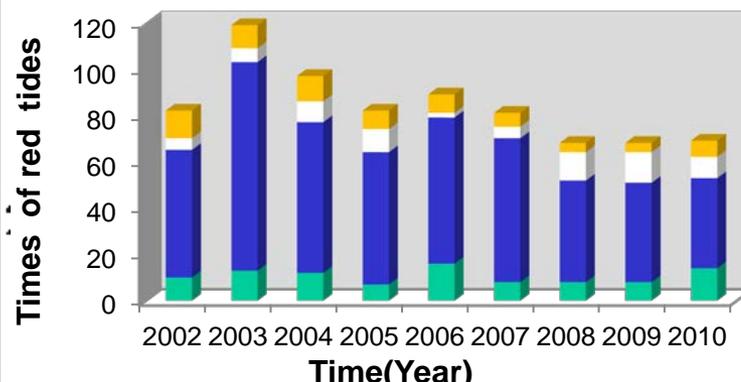
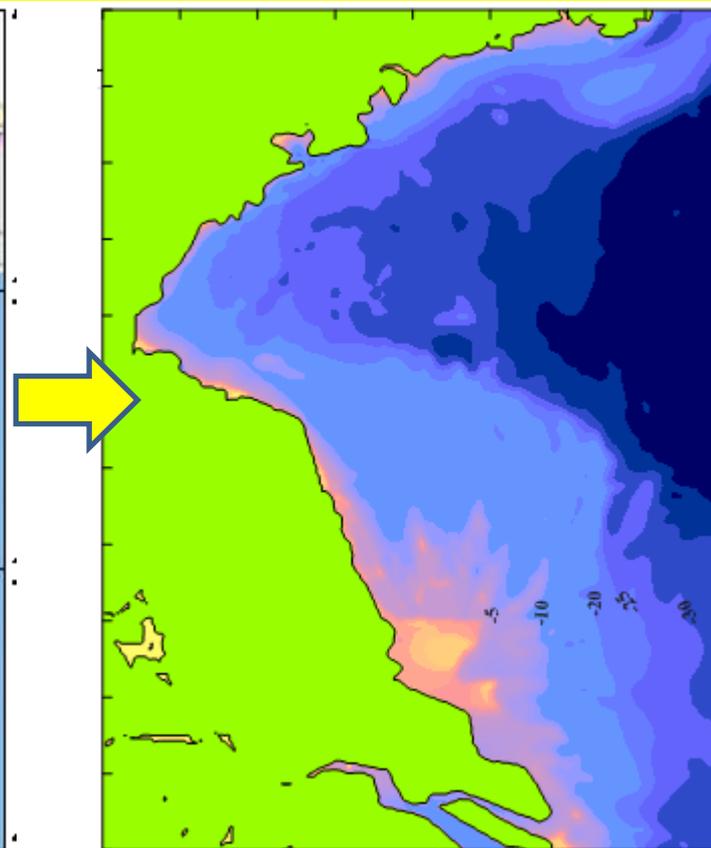
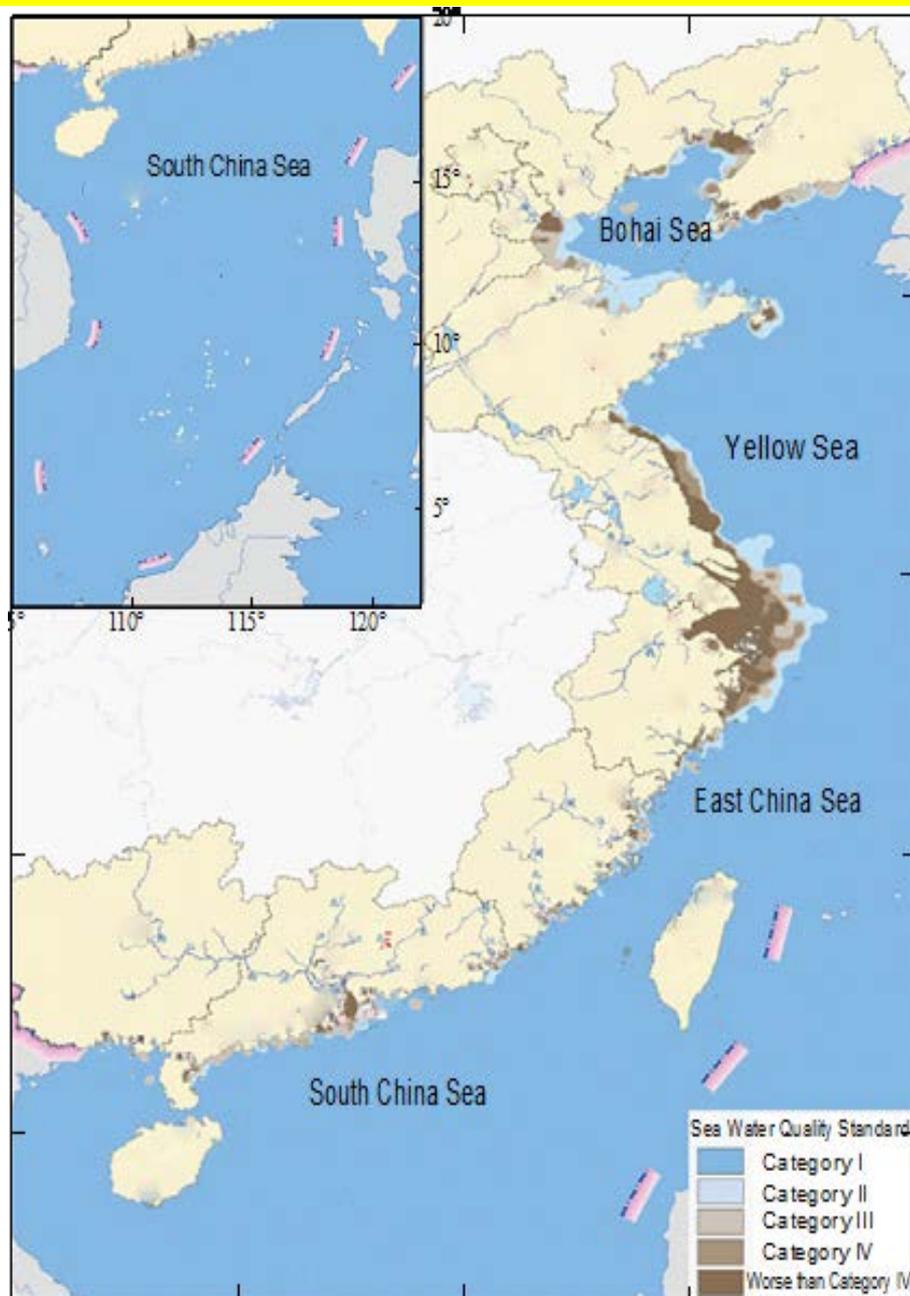
Marine Fisheries Total production value



Marine Aquaculture Total yield

Marine Aquatic Products Total yield

Eutrophication along the coast of China



The origin of the problem :Green tide and Olympic



cns

25,000 Km²

1.2 million tons







“Harmful” green tide

1. Tourism scenery

2. Bacteria spread

3. Smelly

4. Fishery industry

5. Offshore engineering

Heaped green tide

(1)

(2) Floating green tide

Sea surface

Coastal dam

4. Hypoxia

5. Water quality

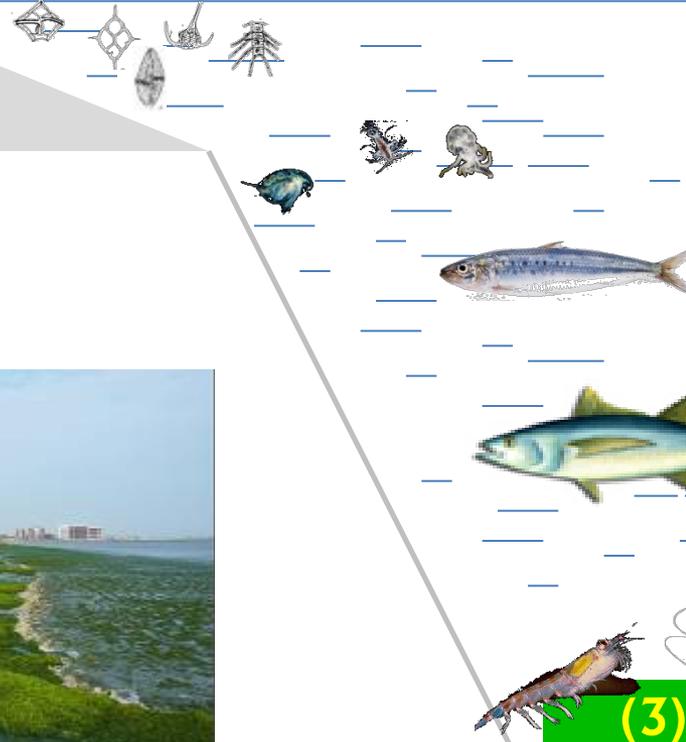
6. Irradiance decrease

7. Benthos died

8. Biocoenosis unbalanced

(3) Settled green algae

bottom





Japan



philippines

Green tide in the world

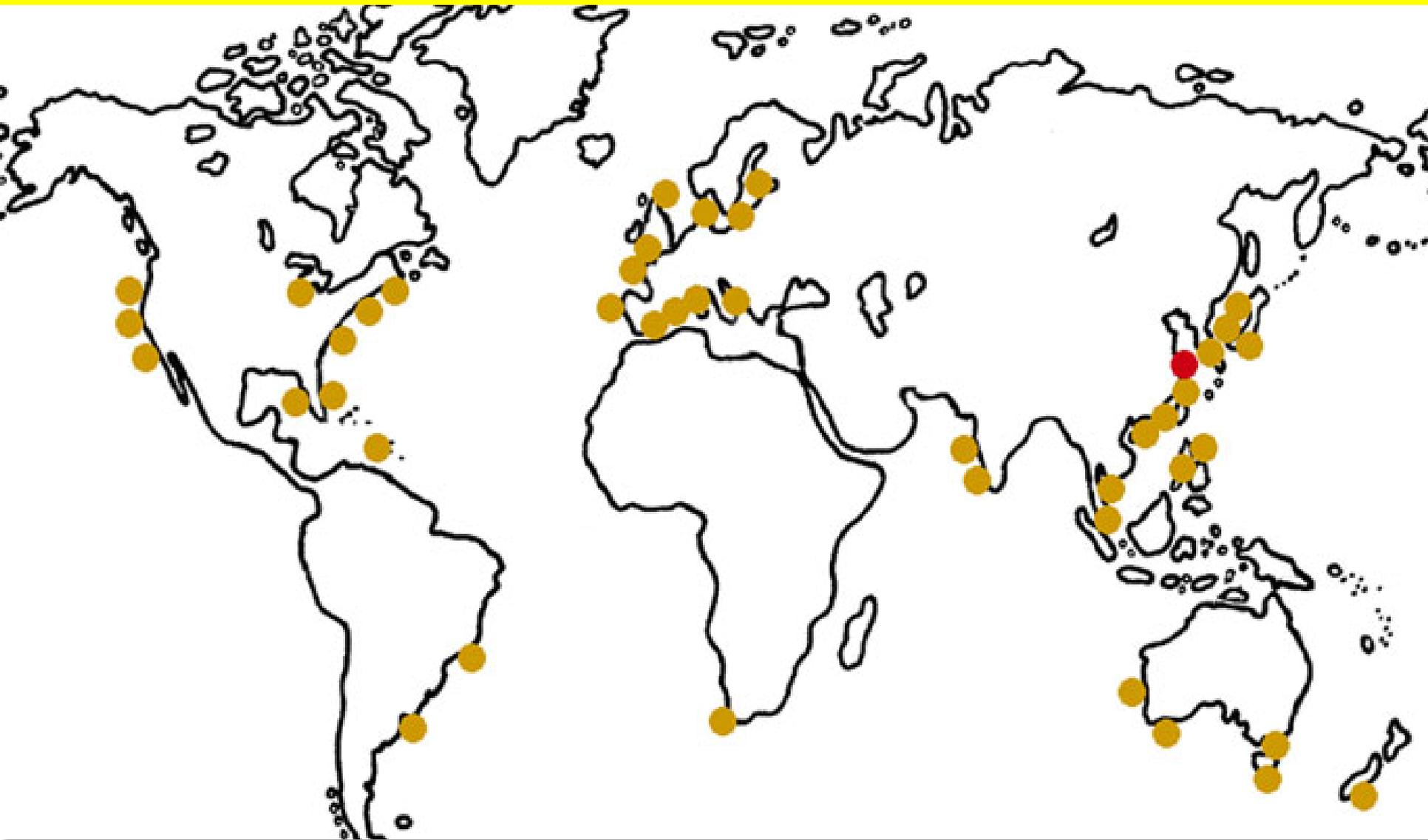


Southern California seas ,USA



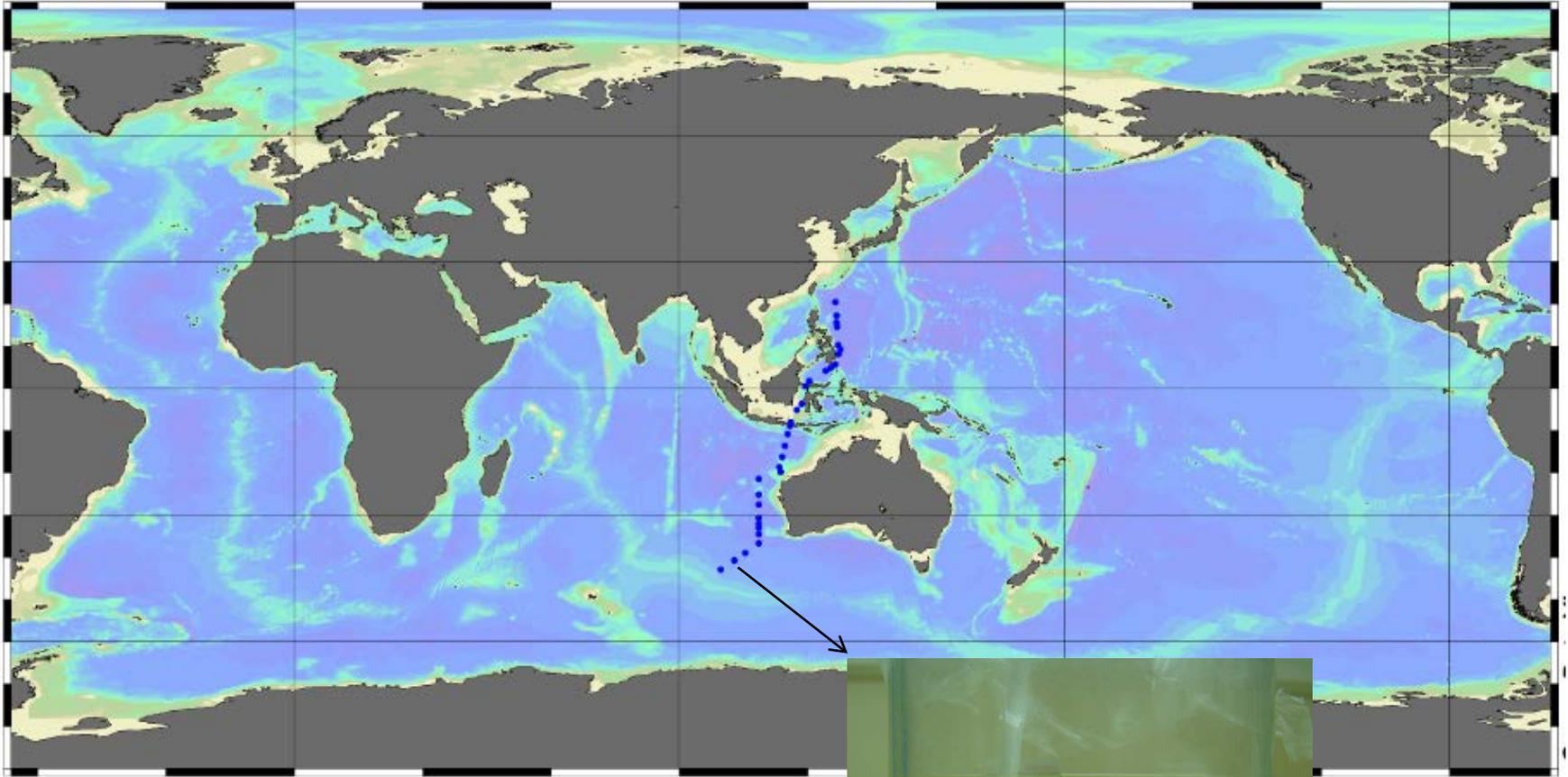
France

Green Tide in the World



The photo was from “Ye et al 2011, ‘Green tides’ are overwhelming the coastline of our blue planet- taking the world’s largest example”

Ulva Microscopic Propagule distribution



Green tides in the Yellow Sea

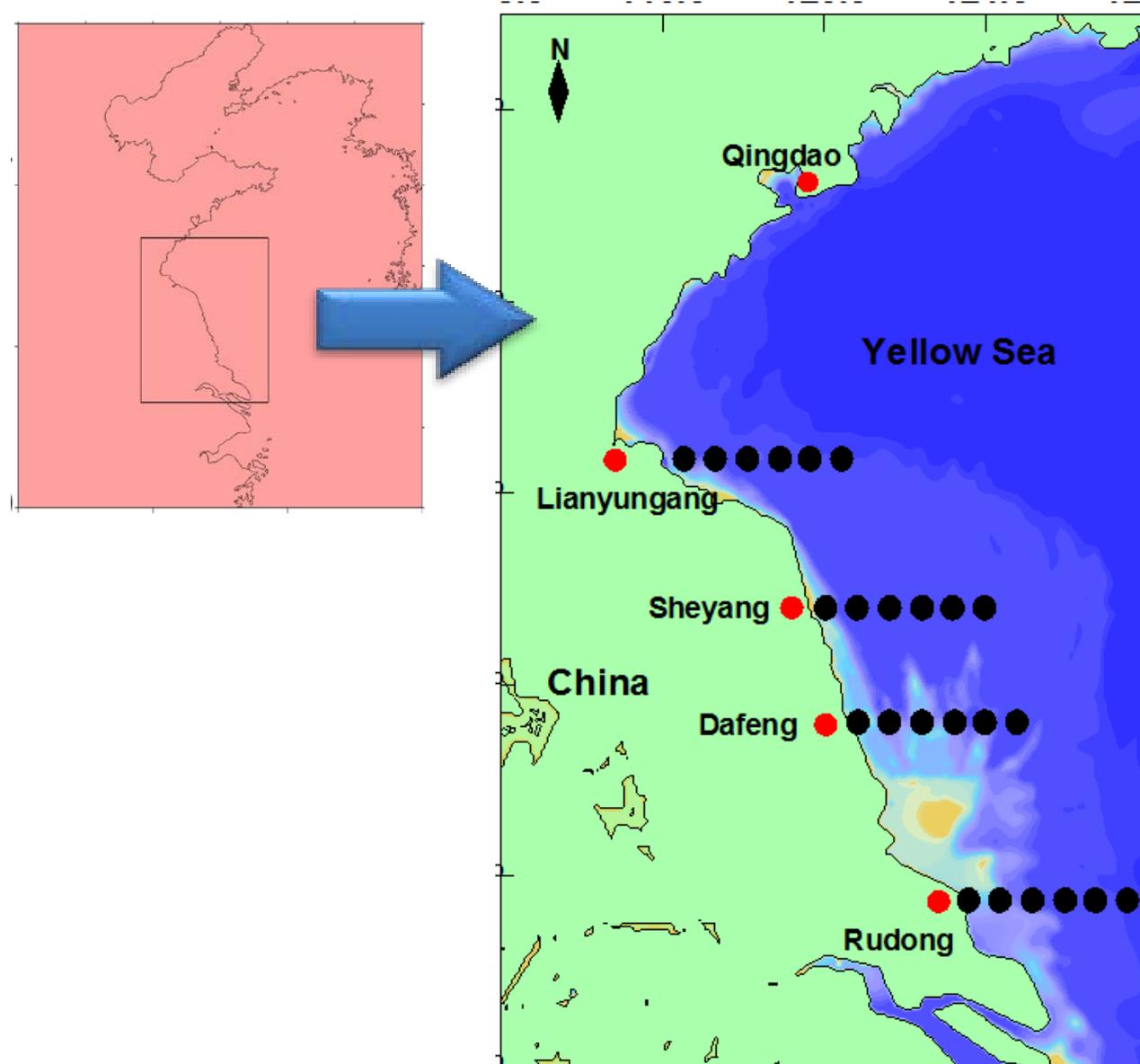
Year	Impacted area/km ²	covered area/km ²
2007	1,500	21
2008	25,000	650
2009	58,000	2,100
2010	29,800	530
2011	26,400	560
2012	19,610	267
2013	13,556	527



Satellite remote sensing in 2013



Shipboard Monitoring in 2010



The forming process of green tide



During the drifting northward, green tide declined and disappeared finally

Green tide attacked the Shandong Peninsula

Floating green tide was drifting northward slowly under the force of monsoon and ocean current

Due to the effect of turbulent flow, scattered green tide algae accumulated gradually



Morphological observation

Observation indexes

branches

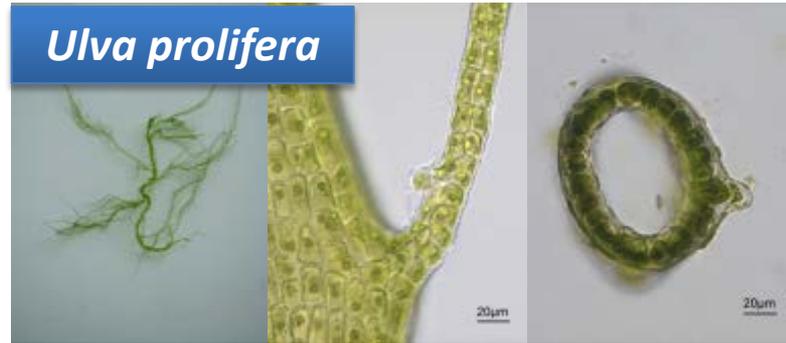
cell arrangement

pyrenoid

transverse section



Ulva prolifera



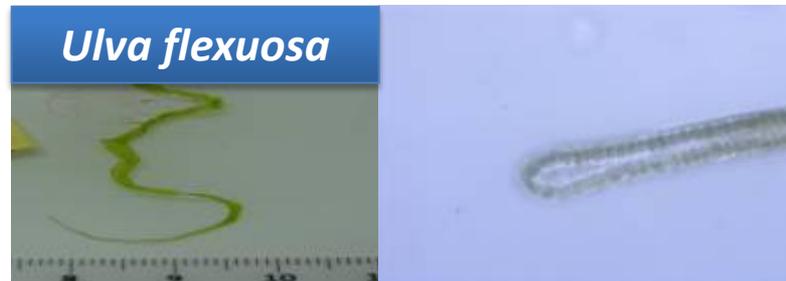
Ulva linza



Ulva compressa



Ulva flexuosa



Molecular Identifying Methods

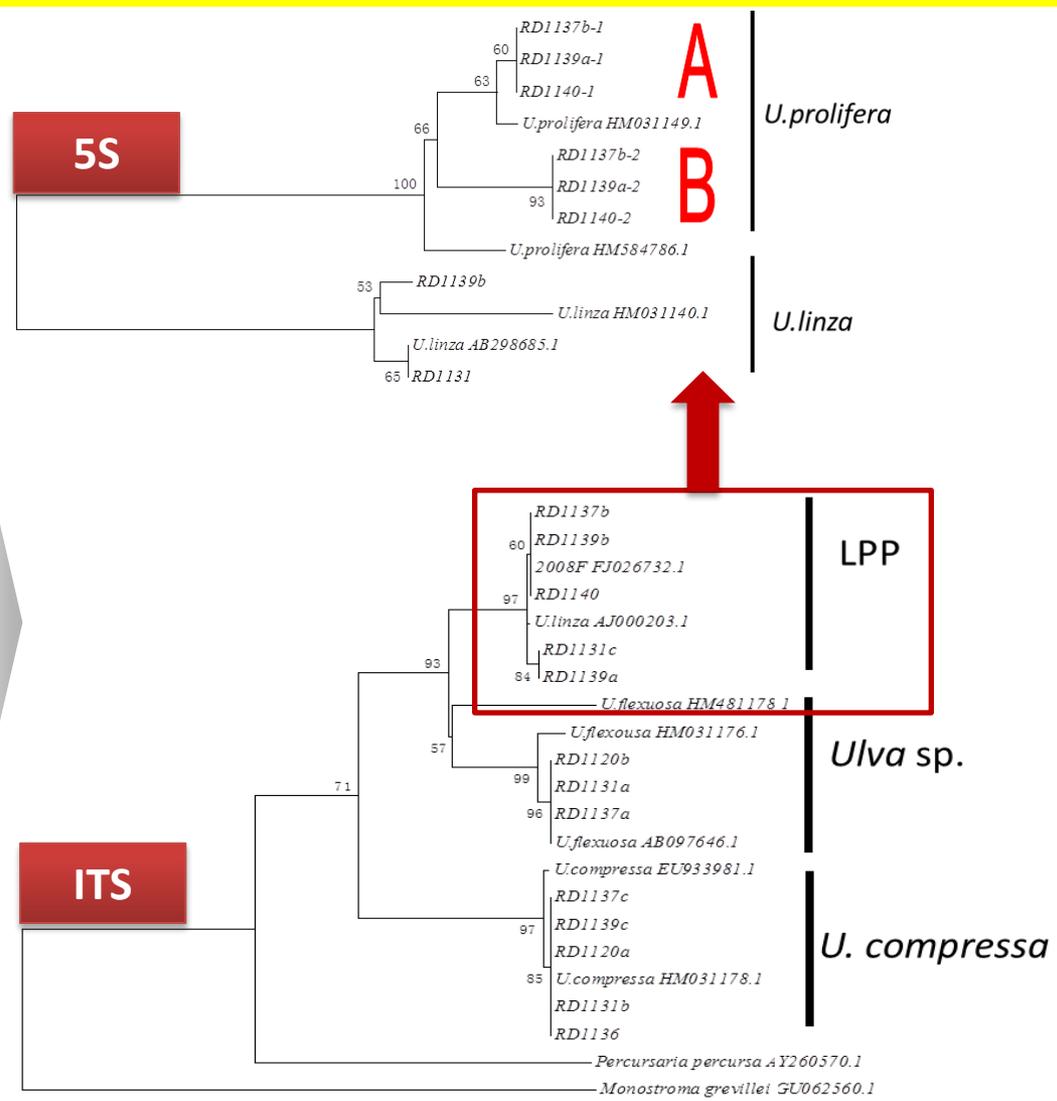
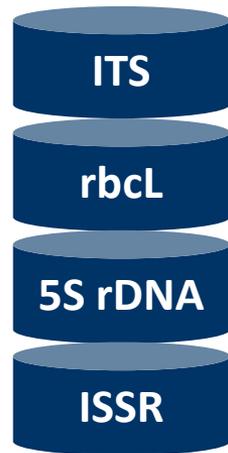


April

May

June

July



U. compressa, *U. sp. LPP* (*U. prolifera*, *U. linza*) could be identified with ITS method, but it can not be used to check *U. prolifera* and *U. linza*.

Source of green tide



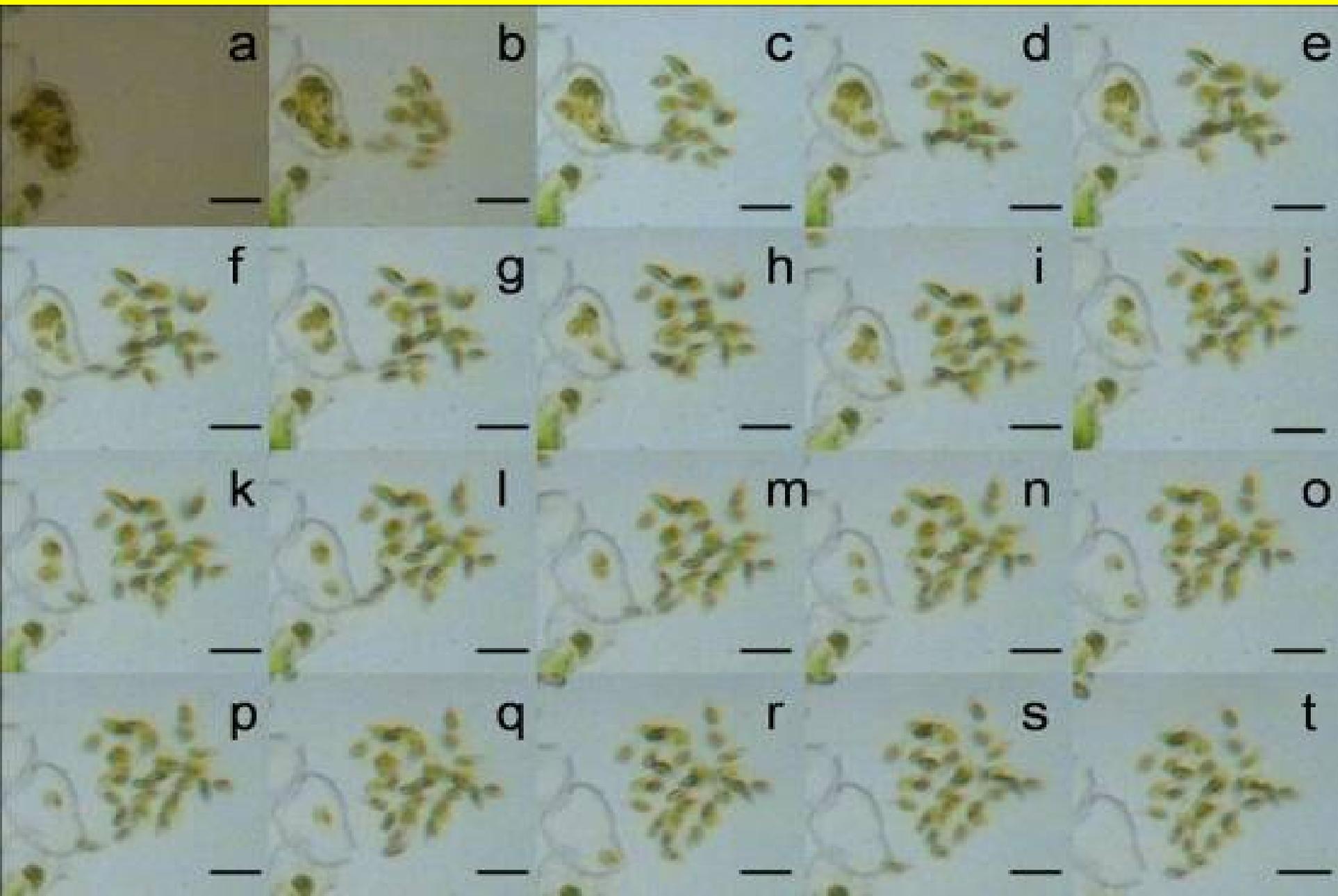
Coastal culture ponds



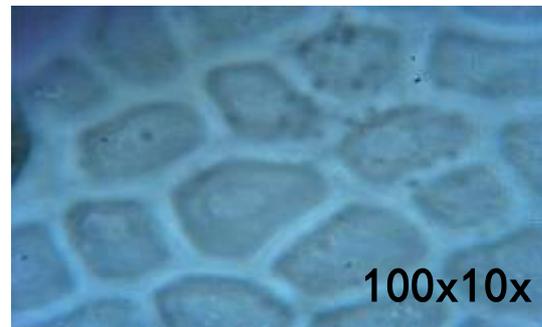
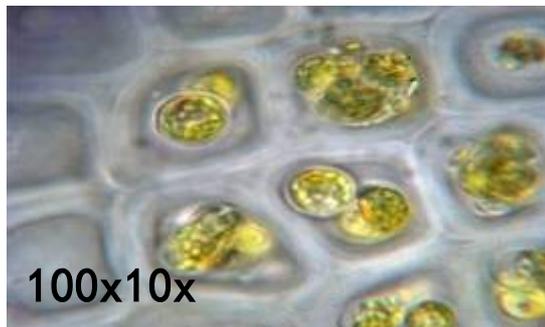
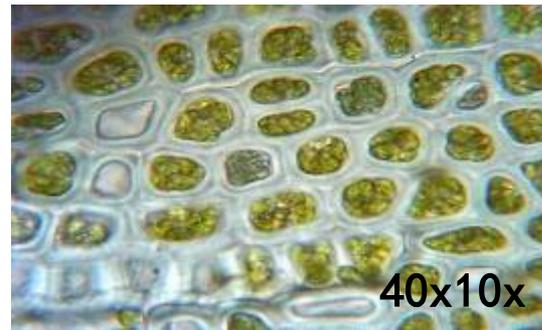
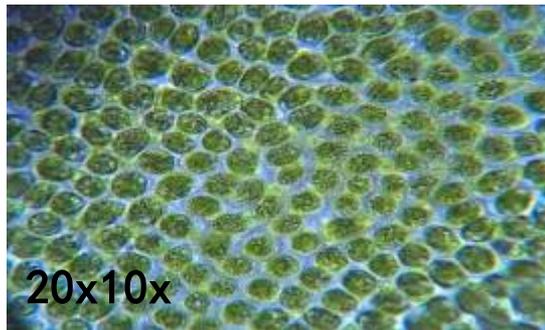
Phorphyra aquaculture rafts



Reproductive ways - Sexual reproduction

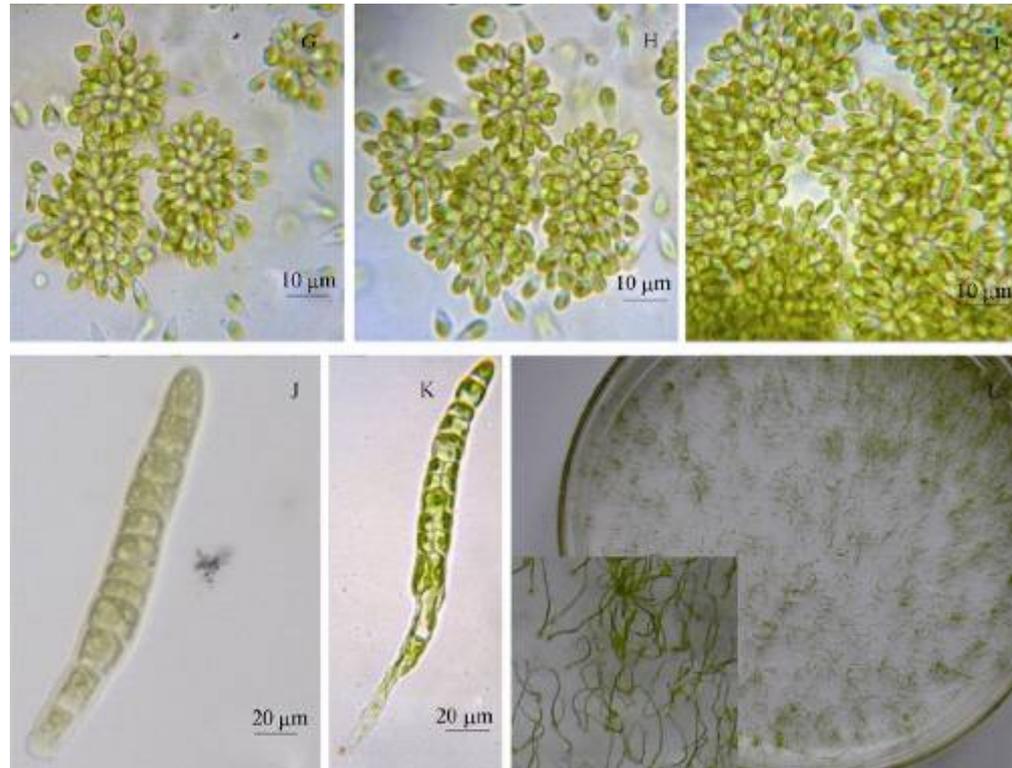


Reproductive capacity of *U. prolifera*



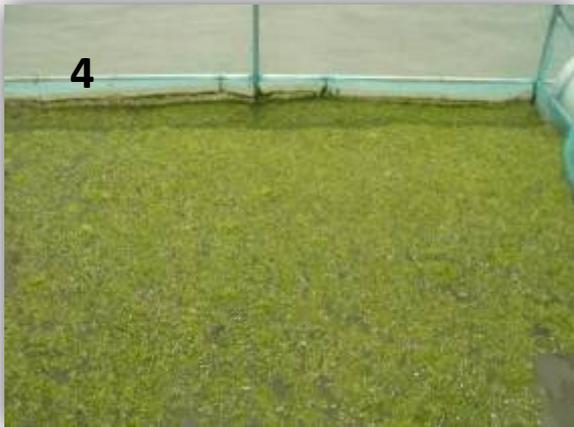
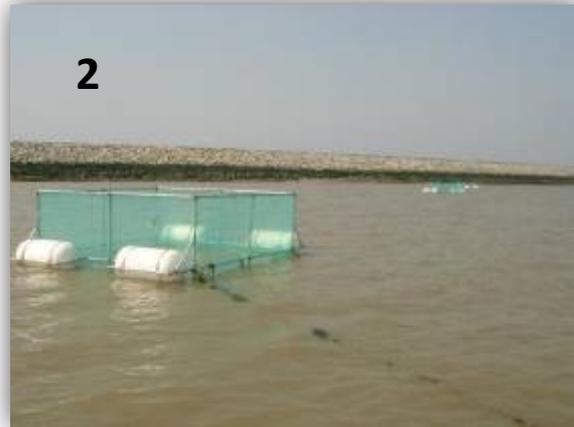
observed items	algal area / μm^2	number of germ cell cytocysts	number of germ cells
results	4225	30-35	spore 4-8 / gamete 16-32
calculated items	no. of germ cell cytocysts on 1cm^2 monolayer algae	no. of spores/gametes discharging from 1cm^2 monolayer algae	no. of spores/gametes in 1 g algae
result	$7.10 \times 10^5 \sim 8.28 \times 10^5$	$2.84 \times 10^6 - 6.62 \times 10^6 /$ $1.14 \times 10^7 - 2.65 \times 10^7$	$3.05 \times 10^8 - 7.08 \times 10^8 /$ $1.22 \times 10^9 - 2.84 \times 10^9$

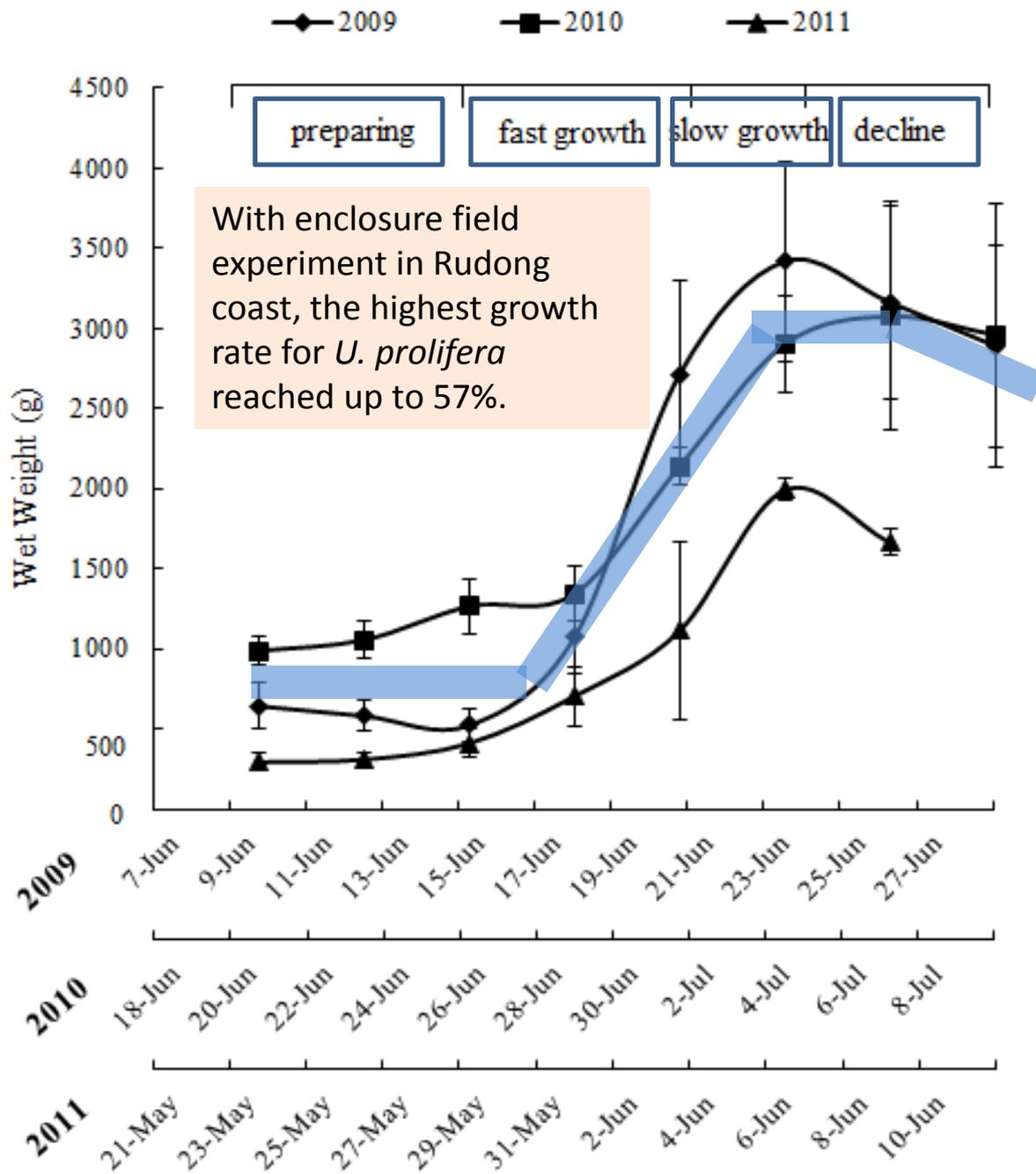
Germinated rate of germ cells in *U. prolifera*



No.	gamete			spore		
	number	number of seedlings	germination rate	number	number of seedlings	germination rate
1	4500	4198 ± 10	93.3	1500	1442 ± 5	96.1
2	6000	5394 ± 10	89.9	2000	1928 ± 5	96.4
3	5500	5038 ± 10	91.6	1500	1437 ± 5	95.8
average		91.6 ± 0.2			96.1 ± 0.3	

Enclosure experiments and the growth rate





Conclusion

- 1. Rudong was the original sea area of the macroalgae blooms in the Yellow Sea.**
- 2. Species composition of the macroalgae blooms were *U. compressa*, *U. sp.*, *U. linza* to *U. prolifera*; *U. prolifera* was the dominate species.**
- 3. *U. prolifera* has a higher growth rate and higher reproductive capacity.**

Acknowledgement:

Thanks Dr. Yarish and Dr. Kim from UCONN for their good suggestions.
Thanks Dr. He from SHOU for his support.



This study was supported by State Oceanic Administration of China



Thanks!

