



# Novel indicator of biopterin to interactions and perturbations associated with trace metals in estuarine and coastal waters



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Background Info.

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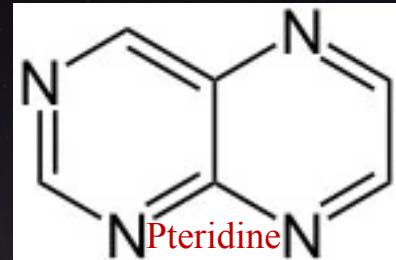
Summary

Discussion & Conclusion

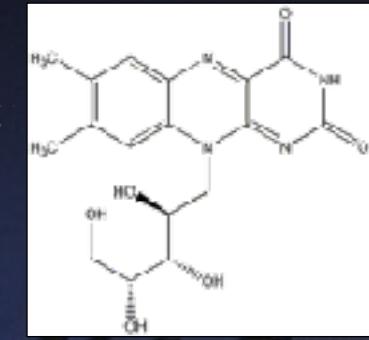
# Content

# 01 Pteridines

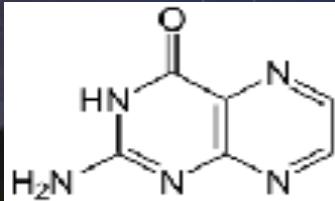
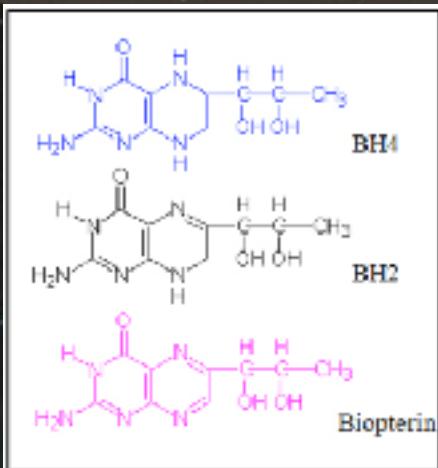
neopterin  
xanthopterin  
**Biopterin**  
.....



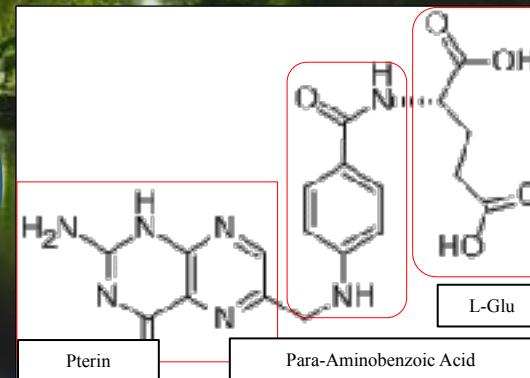
Riboflavin  
(VB2)



Pterins



Folic acid  
(VB9)



>Pigment

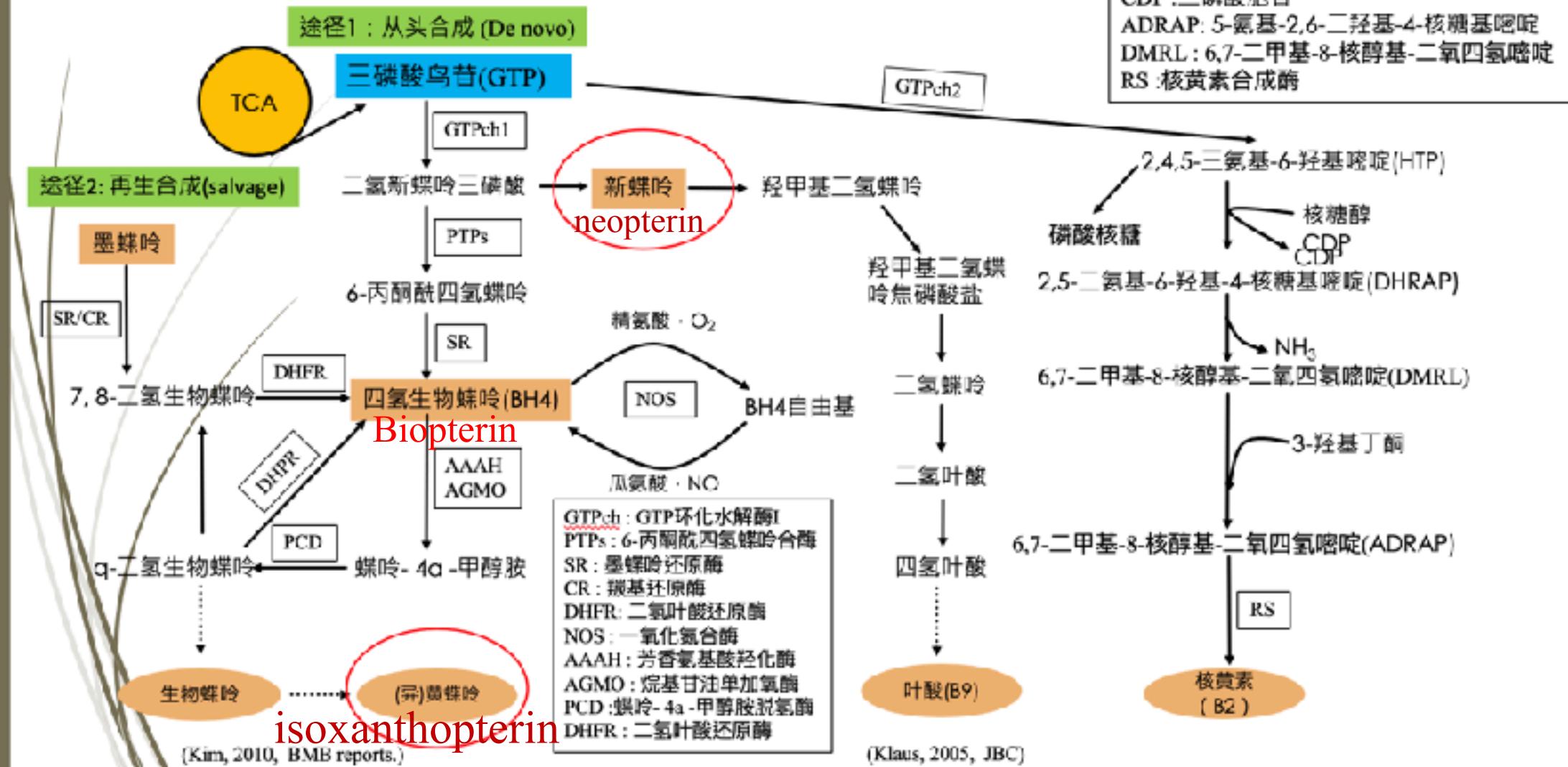
>Precursor

>Cofactor

>C, N, S



# Metabolic pathway



➤ Hundreds of enzymes involved in the metabolic processes and related to metallic elements.

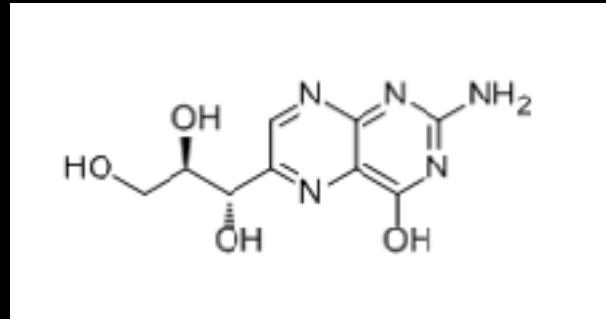


# Study subjects

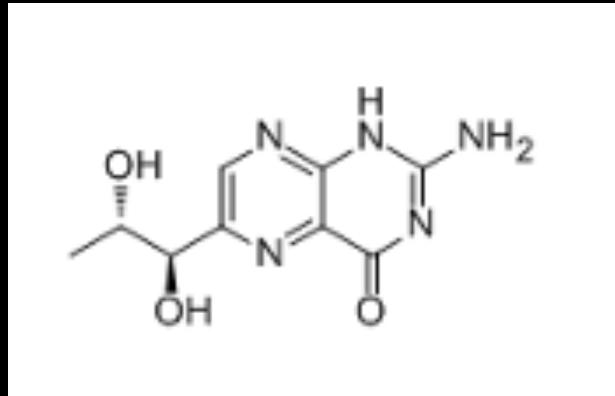
**Neopterin (NP): Intermediate product of the metabolism of guanosine triphosphate (GTP) , the synthetic pathway of tetrahydrobiopterin.**

**Biopterin (BP): Synthesis of pigments, aromatic amino acids, and nitric oxide, to mitigate UV radiation hazards.**

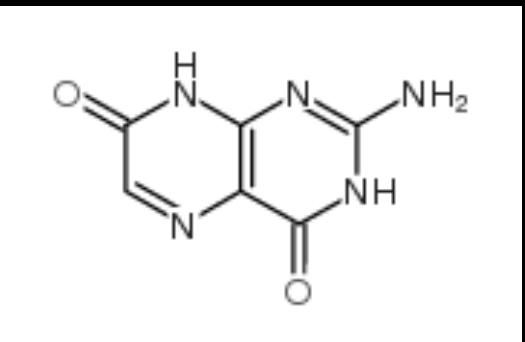
**Isoxanthopterin (IP): metabolite of dihydrobiopterin and tetrahydrobiopterin.**



Neopterin (NP)



Biopterin (BP)



Isoxanthopterin (IP):



Mar. Biotechnol., 1, 207–210, 1998

# MARINE BIOTECHNOLOGY

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## Short Communications

### Isolation of Biopterin- $\alpha$ -glucoside from *Spirulina* (*Arthrospira*) *platensis* and Its Physiologic Function

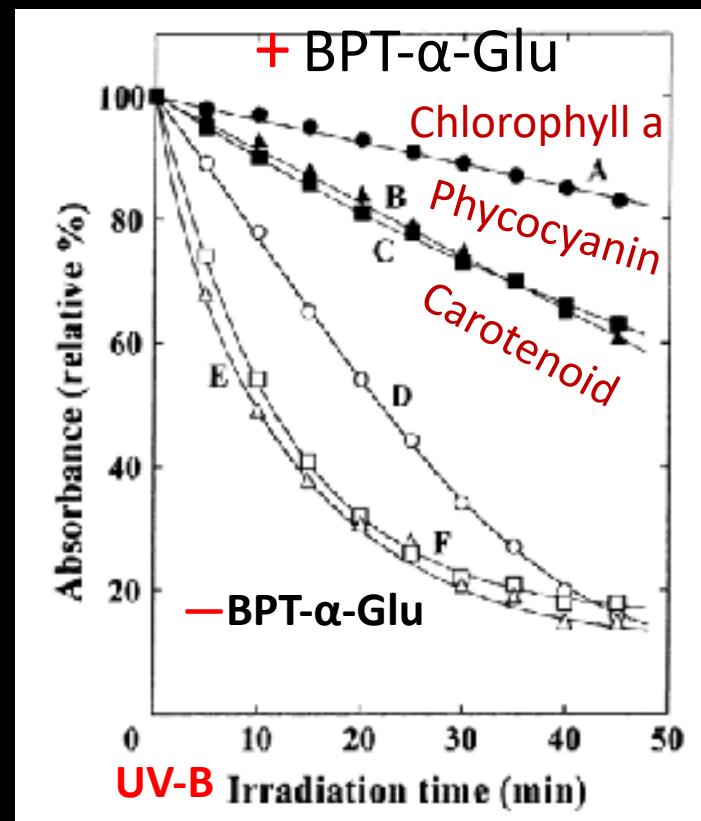
Yukinori Negishi,<sup>1</sup> Asako Ishii,<sup>1</sup> Ayake Matsushima,<sup>1</sup> Daisuke Hatai,<sup>1</sup> Ken-ichi Yasumura,<sup>1</sup> Tomohisa Moriguchi,<sup>2</sup> Takeshi Wada,<sup>2</sup> Yoh Kodera,<sup>2</sup> Misao Hiroto,<sup>1</sup> Hiroyuki Nishimura,<sup>1</sup> Mitsuë Sekine,<sup>2</sup> and Yuji Inada<sup>1,\*</sup>

<sup>1</sup>Tate Museum Science and Technology Center, Department of Materials Science and Technology, Tate University of Yokohama, 234-0032, Aoba-ku, Yokohama 223-0032, Japan

<sup>2</sup>Faculty of Biosciences and Biotechnology, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama 226-8501, Japan

**Abstract:** A fluorescent substance was isolated from the cyanobacterium with a yield of 4.5 mg per 10 g of dried *Spirulina* (*Arthrospira*) *platensis* cells by gentle extraction and ethanol fractionation followed by column chromatography. The fluorescent substance, which has absorption maxima at 256 nm and 362 nm (pH 8.4), was identified as biopterin- $\alpha$ -glucoside by spectrophotometry and nuclear magnetic resonance spectroscopy. Biopterin- $\alpha$ -glucoside prevented decolorization of the phycobilisome pigments, chlorophyll *a*, phycocyanin, and carotenoids in photosynthetic vesicles of *Spirulina* *platensis* cells, by ultraviolet irradiation.

**Key words:** biopterin- $\alpha$ -glucoside, *Spirulina* *platensis*, cyanobacterium, chlorophyll *a*, phycocyanin, carotenoids



(Yukinori, 1999, Mar. Biotec.)

“sunscreen”—UV protection

Cellular levels of biopterin increased under UV-A

➤ + BPT- $\alpha$ -Glu increased the energy capture under UV-B.



# Terrestrial & marine ecosystems



## Terrestrial Ecosystem

Biomass :  $1837 \times 10^9$  t

*Total Primary production*  
:  $115 \times 10^9$  t /yr

Tree & Grass

Biomass: 1/500

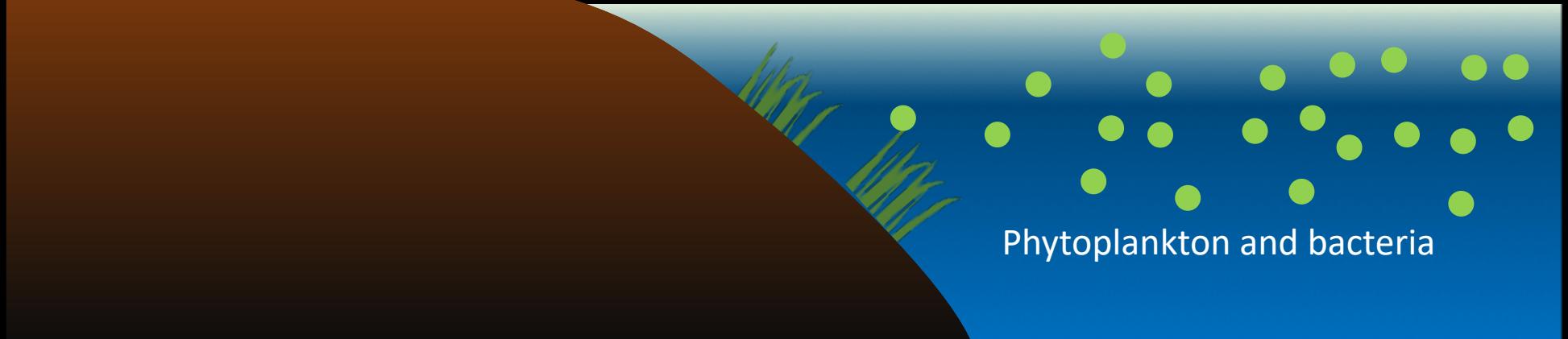
## Marine Ecosystem

Biomass :  $3.9 \times 10^9$  t

*Total Primary production*  
:  $55 \times 10^9$  t /yr

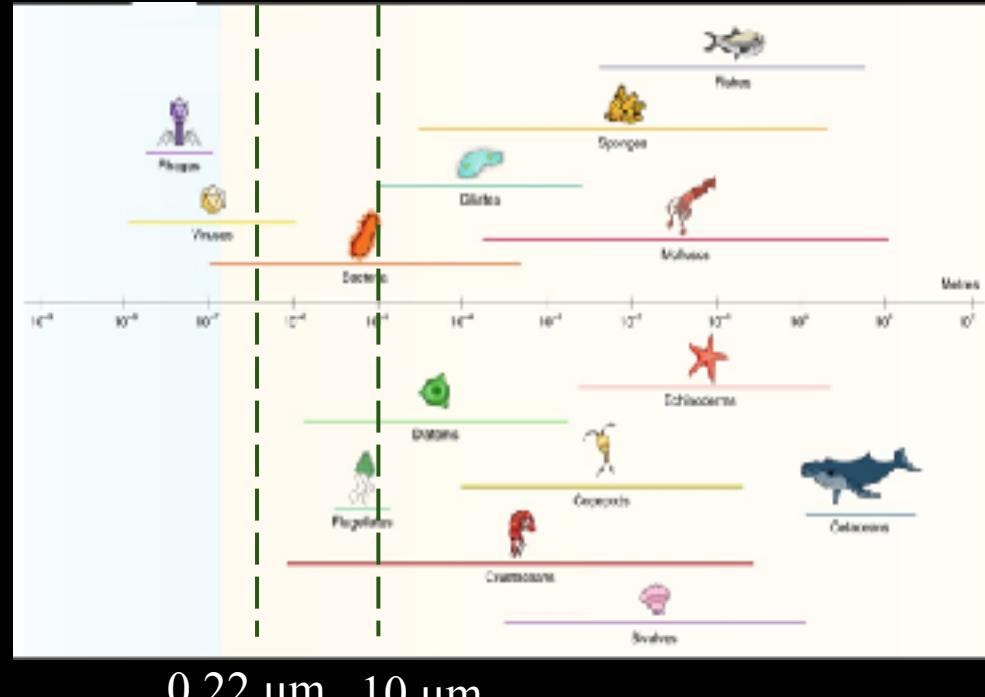
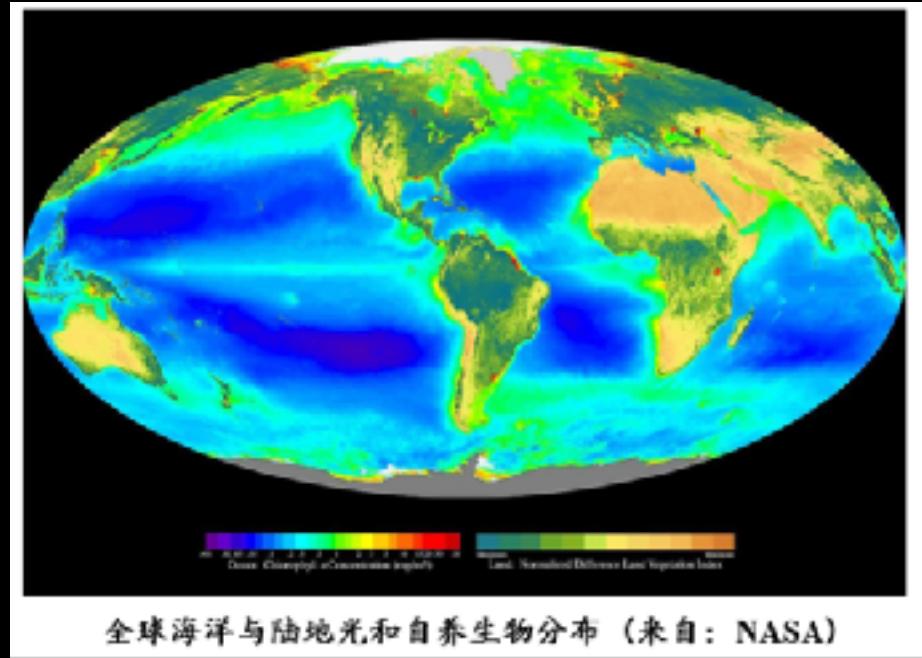
Photoautotroph

PP : 1/2





# ➡️ Marine microplankton



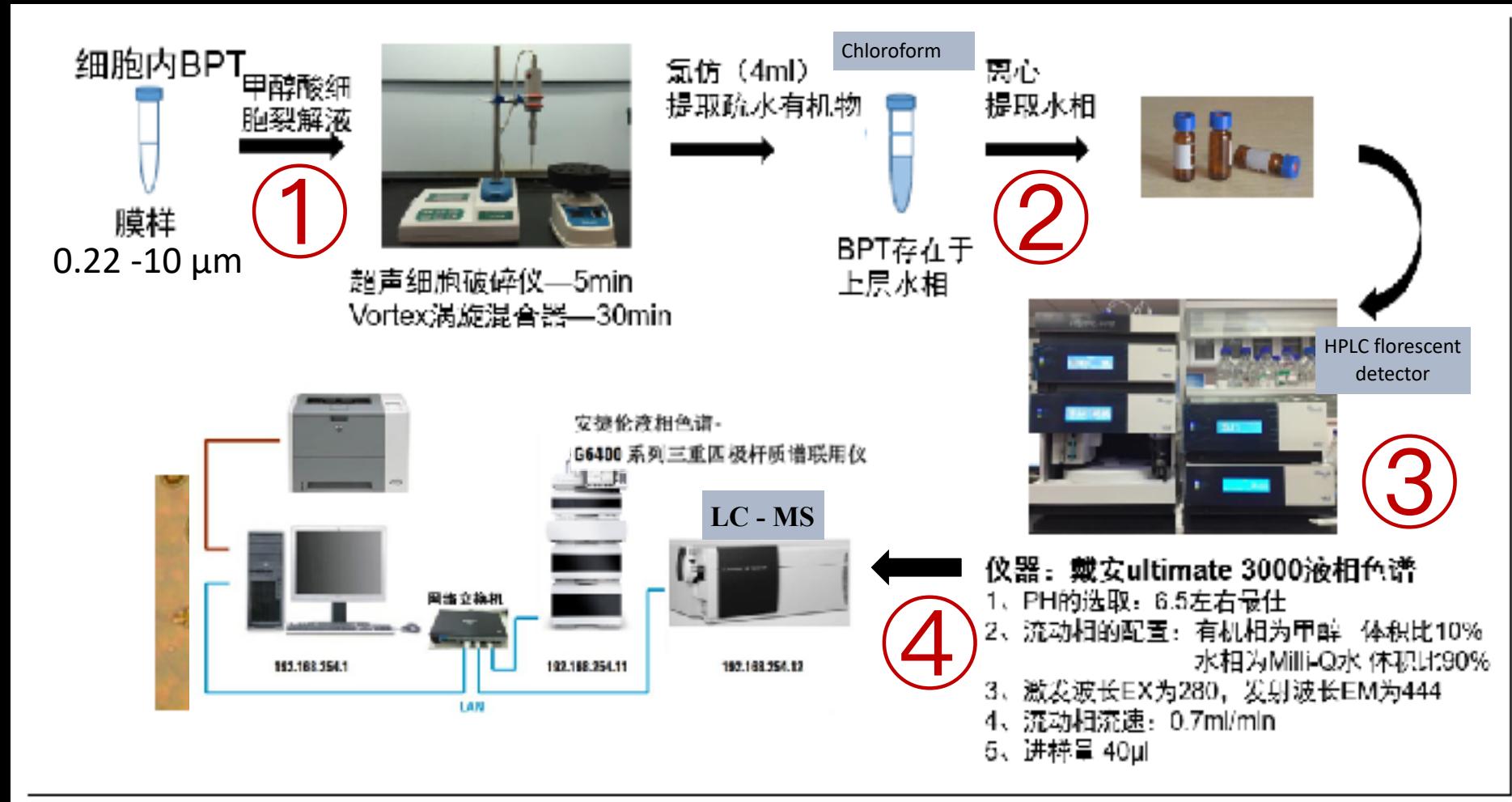
(Yawei Luo et al.)

➢ 0.22-10 μm microorganisms are the main contributor to primary productivity

Question: The contribution and role of pterins in the carbon & nitrogen cycle of marine micro-phytoplankton and bacteria?

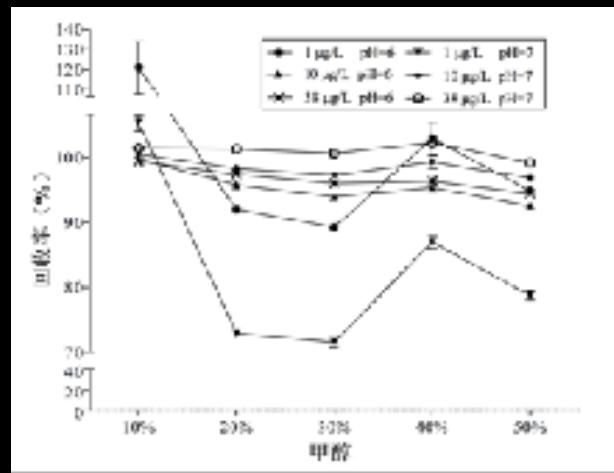
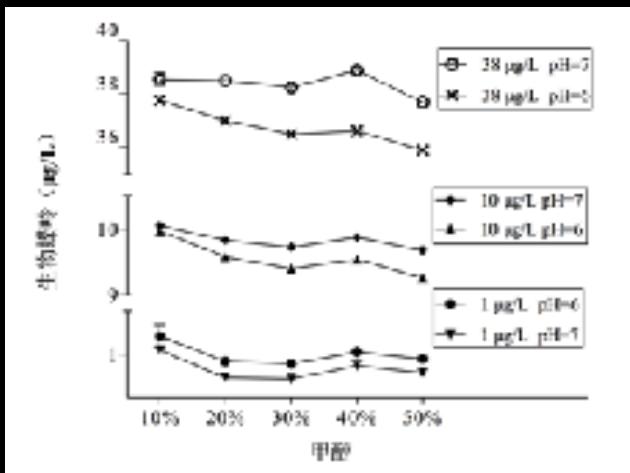
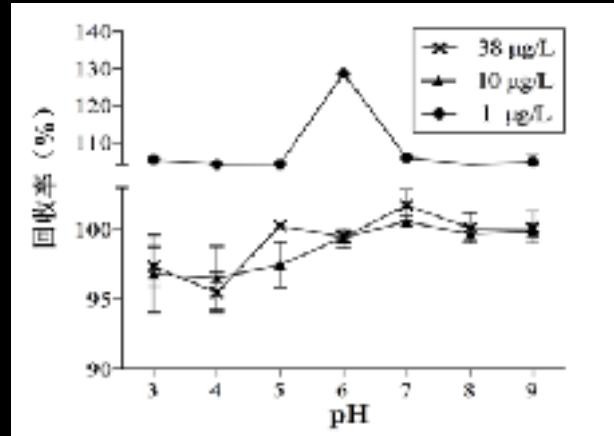
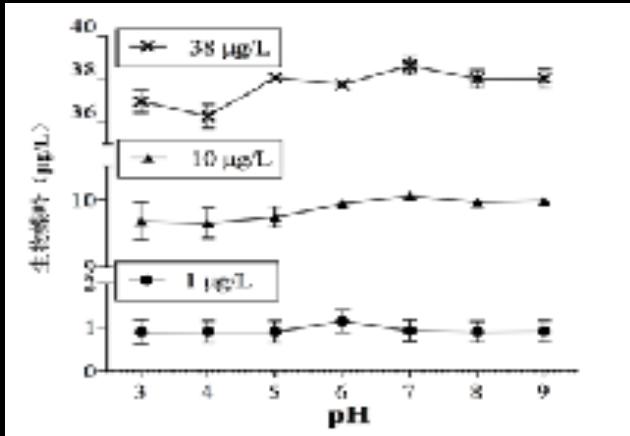


## Sample processing, measurement and verification procedures





# >> Method optimization

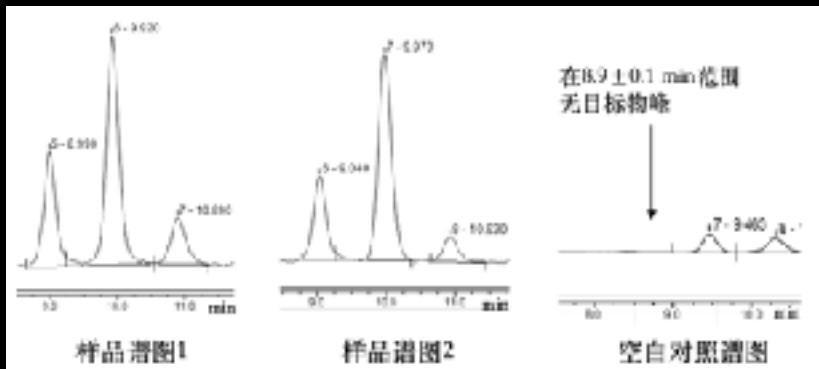
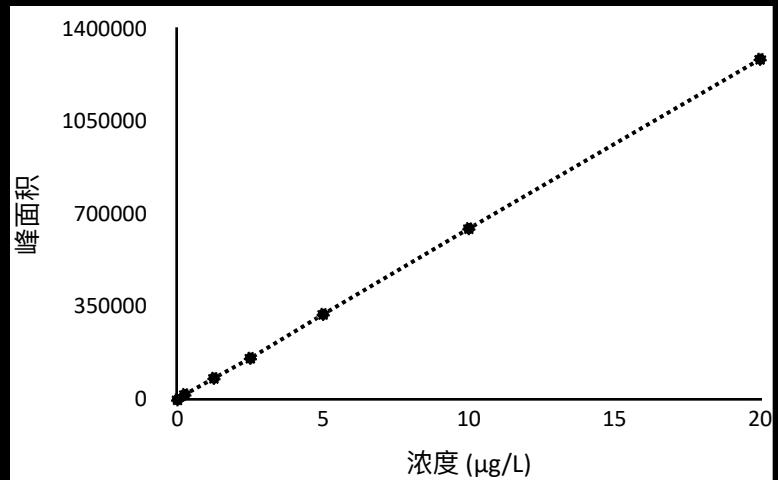


Phase A: MQ water  
Phase B: MeOH

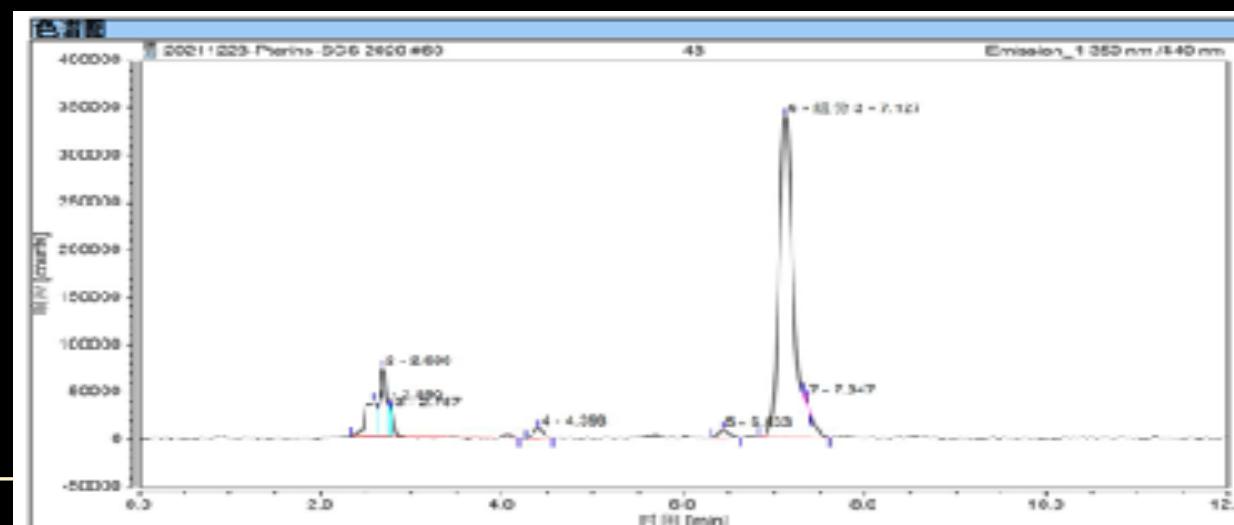
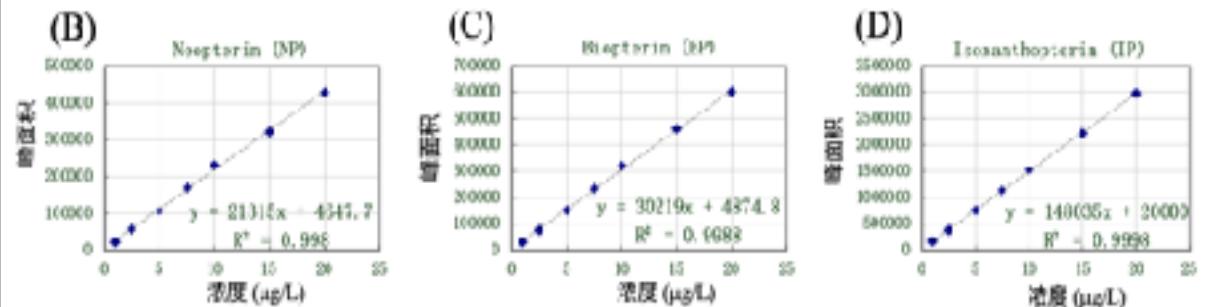
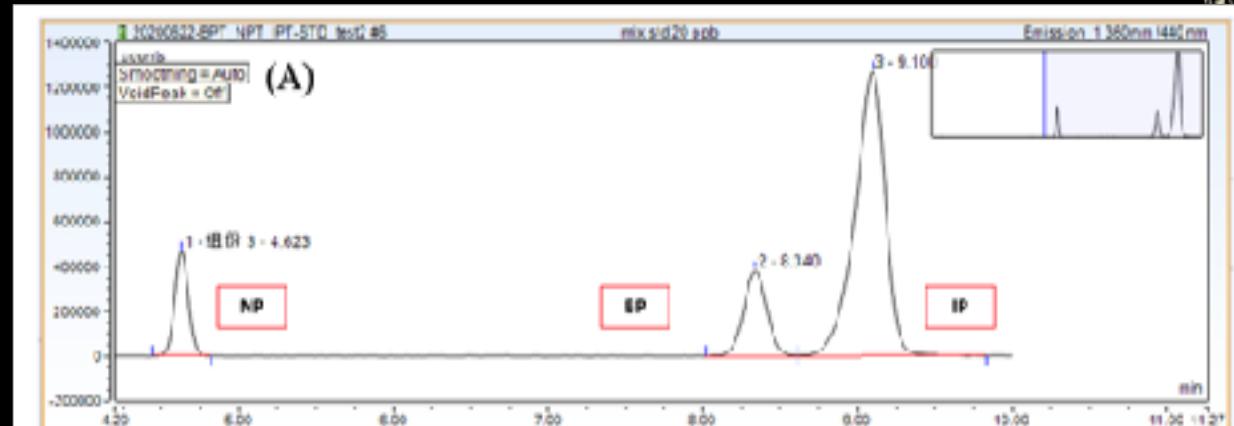
pH: 6 ~ 7  
MeOH : 10%  
Flowrate: 1 ml/min



# Pterins Determination



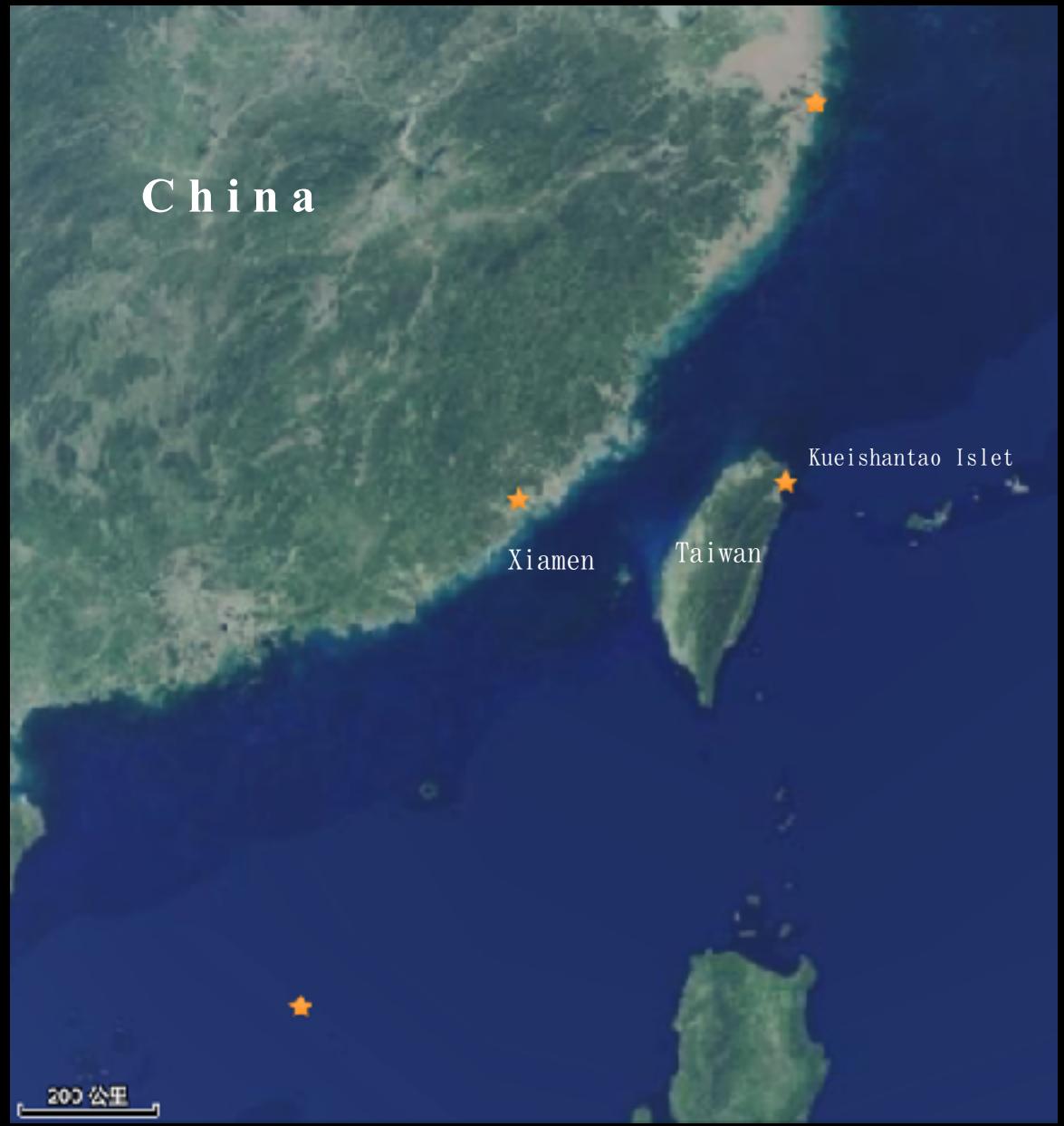
BTP retention time:  $8.97 \pm 0.02 \text{ min}$





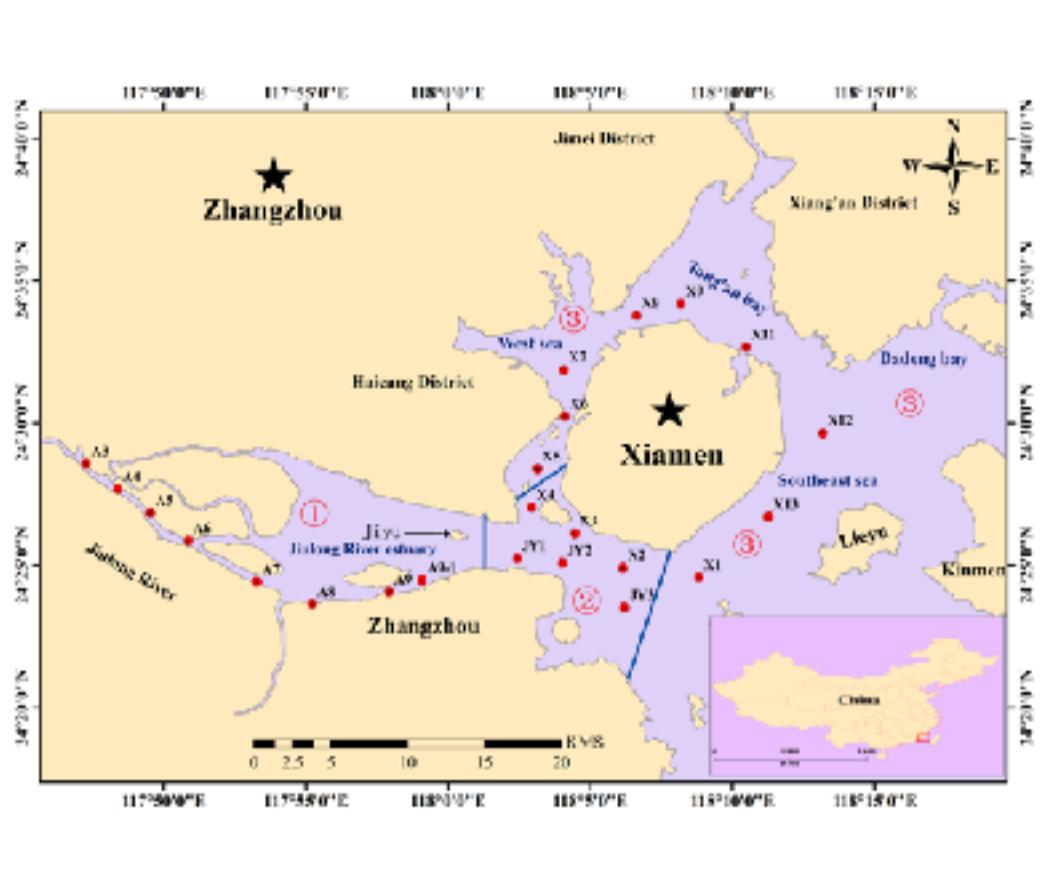
# 03 Field work

- Jiulong River Estuary & Xiamen Bay
- Hydrothermal Water off Kueishantao Island, Taiwan

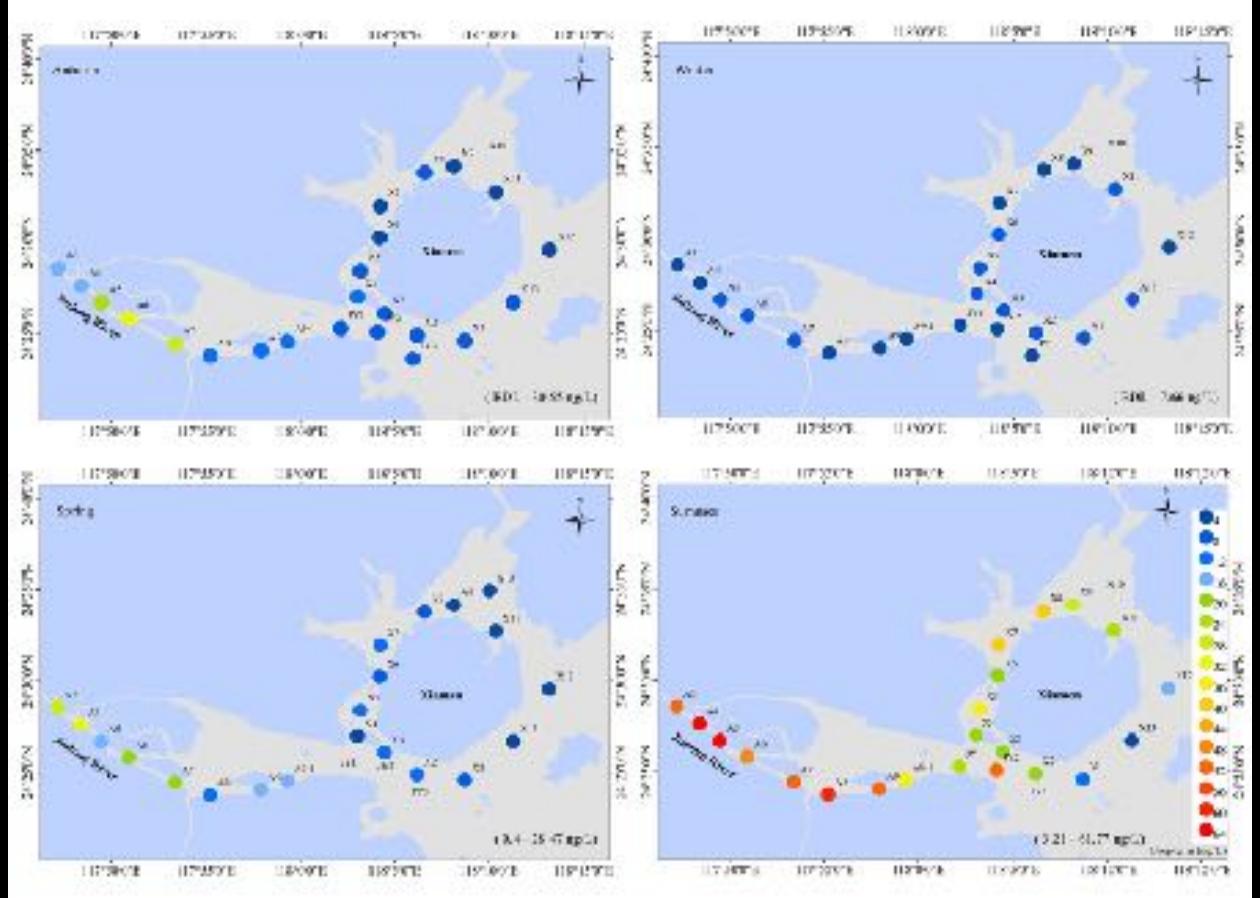


# (1) Jiulong River & Xiamen Bay

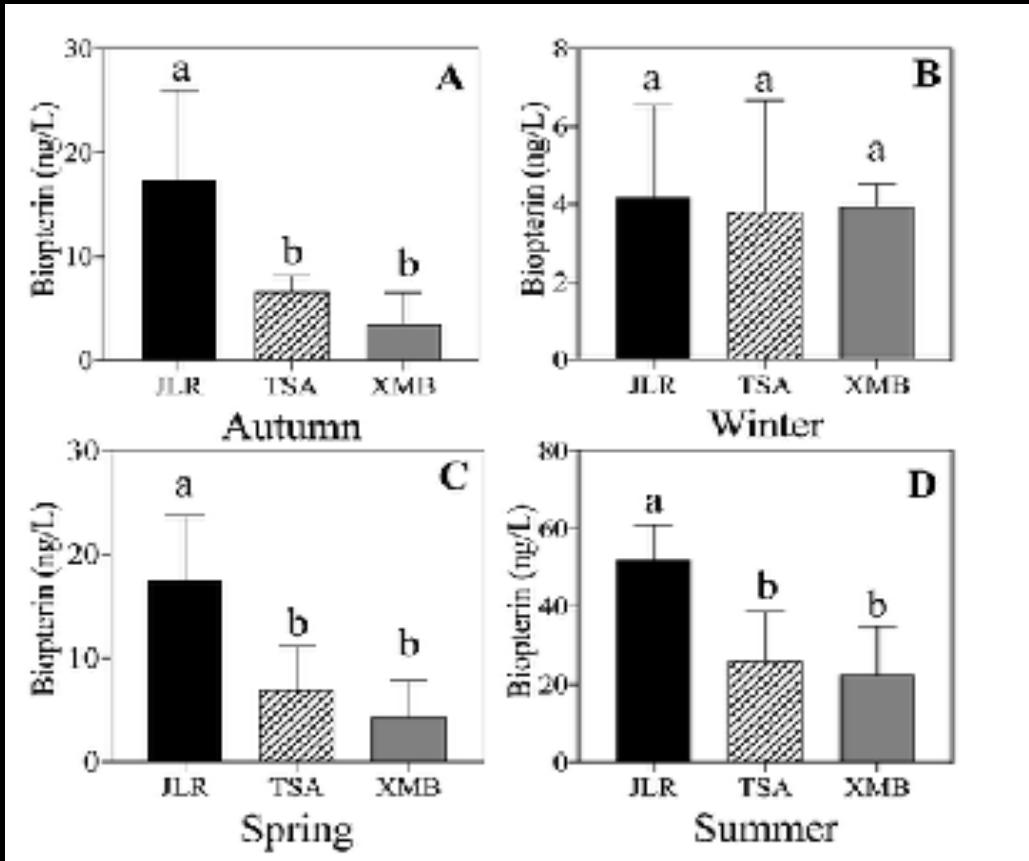
## Distribution of particulate biopterin in water surfaces



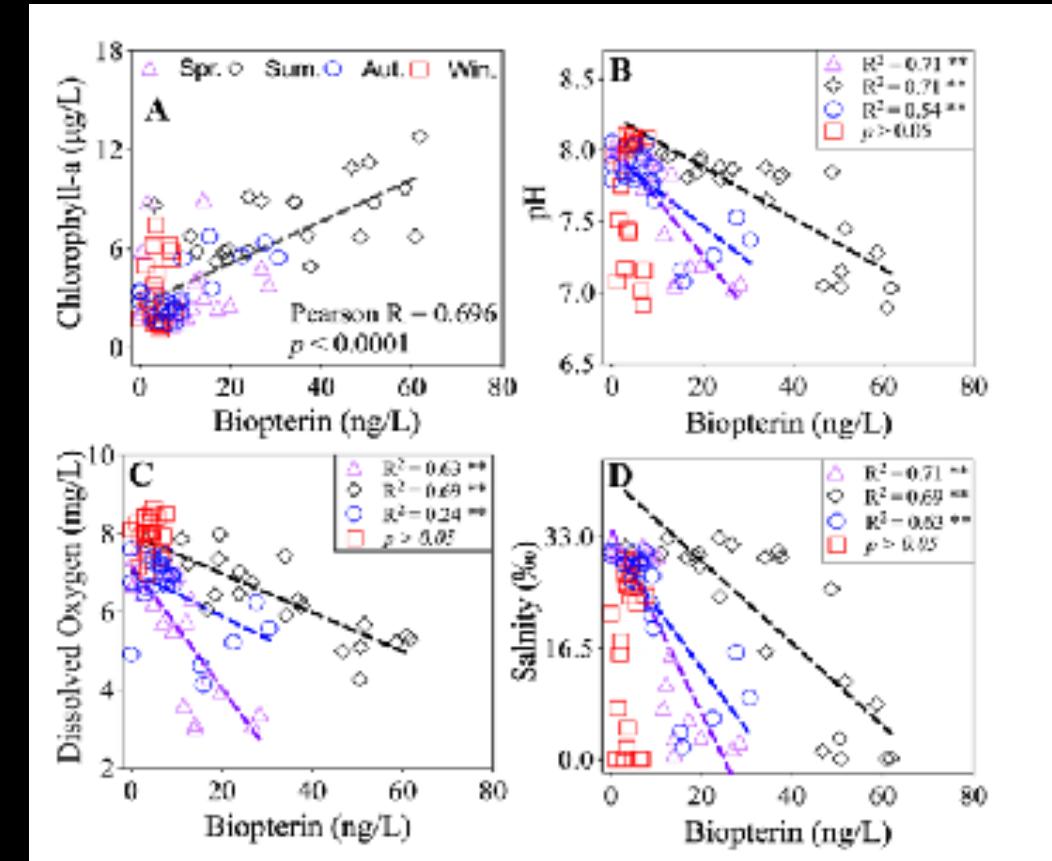
Sampling sites in Jiulong River Estuary and Xiamen coastal seas



Temporal and spatial distribution of particulate biopterin

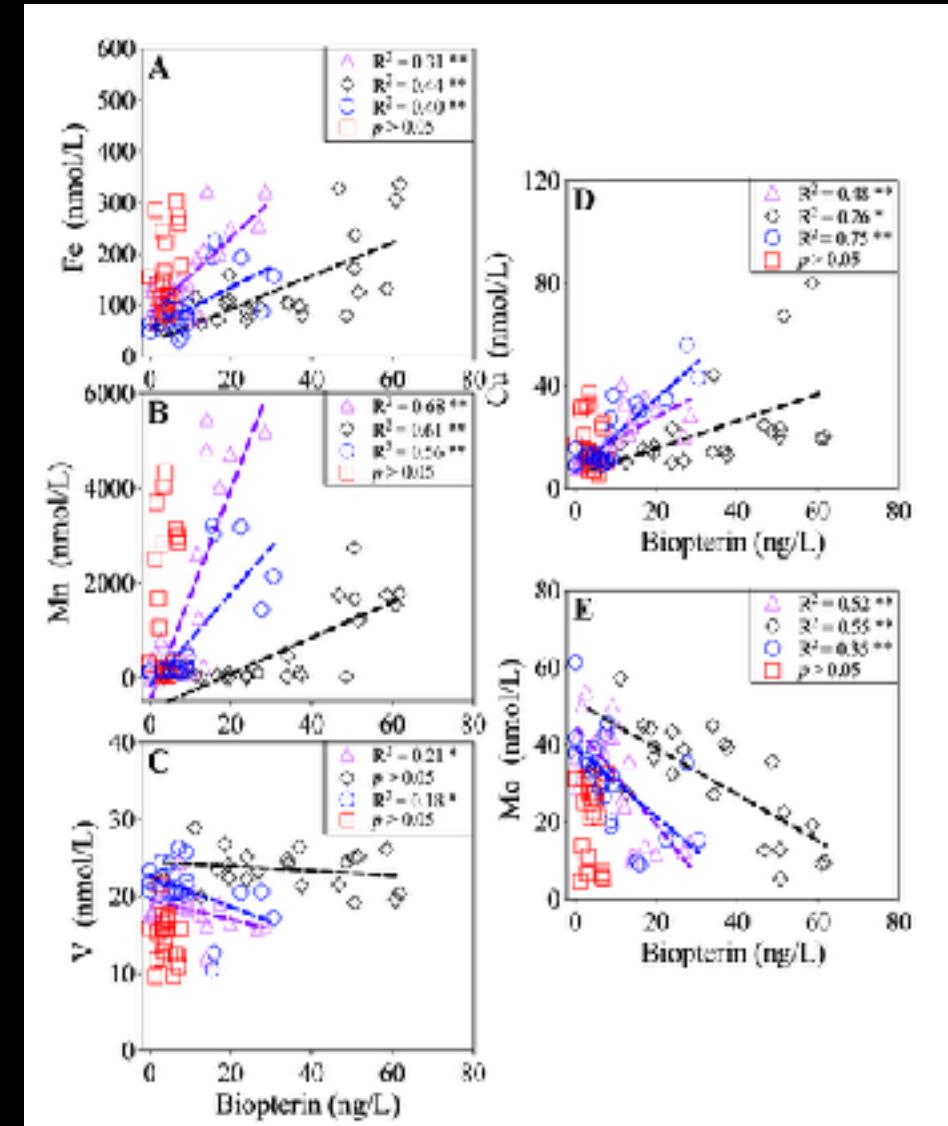
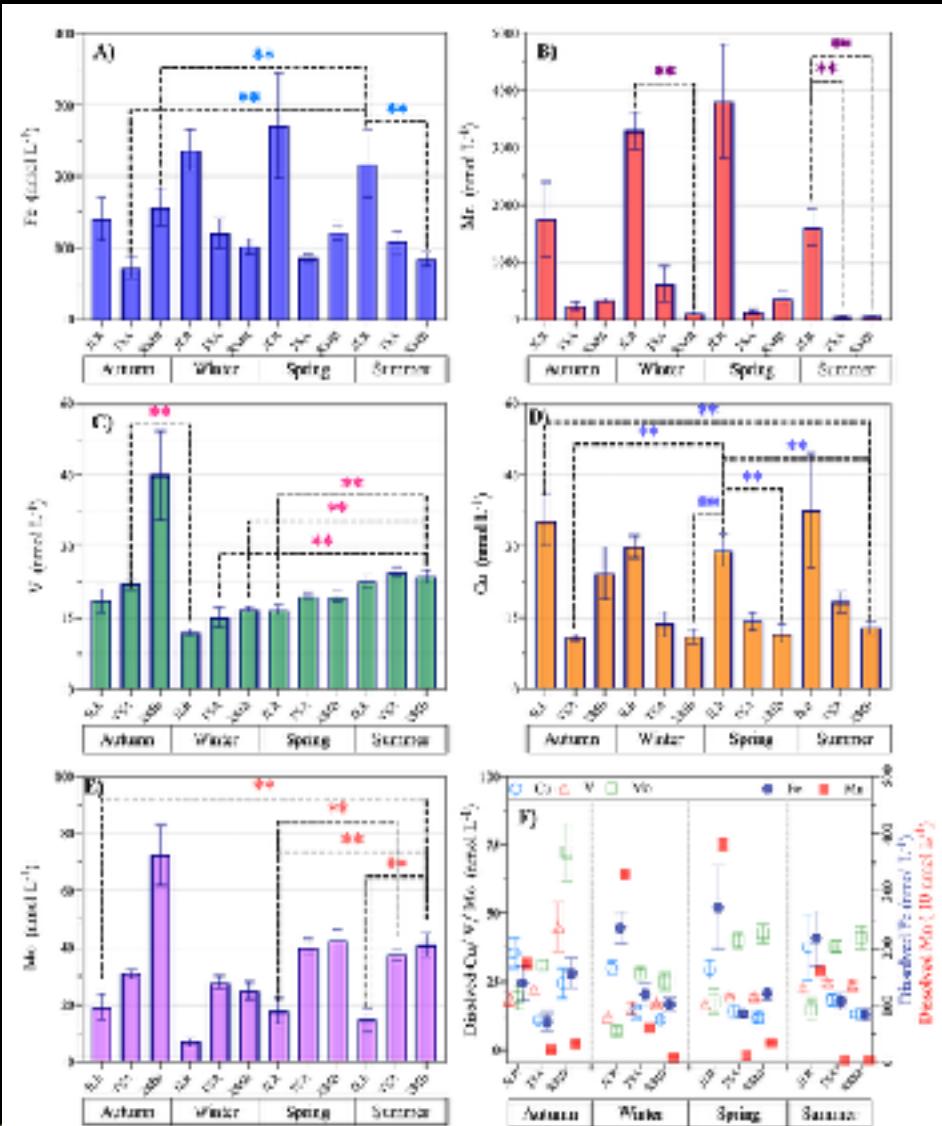


- River > Estuary > Seawater
- Sum. > Aut.; Spr. > Win.



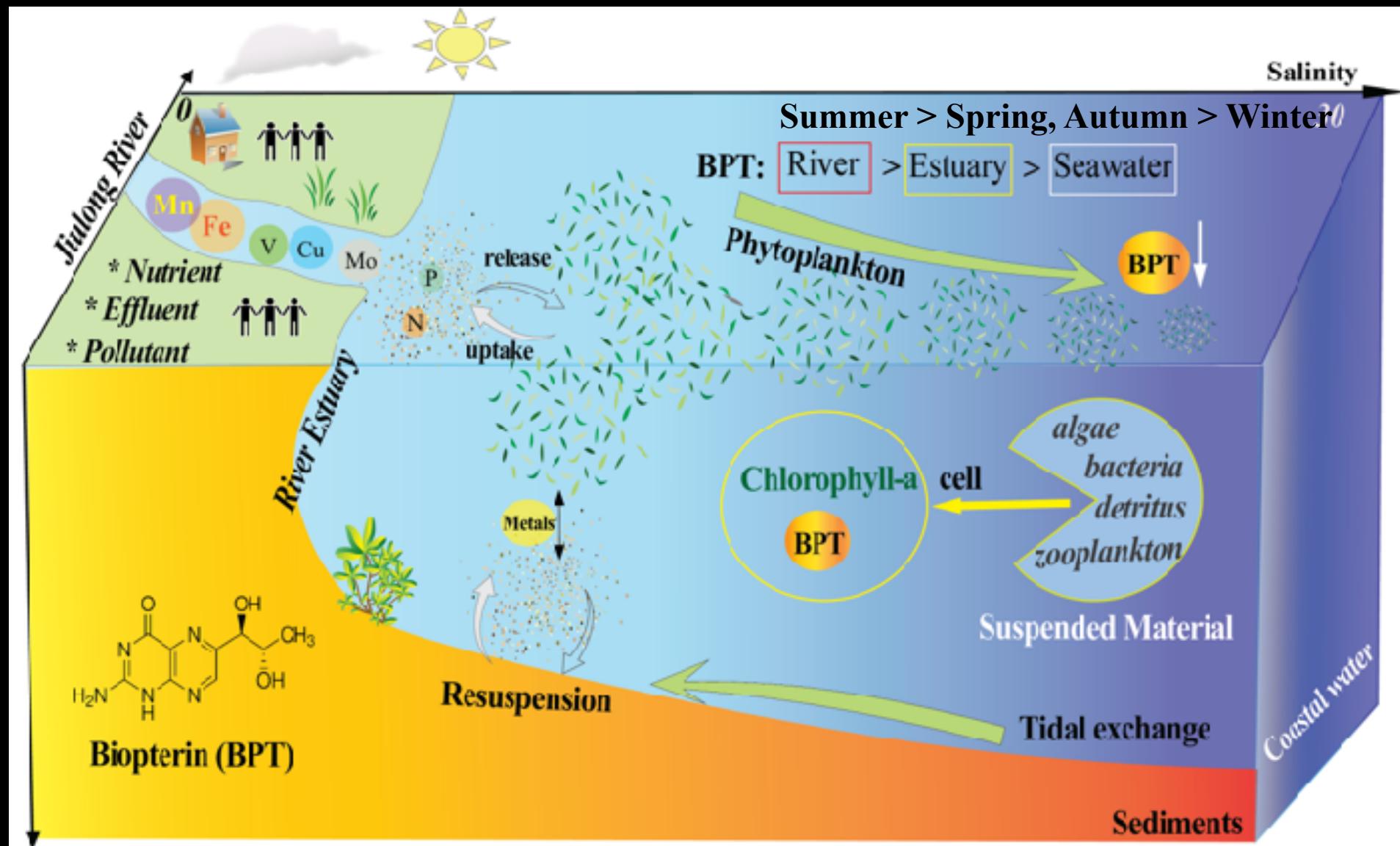
➤ Biopterin was significantly positively correlated with chlorophyll, but was significantly negatively correlated with pH, dissolved oxygen, and salinity.

# Distribution of dissolved metals in water surfaces





# Jiulong River & Xiamen Bay

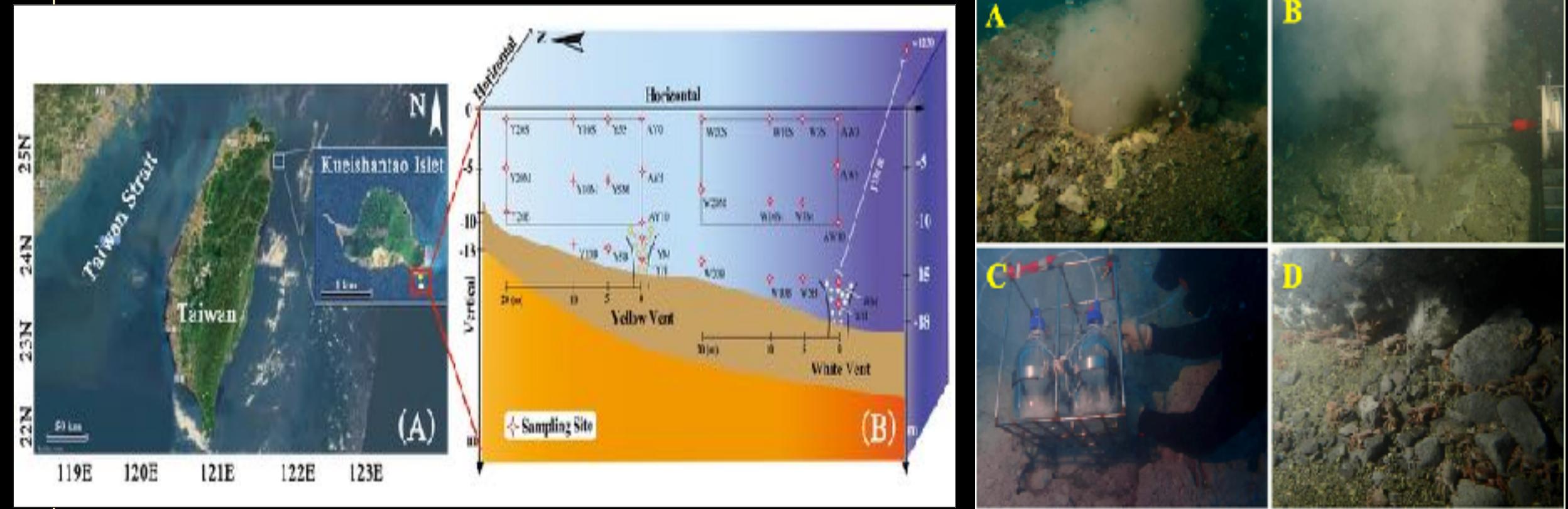


(Kang Mei, 2022, to be submitted)



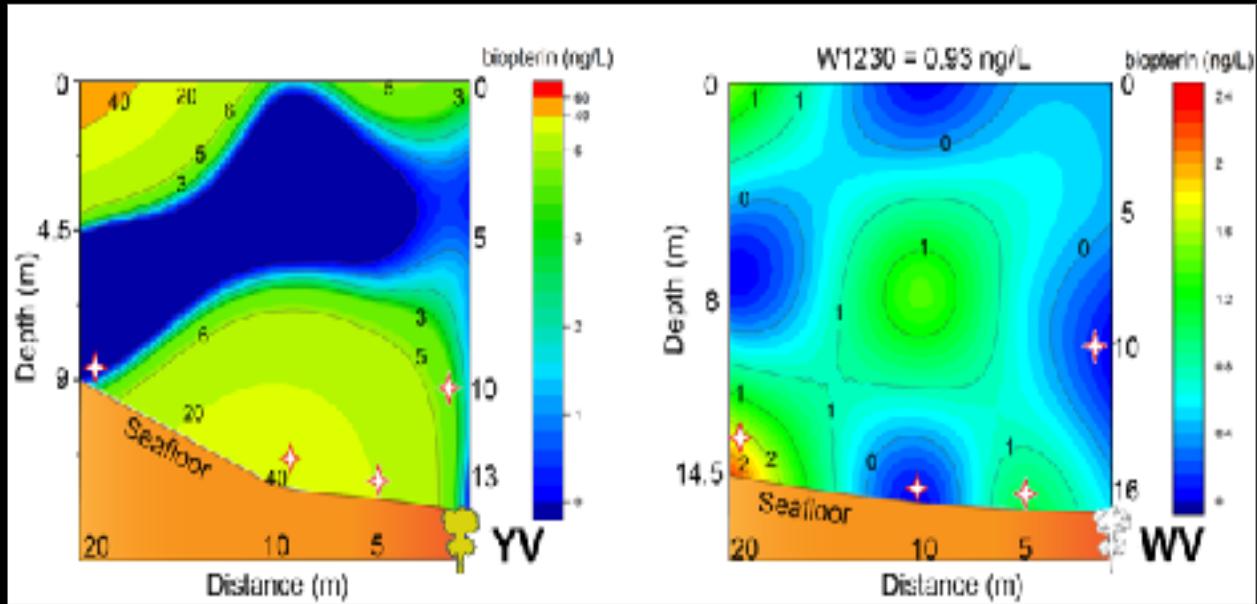
## 2. Shallow Sea Hydrothermal Ecosystem off Kueishantao Island, Taiwan

(Kang Mei, Mengqiu Shi 2022, *Sustainability*)



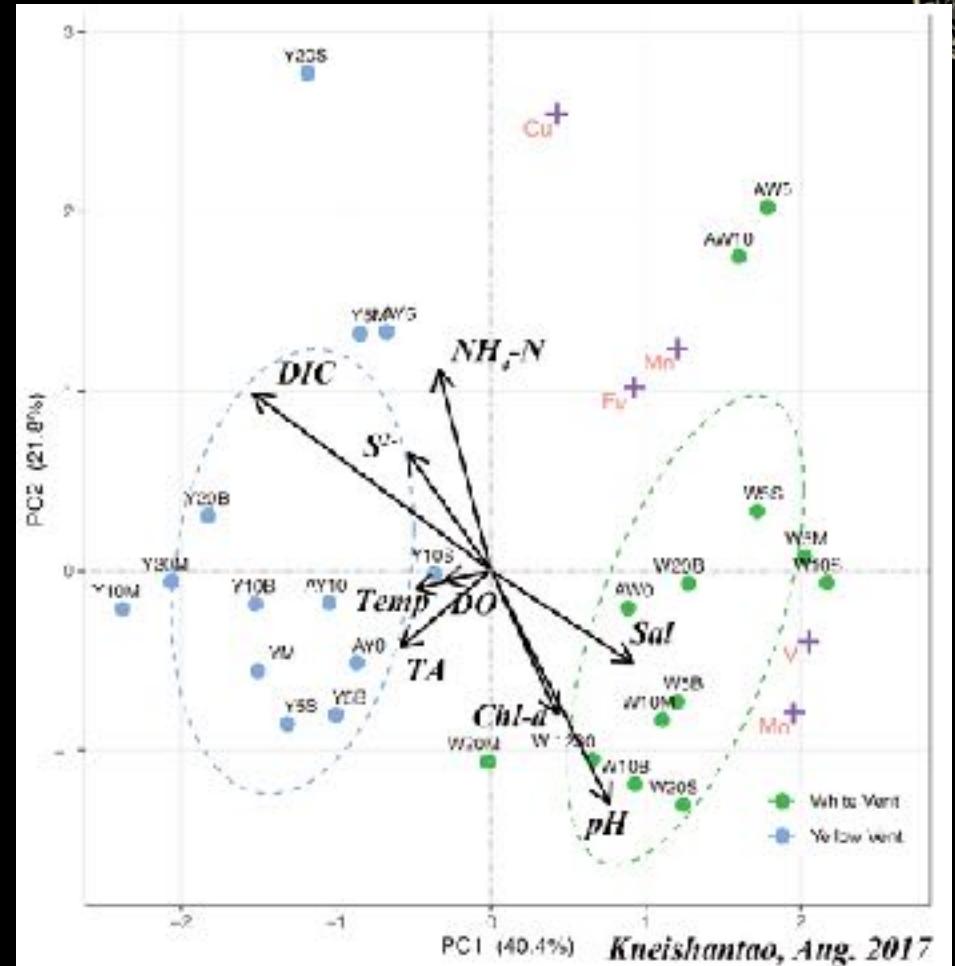
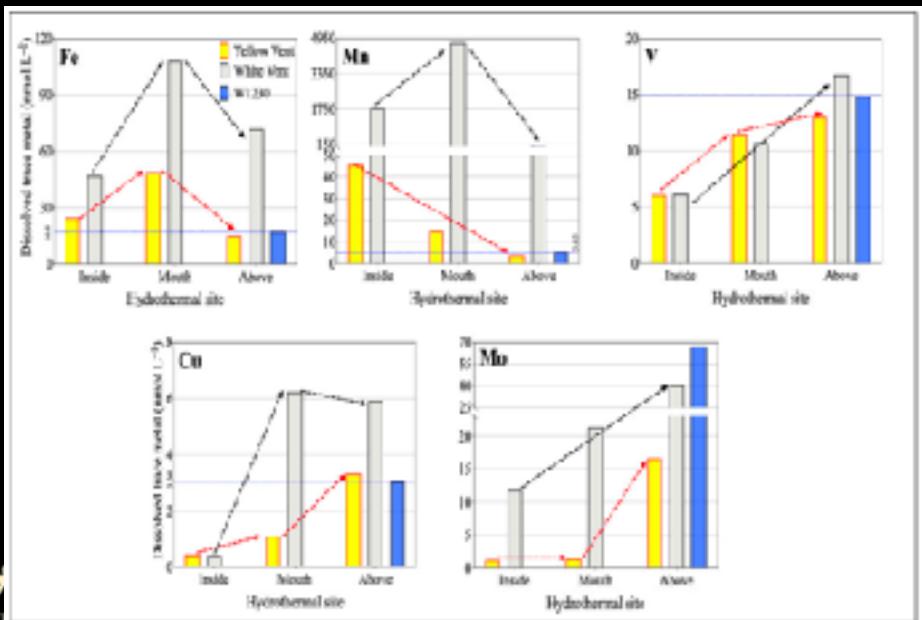
➤ Yellow vent & White vent.

➤ Sampling and collection



Yellow vent: BP average  $14.80 \text{ ng L}^{-1}$

White vent: BP average  $0.65 \text{ ng L}^{-1}$



The content of particulate biopterin in the sample analysis of the hydrothermal water in the shallow sea in the yellow vent was significantly higher than that in the white spring, and the analysis may be related to the abundance of water biomass, e.g. bacterium as the biological factor.



# 04 Summary

- (1) The method establishment of particulate pterins [DL: NP- 120 ng/L, BP: 170 ng/L, IP: 40 ng/L], and obtained 1 patent.
- (2) Seasonal distribution of biological biopterin off Xiamen estuary and offshores : summer > spring, autumn > winter; the content of biopterin in the estuary area is higher than the environmental concentration in the seawater (2.3 to tens of ng/L in natural waters in Jiulong River and Xiamen Bay) [converted as in cells per volume];
- (3) biopterin content is strongly positively connected with Chl-a, suggesting biopterin could be regulated by the abundance of phytoplankton
- (4) The content of biopterin in the hydrothermal samples in the Yellow Vent was significantly higher than that in the White Vent, and the analysis may be related to the abundance of biomass.



# Thank you for your listening!



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