# Ciguatera fish poisoning, the works in China

Pengbin Wang, Douding Lu, Leo Lai Chan, Mark L. Wells

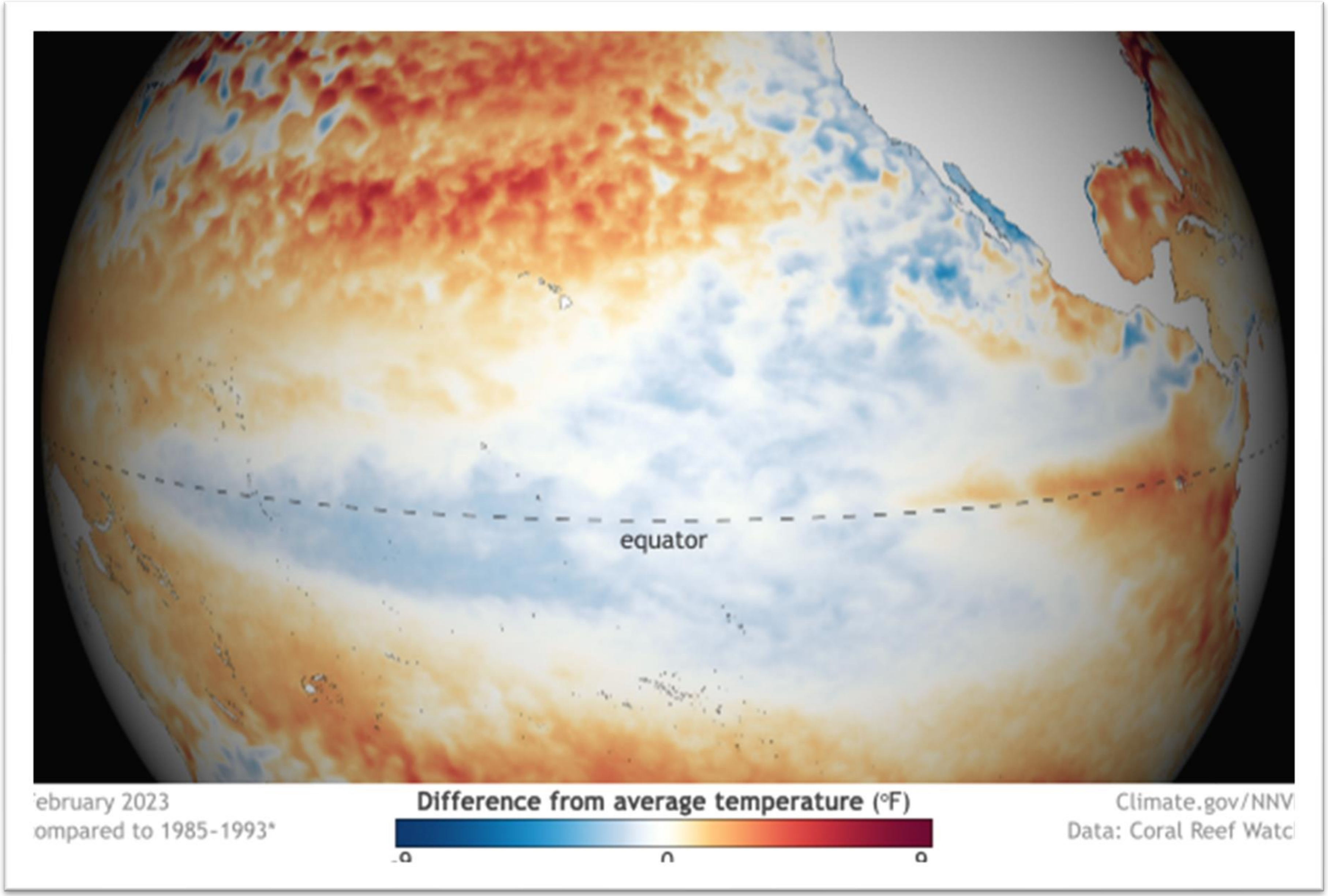
FUTURE Science Program PICES

2023.03.17

# Introduction

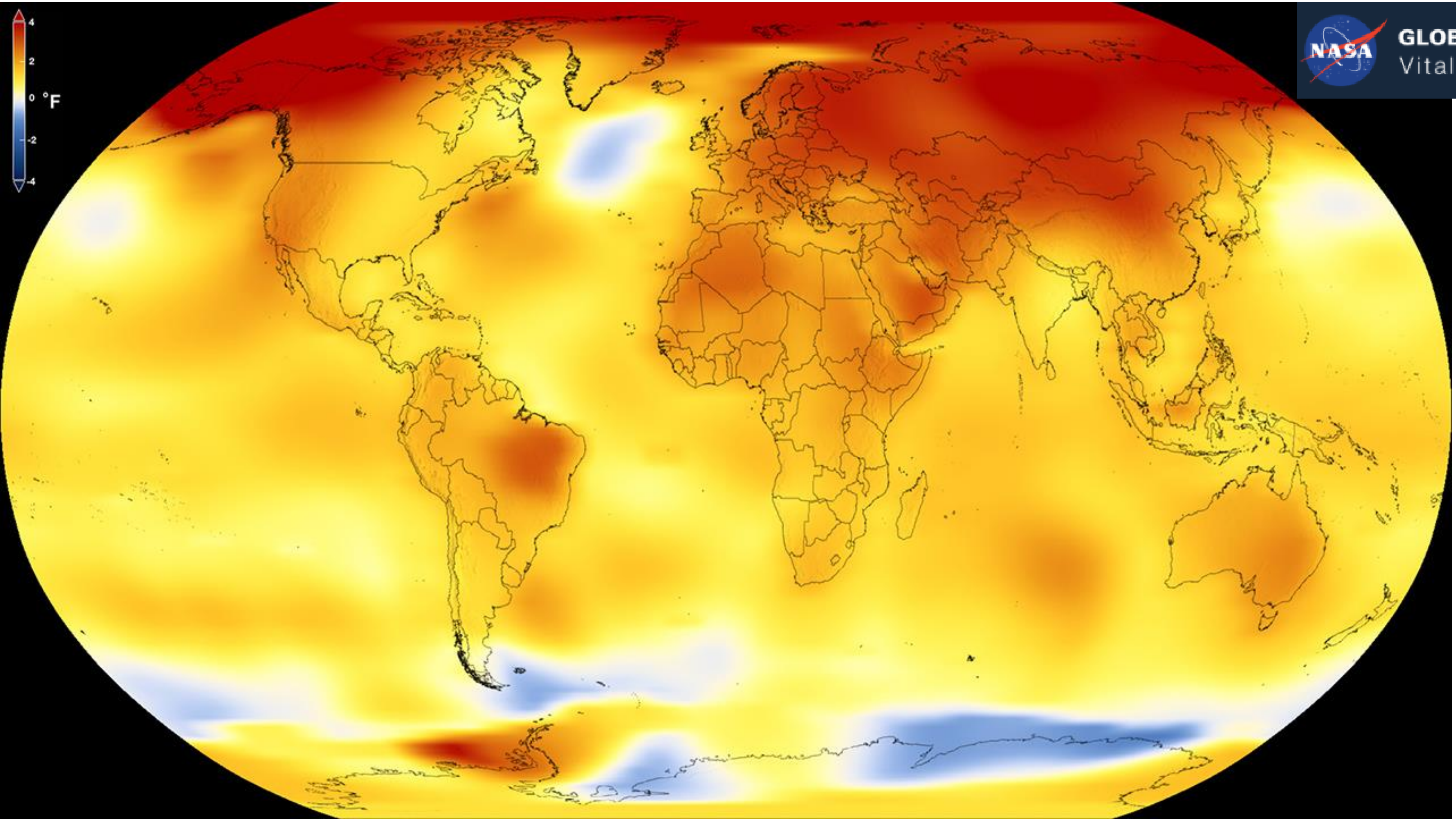
# Climate Change

The environmental effects of climate change are broad and far-reaching, effecting oceans, ice, and weather.



# Introduction

# Global Warming




# Introduction

## Marine pollution

# Introduction

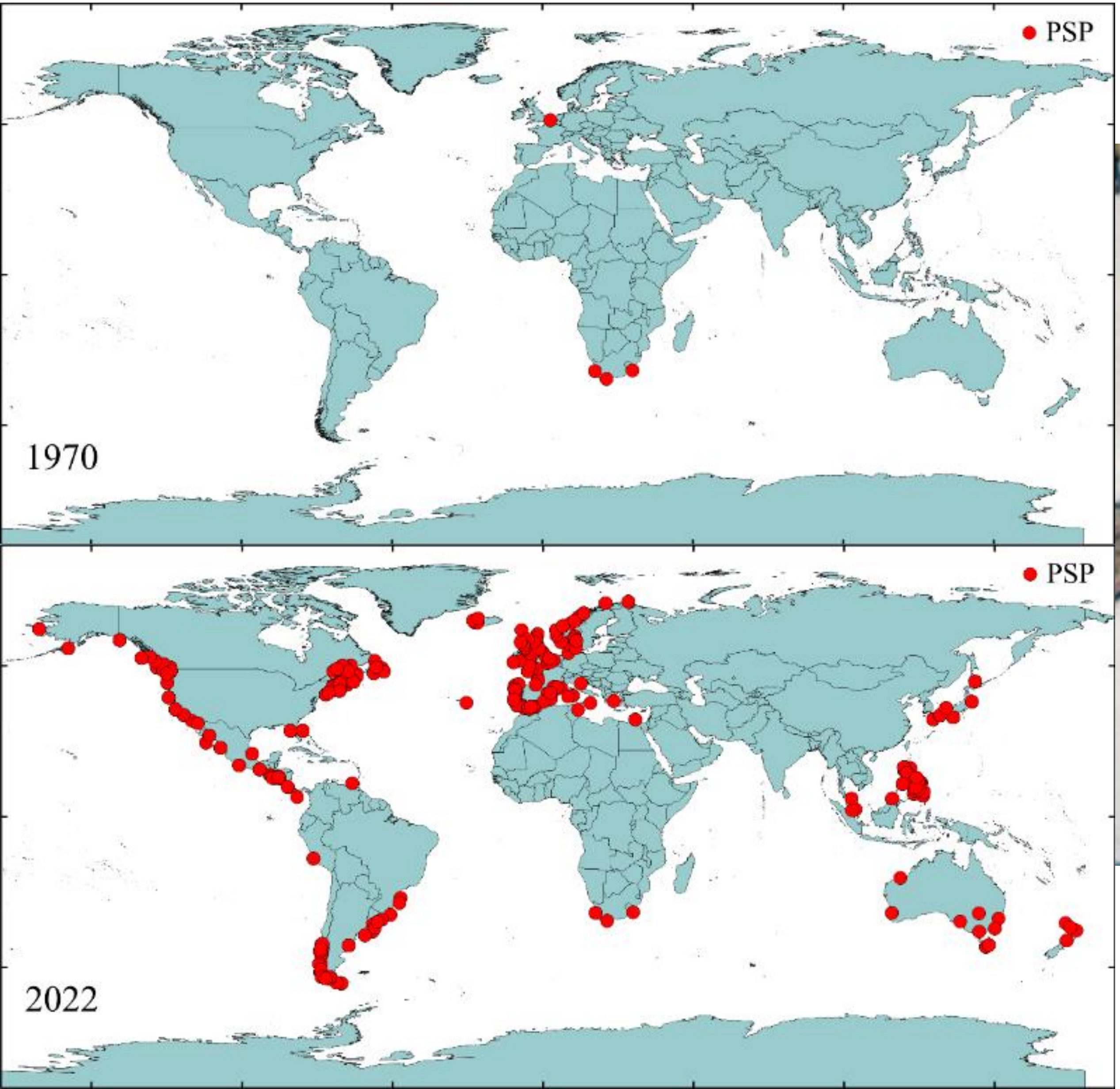
# Harmful algal blooms

# Introduction

## Harmful algal blooms

# Introduction

## Harmful algal blooms

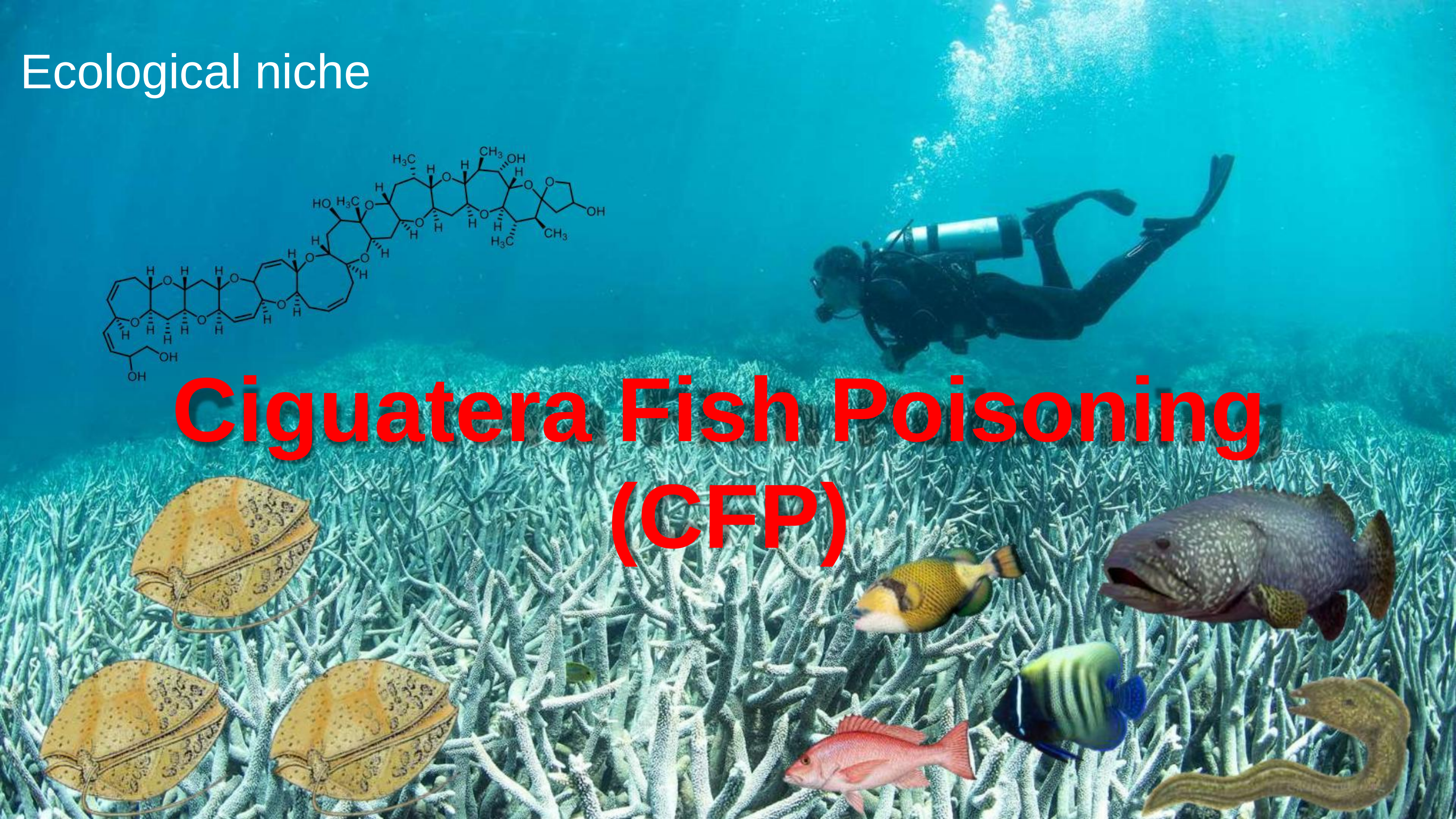



By Pengbin Wang and Jiarong Hu
Data: IOC-UNESCO Harmful Algae Information System

# Introduction

# Coral bleaching


Warm waters cause global coral bleaching/dead


Ecological niche
Ciguatera Fish Poisoning
(CFP)

# Introduction

# Dinotoxin

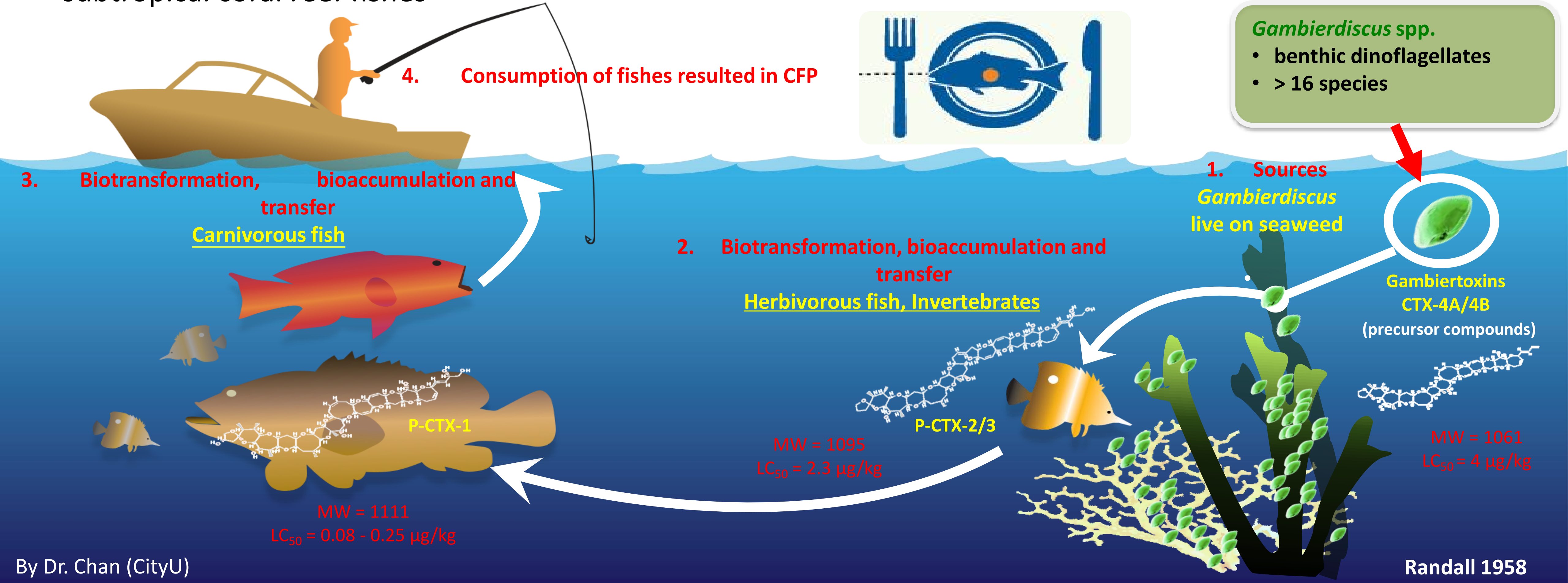
Projects in Progress

Ciguatera

Building Local Warning Networks for the Detection and Human Dimension of Ciguatera Fish Poisoning in Indonesian Communities (April 2020 – March 2023)

## What is Ciguatera Fish Poisoning (CFP)?

CFP is a food-borne illness caused by the presence of ciguatoxins (CTXs) in the flesh and viscera of tropical and subtropical coral reef fishes




By Dr. Chan (CityU)

Randall 1958

# Global distribution of ciguatera fish poisoning (CFP)

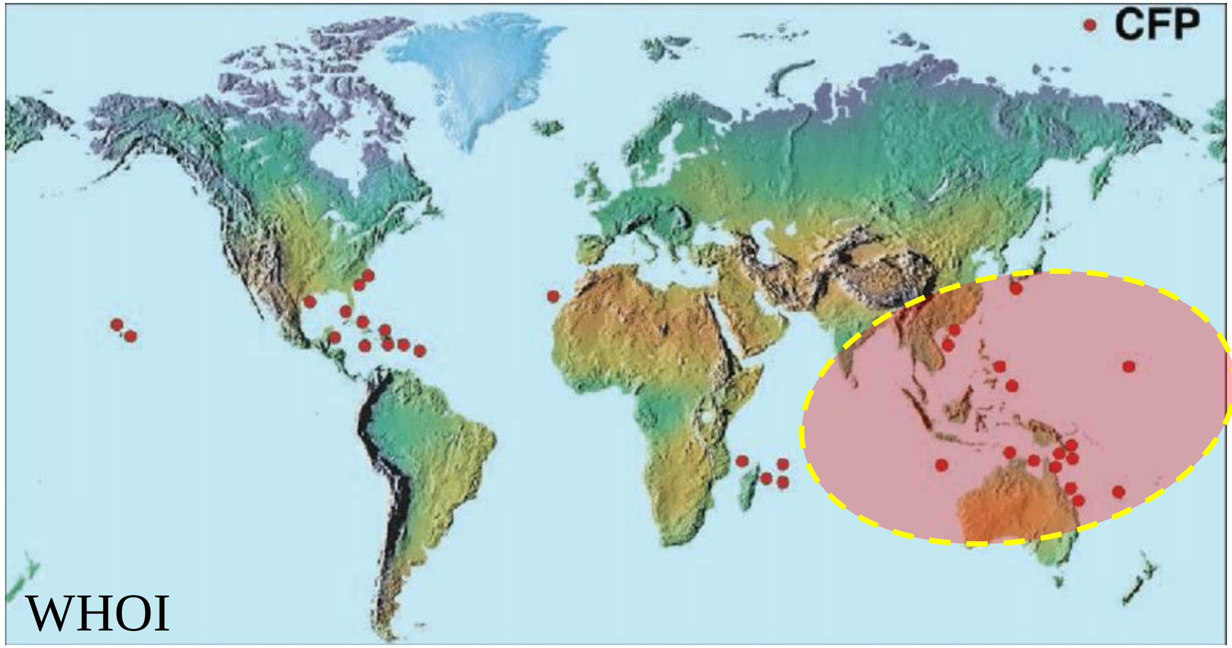
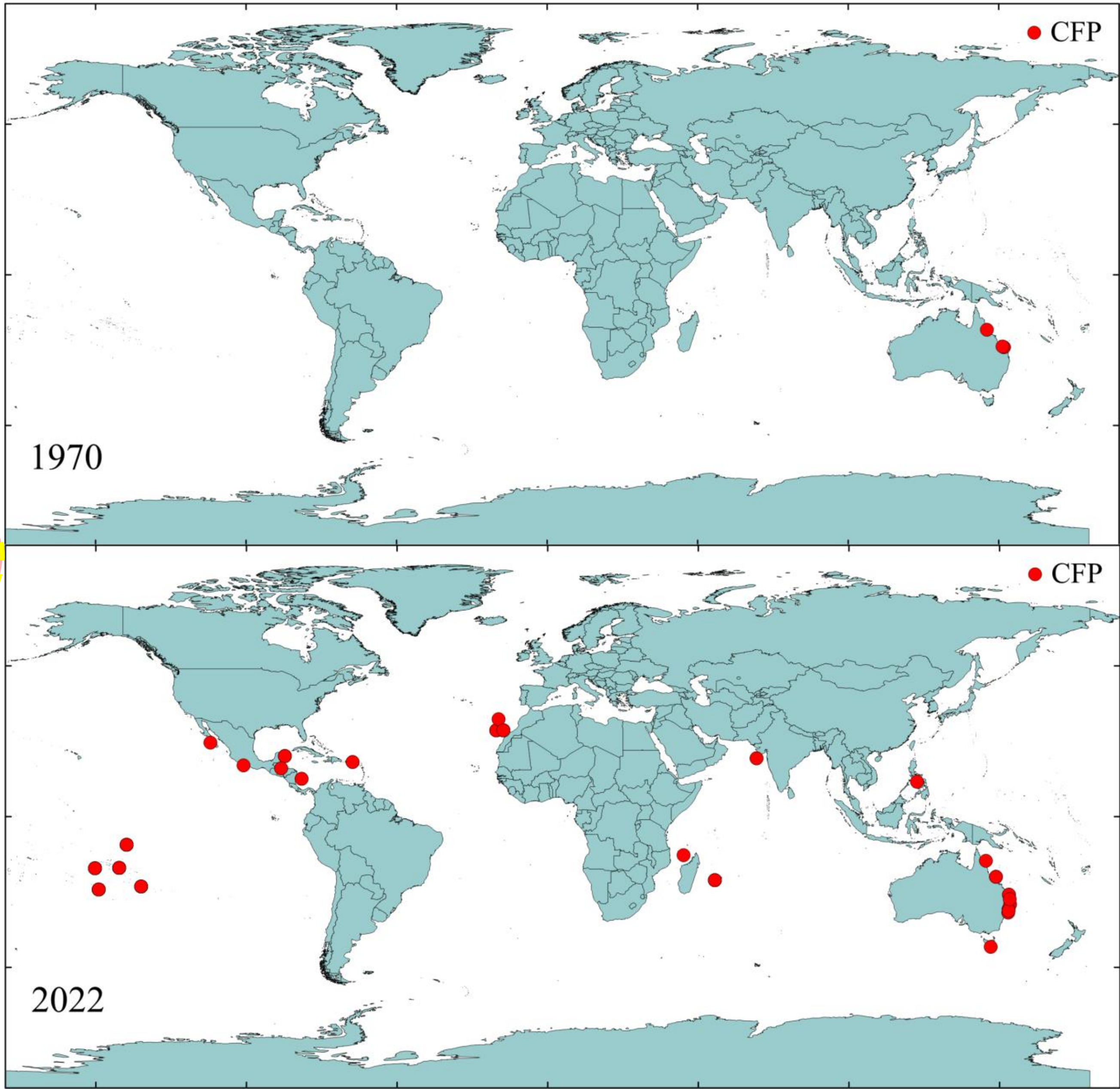



Fig. Global distribution of ciguatera fish poisoning (CFP)



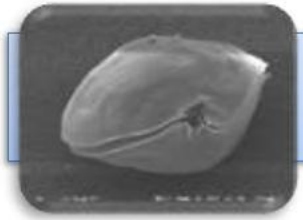

By Pengbin Wang

Data: IOC-UNESCO Harmful Algae Information System

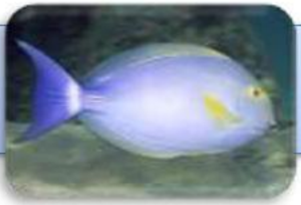
# Ciguatoxins (CTXs)

- a group of secondary metabolites produced by benthic dinoflagellates (*Gambierdiscus* spp.)

- Proposed biotransformation products of algal toxins (Gambiertoxins, GTXs)
- Bioaccumulated along food chains



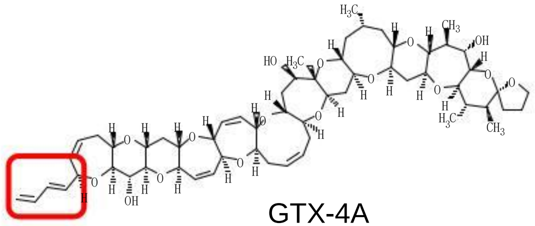
Dinoflagellates
(e.g. Gambierdiscus toxics)



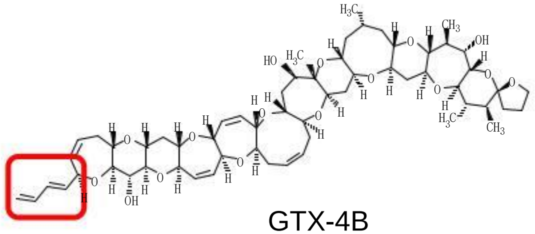
Herbivorous fishes

Carnivorous fishes

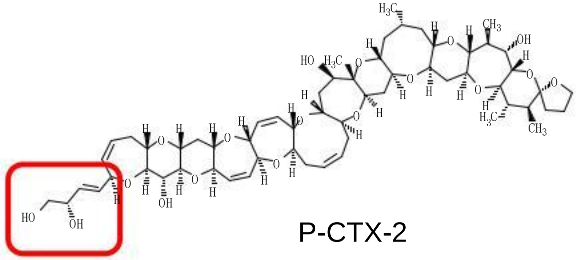
100 x tetrodotoxin



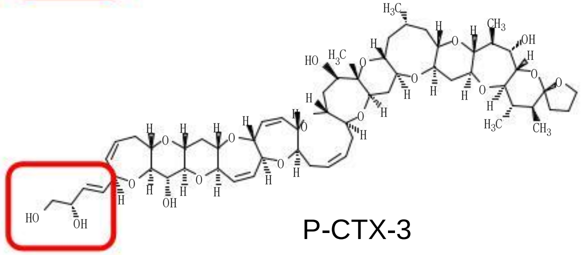
GTX-4A



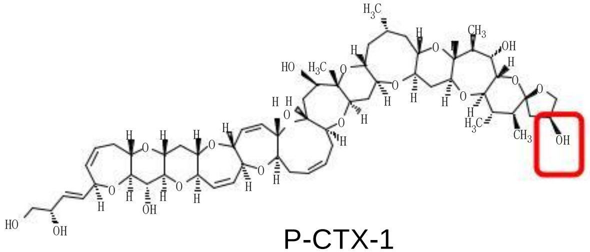
GTX-4B



P-CTX-2



P-CTX-3



P-CTX-1

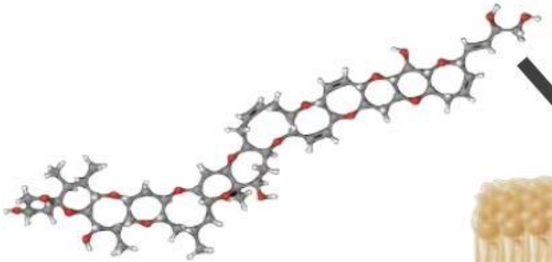
**$LC_{50}$ = 4 µg/kg**

**0.9 - 2.3 µg/kg**

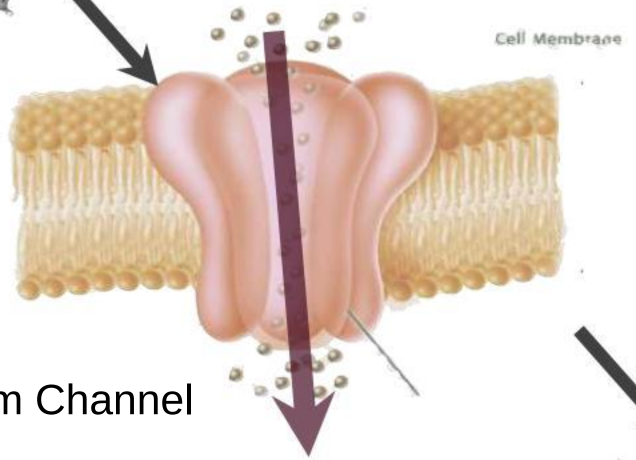
**0.08 - 0.25 µg/kg**

By Dr. Chan (CityU)

# Human Illness Associated with CFP



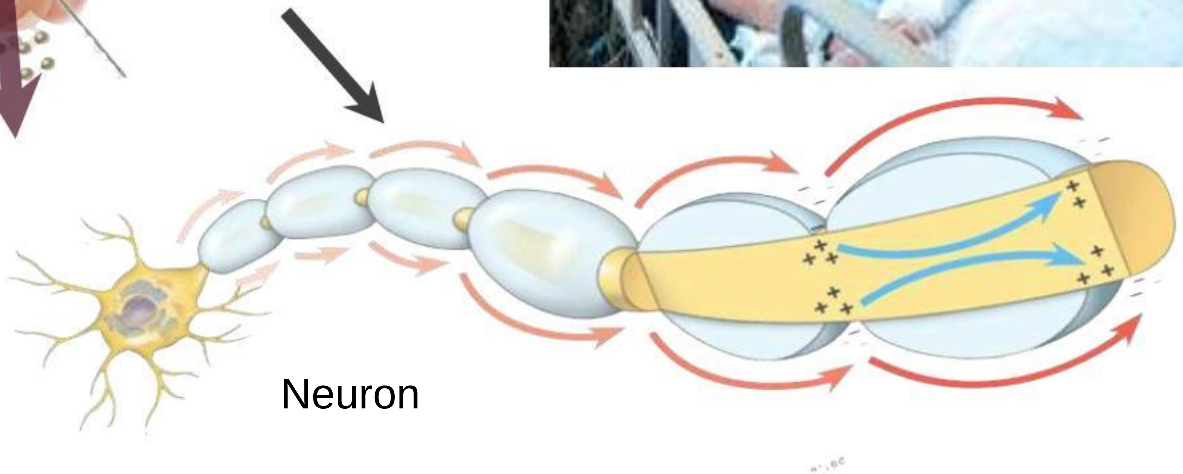
Ciguatoxin (CTX)




Sodium Channel

## Neurological disorder:

Paraesthesia | reversal of hot and cold sensation | numbness | tingling



Neuron

## Gastrointestinal disorder:

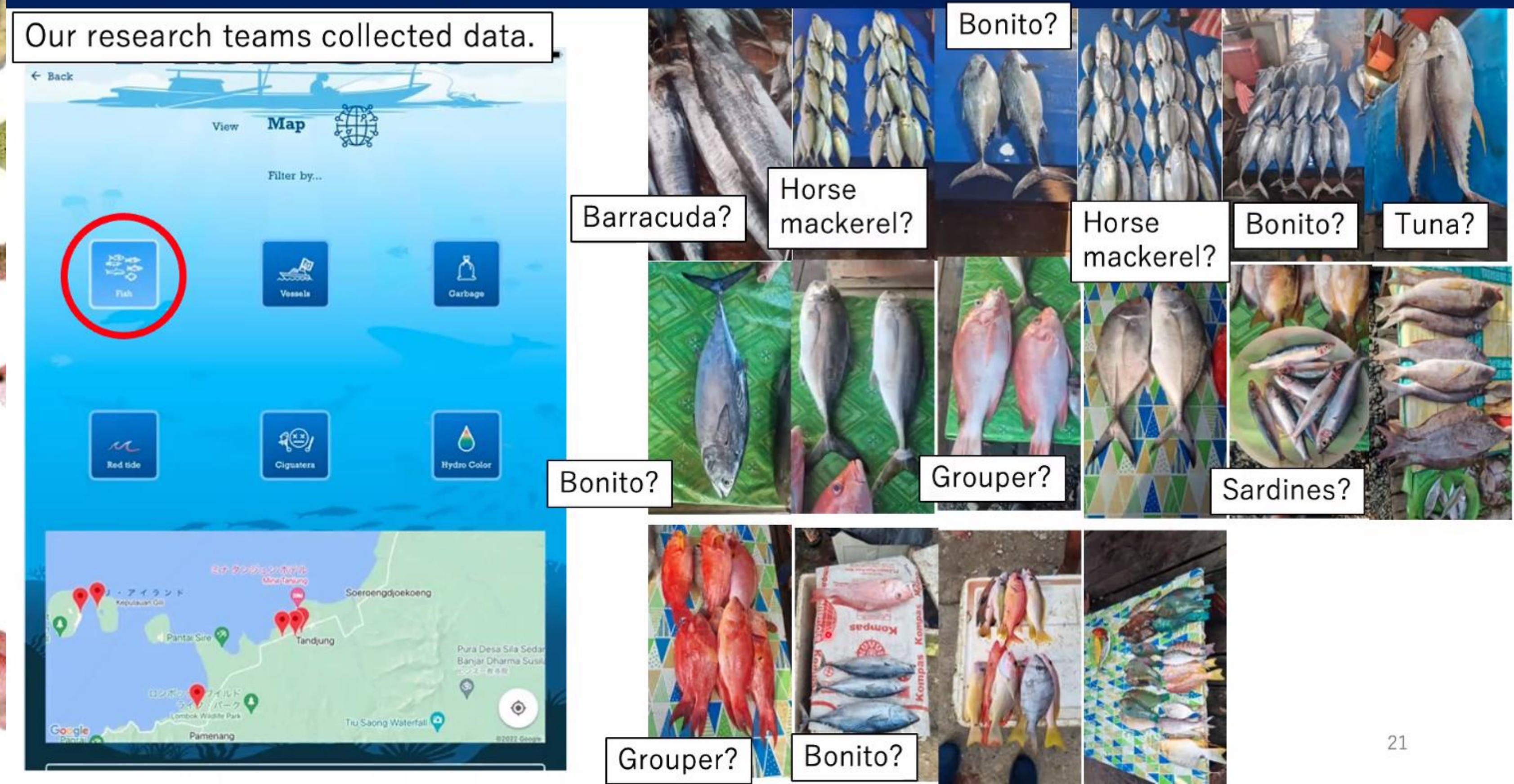
Abdominal pain | vomiting | nausea | diarrhea

## Cardiovascular disorder:

Irregular pulse | decreased blood pressure | bradycardia | dizziness

- **> 400 species** of bony fish at **all trophic levels** have been identified as ciguatoxic.

Examples of **fish photos** collected by the ***FishGIS*** App

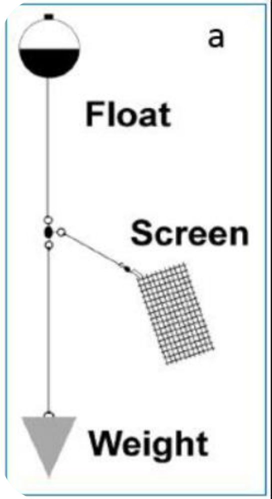


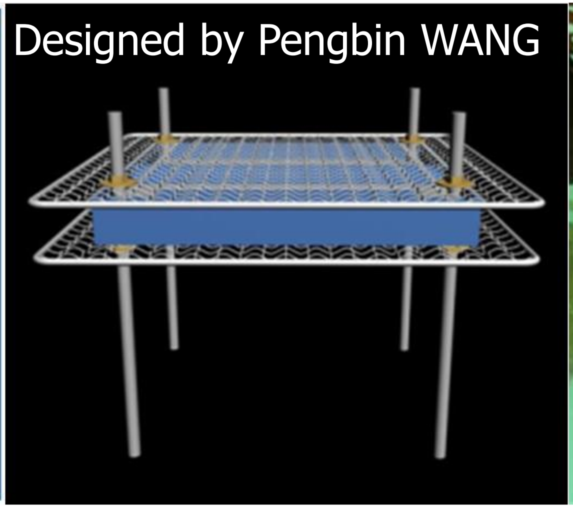
# Works in China

# Works in China



**Not only water samples, but also benthic sample collections.**



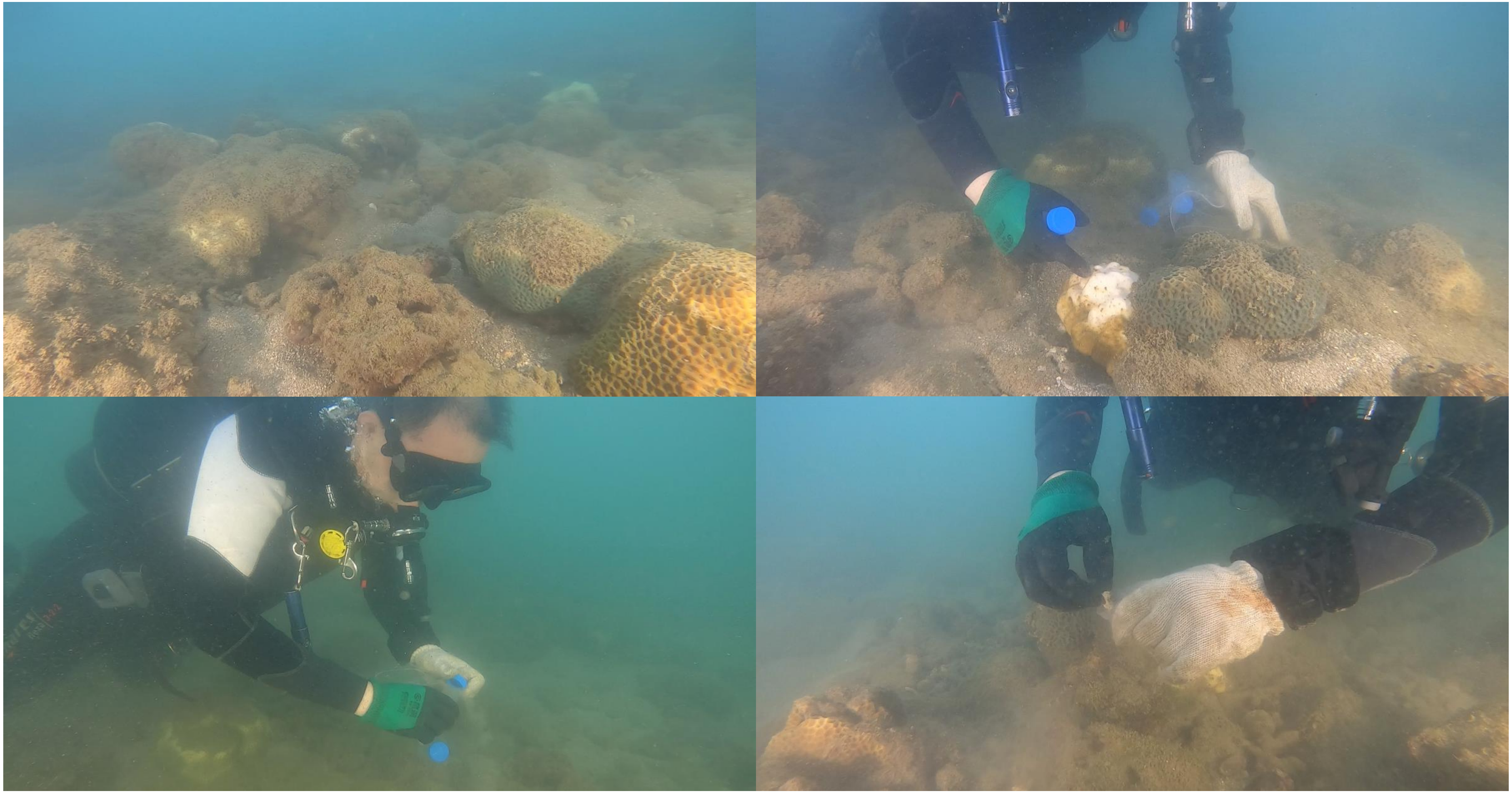

1. Tools

2. SCUBA diving



# Works in China

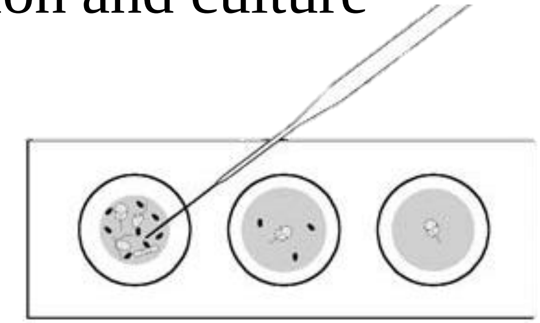
## Sampling



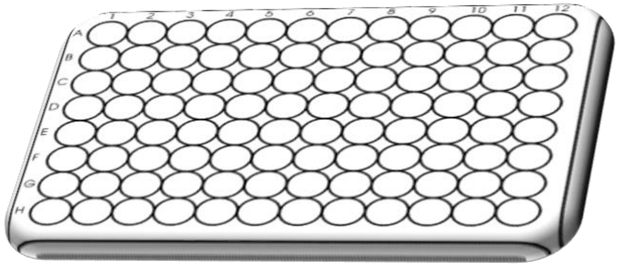
# Works in China

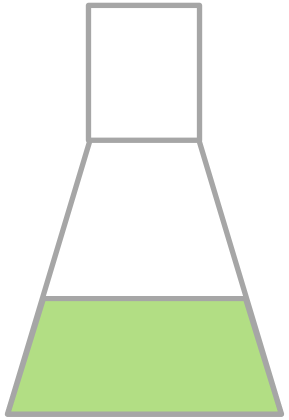
## Isolation

Isolation and culture



f/2 medium; 12L:12D cycle; 20°C





~20 Species have isolated and cultured

SIO-Microalgae Center

# Works in China

# Mass Culture



Storage Rack

# Works in China



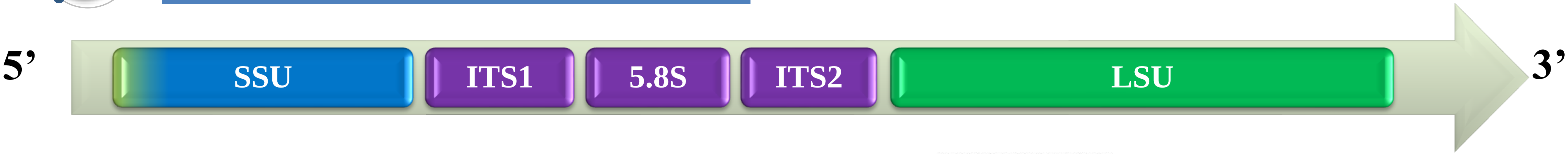
## Morphological study and identification


A. Light microscopy;

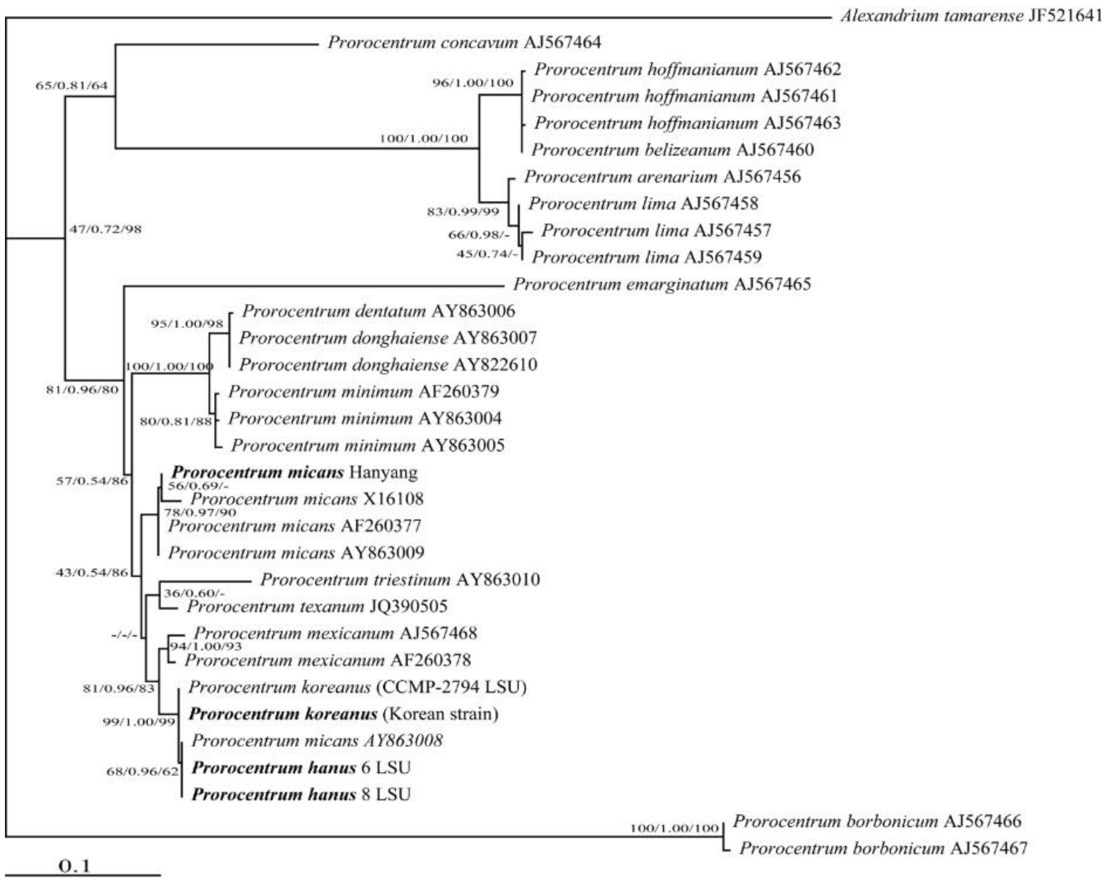

B. Scanning electron microscopy.

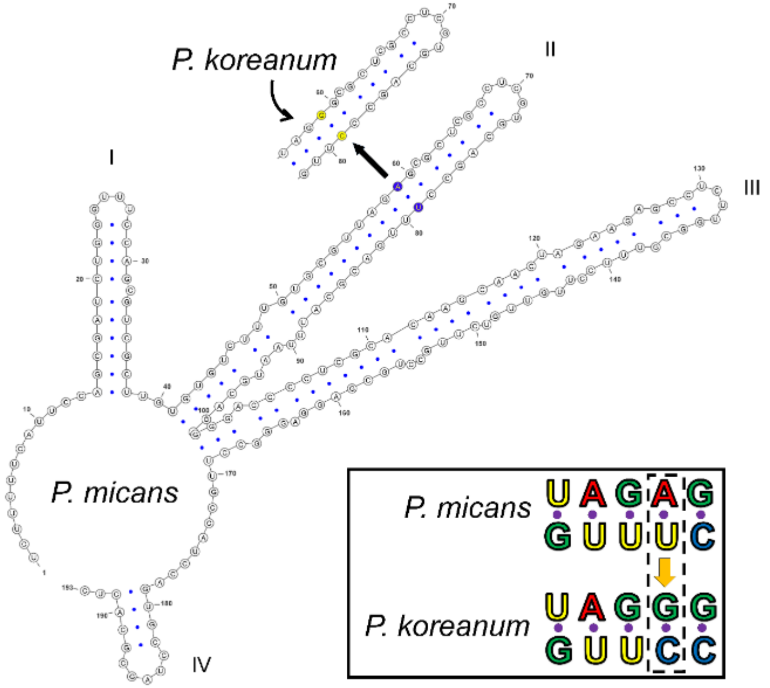
# Works in China

## Molecule work



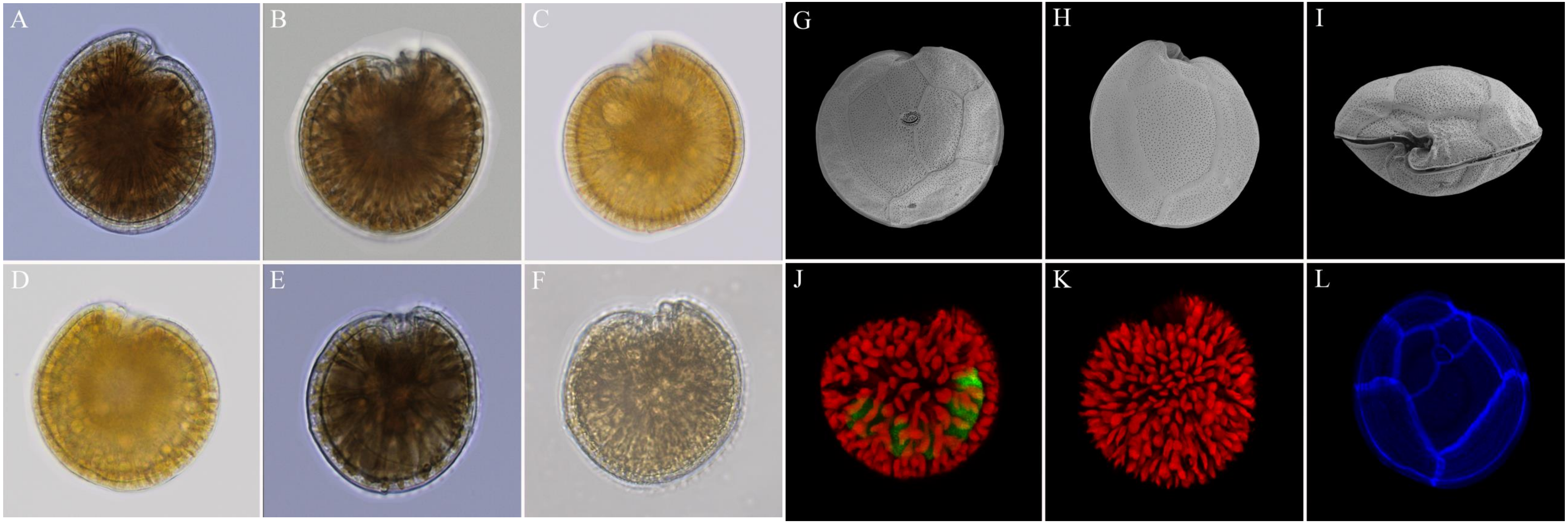




# Works in China

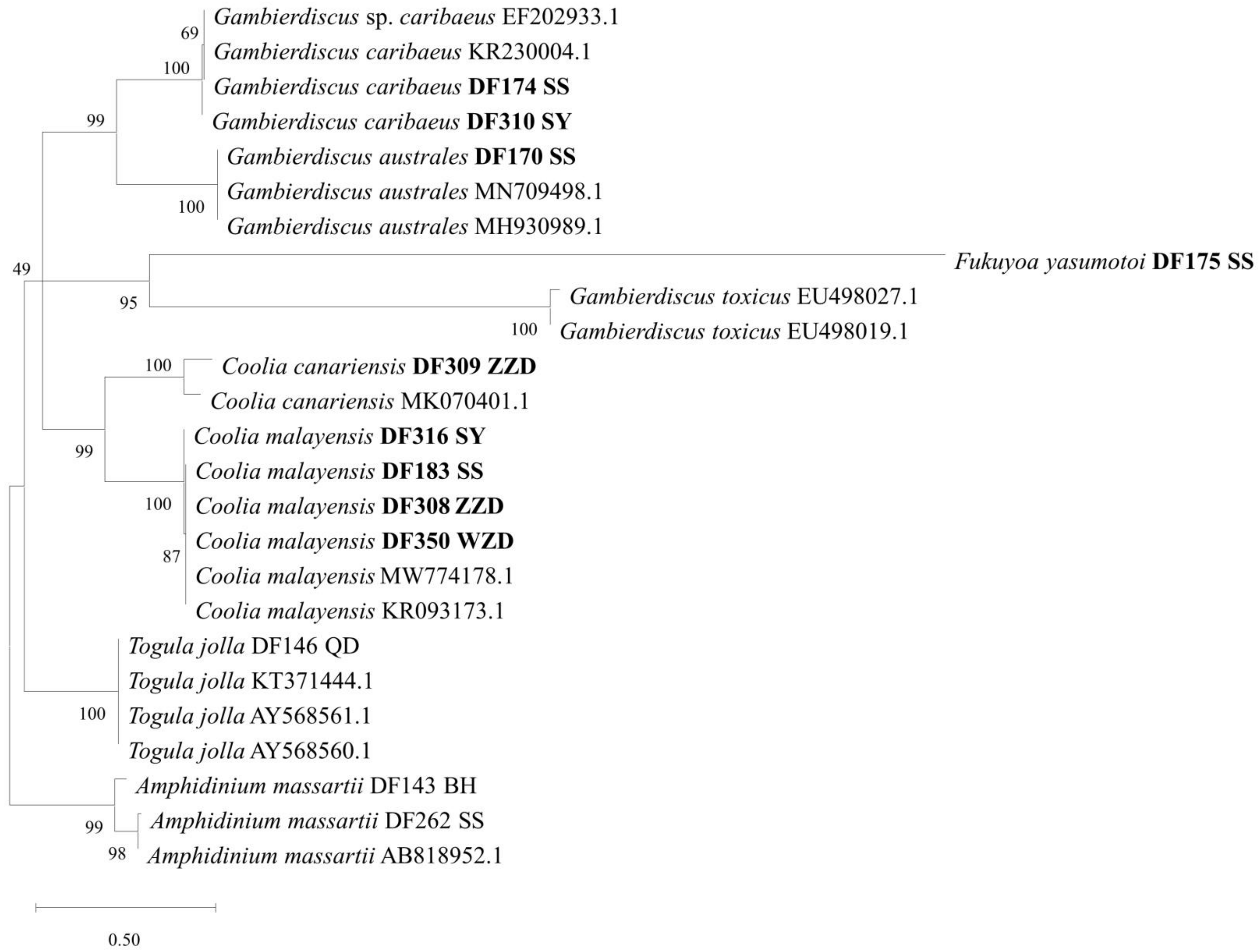
## Morphology




*Gambierdiscus* spp.

# Works in China

# Phylogeny



# Works in China

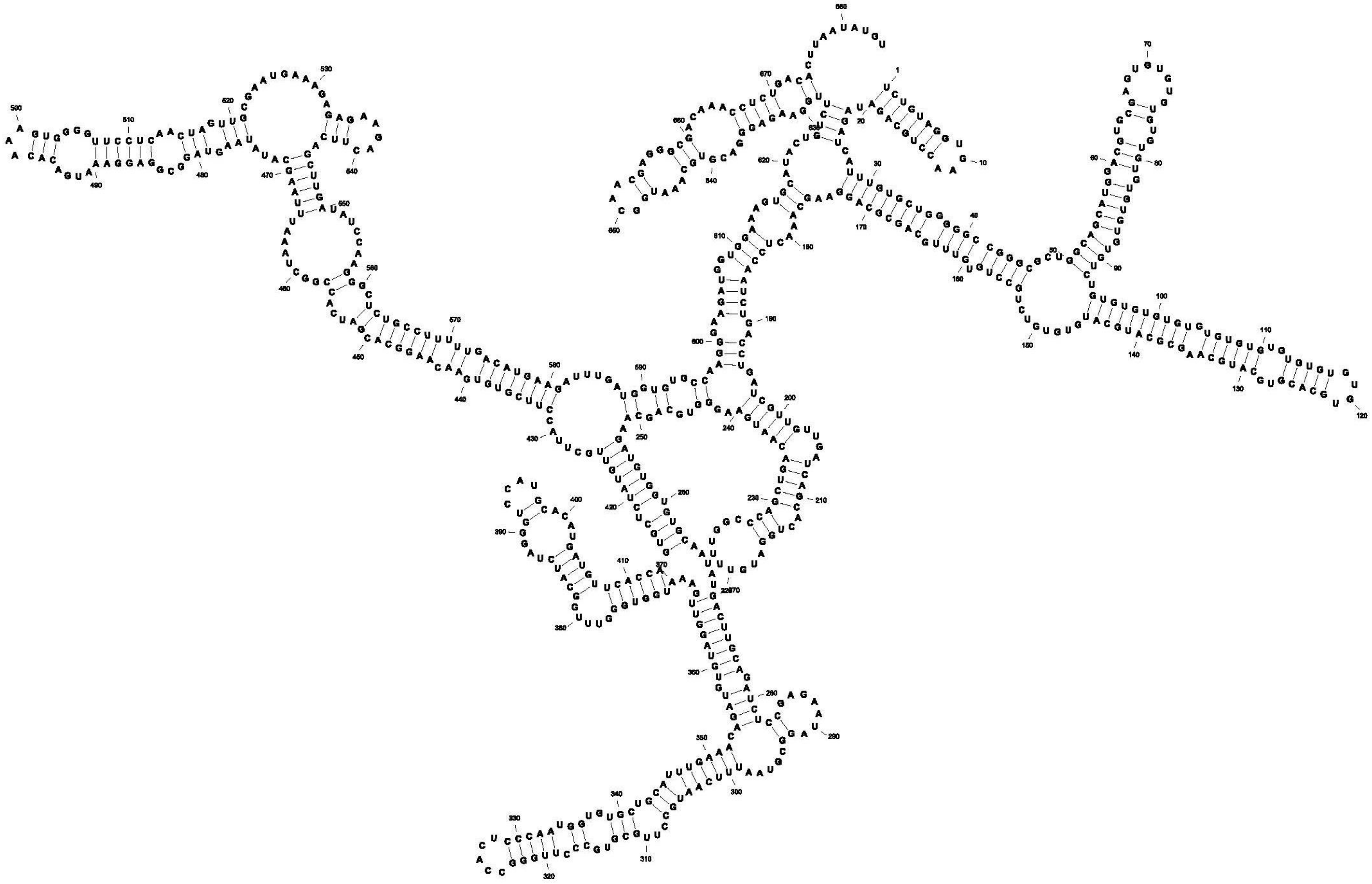
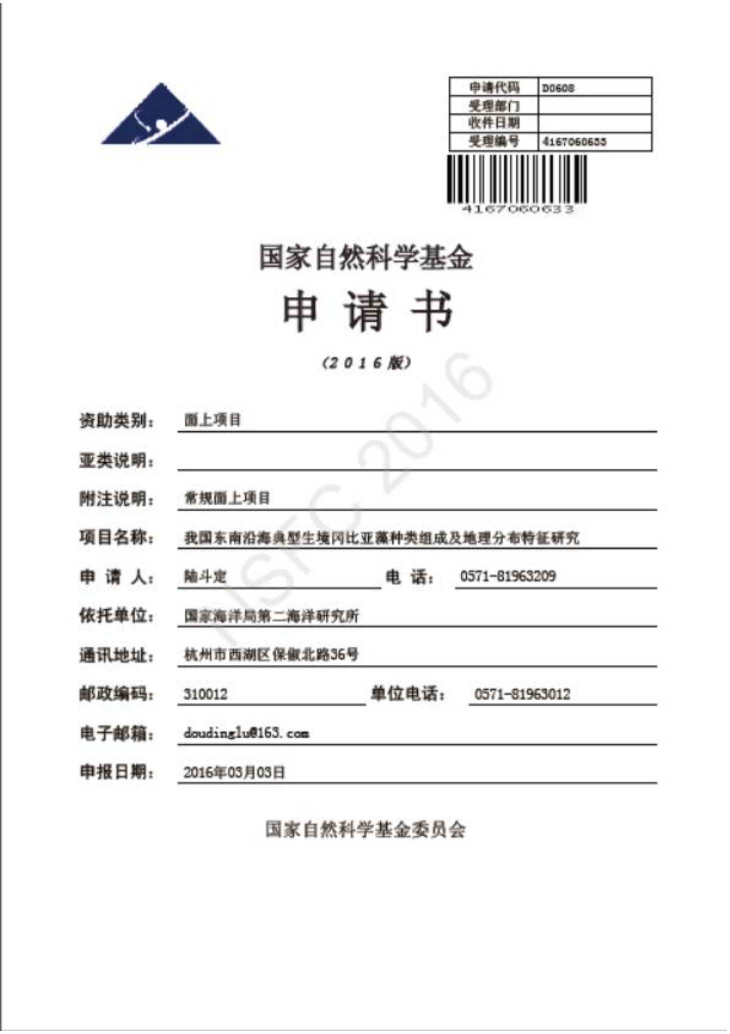


Fig. Secondary structure of ITS of *Gambierdiscus* sp.

# Works in China

# Distributions

## *Gambierdiscus* species



| 申请代码 | D0608 |
|---|---|
| 受理部门 | |
| 收件日期 | |
| 受理编号 | 4167060633 |

国家自然科学基金

申 请 书

（2 0 1 6 版）

资助类别：面上项目

亚类说明：

附注说明：常规面上项目

项目名称：我国东南沿海典型生境冈比亚藻种类组成及地理分布特征研究

申 请 人：陆斗定　电 话：0571-81963209

依托单位：国家海洋局第二海洋研究所

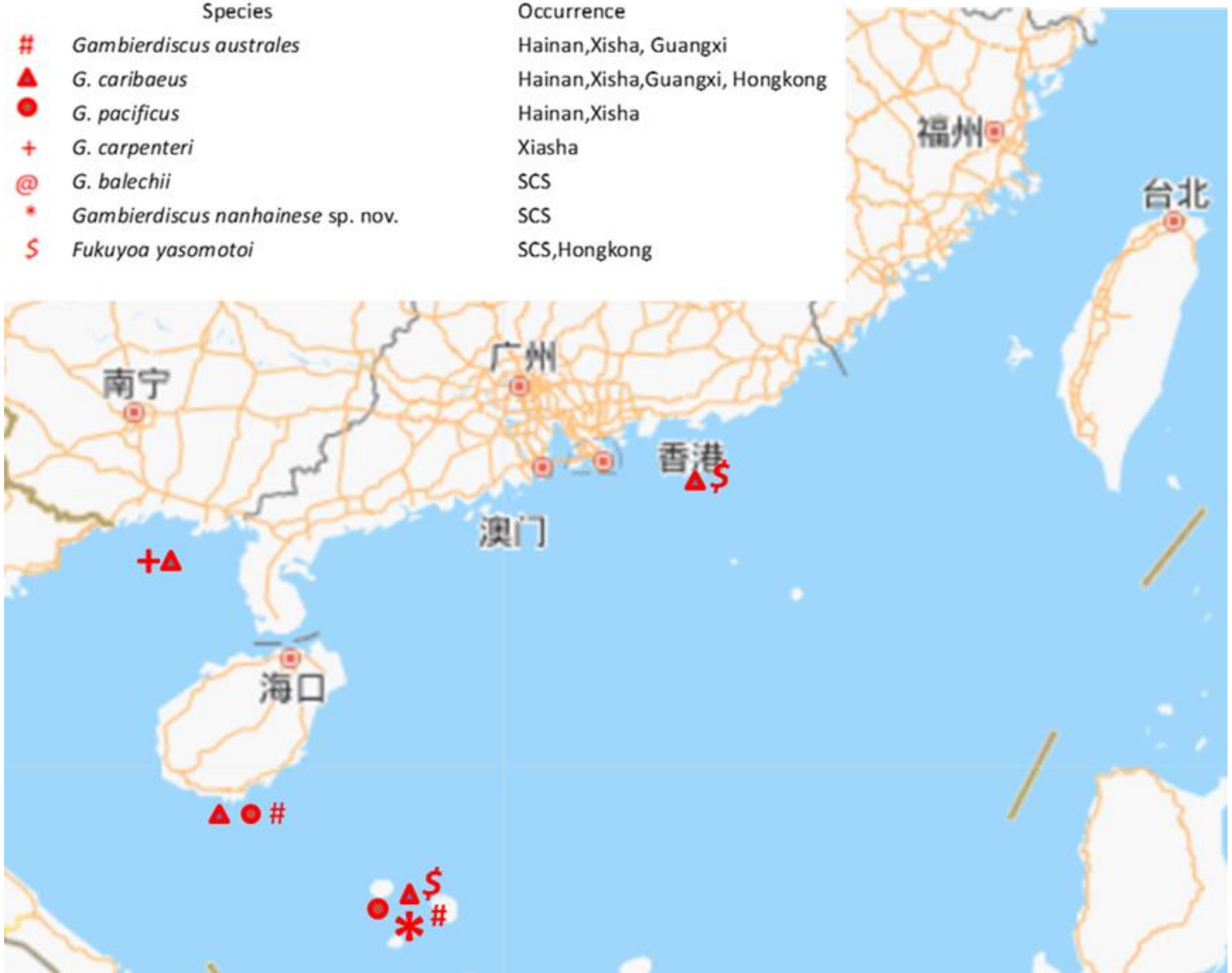
通讯地址：杭州市西湖区保俶北路36号

邮政编码：310012　单位电话：0571-81963012

电子邮箱：doudinglu@163.com

申报日期：2016年03月03日

国家自然科学基金委员会




By Prof. Douding Lu

# Works in China

**Toxins**

| Strain | Toxins |
| --- | --- |
| DF362 | 44-methylgambierone |
| DF171 | 44-methylgambierone, 2,3-dihydro-2-hydroxy CTX3C/2,3-dihydro-3-hydroxy CTX3C (to be confirmed), M-seco CTX3C (to be confirmed), Gambieric acid A (to be confirmed) |
| DF310 | 44-methylgambierone, 51-hydroxy CTX3C (to be confirmed) |
| DF159 | n.d. |
| DF160 | n.d. |
| DF164 | n.d. |

marine drugs MDPI

*Article*

**Characterization of New Gambierones Produced by *Gambierdiscus balechii* 1123M1M10**

Xiaowan Liu [1], Yihan Ma [2], Jiajun Wu [1,3], Qizhao Yin [2], Pengbin Wang [4,5], Jingyi Zhu [1], Leo Lai Chan [1,3,*] and Bin Wu [2,*]

1 The State Key Laboratory of Marine Pollution, Department of Biomedical Sciences, City University of Hong Kong, Hong Kong SAR 999077, China
2 Ocean College, Zhejiang University, Zhoushan 321000, China
3 Shenzhen Key Laboratory for the Sustainable Use of Marine Biodiversity, Research Centre for the Oceans and Human Health, City University of Hong Kong Shenzhen Research Institute, Shenzhen 518057, China
4 Key Laboratory of Marine Ecosystem Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou 310012, China
5 The Fourth Institute of Oceanography, Ministry of Natural Resources, Beihai 536000, China
* Correspondence: leochan@cityu.edu.hk (L.L.C.); wubin@zju.edu.cn (B.W.)

**Abstract:** The benthic dinoflagellate genus *Gambierdiscus* is the primary producer of toxins responsible for ciguatera poisoning (CP), a food intoxication endemic in tropical and subtropical areas of the world. We used high-performance liquid chromatography tandem high-resolution mass spectrometry (HPLC-HRMS) to investigate the toxin profile of *Gambierdiscus balechii* 1123M1M10, which was obtained from Marakei Island (2°01′N, 173°15′E), Republic of Kiribati, located in the central Pacific Ocean. Four new gambierone analogues including 12,13-dihydro-44-methylgambierone, 38-dehydroxy-12,13-dihydro-44-methylgambierone, 38-dehydroxy-44-methylgambierone, and desulfo-hydroxyl gambierone, and two known compounds, gambierone and 44-methylgambierone, were proposed by analyzing their fragmentation behaviors and pathways. Our findings provide new insights into the toxin profile of *Gambierdiscus balechii* 1123M1M10, which can be used as a biomarker for species identification, and lay the foundation for further toxin isolation and bioactivity studies of gambierones.

**Keywords:** *Gambierdiscus balechii*; gambierone; dihydro-44-methylgambierone; dehydroxy-44-methylgambierone; desulfo-hydroxyl gambierone

check for updates

Mar. Drugs 2023, 21, 3. https://doi.org/10.3390/md21010003

Received: 9 November 2022
Revised: 14 December 2022
Accepted: 19 December 2022
Published: 21 December 2022



**1. Introduction**

*Gambierdiscus* is a genus of marine autotrophic epi-benthic dinoflagellate that grows on the surface of macroalgae, corals, and sand grains [1–3]. This dinoflagellate has gained scientists' attention due to its production of ladder-shaped polyether toxins, including ciguatoxins (CTXs) [4,5], maitotoxins (MTXs) [6–8], gambierones [9–11], gambierol [9], gambieric acids [10], and gambieroxide [11]. Most of these toxins can bioaccumulate in the food chain, and the consumption of fish or shellfish contaminated with these toxins can cause ciguatera food poisoning (CFP), which is the most common non-microbial foodborne illness occurring in the tropical and subtropical regions of the world [12]. Patients with CFP may suffer from gastrointestinal, cardiological, and long-lasting neurological symptoms [13]. It is estimated that nearly 50,000 people are affected by CFP annually [14]. However, no effective CFP prevention and treatment strategy has been presented thus far, which is attributable to a lack of pure toxins and a poor understanding of their toxicity. Although these toxins are notoriously toxic, they have potential medicinal value because of their desirable biological activities. For instance, gambieric acids show significant antifungal properties [10], while gambierol inhibits voltage-gated potassium channels [15,16]. Maitotoxins (MTXs) enhance calcium ion influx across cell

# Works in China



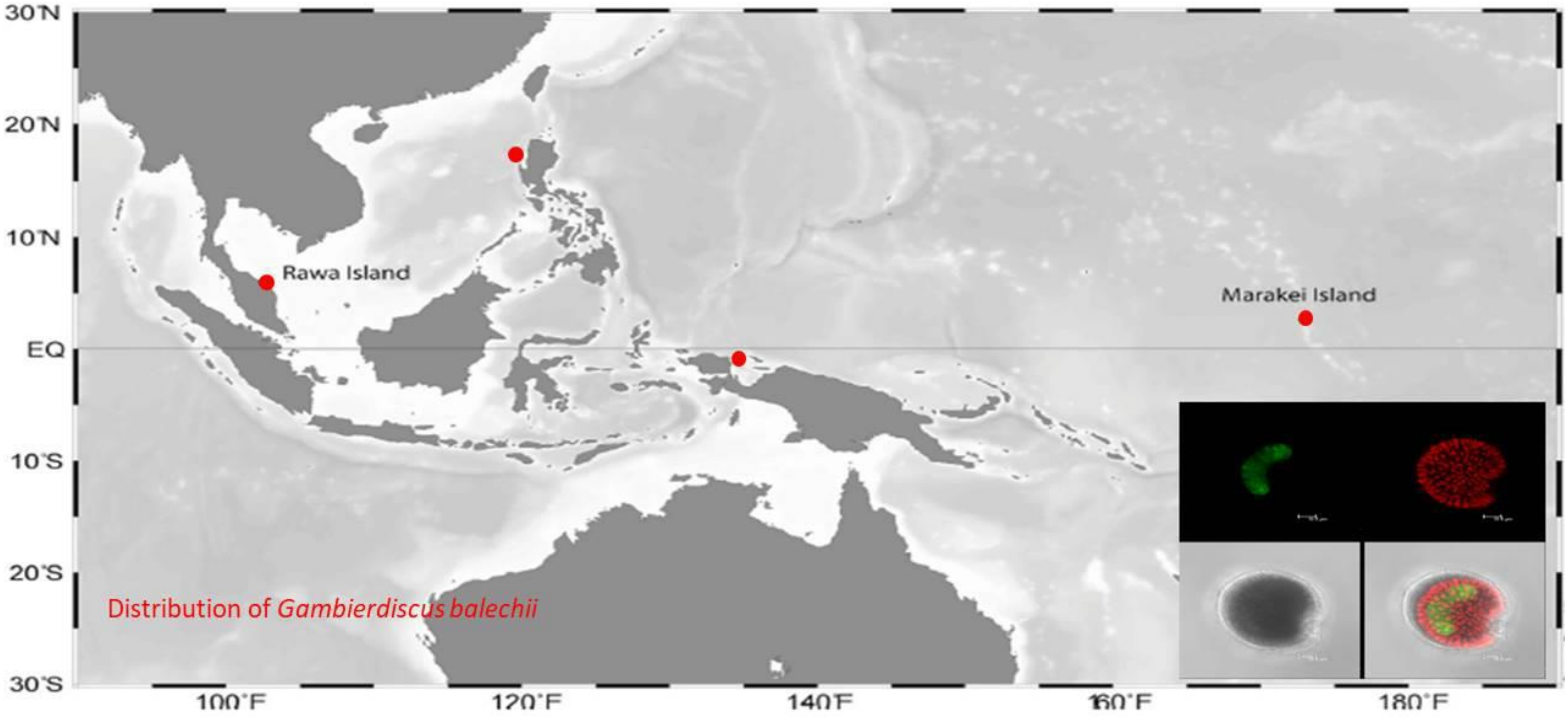
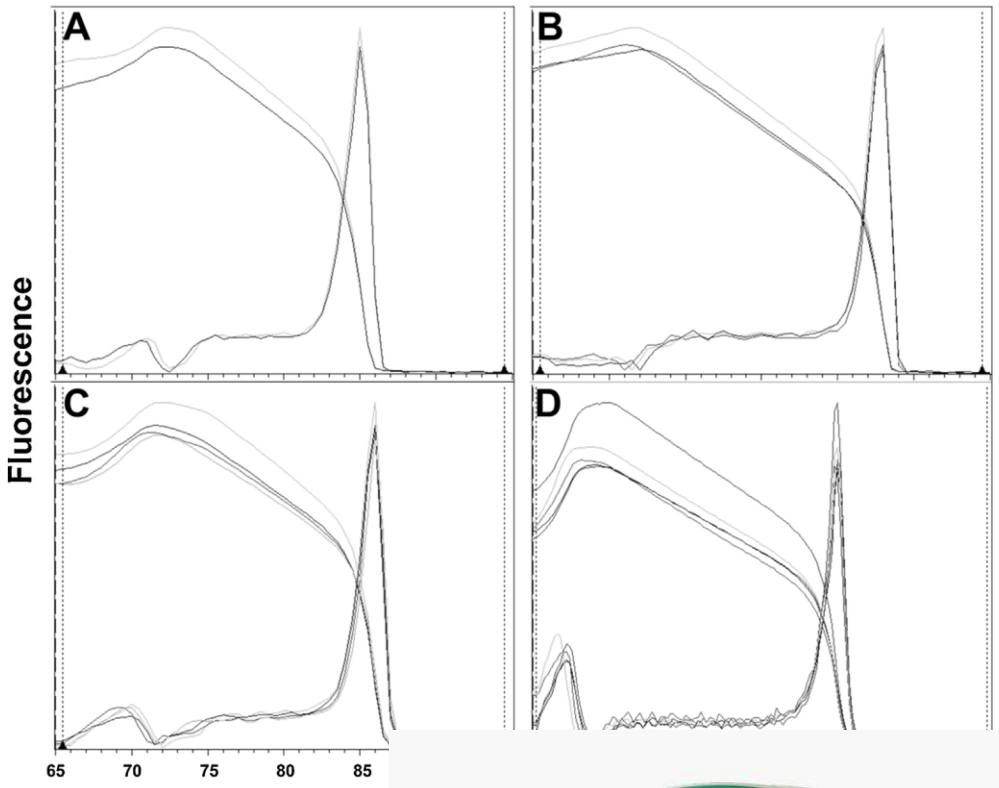
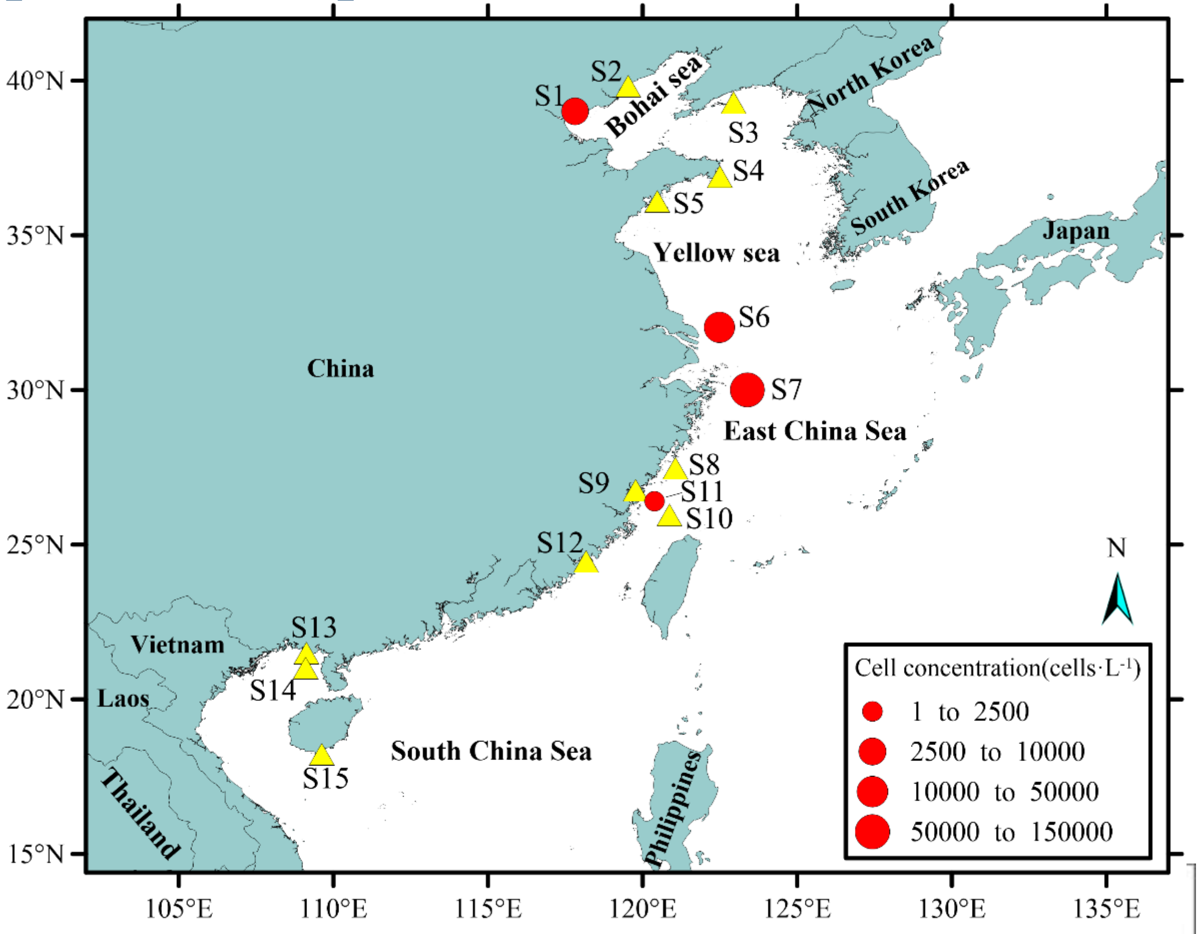



Fig. current distribution of *Gambierdiscus balechii.*

# Works in China （Later）

qPCR




toxins

MDPI

*Article* 1

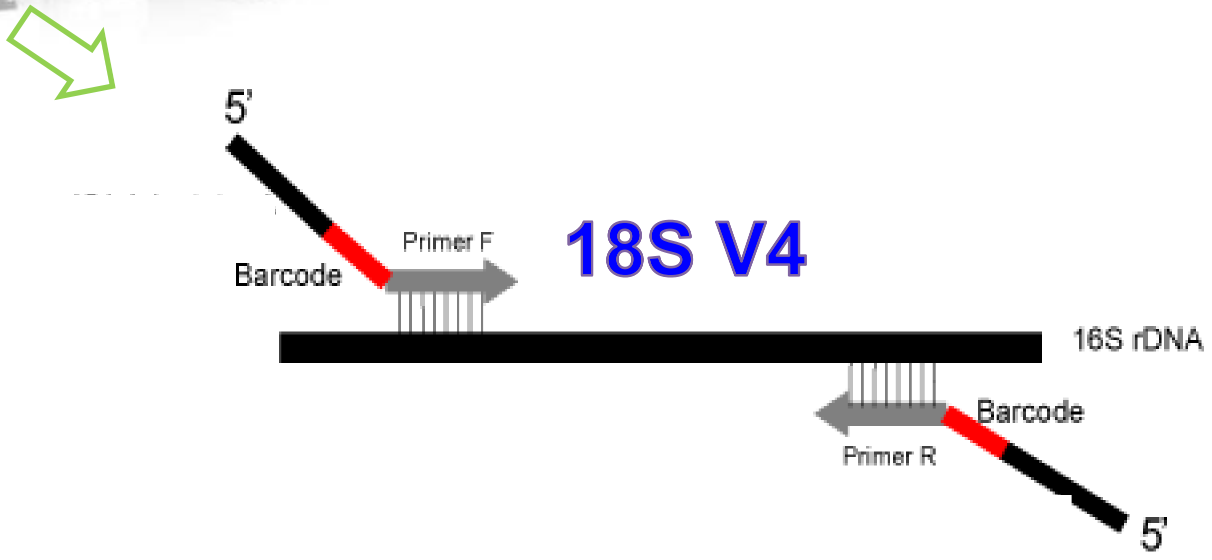
Detection and quantification of the harmful dinoflagellates 2
*Margalefidinium polykrikoides* (East Asian ribotype) in the 3
coastal waters of China 4

# Works in China (later)

NGS

Illumina MiSeq Next Generation Sequencing (NGS-II)

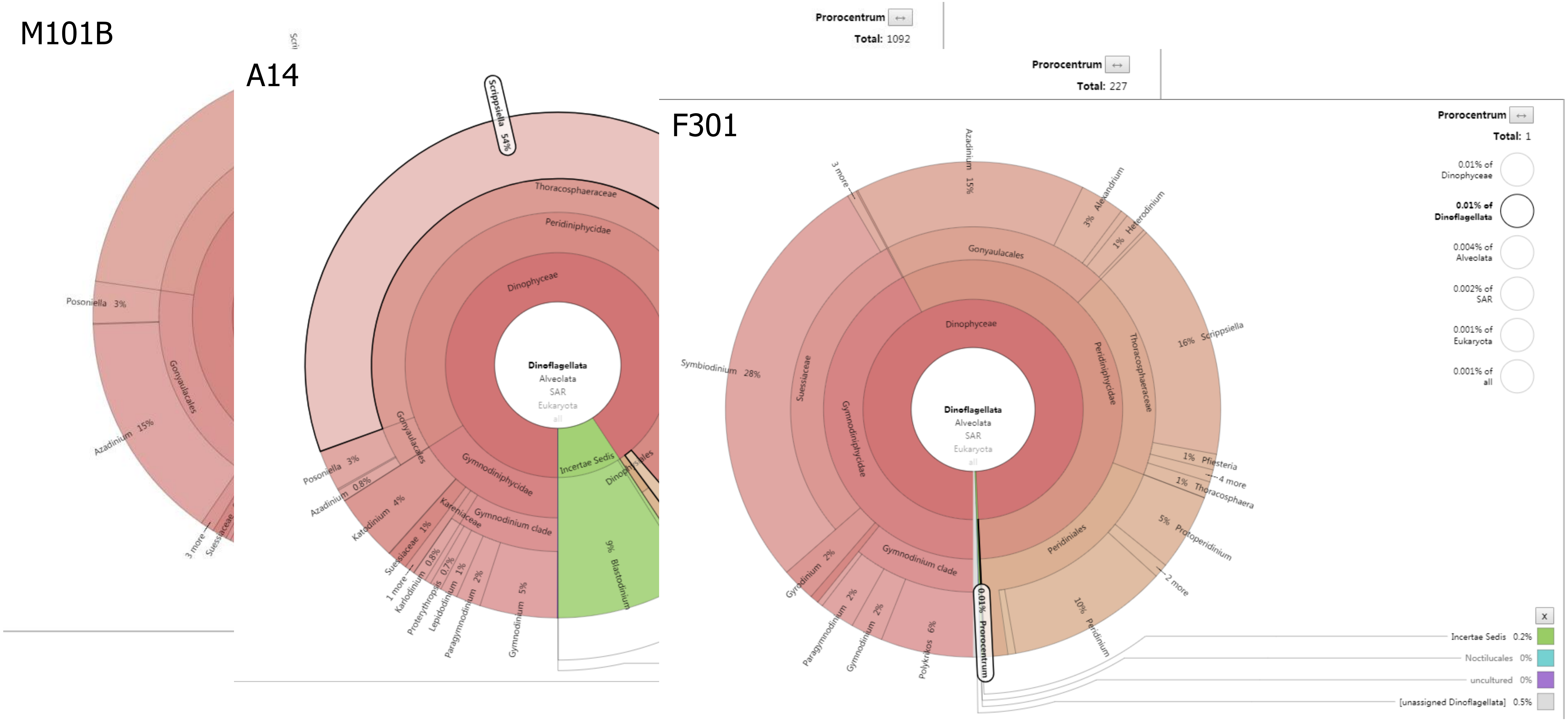
## NGS analysis for HABs



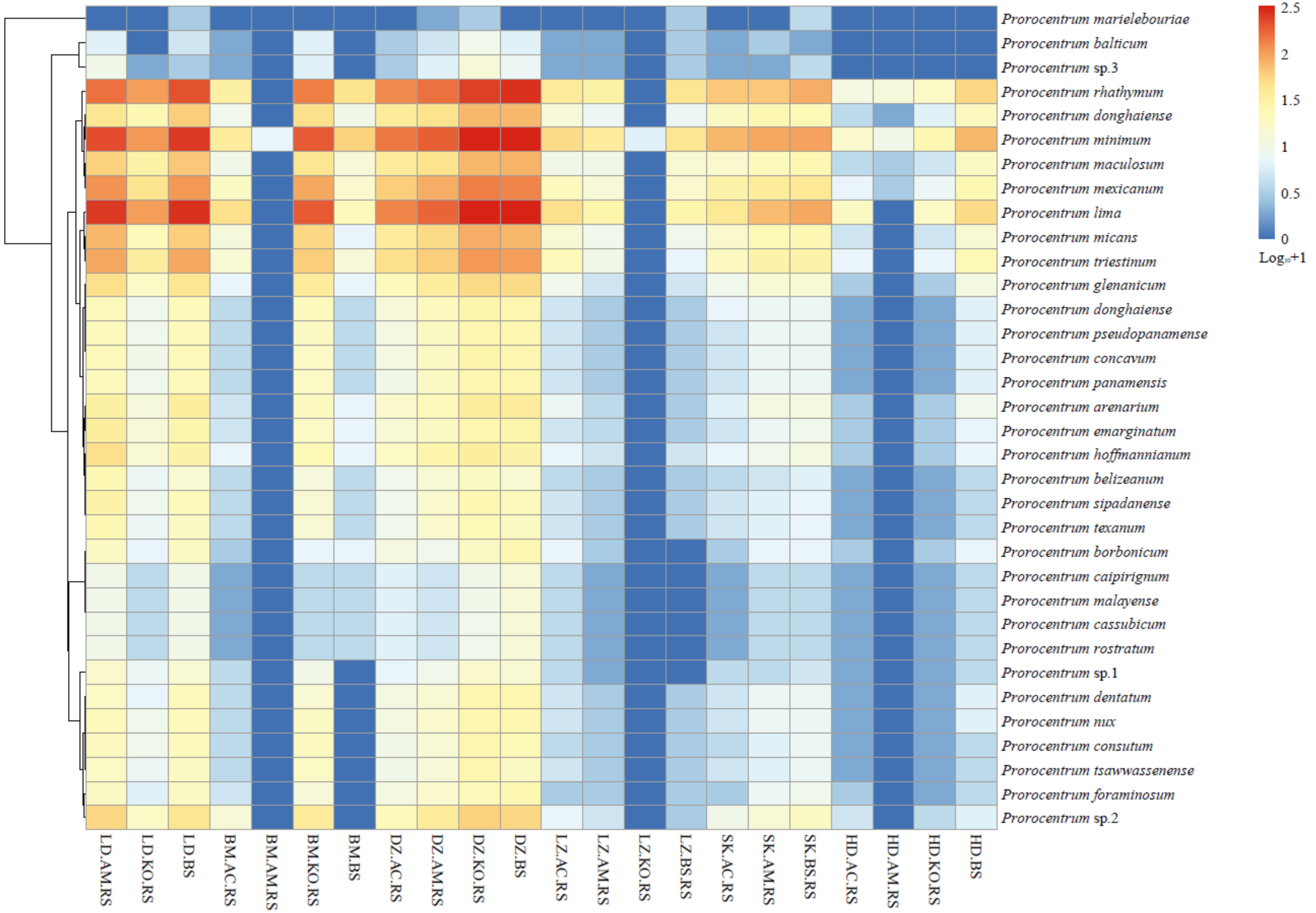
# Works in China

NGS

## NGS on the potential harmful species detection



# Works in China

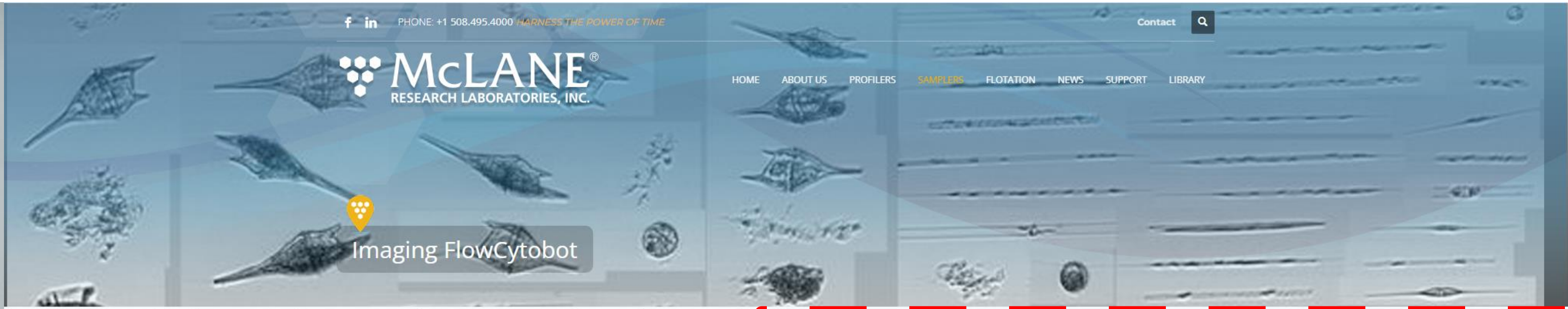


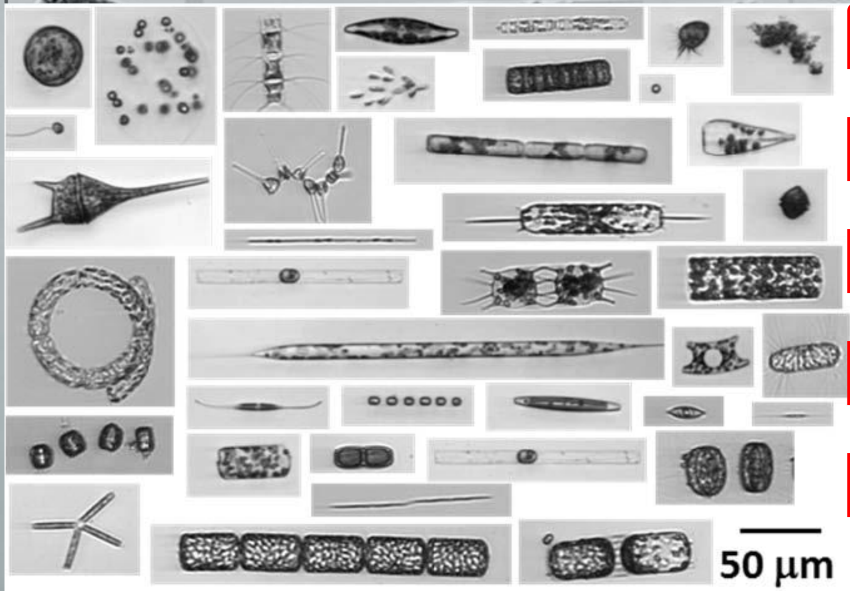

**NGS on the *Prorocentrum* species detection**

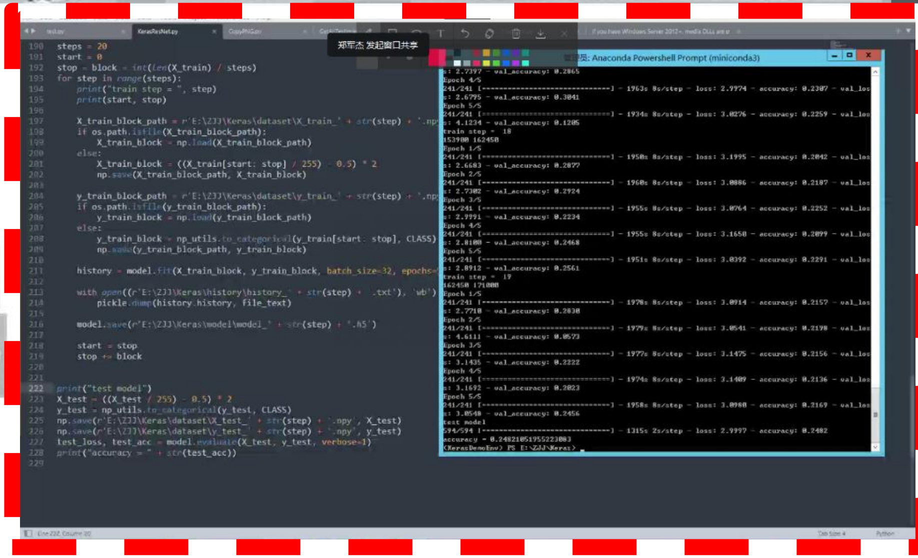
# Works in China

# IFCB or Phytoscope?

IFCB

Flow Cam+ AI (under developing)

# Works in China


中华人民共和国国家版权局

计算机软件著作权登记证书

证书号：软著登字第5231014号

软件名称：东海赤潮藻类3D图谱手机应用软件
[简称：赤潮藻类图谱]
V1.0

著作权人：王鹏斌；陆斗定；戴鑫烽；郭若玉；王瑞芳；何鑫琪；自然资源部第二海洋研究所

开发完成日期：2019年11月26日

首次发表日期：2019年11月26日

权利取得方式：原始取得

权利范围：全部权利

登记号：2020SR0352318

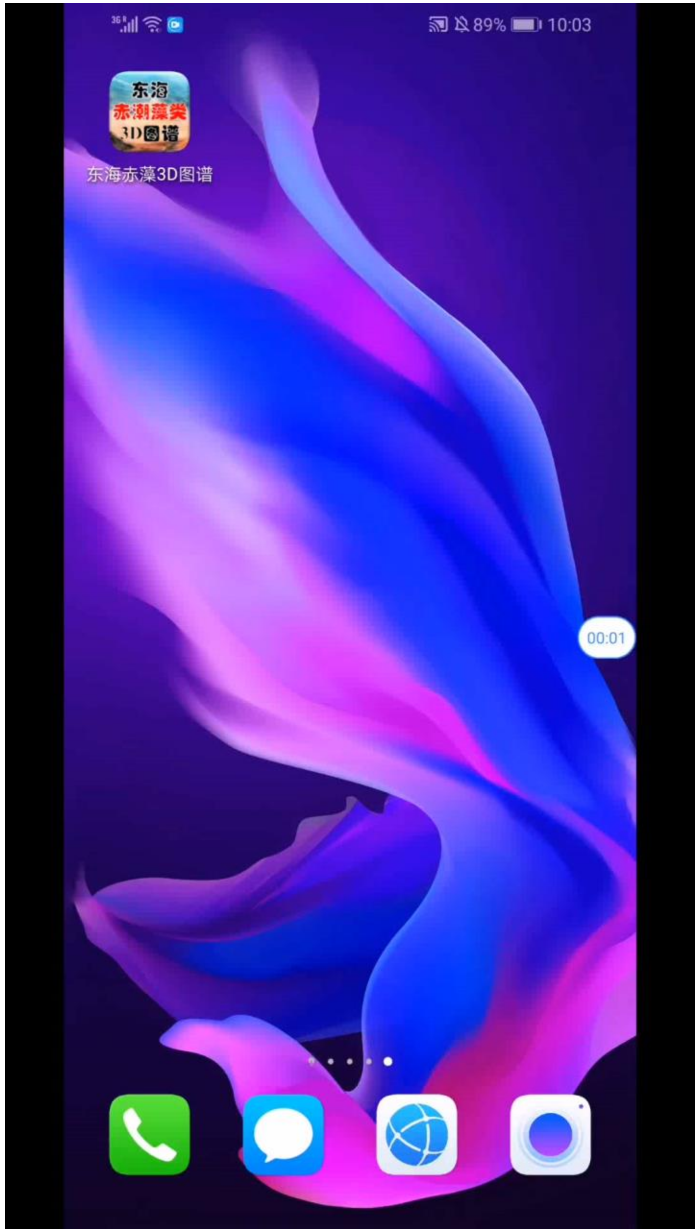
根据《计算机软件保护条例》和《计算机软件著作权登记办法》的规定，经中国版权保护中心审核，对以上事项予以登记。

No.

中华人民共和国国家版权局 计算机软件著作权登记专用章

2020年04月21日

Android

# Thanks!