福建台湾海峡海洋生态系统
国家野外科学观测研究站

National Observation and Research Station
for the Taiwan Strait Marine Ecosystem

T-SMART

厦門大學

2022 年度报告
Annual Report

T-SMART INTRODUCTION

福建台湾海峡海洋生态系统国家野外科学观测研究站（以下简称“台海站”，英文缩写T-SMART）依托厦门大学，于2021年10月获科技部批准建设。台海站由“东山太古海洋观测与实验站”（简称“东山实验场”）和“漳江口红树林湿地生态站”（简称“漳江口实验场”）两个分站组成，涵盖台湾海峡上升流、东山湾、厦门湾、漳江口四个观测区，致力于台湾海峡海洋生态系统结构与功能的长期观测和实验生态研究，为保障海洋生态环境健康和促进经济可持续发展提供科技支撑。

National Observation and Research Station for the Taiwan Strait Marine Ecosystem (T-SMART) was approved by the Ministry of Science and Technology of China in October 2021. T-SMART consists of two substations, "Dongshan Swire Marine Station (D-SMART)" and "Zhangjiang Estuary Mangrove Wetland Ecosystem Station (M-ECORS)", which covers four observation areas including Zhangjiang Estuary, Dongshan Bay, Xiamen Bay, and Taiwan Strait Upwelling. It is mainly committed to the long-term monitoring and experimental research on marine ecosystem structure and function, which provides science and technology support for the marine health and the sustainable economic development.

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Advisers

Huasheng Hong, Dongxing Yuan, Changyi Lu, Yan Li, Liwu Wu, Mingzhi Zhang

T-SMART Leadership Team

Director: Bangqin Huang

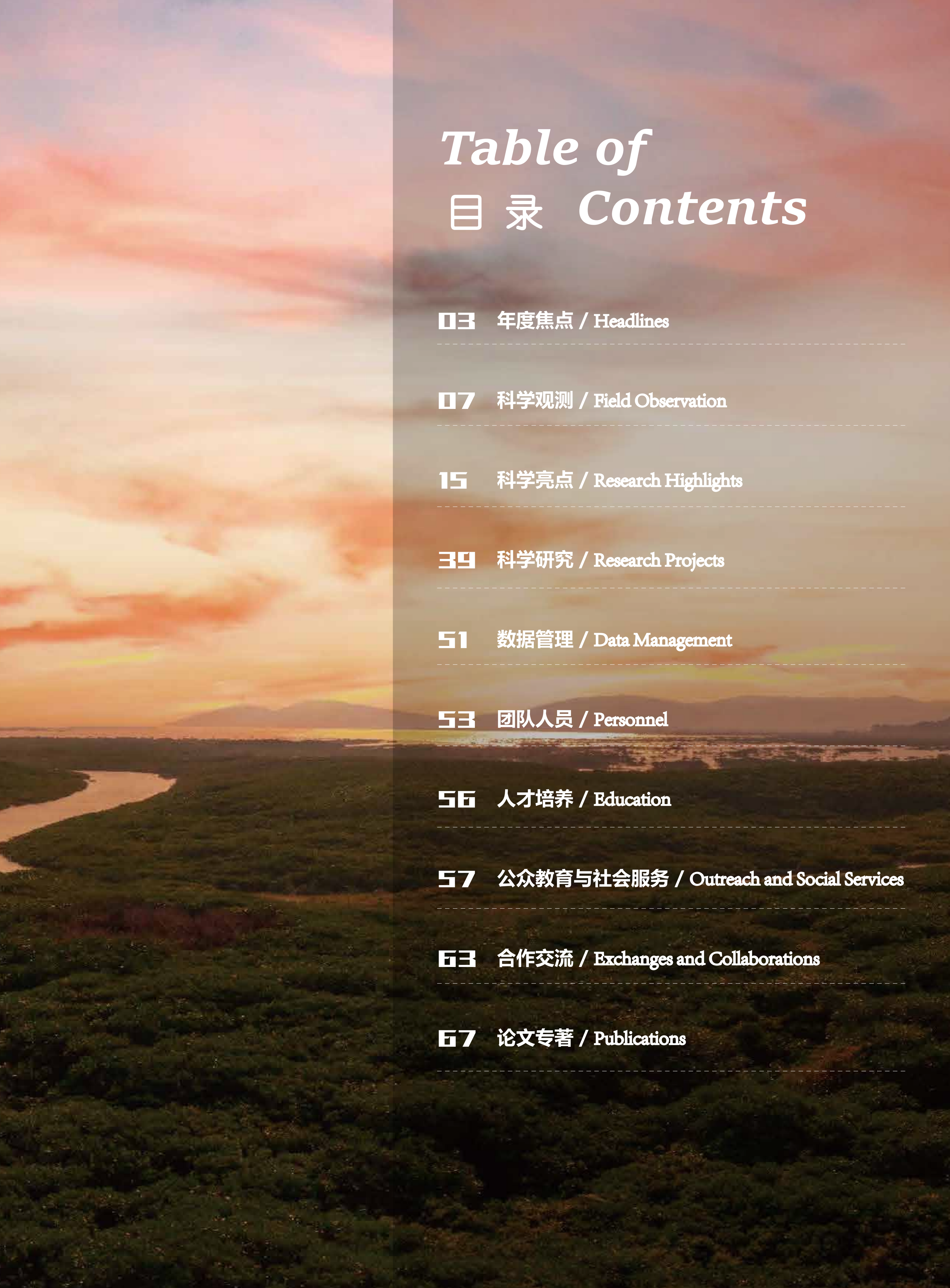
Associate Director: Yuwu Jiang, Wenqing Wang

D-SMART: Yuwu Jiang, Jian Ma, Weiwei You

M-ECORS: Wenqing Wang, Xudong Zhu, Xiaoping Zhou

Technical and Administrative Team

Shengyao Sun, Zhishan Fang, Yamian Zhang, Jixin Chen, Shuiying Huang , Qisi Cai, Jinhua Xue,



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序言

律回春渐，新元肇启。厦门大学福建台湾海峡海洋生态系统国家野外科学观测研究站（以下简称台海站）已正式列入国家野外站一年。回首2022年，全体台海站人精诚团结，坚守“观测、研究、示范、服务”宗旨，攻坚克难，孜孜以求。

持续推进科学观测

台海站按规范组织开展台湾海峡上升流、东山湾、厦门湾、漳江口四个观测区冬、春、夏、秋季度航次观测，完成漳江口红树林和盐沼样方观测各1次，滨海湿地鸟类、鱼类和底栖动物观测各2次。基于台海站建成的红树林湿地涡度通量、滨海湿地地表高程、东山湾水文浮标、东山珊瑚在线观测、渔排基水生态在线观测等13套自动观测系统开展连续观测，获取观测数据总量超过35 GB，珊瑚监测视频超过3800小时。新建成滨海湿地地下河口观测系统，完成海底珊瑚原位观测系统升级，为相关科学研究提供数据支持。

积极开展科学研究

台海站新获批纵向科研项目24个，横向项目26项，合同经费共4500万元，包括国家重点研发项目2项、国家基金委优秀青年基金项目1项、国家基金委联合基金重点项目4项。发表论文70篇;出版专著5部。57名固定人员中，1人入选农业农村部神农青年英才，1人获亚洲-大洋洲地球科学学会“艾克斯福特奖”，1人获第七届“曾呈奎海洋科技奖”青年科技奖；1人当选俄罗斯科学院外籍院士、国际科学理事会会士。

充分发挥示范引领作用

台海站牵头制定海洋行业标准3项、地方标准1项，参与制定海洋行业标准3项。漳江口实验场完成漳江口红树林国家级自然保护区退养还湿成效及生物多样性评估，为红树林保护修复工作与互花米草清除工作提供技术支持与监测服务。东山实验场与东山县政府合作推进海龟救护工作，7月救助太平洋丽龟一只。台海站数据中心完成台海站大屏综合展示数字系统，实现野外观测数据的实时传输和展示。

开放服务促进人才培养

台海站新增4名研究人员，1名技术人员，1名行政秘书；培养博士研究生34名，硕士研究生54名。同时，台海站为相关学科的科研和教学实习实践提供了强大的硬件支撑和保障，在站开展科研和实习工作的校内外人员达2360人天，接待超过23家科研院所及企事业单位来访，接待厦门大学、华东师范大学、华侨大学、泉州师范学院等开展生产实习的师生超1200人天。与70.8海洋媒体实验室、东海卫士等平台联合举办“少年蓝色先锋培养计划”、“第六届全国净滩公益活动”等科普活动7场，到站访问达1000人次。

一路走来，我们深刻感知，台海站取得的成绩离不开社会各界的关心和厚爱！在此，谨向长期以来关心、支持和帮助台海站建设发展的国家相关部委、地方政府、社会各界人士和国际同仁表示衷心感谢！向太古集团慈善信托基金、厦门大学及其相关职能部门表示诚挚感谢！未来，全体台海站人将踔厉奋发，笃步前行，继续提升台湾海峡生态系统方面的观测和研究能力，为我国海洋生态文明建设源源不断贡献“厦大力量”！

站长：

于2023年3月

Message from Director

The national observation and research station for the Taiwan Strait Marine Ecosystem (T-SMAR) has been officially approved for one year. Looking back on 2022, T-SMART scientists worked hard and focused on the overall position of "observation, research, demonstration and social service" to explore major ocean issues. Throughout this process.

Long-term observation

We continued to improve both our observation capabilities and comprehensive observation system. Except for the existing 13 sets of intelligent-observation,, we constructed a new subterranean estuary monitoring system in mangrove wetland. We also improved the Coral Ecosystem Cabled Observatory (CECO) with fewer nodes and higher stability. In addition, quarterly cruises were completed in four observation areas, including the upwelling area in the Taiwan Strait, Dongshan Bay, Zhangjiang Estuary, and Xiamen Bay. We collected over 35 GB of data. We also established an Observation Data Center to promote public sharing of the collected data.

Scientific research

A total of 51 research projects were approved, including two key projects funded by the National Natural Science Fund of China (NSFC), and one projects for excellent young scientists funded by the NSFC; In addition, 70 research articles and two books were published. Among 57 regular researchers, one person was selected as the Shennong China Agricultural Science and Technology Award of the Ministry of Agriculture and Rural Affairs; one person was received the Axford Medal Award from the Asia Oeania Geosciences Society (AOGS); one person was awarded the "Zeng Cheng Kui Marine Science and Technology Award - Young Scientist Award"; one person was elected a foreign academician of the Russian Academy of Sciences and a Fellow of the International Council for Science.

Demonstration

We participated the set of six professional standard, including four monitoring standard for marine environment and two assessment standard for carbon dioxide flux. Addtionally, we completed assessments evaluating the effectiveness of the ecological restoration of the Zhangjiang Estuary National Nature Reserve and estimating its biodiversity. Technical support and monitoring service were provided for the removal of invasive Spartina alterniflora and mangrove conservation and restoration. We also collaborated with the Dongshan County Government to protect sea turtles and rescued one Pacific green turtle in July. Furthermore, our data centre constructed a comprehensive digital system for displaying field observation data in real-time.

Talent cultivation

There are four scientists and one technical personnel joined our team. Within our team, Prof. Nianzhi Jiao received the Xiamen University Nanqiang Outstanding Contribution Award. Prof. Minhan Dai received the Axford Medal Award from the Asia Oceania Geosciences Society (AOGS). Prof. Yonglong Lu was invited by the 15th Conference of the Parties (COP15) of the United Nations Convention on Biological Diversity (CBD) to jointly publish an editorial article on "Curtailing the Collapse of the Living World"in Science Advances. At the same time, T-SMART has made many outreach efforts. Seven workshops for talent training and popularization of science were carried out in 2022; more than 1,000 participants took part in these activities.

Thanks to strong partners, the achievements of the past year are only the beginning. With energy and anticipation, the leadership and staff of T-SMART look forward to continuing our work to promote the observational and research capacity of Xiamen University for the Taiwan Strait marine ecosystem, and contribute to formulating strategies for encouraging marine conservation and nurturing an ecological civilization!

Director: Bangqin Huang

March 2023

2022 年度焦点 Headlines

DATA

35 GB
DATA PRODUCED

3800 HOURS
CORAL VIDEO STORAGE

37 SCIENTISTS AT THE STATION

*Users not resident scientists

13 RESEARCH CRUISES

70 RESEARCH PAPERS

365 WORKING SCIENCE DAYS

38 STUDENTS AT THE STATION

7 OUTREACH EVENTS

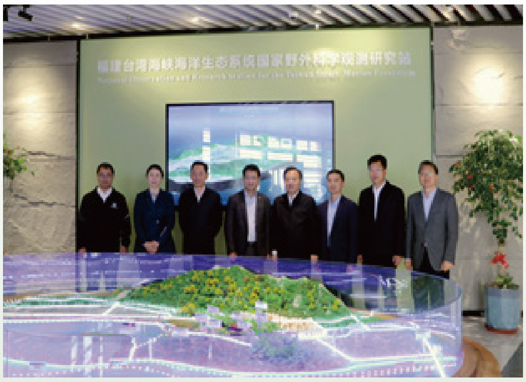
23 INSTITUTIONS AND UNIVERSITIES REPRESENTED

1000+ VISITORS

1月/January

台海站漳江口实验场依托厦门大学环境与生态学院与云霄县人民政府签订校地合作协议。

M-ECORS signed the School-local cooperation agreement with the Yunxiao government.



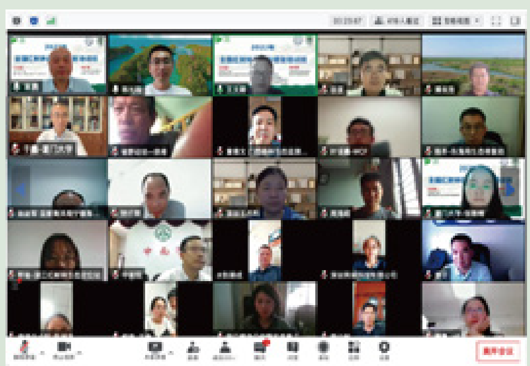
4月/April

福建省委常委、宣传部部长张彦一行赴台海站漳江口实验场调研。

Yan Zhang, the director of the Ministry of Fujian Properganda, visited M-ECORS.

7月/July

台海站漳江口实验场联合红树林基金会举办“2022年全国红树林保护与修复会议”。
M-ECORS hold the “2022 Mangroves Conservation and Restoration Conference”.



7月/July

台海站漳江口实验场与漳江口红树林国家级自然保护区、云霄竹塔学校签订《红树林科普合作协议》。

M-ECORS signed the Mangrove science education cooperation agreement with Zhangjiang Estuary Mangrove Nature Reserve and Zhuta School.

8月/August

刘文文获批国家优秀青年科学基金项目。

Wenwen Liu received the National Science Foundation of China award For Excellent Young Scientists.

台海站东山实验场在东山近岸海域顺利完成第二代海底有缆珊瑚生态在线观测系统（Coral Ecosystem Cabled Observatory, 简称“CECO-II”）为期两个月的海试工作并正式上线。

Self-developed Coral Ecosystem Cabled Observatory of D-SMART was updated to the second generation and applied.

9月/September

台海站东山实验场联合中国海洋发展基金会和东海卫士（东山当地NGO），开展“第六届全国净滩公益活动”。

D-SMART collaborated with the local NGO “Donghai Guard” to hosted the Sixth National Beach Cleaning Activity.

11月/November

“台海站第一届学术委员会第一次会议暨战略规划研讨会”顺利召开。

The first Academic Committee Conference of T-SMART hold in Dongshan and Yunxiao county.

12月/December

福建省副省长李建成、漳州市委书记张国旺带队调研东山实验场。

Jiancheng Li, the vice-governor of Fujian Province and Guowang Zhang, the Party Chief of the city of Zhangzhou visited D-SMART with his colleagues.

Field observation

科学观测

台湾海峡上升流观测区调查航次

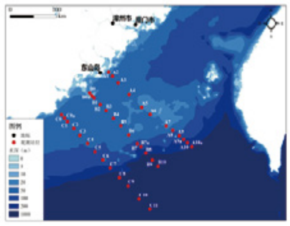
Cruises of the T-SMART in the Taiwan Strait upwelling observation area

台海站台湾海峡上升流观测区位于台湾海峡南部海域，在东山外海至南澳岛以东海域设置3个断面，进行长期观测研究，获取上升流区域海水物理、化学、生物参数，以探究台湾海峡上升流区生态系统特征、动态变化及其驱动机制。

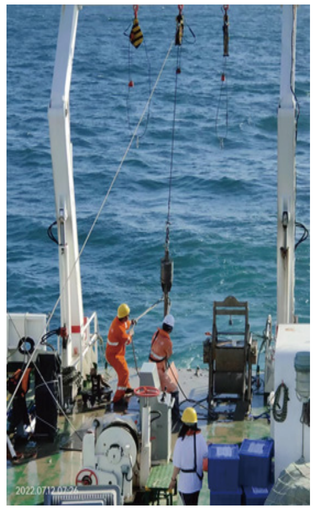
2022年，台海站完成台湾海峡上升流观测区春季、夏季、秋季3次大面站航次调查。其中，夏季还进行台湾海峡上升流专项观测，在上升流区域设置时间序列站进行定点连续观测，获取高时间频率的物理、化学、生物参数。

The Taiwan Strait Upwelling Observation Area of T-SMART is located in the southern area of the Taiwan Strait. Three sections were set up in the observation area, which spanning from the offshore area of Dongshan Island to the eastern sea area of Nan'ao Island. Its primary objective is to conduct extensive and enduring observations and research, aimed at acquiring comprehensive physical, chemical, and biological data regarding the seawater parameters within the upwelling zone. Such endeavors are pivotal in elucidating the upwelling ecosystem's inherent characteristics, dynamic changes, and their underlying mechanisms within the Taiwan Strait.

During 2022, T-SMART successfully executed three cruises within the Taiwan Strait upwelling observation area in spring, summer, and autumn. Notably, a dedicated set of observation focused on upwelling system was conducted in summer, wherein time series stations were set for continuous observation at fixed point, which aimed to obtain the marine physical, chemical and biological parameters of high frequency.



上升流生态系统观测站位
Observation sites in the Upwelling ecosystem



上升流共享航次照片
Photo of the upwelling cruise

东山近岸（兄弟屿）海域潜水调查

Diving survey in the Dongshan Bay

工作照片
Working photo

水下生物照片
Underwater images of local species

东山实验场技术员团队定期组织科研潜水活动，关注东山近岸特别是保护区核心区域的珊瑚和生物多样性资源，2022年，团队多次下水拍摄了东山珊瑚与生物的影像资料。

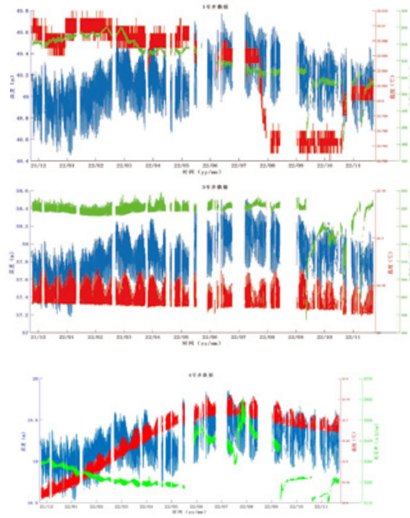
The D-smart team regularly organizes research diving activities, focusing on the coral and biodiversity resources in the nearshore and core area of the Dongshan reserve zone. In 2022, the team conducted multiple dives to collect image data of the coral and reef-dwelling organisms in Dongshan water.

地下河口观测

Subterranean estuary monitoring

地下河口观测系统配备了锚定自动升降系统，多参数温盐深仪、微型井潜水采样泵和多通道远程数据传输系统，以实现地下水中温度、盐度、地下水位的连续观测和溶氧、氧化还原电位、溶解无机碳、碱度、pH、硝酸盐、磷酸盐、硅酸盐、示踪地下水入海的天然示踪剂镭和氡的长期观测。2022年10月，漳江口新布设两口监测井，与东山湾四口监测井共同组成地下河口观测系统，全年产生数据有效天数为220天，累计获取数据10MB。

M-ECORS displayed 2 monitoring wells in the Zhangjiang Estuary Mangrove Reserve in October 2022. The two newly constructed wells and four previously constructed wells in Dongshan Bay compose the subterranean estuary monitoring system. Every well is equipped with an automatic lifting system, multi-parameter water quality meter, micro pump, and multi-channel data transmission system. Parameters indicating water quality such as temperature, salinity, pH, phosphate, silicate and etc., could be collected consistently. In 2022, the system runs efficiently for about 220 days, collected data 10 MB.



地下河口观测数据

Data collected by the subterranean estuary monitoring system

陆–海、海–气界面立体观测

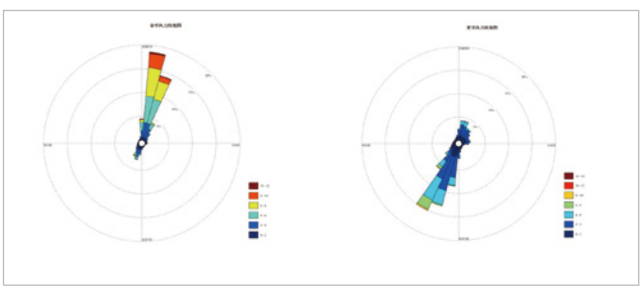
Land-ocean and ocean-atmosphere interface stereoscopic observation

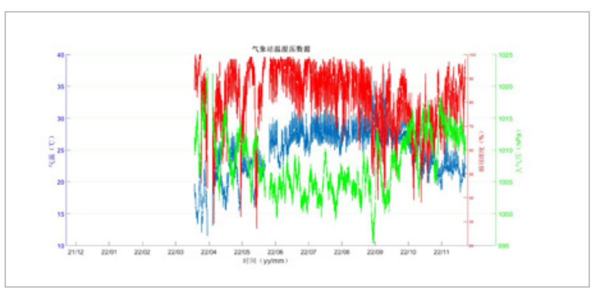
气象观测系统是东山站滨海界面大气环境监测系统规划中的基础部分，目前已实现岸基气温、风速、风向、相对湿度、气压、能见度、UVA、UVB、UVI等参数的连续观测。2022年，东山实验场继续完善大气观测系统建设，更新了DZZ4六要素新型区域自动气象站，系统数据存储频率加密为5分钟。全年除不确定因素导致数据缺失几次外，运行稳定，有效数据生产天数约为 253 天。

The atmospheric observation system is a crucial part of the stereoscopic observation system and is able to continuously collect atmospheric data such as temperature, wind speed, wind direction, relative humidity, air pressure, visibility, UVA, UVB, UVI, and etc. In 2022, D-SMART has continued to improve the construction of its atmospheric observation system, updated the DZZ4 automated atmospheric station, and intensified the data storage frequency to 5 minute. Except for several times data losses, its cumulative working day is about 253.

气象观测系统

Atmosphere observation system in the sea-land Interface





气象观测数据

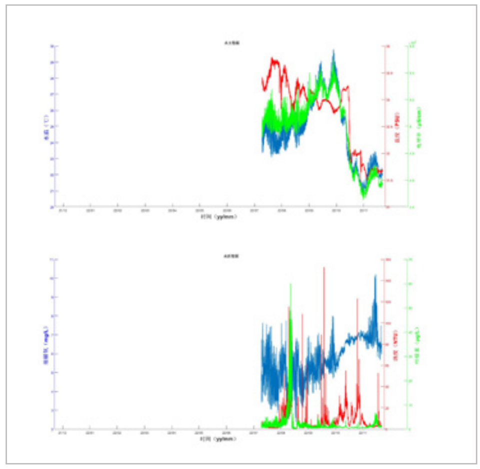
Data collected by the Atmosphere observation system

海底有缆珊瑚生态在线观测

Coral ecosystem cabled observation

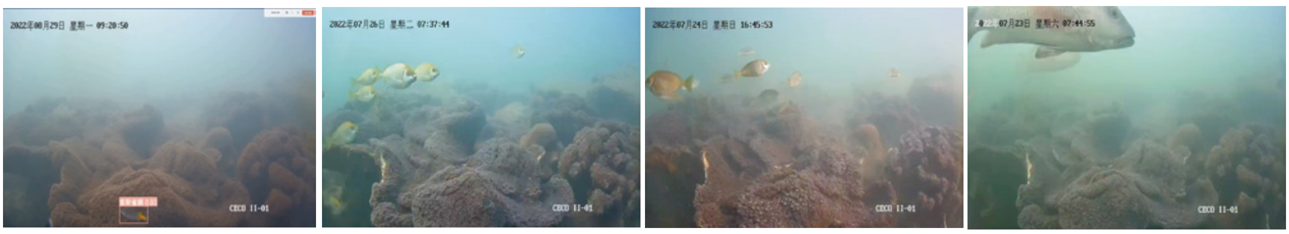
2022年，台海站对海底有缆珊瑚生态在线观测系统进行了自主维修改造，有效降低了系统的故障率，稳定了网络环境，保障数据及时回传，提供更稳定的观测数据和水下视频资料。全年数据产出天数170天，维护5次，累计获取高清录像时长3800小时。在东山湾养殖密集区布放的养殖水体观测系统初步实现温度、盐度、深度、电导率的剖面实时观测。为开展造礁珊瑚生态实验、保育及救护工作提供技术支撑。

In 2022, the second-generation coral ecosystem cabled observatory (CECO-Ⅱ) was passed sea trials and officially put into use, which reduces the fault frequencies and provides observation data and video under higher stability. It was salvaged for maintenance five times, and the cumulative acquisition of underwater HD recording is about 3800 hours in the whole year. It achieves real-time observation of water temperature, depth, salinity, and conductivity in intensive farming areas in Dongshan Bay, which provides technical support for reef-building coral ecological experiments and coral restoration.



海底珊瑚原位观测数据

Data collected by the CECO-II



实时水下观测视频图像

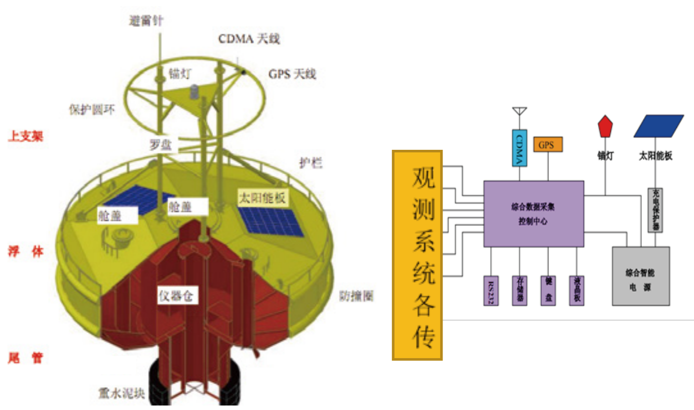
Screenshot of underwater HD recording

水动力浮标观测

Hydrological observation system

2022 年 4 月，台海站在东山湾上升流海域投放水动力浮标观测系统，收集气象，水文及水质等参数。5月1日开始计算数据产出， 11月26日回收。以波浪数据为参考，该系统在位期间共产生约162天观测数,收集12MB数据。

T-SMART displayed the hydrological observation system (HYDRO) in April 2022 to collect atmospheric and hydrological data. From 1 May to 26 November, the system runs efficiently for about 162 days based on wave parameters, collected data 12 MB.



水动力浮标观测

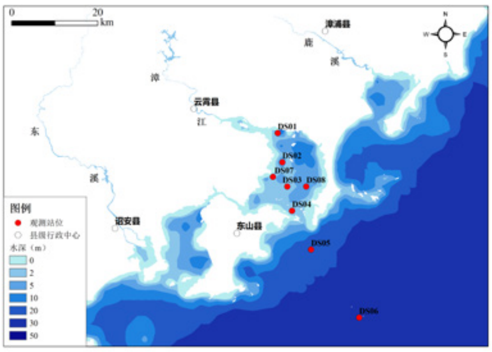
Hydrological observation system

东山湾观测区调查航次

The quarterly cruises of the T-SMART in the Dongshan Bay observation area

长期定点观测是台海站的主要任务之一，也是揭示人类活动和全球变化对海洋生态系统长期影响的研究基础。2022年，台海站在1月、4月、8月、11月完成了东山湾冬季、春季、夏季、秋季季度观测航次，逐步积累东山湾水文，生态环境关键背景资料，有力支持海洋环境参数的时间动态和空间变异解析。

Long-term field fixed-point observations are one of the main tasks of T-SMART, and it also serves as a base to reveal the long-term impact of human activities and global change on marine ecosystems. The quarterly cruise was officially launched in Dongshan bay in January, April, August, and November 2022, and collected data for local hydrology and environment.



东山湾观测站位
Observation sites in the Dongshan Bay

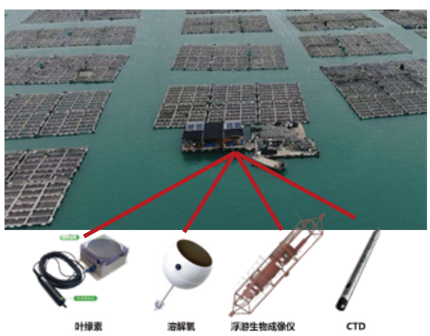
2022年东山湾共享航次合影
Group photo of the cruise in the Dongshan Bay

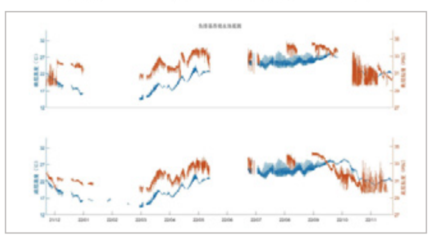
东山湾养殖水体实时观测

Real-time monitoring for mariculture seawater in Dongshan Bay

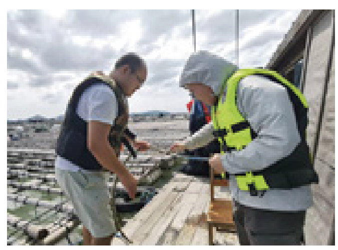
东山实验场依托渔排基海洋观测平台，利用物联网技术，在东山湾养殖密集区布放温盐链、太阳能多参数水质仪，初步实现温度、盐度、叶绿素等参数的实时观测。2022年度渔排基养殖水体观测系统，收集数据11MB。期间共计运行维护5次；主要进行传感器清洁校准维护，传输系统维护。

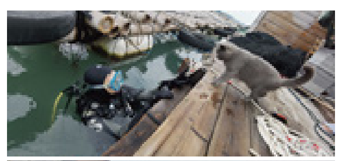
Relying on the Ocean Observation Platform based on Mariculture Rafts and using the Internet of Things system, the CTD chain and a solar multiparameter water quality monitoring instrument were deployed in the intensive aquaculture area of Dongshan Bay to gather preliminary real-time temperature, salinity, and chlorophyll data. In 2022, the system was maintained 5 times, producing data 11 MB.

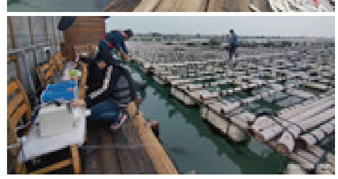




渔排基养殖水体观测系统表底温盐数据
Temperatur and salinity data collected by monitoring system based on mariculture rafts





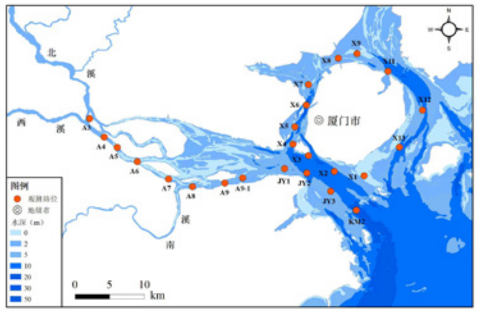


厦门湾观测区季度调查航次

The quarterly cruise in the Xiamen Bay observation area

2022年，台海站以“海洋2号”（76吨）科考船为支撑，开展九龙江口–厦门湾季度共享航次4次，服务了厦门大学、集美大学、自然资源部第三海洋研究所等20多个课题组，获取九龙江口–厦门湾多学科参数，获取水文、生源要素、水化学、生物等综合参数集，搭建河海界面多学科交叉研究平台，共同推进河海界面生物地球化学过程、生态过程和环境效应等研究。

In 2022, supported by the "Ocean 2" (76 tons) scientific research vessel, T-SMART carried out quarterly cruises in the Jiulong River Estuary - Xiamen Bay, serving more than 20 research groups from universities and research institutes including Xiamen University, Jimei University and Third Institute of Oceanography of the Ministry of Natural Resources. Parameters of hydrology, biogenic elements, hydrochemistry, and biology were collected in the Jiulong River Estuary - Xiamen Bay. By establishing an interdisciplinary research platform for the river-sea interface, the cruise jointly promotes the study of biogeochemical processes, ecological processes and environmental effects at the river-sea interface.



厦门湾观测站位

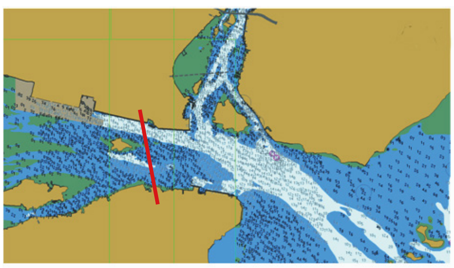
Observation sites in the Xiamen Bay

2022年九龙江口–厦门湾冬季共享航次合影

Group photo of the winter cruise in the Jiulong River Estuary - Xiamen Bay

水质综合在线监测浮标

Online integrated water quality monitoring buoy



九龙江河口鸡屿断面

Jiyu Section in Jiulong River Estuary

水质综合在线监测浮标

Online Integrated Water Quality Monitoring Buoy

2022年，台海站布放于九龙江河口鸡屿断面（24° 25.7’ N, 118° 0.513’ E）的水质综合在线监测浮标运行稳定，监测指标包括硝氮、亚硝氮、氨氮、磷酸盐、水温、盐度、pH、溶解氧、浊度、叶绿素、气温、气压、风速、风向和相对湿度等参数，实时观测数据通过GPRS等无线通讯方式传输到地面控制中心。为河海界面污染物通量的估算提供了有力支撑。

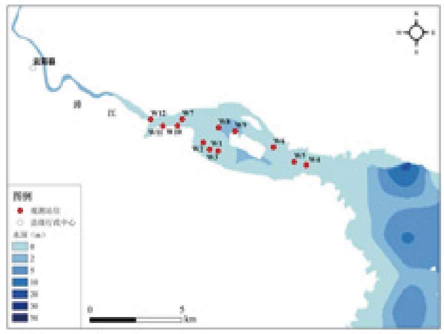
In 2021, the online integrated water quality monitoring buoy deployed by T-SMART at the Jiyu section of the Jiulong River Estuary (24°25.7’N, 118°0.513’E) operated stably. The monitoring indicators such as nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, phosphate, water temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll, air temperature, air pressure, wind speed, wind direction, relative humidity were included. The real-time observation data were transmitted to the ground control center through GPRS and other wireless communication methods. In 2021, the effective data acquisition rate of the online integrated water quality monitoring buoy reached 98.8%, which provides strong support for estimating pollutant flux at the river-sea interface.

漳江口观测区季度调查航次

The quarterly cruise in the Zhangjiang Estuary observation area

长期定点观测是台海站的主要任务之一，也是揭示人类活动和全球变化对滨海湿地生态系统长期影响的研究基础。2022年台海站漳江口场完成春、夏、秋、冬四个季度的航次调查，获得水文水质、浮游动物、底栖动物等方面的监测数据。漳江口观测区位于福建省漳州市云霄县漳江口，沿漳江河口水域至红树林潮沟，结合潮周期人工取样，量化地表水−地下水垂向交换水量和物质通量、红树林/互花米草−河口系统横向物质交换通量。漳江口实验场为航次的执行提供了有力的技术支撑和后勤保障。

Long-term field fixed-point observations are one of the main tasks of T-SMART. It also serves as a base to reveal the long-term impact of human activities and global change on coastal wetland ecosystems. The quarterly cruise was officially launched in Zhangjiang Estuary in January, April, August, and November 2022. Samplings have been set during a tidal cycle from Zhangjiang estuarine waters to mangrove tidal creeks, to quantify surface water-groundwater vertical exchanges of water and material flux, and mangroves/Spartina alterniflora-estuary system horizontal material exchange flux. M-ECORS provides technical and logistical support for the cruise.



漳江口观测站位

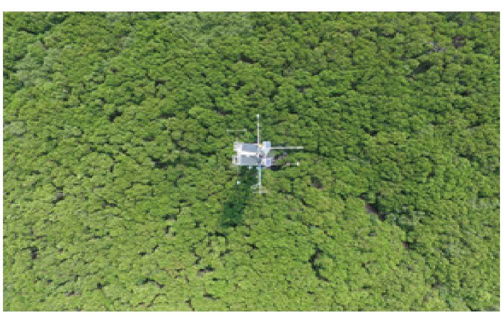
Observation sites in the Zhangjiang Estuary

漳江口站航次监测合照

Photos of Zhangjiang Estuary cruises

滨海湿地遥感观测

Remote sensing observation for coastal wetlands



无人机拍摄的漳江口景观

Landscape photos of Zhangjiang Estuary from drone

漳江口实验场红树林通量观测塔塔顶安装了遥感光谱观测系统，包括多光谱观测仪器（Decagon植被指数观测仪）和高光谱观测仪器。仪器观测频率为每5分钟1次。通过配置仪器温控系统、数据自动采集系统，开展红树林植被光谱数据的长期连续测量，计算多种植被光谱指数与日光诱导的叶绿素荧光。另外，依托遥感观测监测，掌握漳江口湿地不同生境类型的变化情况，以及外来物种的扩散情况。

A remote sensing spectral observation system is installed on the top of the mangrove flux observation tower in M-ECORS, including a multispectral observation instrument (Decagon vegetation index observer) and a hyperspectral observation instrument. The system works every five minutes to collect data. Equipped with an instrument temperature control system and automatic data acquisition system, the system manages to carry out long-term continuous measurement of the spectral data of mangroves and to calculate the spectral index and chlorophyll fluorescence induced by the sunlight of different vegetation species. In addition, based on the remote sensing observation system, changes in different habitat types in Zhangjiang Estuary Wetland, and expansion of invasive species could be monitored.

滨海湿地动物监测

Faunal biodiversity surveys for coastal wetlands

为长期跟踪监测漳江口红树林湿地的动物多样性，漳江口实验场设置了鸟类、鱼类和底栖动物等监测样线和样方，监测指标包括动物的种类、数量、生物量和分布等，2022年，漳江口实验场完成动物多样性监测2次。在漳江口红树林国家级自然保护区的支持下，漳江口实验场开展了多年的鸟类和底栖动物等，掌握了不同动物类群的种群动态和分布，为生物多样性保护积累了重要的基础数据。

To carry out long-term surveys of the faunal biodiversity, line transects and quadrats have been set in Zhangjiang Estuary to conduct bird, fish, and benthic fauna surveys. M-ECORS, with supports from Zhangjiang Estuary Mangrove Nature Reserve, The survey are conducted twice in 2022 to record species and their quantity as well as distribution, which provides basic evidence for biodiversity conservation in this estuary.

漳江口实验场动物监测

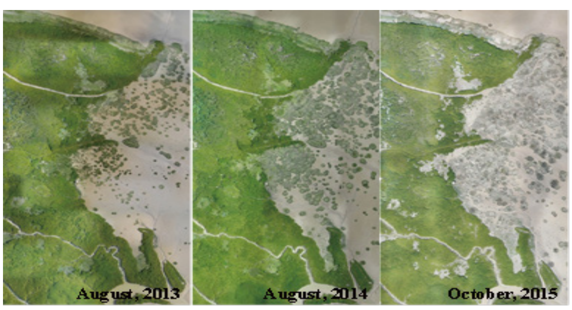
Photos of fuana biodiversity survey in Zhangjiang Estuary

盐沼和红树林样方监测

Quadrat survey in salt marsh and mangrove forests

为长期跟踪监测红树林及盐沼湿地植被生长情况、湿地面积变化、外来物种入侵情况，及其对全球气候变化和人类活动的响应等，在漳江口实验场设置了6个红树林永久样地，观测频率为每年1次，观测指标包括红树植物群落种类、高度、密度、胸径以及红树植物凋落物的类别、质量等，同时设置了10个盐沼植物样地，2022年漳江口实验场完成红树林和盐沼固定样方监测各1次，观测指标包括盐沼植物群落种类、高度、密度、基径等。以上观测为红树林生态系统研究，红树林湿地蓝碳以及互花米草入侵红树林的格局、过程和机制研究提供重要支撑。

To carry out long-term surveys of the vegetation growth, wetland areas, and invasive species of both mangrove wetlands and salt marshes, as well as their responses to global climate change and human activities, six mangrove permanent quadrats and ten salt marshes permanent quadrats have been set in Zhangjiang Estuary. Quadrat surveys of both mangrove wetlands and salt marshes are carried out once in 2022. The parameters of mangrove permanent quadrats surveyed include mangrove species, tree height, tree density, diameter at the breast (DBH), as well as the category and weight of mangrove plant litter, etc. The parameters of salt marsh permanent quadrats surveyed include salt marsh plant species, height, density, stem base diameter, etc. These surveys provide important support for the study of mangrove ecosystems, as well as the pattern, process, and mechanism of blue carbon and *spartina alterniflora* invasion in mangrove wetlands.



外来种互花米草在漳江口滩涂扩张的时空动态

Expansion of the invasive *Spartina alterniflora* on the mudflats in Zhangjiang Estuary from 2013 to 2015

漳江口盐沼植被长期定位观测样方

Salt marsh permanent quadrats in Zhangjiang Estuary

Research Highlights

科学亮点

寡营养海域微微型浮游植物昼夜变动研究新进展

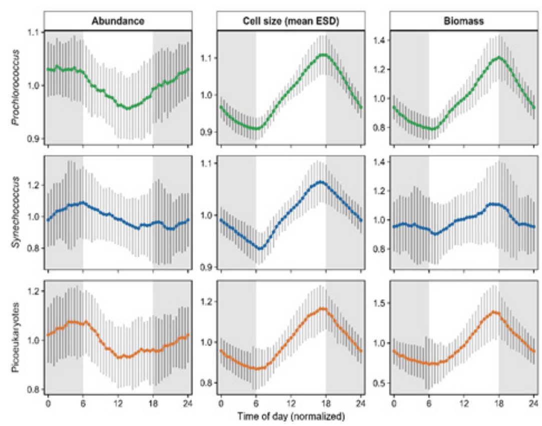
Quasi-antiphase diel patterns of abundance and cell size/biomass of picophytoplankton in the oligotrophic ocean

海洋微微型浮游植物是地球上粒径最小、丰度最高的产氧光合生物。作为广阔寡营养海域的优势微生物类群，微微型浮游植物是海洋初级生产力的重要组成部分，在海洋生态系统功能和生物地球化学循环中发挥着重要作用。早期研究表明微微型浮游植物细胞丰度的昼夜变动特征表现为夜间上升白天下降，而细胞大小表现为白天增大夜间变小。近年来的研究发现其碳生物量也呈现白天增加夜间下降的昼夜变动特征。关于捕食者在调控微微型浮游植物昼夜变动上的作用的研究仍是有限的，甚至出现一些相互矛盾的结论。考虑到上述研究工作都是独立的，涉及的参数也都不全面，基于多参数（细胞丰度、细胞大小、碳生物量及捕食等下行调控因素）同步分析去研究微微型浮游植物的昼夜变动是很有必要的。目前尚缺乏这种综合性的研究。

研究团队在南海三个寡营养测站开展高分辨率的时间序列观测，并通过经实验室藻株“校准”的流式细胞仪同时测定微微型浮游植物的细胞数量、细胞大小和碳生物量。结果表明微微型浮游植物的细胞数量和细胞大小/碳生物量与昼夜周期密切同步，但它们之间存在准反相关系；即细胞丰度夜间分裂上升、白天下降，而细胞大小和碳生物量均呈白天增大、夜间降低。此外，培养实验还发现在白天与夜间微型鞭毛虫对原绿球藻和聚球藻的捕食压力是相当的。进一步利用已公开发表的包含37个航次的高分辨率时空变动的SeaFlow 数据集联合分析，证实了南海观测到的这种准反相昼夜变化模式在寡营养海区具有普适性。

本研究证实并扩展了先前关于寡营养海域中微微型浮游植物的昼夜周期变化的研究结果，指出了微微型浮游植物细胞丰度与细胞大小/碳生物量呈现的准反相昼夜变化关系很可能是近稳态寡营养生态系统的一个普遍特征。这项研究提高了我们对这些最小的自养生物的认知，有助于更好地理解寡营养海区生态系统和生物地球化学过程。

Picophytoplankton are the smallest, most abundant photosynthetic organisms in the ocean. Knowledge of the diel variability of these tiny microbes has important implications for the structure of microbial food webs and key biogeochemical processes. However, insight into the mechanisms that underlie picophytoplanktonic diel dynamics is limited. By combining a field survey with a published dataset, we found that cell numbers and cell sizes/biomasses of picophytoplankton were tightly synchronized to the day-night cycle, but they were in a quasi-antiphase relationship to each other. This pattern is a confirmation and extension of previous studies. Mortality rates showed that Prochlorococcus and Synechococcus were subject to considerable grazing pressure throughout the day and night. The quasi-antiphase diel cycles in abundance and cell size/biomass are likely determined by the light-dependent diel behavior of cell growth and division and continuous losses to grazing. This work significantly improves our understanding of autotrophic picoplankton in the oligotrophic ocean.



联合分析的38个航次每半小时平均的三个类群的微微型浮游植物细胞数量、细胞大小和碳生物量的变动。

Average half-hourly values of cell numbers, cell sizes, and carbon biomasses of three picophytoplankton groups across all 38 cruises.

以上工作于2022年3月发表于*Geophysical Research Letters*期刊，博士生李长林为第一作者，黄邦钦教授为通讯作者。

Reference : LI, C., CHIANG, K.-P., LAWS, E. A., LIU, X., CHEN, J., HUANG, Y., CHEN, B., TSAI, A.-Y. & HUANG, B. 2022. Quasi-Antiphase Diel Patterns of Abundance and Cell Size/Biomass of Picophytoplankton in the Oligotrophic Ocean. Geophysical Research Letters, 49, e2022GL097753.

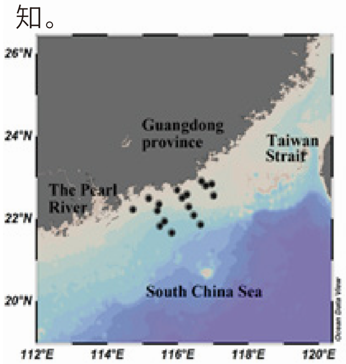
河口羽流-上升流耦合系统中微生物群落的构建机制研究

Water masses and their associated temperature and cross-domain biotic factors co-shape upwelling microbial communities

河口羽流区与近岸上升流区是海-陆界面相互作用中最重要、最典型的两个区域。河口羽流-上升流耦合系统接受大量河流径流的同时，受海水涌升等物理过程的强烈影响，系统中微生物群落与环境因素之间关系尤为复杂。以往研究多关注非生物因素对原核类群的影响，对物理过程、生物因素与非生物因素如何相互作用，驱动河口羽流-上升流耦合系统中微生物组分布模式，知之甚少。

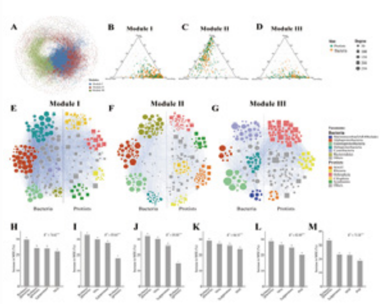
针对以上科学问题，通过大面站走航与锋面区连续观测，利用基于小亚基核糖体转录本的高通量测序技术，较为系统地研究了南海北部粤东上升流系统中微生物群落分布及其驱动因素。发现西南季风期间，粤东上升流受珠江羽流影响，水团间相互作用导致了锋面区群落的积累与交换，而微生物群落在水团之间存在强烈扩散限制。

通过跟踪不同水团的生物和非生物因子的变化，发现生物（特别是跨界生物互作）和温度在塑造微生物群落中发挥重要作用。进一步分析发现，温度和跨界生物因素对原生生物与细菌的贡献不同，相较于原生生物，细菌与温度及其它理化参数相关性较强，表明细菌与理化因子耦合性更强；跨界生物因素对原生生物的影响更大，可能反映了其对生物互作的高度依赖，但对非生物资源消耗的依赖程度较低。进一步利用零模型分析，发现随机过程是驱动河口羽流-上升流耦合系统微生物群落构建的主要过程，其中，决定性过程对上升流中群落的影响较大，表明珠江羽流入侵对耦合系统微生物群落产生更多随机影响。这项研究推进了我们对河口羽流-上升流耦合系统微生物群落分布、驱动因素与构建机制的认知。



河口羽流-上升流航次观测站位与微生物多样性及群落组成

Sampling sites of upwelling cruise and microorganism diversity and their community structures



微生物群落共现模式及其驱动因素

Co-occurrence pattern of microbial communities and its trigger

Disentangling the drivers and mechanisms that shape microbial communities in a river-influenced coastal upwelling system requires considering a hydrologic dimension that can drive both deterministic and stochastic community assembly by generating hydrological heterogeneity and dispersal events. Additionally, ubiquitous and complex microbial interactions can play a significant role in community structuring. However, how the hydrology, biotic, and abiotic factors collectively shape microbial distribution in the hydrologically complicated river plume-upwelling coupling system remains unknown. Through underway sampling and daily observations, we employed 16S and 18S ribosomal RNA sequencing to disentangle drivers and mechanisms shaping the protist-bacteria microbiota in a river-influenced coastal upwelling system. Our findings indicate that the composition of microbial communities was water mass specific. Collectively, water mass, local water chemistry (mostly temperature) and biotic interaction (mostly cross-domain biotic interaction) shaped the protistan-bacterial communities. In comparison to protists, bacteria were more influenced by abiotic factors such as temperature than by cross-domain biotic factors, implying a stronger coupling of geochemical cycles. Both deterministic and stochastic processes had an effect on the distribution of microbial communities, but deterministic processes were more important for bacteria and were especially pronounced for upwelling communities. The co-occurrence network revealed strong associations between the protistan assemblages Orchrophyta and Ciliophora and the bacterial assemblages Alphaproteobacteria, Deltaproteobacteria, and Bacteroidetes, which may reflect predation and mutualism interactions. Overall, this study emphasizes the importance of taking water masses, temperature and domains of life into account when seeking to understand the drivers and assemblies of protist-bacteria microbiome dynamics in coastal upwelling systems, which is especially true given the complex and dynamic nature of the coastal ecosystem.

以上工作于2022年发表于*Water Research*期刊，孙萍副教授为本文第一作者和通讯作者，黄邦钦教授为共同通讯作者。

Reference: SUN, P., WANG, Y., HUANG, X., HUANG, B. & WANG, L. 2022. Water masses and their associated temperature and cross-domain biotic factors co-shape upwelling microbial communities. Water Research, 215, 118274.

基于智能手机的便携式水环境分析系统

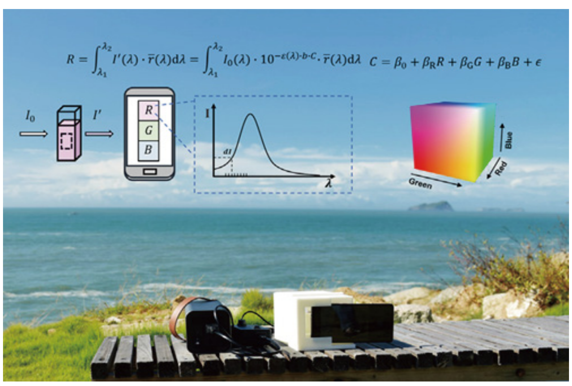
Development of a versatile smartphone-based environmental analyzer, vSEA and its application in on-site nutrient detection

随着数字通讯技术的发展，智能手机因兼具集成各种传感器、操作简单、便携易用、通讯功能强大等优点，成为搭载便携式现场分析设备的良好载体。但现有基于智能手机的分析检测仍存在算法模型复杂、未标准化、缺乏对不同手机造成的偏差的理解与校准、现场应用较少等诸多局限性。

本研究提出了一种基于智能手机的通用型比色检测算法，并建立了一个模型，模拟分析了从相机光谱信息到RGB（Red，Green，Blue）颜色信息的转换过程。此外，还探讨了该算法用于不同目标物定量的可行性。

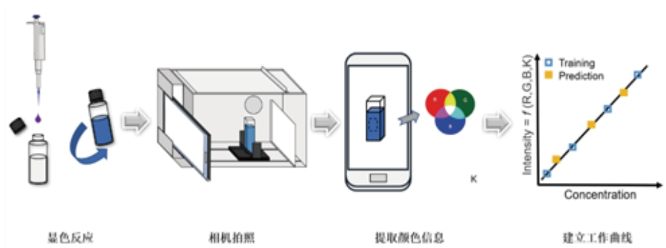
根据所研发的新算法，我们建立了基于智能手机的便携式水环境分析仪，即vSEA，通过优化传感器装置结构，标准化测定过程，开发与传感器适配的应用程序，我们对vSEA的可靠性、通用性和分析性能进行了综合优化，其具有良好的线性度（$R^2 \geq 0.9954$）和精密度（相对标准偏差< 5.3%）。

有研究表明不同手机性能之间存在巨大差异。本研究探究了不同手机、不同操作人员对测定结果的影响，结果显示不同手机的灵敏度虽然不同，但得到的工作曲线均有良好的线性度，因此认为vSEA对智能手机无严格要求，只需要保证定标和测定过程使用同一手机即可；不同操作人员使用同一手机进行检测其测定结果也无显著差异。将vSEA用于环境水体中五种营养盐（氨氮、硝酸盐、亚硝酸盐、磷酸盐、硅酸盐）的现场分析，测定结果与标准的分光光度法无显著性差异，且vSEA操作简单、对使用人员的专业性要求低，可将其推广至公民科学的应用中。



The citizen-science-based environmental survey can benefit from the smartphone technology used in chemical and biological sensing of a wide range of analytes. Quantification by smartphone-based colorimetric assays is being increasingly reported, however, most of the quantification uses an empirical formula or complex exhaustive methods. In this study, a versatile and robust algorithm is proposed to overcome these limitations. A model is established to simulate and analyze the conversion process from the camera's spectral information into RGB (Red, Green, Blue) color information. Moreover, the feasibility of the algorithm for the quantification of different analytes is also explored. Based on this algorithm, a versatile smartphone-based environmental analyzer (vSEA) is built and its reliability, versatility, and analytical performance are comprehensively optimized. The good linearity ($R^2 \geq 0.9954$) and precision (relative standard deviations < 5.3%) indicate that the vSEA is accurate enough to quantify the nutrients in most natural waters.

Although studies have argued that there is a huge difference in performance between different phones, our results identified a relative error of less than 10% are obtained using different smartphones ($n = 3$), color extracting software ($n = 6$), and with multiple individual users ($n = 5$). These results show the robustness and applicability of the proposed method. Furthermore, the vSEA is used for the field measurement of five important nutrients, and the results show no significant difference compared to conventional methods. The vSEA offers a simpler and easier method for the on-site measurement of nutrients in natural water bodies, which can aid in the emergency monitoring of aqueous ecosystems and the performance of citizen-science-based research.



vSEA系统测定流程

vSEA testing process

以上工作于2022年发表于*Science of The Total Environment*、*Microchemical Journal* 期刊，博士生李杭茜、方腾越，硕士生郑书露分别为系列论文的第一作者，马剑教授为论文的通讯作者。

Reference :

ZHENG, S., LI, H., FANG, T., BO, G., YUAN, D. & MA, J. 2022. Towards citizen science. On-site detection of nitrite and ammonium using a smartphone and social media software. Science of The Total Environment, 815, 152613.

LI, H., FANG, T., TAN, Q.-G. & MA, J. 2022. Development of a versatile smartphone-based environmental analyzer (vSEA) and its application in on-site nutrient detection. Science of The Total Environment, 838, 156197.

基于自动化流动分析仪实时走航观测表层海水的营养盐浓度

Real-Time Underway Mapping of Nutrient Concentrations of Surface Seawater Using an Autonomous Flow Analyzer

受人类活动和全球变化影响，河口–近海区域富营养化、缺氧、酸化等生态环境问题严峻，且形成了复杂的多重效应耦合机制，是国际“未来地球（Future Earth）”研究计划聚集的区域。“工欲善其事，必先利其器”。为提升生物地球化学过程与生态系统过程等基础科学研究，亟需对海洋环境参数进行现场多参数、高精度、高时空分辨率的自动测定。

本研究以科学需求为导向，结合分析化学、电子学、仪器科学、环境科学、海洋化学等多个学科，从快速简便、用户友好、环境友好、多目标同时测定四个方面入手，对课题组多年潜心钻研的集成式水环境营养盐分析仪（iSEA系统）进行优化与升级，形成了全新的iSEA–II系统。该系统突破国内外在海水化学参数现场分析方面的技术瓶颈，并与自动在线过滤系统结合，成功应用于河口–海湾营养盐（氨氮、硝酸盐、亚硝酸盐、硅酸盐和磷酸盐）监测，实现获取高时空分辨率、高准确度的营养盐多参数同步走航观测数据的目标。

iSEA–II仪器的性能主要表现如下：

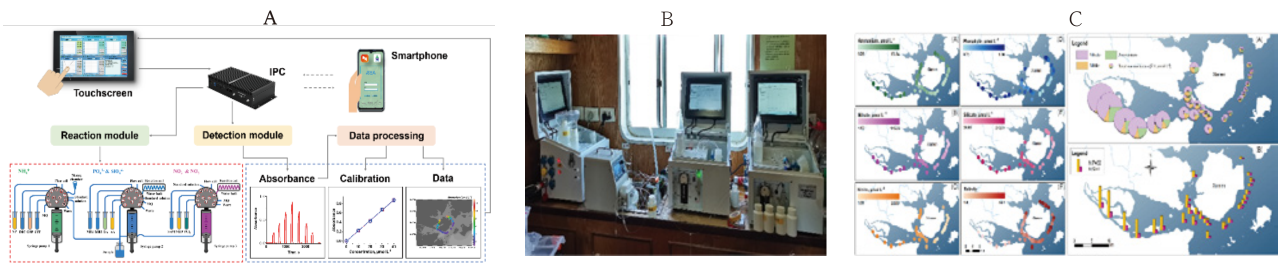
1. 结构紧凑，集成分析模块、检测模块及人机交互模块，做到即插即用，操作简便，适用于海洋调查的现场艰苦环境；

2. 自动化程度高，自主研发软件实现自动绘制工作曲线、自动质量控制、自动稀释高浓度样品、数据自动处理、保存和传输、自

3. 测定速度快、测定范围宽、可克服盐度干扰，适用于河口–海湾营养盐的走航观测；

4. 样品和试剂消耗量小，对于单个样品单参数测定，样品和试剂消耗量分别少于500 μ L、50 μ L，适用于小体积样品的测定。

High-frequency field nutrient analyzers offer a promising technology to solve time-consuming and laborious sampling problems in dynamic and complex river–estuarine–coastal ecosystems. However, few studies on the simultaneous underway analysis of five key nutrients (ammonium, nitrite, nitrate, phosphate, and silicate) in seawaters are available because of the limitations of the technique. In this study, a state-of-the-art autonomous portable analyzer for the shipboard analysis of nutrients in the environment of varied salinities and concentration ranges was reported. The analyzer consisted of compact hardware that was well suited for shipboard deployment with minimal maintenance. Moreover, a novel LabVIEW-based software program was developed, containing additional functions such as automated calibration curve generation, auto-dilution of high-concentration samples, and a user-friendly interface for multiparameter analysis using a single instrument. After the optimization of chemical reactions and work flow chart, the analyzer exhibited low limits of detection, a large linear range with automated dilution, and relative standard deviations of less than 2% (n = 11). Compared to other flow-based techniques, this analyzer is more portable and consumes less reagent with an autonomous data processing function and applicability within a broad salinity range (0-35). The analyzer was successfully applied for real-time analysis in the Jiulong River Estuary–Xiamen Bay with excellent on-site accuracy and applicability. The relationship between high spatial resolution nutrient concentrations and salinities showed very different patterns in estuarine and coastal areas, indicating the benefit of using an underway automated analyzer for chemical mapping in a dynamic environment.



A: iSEA–II营养盐测定系统流程图；B：iSEA–II系统现场应用实拍图；C：iSEA–II应用于河口–海湾进行营养盐五参数的同步走航观测。

以上工作于2022年7月发表于*Analytical Chemistry*期刊，博士生方腾越为第一作者，马剑教授为通讯作者。

Reference : Fang, T. Y., Bo, G. Y., Zhang, Z. J. & Ma, J. 2022. Real-Time Underway Mapping of Nutrient Concentrations of Surface Seawater Using an Autonomous Flow Analyzer. Analytical Chemistry, 94, 11307-11314.

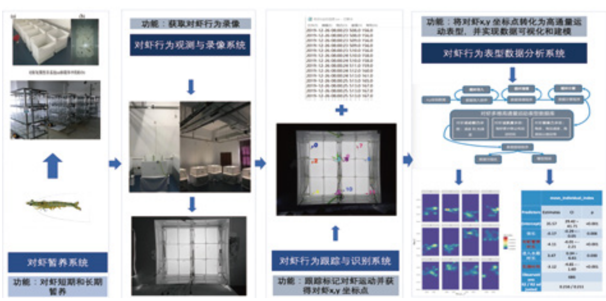
基于计算机视觉的对虾高通量表型大数据智能化测量及装备研发研究

Research and development of equipment of Intelligent measurement of high-throughput phenotype of shrimp based on computer vision technology

借助于互联网、大数据和人工智能技术，可以快速、精准、高效的获取高通量的表型数据，并将其与环境数据和遗传资源数据相结合，以最快速、最有效、最智能的方式确定特定生物育种路线，加速育种进程。

在传统的对虾育种过程中，对虾表型获取主要依靠手工测量，其具有耗时长、误差大、无法规模化获取批量表型数据等缺陷。计算机视觉技术可以通过图像采集技术经过预处理、分割和特征提取，可高效、精准、无损和低成本的获取表型量化数据，进而有效解决对虾传统表型测量中的困难。在植物表型组学研究领域，向量机（SVM）、随机森林、人工神经网络（ANN）、卷积神经网络（CNN）和深度卷积神经网络（DCNN）等人工智能算法结合计算机视觉技术，已实现对植物器官自动分类与识别、表型性状的高通量解析和植物病害性状的自动解析。

本课题组与信息学院刘向荣教授课题组长期以来一直合作致力于对虾表型量化研究，已实现对虾形态和体重的自动识别，通过对虾行为表型识别系统的开发，分别实现了对虾单尾和多尾的行为跟踪和量化，并建立了对虾高通量行为表型测量平台，首次实现了对虾高通量表型的提取、量化和分析，确定了对虾表型测量的技术流程，建立了首个对虾高通量表型数据库，并完成了数据统计分析、可视化和建模。基于上述研究基础之上，本课题组还建立了对虾组织、生理、形态和摄食表型高通量量化技术，初步研发了对虾多种高通量表型测量装置，为对虾由分子育种阶段到智能化育种阶段的转变打下基础，加速对虾育种进程。



对虾高通量行为表型观测平台

High-throughput behavioural phenotyping platform for shrimps

Artificial intelligence breeding technology allows quickly, accurately and efficiently obtain high-throughput phenotypic data and combine it with environmental and genetic resource data to determine the fastest, most effective and most intelligent way to breed a particular organism and accelerate the breeding process.

In the traditional shrimp breeding process, shrimp phenotypes are mainly obtained by hand, which is time-consuming, error-prone and unable to obtain bulk phenotypic data on a large scale. Computer vision technology can be used to obtain quantitative phenotypic data through image acquisition, pre-processing, segmentation and feature extraction in an efficient, accurate, non-destructive and low-cost manner, thus effectively solving the difficulties in the traditional phenotypic measurement of shrimps. In the field of plant phenomics research, artificial intelligence algorithms such as vector machines (SVM), random forests, artificial neural networks (ANN), convolutional neural networks (CNN) and deep convolutional neural networks (DCNN) combined with computer vision technology have been used to achieve automatic classification and identification of plant organs, high-throughput analysis of phenotypic traits and automatic analysis of plant disease traits.

The group has been working with Professor Liu Xiangrong's group in the School of Information Technology for a long time on the quantification of shrimp phenotypes, and has achieved automatic recognition of shrimp morphology and body weight. Through the development of a shrimp behavioral phenotype recognition system, the behavioral tracking and quantification of single-tailed and multi-tailed shrimp have been achieved respectively, and a high-throughput behavioral phenotype measurement platform for shrimp has been established to extract, quantify and analyse shrimp high-throughput phenotypes for the first time. The technical process of shrimp phenotype measurement was defined, the first shrimp high-throughput phenotype database was established, and statistical analysis, visualisation and modelling of the data were completed. Based on the above research, the group has also established techniques for high-throughput quantification of shrimp tissue, physiology, morphology and feeding phenotypes, and has initially developed a variety of high-throughput phenotyping devices for shrimp, laying the foundation for the transition from the molecular breeding stage to the intelligent breeding stage of shrimp and accelerating the shrimp breeding process.

以上工作于2022年发表于*Fish & Shellfish Immunology*期刊，博士后程文志为第一作者，毛勇教授为通讯作者。

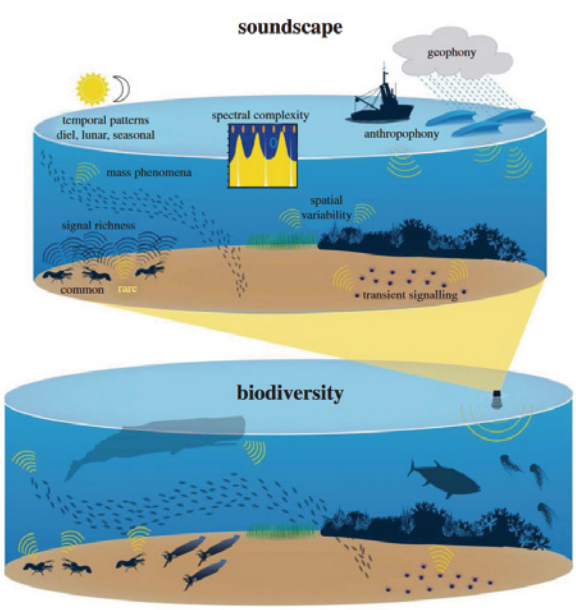
Reference： ZHANG, H., ZHENG, J., CHENG, W., MAO, Y. & YU, X. 2022. Antibacterial activity of an anti-lipopolysaccharide factor (MjALF-D) identified from kuruma prawn (Marsupenaeus japonicus). Fish & Shellfish Immunology, 127: 295-305.

鱼类听觉感知机制研究

The study of hearing mechanism in fish

海洋作为一个巨大的“声数据库”，包含着如：海洋生物发声信号、地球物理运动和人为活动的声信号等。水下声音的多样性为海洋栖息生物有利于生存的信息和线索。许多种群，包括鱼类、海洋哺乳动物和无脊椎动物，长期以来都被认为是制造和利用声音的专家，以完成捕食、产卵和社会交流等生物行为。声音探测对于鱼类在合适的栖息地定居、交流和躲避捕食者至关重要。其内耳作为声接收的主要器官，可以通过直接刺激途径和间接刺激途径接收声信号，从而感知声音，获取声信号中的矢量信息（particle motion）和标量信息(sound pressure)。

通过Micro-CT技术，对不同鱼类进行断层扫描，重建鱼类听觉感知器官(耳石和鱼鳔)。并采用听觉诱发电位测量技术(AEP，Auditory evoked potentials)和有限元数值模拟(FEM，finite-element modeling)，分别进行生物学实验和数值模拟实验。结果表明，在声刺激的作用下，鱼鳔的共振使鱼类在相应的频率产生局部听觉阈值，并提高其听觉带宽。另外，我们对东山县常见经济鱼类，包括黄姑鱼*Nibea albiflora*、红拟石首鱼 *Sciaenops ocellatus* 和双棘原黄姑鱼 *Protonibea diacanthus* 开展听觉能力测量实验，研究了不同鱼类在听觉特性上的差异。



海洋水下声景的多样性

Acoustic diversity from the ocean soundscape.

The ocean is a rich natural reservoir of sounds from biological, geophysical, and anthropogenic sources. The diversity of sounds provides ocean inhabitants with information and cues that facilitate survival. Many taxa, including fish, marine mammals, and invertebrates, have long been known as experts in producing and interpreting sounds to fulfill the biological processes of feeding, spawning, and social communication. Sound detection is critical for fish to settle in suitable habitats, communicate, and avoid predators. The inner ear, as the organ of sound reception, can receive sound signals through direct and indirect stimulation pathway, to perceive and obtain the vector (particle motion) and scalar information (sound pressure) in the sound signal.

We conducted the tomography scanning on different fish based on Micro-CT technique to rebuild the auditory sensing organs including swim bladder and otoliths in fish. And we combined AEP measurement and numerical simulation based on finite-element modeling to conduct the various experiment. The results showed that the resonance of swim bladder could decrease the threshold on relative frequency responded and expand the acoustic detective bandwidth with responding to sound stimulation. Otherwise, we also conducted the hearing measurement on cultured commercial fish in Dongshan including *Nibea albiflora, Sciaenops ocellatus*, and *Protonibea diacanthus* to study the different fish in auditory characteristics.

在东山实验场进行鱼类听觉特性测量实验

Conducting the auditory characteristics measurement of different fish at D-SMART

以上工作于2022年发表于*Journal of Experimental Biology*期刊，博士研究生李泓泉为第一作者，张宇教授为通讯作者.

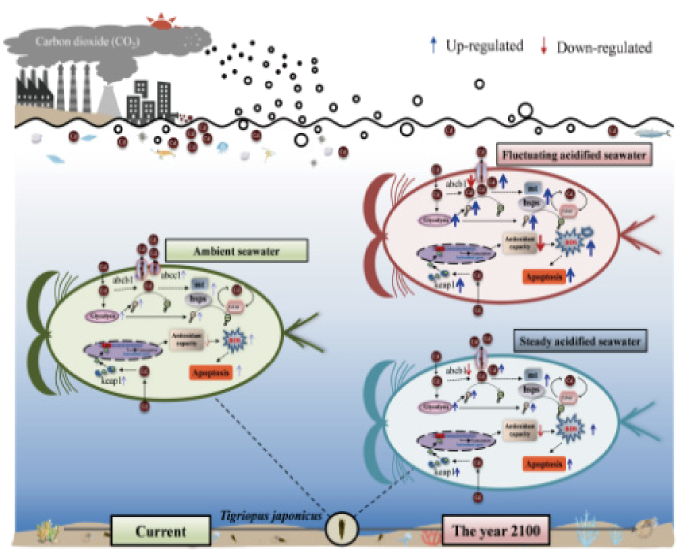
Reference : LI, H., GAO, Z., SONG, Z., SU, Y., OU, W., ZHANG, J. & ZHANG, Y. 2022. Swim bladder resonance enhances hearing in crucian carp (*Carassius auratus*). Journal of Experimental Biology, bioRxiv, 2022.08.01.502303.

昼夜波动的高二氧化碳分压强化了镉对海洋桡足类的生物毒性

Diel fluctuation superimposed on steady high pCO_2 generates the most serious cadmium toxicity to marine copepods

近岸水域由于生态环境复杂，其pH值呈现季节性和昼夜波动。此外，近岸水域也受到镉污染的严重威胁。因此海洋酸化（特别是波动酸化）和镉污染的耦合效应是中国近海面临的严重的环境问题之一。

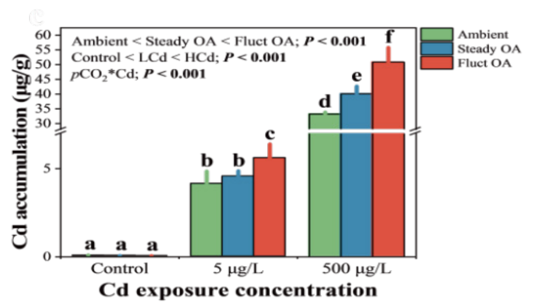
本研究以生态毒理学研究的模式物种—日本虎斑猛水蚤（*Tigriopus japonicus*）为研究对象，首先利用稳定同位素示踪技术确定在环境对照pCO_2（400 μ atm），稳定高pCO_2（1000 μ atm，稳定酸化）和波动高pCO_2（1000 ± 600 μ atm，波动酸化）与镉联合胁迫下镉的累积速率常数（kaccu）；之后我们将日本虎斑猛水蚤暴露于上述3种pCO_2情境与环境相关镉污染（5 μ g/L和500 μ g/L）下7天，分析桡足类体内镉累积和生理生化指标。结果表明：1）波动酸化的kaccu显著高于环境对照pCO_2和稳定酸化的kaccu；2）暴露后，相同水平镉污染下，比起环境对照pCO_2，酸化显著增加桡足类体内镉的累积，且波动酸化组最高；3）相较于单独镉污染，酸化与镉联合胁迫显著抑制了桡足类体内镉的外排，造成镉累积的增加。此外，联合胁迫产生了更多的能量、更强的解毒防御和应激反应、并增加了氧化应激和凋亡。



不同pCO_2与镉联合胁迫对日本虎斑猛水蚤影响的机制图

Schematic diagram of proposed mechanism concerning the effects of seawater acidification (steady and fluctuating) on cadmium (Cd) biotoxicity in *Tigriopus japonicus*.

Coastal systems experience diel fluctuation of pCO_2 and cadmium (Cd) pollution; nevertheless, the effect of fluctuating pCO_2 on Cd biotoxicity is poorly known. In this study, we initially performed the isotopically enriched organism bioassay to label Tigriopus japonicus with 113Cd (5 μg/L) to determine the Cd accumulation rate constant (kaccu) under ambient (400 μatm) and steadily (1000 μatm) and fluctuatingly elevated (1000 ± 600 μatm) pCO_2 conditions for 48 h. Next, T. japonicus was interactively subjected to the above pCO_2 exposures at Cd (control, 5, and 500 μ g/L) treatments for 7 d. Biochemical and physiological responses for copepods were analyzed. The results showed that steadily increased pCO_2 facilitated Cd bioaccumulation compared to ambient pCO_2, and it was more under fluctuating acidification conditions. Despite compensatory reactions (e.g., increased energy production), Cd ultimately induced oxidative damage and apoptosis. Meanwhile, combined treatment exhibited higher toxicity (e.g., increased apoptosis) relative to Cd exposure, and even more if fluctuating acidification was considered. Intriguingly, fluctuating acidification inhibited Cd exclusion in Cd-treated copepods compared to steady acidification, linking to higher Cd kaccu and bioaccumulation. Collectively, CO_2-driven acidification could aggravate Cd toxicity, providing a mechanistic understanding of the interaction between seawater acidification and Cd pollution in marine copepods.



不同pCO_2和镉污染下桡足类体内镉的累积量

Cd accumulation in the copepod after exposure to different pCO_2 and Cd

以上工作于2022年发表于*Environmental Science & Technology*期刊，博士生魏辉为第一作者，王大志教授和王明华教授为共同通讯作者。

Reference : WEI, H., QIAN, J., XIE, Z. X., LIN, L., WANG, D. Z. & WANG, M. H. 2022. Diel Fluctuation Superimposed on Steady High pCO_2 Generates the Most Serious Cadmium Toxicity to Marine Copepods. Environmental Science & Technology, 56, 13179-13188.

红树植物秋茄白化繁殖体形成的分子与遗传机制

Plastid development of albino viviparous propagules in the woody mangrove species of Kandelia obovata

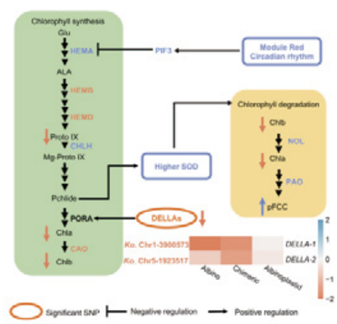
质体发育成叶绿体的过程对植物的生存至关重要。秋茄（*Kandelia obovata*）是一种常见的胎生红树植物，具有独特的发育方式，即种子不经过休眠，直接在母树上萌发而形成成熟的繁殖体。已经发现，繁殖体存活率与其颜色（棕色、绿色和白化）存在相关性。通过野外观察，在正常的绿色和棕色繁殖体中发现了罕见的白化繁殖体。亚细胞电镜观察表明，白化繁殖体叶片中只有白色体；生理测验表明其光合速率低，叶绿素a/b和类胡萝卜素含量显著降低，但超氧化物歧化酶活性增加。为了揭示控制白化质体发育的关键候选基因，对白化繁殖体和绿色繁殖体进行了全基因组关联研究（GWAS）。通过对30个繁殖体进行全基因组DNA测序分析，结果显示有25个显著的单核苷酸多态性位点（SNPs）与白化繁殖体发育相关，其中最显著的SNP位点位于1号和5号染色体上。通过将转录组数据和GWAS数据相结合比较，结果显示，显著差异表达基因主要参与卟啉和叶绿素代谢、类胡萝卜素和类黄酮生物合成等通路。特别是编码转录因子的基因KoDELLAs和编码查尔酮合成酶的基因KoCHS可能在促进叶绿素降解的同时，通过减弱叶绿素和类黄酮生物合成途径，进而在调控白化繁殖体质体发育中发挥重要作用。本研究旨在开发红树及其他木本植物的遗传资源，同时也为育林、生态恢复中选择合适的胎生红树植物繁殖体提供理论基础。

用于遗传分析的秋茄繁殖体的表型

A 三种颜色繁殖体（下胚轴）；B–C，在光下由白化繁殖体产生的白化或黄绿嵌合叶；D–E 在光下长出的绿色与棕色繁殖体苗；F 绿色繁殖体在暗中长出白化苗。

Phenotypes of propagules and true leaves of K. *obovata*. (A) Left to right: the brown, green and albino propagules of K. *obovata*. (B) Leaves of light-grown albino propagule (termed herein as Albino_L). (C) Chimeric leaves of light-grown albino propagule (Chimeric_L). (D) Leaves of light-grown green propagule. (E) Leaves of light-grown brown propagule (Brown_L). (F) Leaves of dark-grown green propagule (Green_D). Scale bar = 1 cm.

The process of plastids developing into chloroplasts is critical for plants to survive. However, this process in woody plants is less understood. *Kandelia obovata Sheue,* Liu & Yong is a viviparous mangrove species; the seeds germinate on the maternal tree, and the hypocotyls continue to develop into mature propagules. We identified rare albino propagules through field observation among normal green and brown ones. Toward unveiling the propagule plastid development mechanism, albino propagule leaves only have etioplasts, low photosynthesis rates, and drastically reduced chlorophyll a/b and carotenoid contents, but with increased superoxide dismutase activities. To identify candidate genes controlling propagule plastid development, a genome-wide association study (GWAS) was performed between the albino and green propagules. Twenty-five significant single nucleotide polymorphisms (SNPs) were associated with albino propagule plastid development, the most significant SNPs being located on chromosomes 1 and 5. Significant differentially expressed genes were identified in porphyrin and chlorophyll metabolisms, carotenoid and flavonoid biosynthesis by combining transcriptome and GWAS data. In particular, KoDELLAs, encoding a ·anscription factor and KoCHS, encoding chalcone ynthase, may be essential to regulate the albino ropagules plastid development through weakened hlorophyll and flavonoid biosynthesis pathways /hile promoting chlorophyll degradation. Our esults provide insights into genetic mechanisms egulating propagule plastid development in woody lants.



控制白化繁殖体质体发育的可能机制

Proposed molecular mechanism of transcription factors controlling the albino leaf color

以上工作于2022年发表于*Tree Physiology*期刊，博士生郝赛琦为第一作者，李庆顺教授为通讯作者。

Reference：HAO, S., HU, W., YE, C., SHEN, Y. & LI, Q. Q. 2022. Plastid development of albino viviparous propagules in the woody mangrove species of Kandelia obovata. Tree Physiology, 42, 2353-2368.

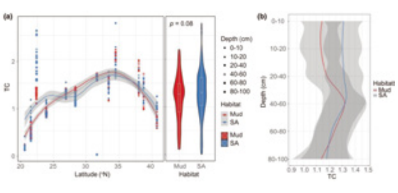
大陆尺度植物入侵重塑滨海蓝碳生态系统的土壤微生物组

Continental-scale plant invasions reshuffle the soil microbiome of blue carbon ecosystems

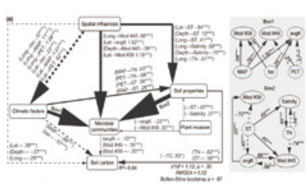
滨海湿地是地球上重要的蓝碳生态系统，在维持生物多样性和调节全球气候变化等方面发挥着关键作用。然而，过去四十年来，我国滨海湿地遭受了大面积的互花米草（*Spartina alterniflora*）入侵。作为入侵种，互花米草具有极强的环境适应性和繁殖能力，自1979年引入中国后已沿我国海岸线迅速扩张，侵占了大面积本土生境（包括芦苇、红树林和光滩等生境），严重威胁当地生物多样性与生态系统功能，引起学者的广泛关注。滨海湿地生境特殊，孕育了丰富且独特的微生物资源，然而，大陆尺度互花米草入侵下滨海湿地土壤微生物群落多样性的空间分布及其驱动机制仍是未知，这限制了我们对全球变化背景下滨海湿地土壤微生物组演变的准确认识以及对于滨海湿地微生物资源的挖掘。

研究表明：（1）光滩（Mud）与互花米草（SA）土壤在北纬34°左右区域具有最高的土壤碳库，两者总碳含量相当，均表现出明显的纬度分布模式。与光滩土壤相比，互花米草生境土壤的碳积累主要在浅层土壤（0–60厘米）；（2）互花米草入侵显著增加了土壤细菌α多样性，但同时也增加了细菌群落生物同质化程度，这表明互花米草入侵显著改变了土壤细菌群落结构，且细菌α多样性与β多样性之间存在权衡；（3）互花米草与光滩的土壤细菌群落相似性呈明显的距离衰减（distance-decay relationship，DDR）模式。与光滩生境相比，互花米草深层土壤中的DDR更显著，表明互花米草入侵加速了细菌群落的空间周转速率。其次，通过构建微生物生态网络，发现互花米草入侵降低了细菌共存网络的复杂性和稳健性；（4）本研究从微生物生态网络中鉴定了7个重要的生态模块，解析了生态网络复杂性、模块相对丰度与土壤碳库的关系。综上，土壤总碳主要受非生物因子调控，同时也受微生物组（包括模块#36、模块#45等）和网络复杂性的影响，而互花米草入侵则弱化了微生物组与总碳之间的强耦合关系。

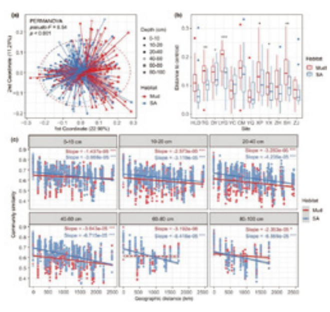
Theory and experiments support that plant invasions largely impact aboveground biodiversity and function. Yet, much less is known on the influence of plant invasions on the structure and function of the soil microbiome of coastal wetlands, one of the largest major reservoirs of biodiversity and carbon on Earth. We studied the continental-scale invasion of *Spartina alterniflora* across 2451 km of Chinese coastlines as our model-system and found that *S. alterniflora* invasion can largely influence the soil microbiome (across six depths from 0 to 100 cm), compared with the most common microhabitat found before invasion (mudflats, Mud). In detail, *S. alterniflora* invasion was not only positively associated with bacterial richness but also resulted in important biotic homogenization of bacterial communities, suggesting that plant invasion can lead to important continental scale trade-offs in the soil microbiome. We found that plant invasion changed the community composition of soil bacterial communities across the soil profile. Moreover, the bacterial communities associated with *S. alterniflora* invasions where less responsive to climatic changes than those in native Mud microhabitats, suggesting that these new microbial communities might become more dominant under climate change. Plant invasion also resulted in important reductions in the complexity and stability of microbial networks, decoupling the associations between microbes and carbon pools. Taken together, our results indicated that plant invasions can largely influence the microbiome of coastal wetlands at the scale of China, representing the first continental-scale example on how plant invasions can reshuffle the soil microbiome, with consequences for the myriad of functions that they support.



互花米草和光滩生境土壤总碳的空间分布规律
The latitudinal pattern of soil TC for mud and Spartina alterniflora habitats respectively



微生物共存网络与主要生态模块
The Structural equation model (SEM)



互花米草和光滩生境土壤细菌群落异质性和距离衰减模式
The influence of plant invasions on bacterial community composition and heterogeneity.

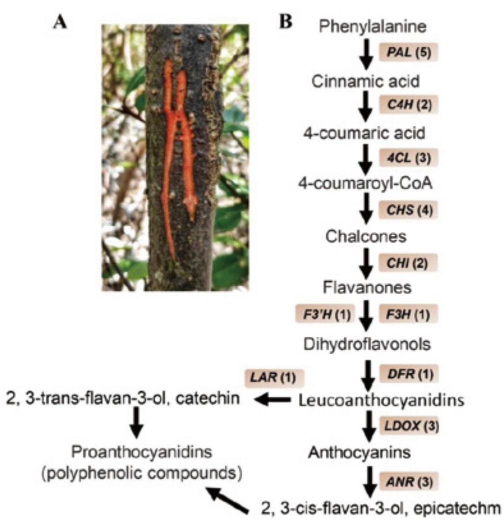
以上工作2022年发表于*Global Change Biology*期刊，博士生高贵锋和李欢为本论文共同第一作者，郑海雷教授、中国科学院南京土壤研究所褚海燕研究员与西班牙塞维利亚自然资源和农业生物学研究所Manuel Delgado-Baquerizo研究员为论文共同通讯作者。

Reference： GAO, G.-F., LI, H., SHI, Y., YANG, T., GAO, C.-H., FAN, K., ZHANG, Y., ZHU, Y.-G., DELGADO-BAQUERIZO, M., ZHENG, H.-L. & CHU, H. 2022. Continental-scale plant invasions reshuffle the soil microbiome of blue carbon ecosystems. Global Change Biology, 28, 4423-4438.

桐花树基因组结构及其进化和适应潮间带的研究

Chromosome-level assembly of the mangrove plant *Aegiceras corniculatum* genome generated through Illumina, PacBio and Hi-C sequencing technologies

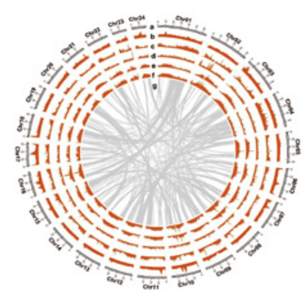
红树林定居并适应潮间带生境，进化出一系列适应性特征，包括耐盐、胎生、高单宁含量和气生根等。本研究利用第三代单分子测序技术拟合Hi-C测序技术和第二代短读长测序技术，首次获得了高质量染色体级别的桐花树基因组，这也是紫金牛科第一个参考基因组。基因组大小为906.63MB，平均GC含量41.77%，是目前已发表红树植物基因组最大的物种。利用Hi-C辅助技术，885.06 MB序列可以挂载到了24条染色体上，Contig和Scaffold的N50分别为7.1MB和37.74MB。BUSCO完整性评估结果为95.6%，表明基因组组装完整度高。结合同源预测、从头预测和转录组数据预测，注释了40,727个蛋白编码基因。另外还注释得到了603.93MB的重复序列，1,735个转录因子以及2,506个非编码RNA。基因组进化分析表明，桐花树在进化过程中经历了两次全基因组加倍事件。比较基因组分析显示，为适应潮间带复杂的生态环境，光合作用、氧化磷酸化、苯丙氨酸代谢等相关的1,488个基因家族发生了扩张。对AcNHXs基因家族进行系统分析，结果表明，桐花树基因组中存在8个NHX基因家族成员，基于系统进化分析被分为3类，部分AcNHXs基因的表达具有显著的组织特异性，与拟南芥AtSOS1基因进化关系相近的AcNHX8可能参与Na+的运输。同时，本研究还发现类黄酮合成途径中的关键基因发生了多拷贝现象，解释了这些特征和桐花树潮间带适应性之间的关系。



桐花树中的红色树皮特征和类黄酮合成通路分析

Red bark characteristic and flavonoid biosynthesis pathway in the *A. corniculatum.*

Aegiceras corniculatum is a major mangrove plant species adapted to waterlogging and saline conditions, grows in the coastal intertidal zone of tropical and subtropical regions. Here, we present a chromosome-level genome assembly of *A. corniculatum* by incorporating PacBio long-read sequencing and Hi-C technology. The results showed that the PacBio draft genome size is 906.63 MB Hi-C scaffolding anchored 885.06 MB contigs (97.62% of draft assembly) onto 24 pseudochromosomes. The contig N50 and scaffold N50 were 7.1 MB and 37.74 MB, respectively. Out of 40,727 protein-coding genes predicted in the study, 89% have functional annotations in public databases. We also showed that of the 603.93 MB repetitive sequences predicted in the assembled genome, long terminal repeat retrotransposons constitute 41.52%. The genome evolution analysis showed that the *A. corniculatum* genome experienced two whole-genome duplication events and shared the ancient γ whole-genome triplication event. A comparative genomic analysis revealed an incidence of expansion in 1,488 gene families associated with essential metabolism and biosynthetic pathways, including photosynthesis, oxidative phosphorylation, phenylalanine, glyoxylate, dicarboxylate metabolism, and DNA replication, which probably constitute adaptation traits that allow the *A. corniculatum* to survive in the intertidal zone. Also, the systematic characterization of genes associated with flavonoid biosynthesis pathway and the AcNHX gene family conducted in this study will provide insight into the adaptation mechanism of *A. corniculatum* to intertidal environments. The high-quality genome reported here can provide historical insights into genomic transformations that support the survival of *A. corniculatum* under harsh intertidal habitats.



桐花树基因组特征分布图谱

Distribution of the elements on the chromosomes of *A. corniculatum.*

以上工作于2022年发表于*Molecular Ecology Resources*期刊，博士生马东娜为论文第一作者，郑海雷教授为通讯作者

Reference：MA, D., GUO, Z., DING, Q., ZHAO, Z., SHEN, Z., WEI, M., GAO, C., ZHANG, L., LI, H., ZHANG, S., LI, J., ZHU, X. & ZHENG, H.-L. 2021. Chromosome-level assembly of the mangrove plant Aegiceras corniculatum genome generated through Illumina, PacBio and Hi-C sequencing technologies. Molecular Ecology Resources, 21, 1593-1607.

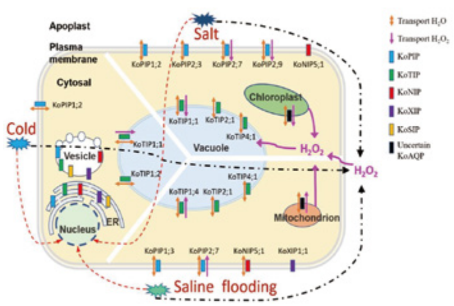
红树植物秋茄水通道蛋白转运水和过氧化氢的功能以及在适应滨海湿地环境中的作用

Genome-wide identification and characterization of aquaporins in mangrove plant *Kandelia obovata* and its role in response to intertidal environment

水是生命之源，植物的生长和发育依赖水的吸收和运输。水通道蛋白(AQPs)跨膜运输水分子，在调节植物细胞和组织的水分平衡中起着重要作用。作为一个典型的真红树林植物，秋茄对沿海湿地的极端潮间带环境具有高度的适应性，表现出对高盐、水淹、高光和高温等环境压力的耐受性。为了了解AQPs基因家族的信息和生理功能，该研究在秋茄全基因组中鉴定到了34个水通道蛋白基因，这些基因被分为五个亚家族，包括PIP、TIP、NIP、SIP和XIP。系统发育、基因结构、保守序列、蛋白质结构分析表明KoAQP（秋茄水通道蛋白）在进化上是保守的，具有水通道蛋白的一般特征。顺式元件分析显示在KoAQPs基因的启动子区域有胁迫和激素类的响应元件，表明 KoAQP可能对胁迫和激素有响应。亚细胞定位和功能分析表明，KoAQPs在细胞膜或亚细胞器膜上起转运H_2O和H_2O_2的功能。组织特异性表达谱显示KoAQPs在根、茎、叶、花和果实发育的各个阶段中的有不同的表达模式，表明KoAQPs在植物生长发育和生殖发育过程中发挥重要作用。此外，实时荧光定量PCR分析结合转录组数据表明，环境改变会导致KoAQPs的表达量发生变化，它对环境因素具有复杂的响应，包括盐度、水淹和寒冷。总的来说，KoAQPs对水和溶质的运输有助于秋茄适应沿海潮间带环境。

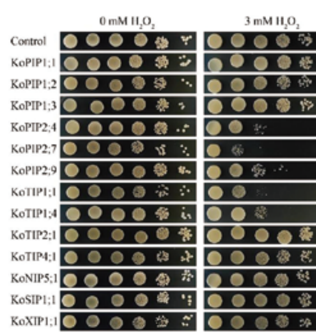
通常植物在受到胁迫后细胞中会积累过量的H_2O_2，红树植物秋茄在经历盐、水淹和冷刺激后，也会导致叶绿体、线粒体、细胞质和质外产生过量的H_2O_2，同时这些环境胁迫也会导致一些KoAQPs的表达量上升，其中一些表达量上升的水通道蛋白可以将过量的H_2O_2运输到液泡中降解，最终减少胁迫造成的损伤。

Aquaporins (AQPs) play important roles in plant growth, development and tolerance to environmental stresses. To understand the role of AQPs in the mangrove plant *Kandelia obovata*, which has the ability to acquire water from seawater, we identified 34 AQPs in the *K. obovata* genome and analysed their structural features. Phylogenetic analysis revealed that KoAQPs are homologous to AQPs of Populus and Arabidopsis, which are evolutionarily conserved. The key amino acid residues were used to assess water-transport ability. Analysis of cis-acting elements in the promoters indicated that KoAQPs may be stress- and hormone-responsive. Subcellular localization of KoAQPs in yeast showed most KoAQPs function in the membrane system. That transgenic yeast with increased cell volume showed that some KoAQPs have significant water-transport activity, and the substrate sensitivity assay indicates that some KoAQPs can transport H_2O_2. The transcriptome data were used to analyze the expression patterns of KoAQPs in different tissues and developing fruits of *K. obovata*. In addition, real-time quantitative PCR analyses combined transcriptome data showed that KoAQPs have complex responses to environmental factors, including salinity, flooding and cold. Collectively, the transport of water and solutes by KoAQPs contributed to the adaptation of *K. obovata* to the coastal intertidal environment.



KoAQP响应环境压力和对H_2O和H_2O_2运输的模型

A model of *KoAQPs* in response to environmental stress and transport of H_2O and H_2O_2



在含H_2O_2的培养基上表达KoAQP基因的酵母细胞的毒性生长测定

Toxicity growth assay of yeast cells expressing *KoAQP* genes on H_2O_2-containing media

以上工作于2022年发表于*Plant, Cell & Environment*期刊，博士生郭泽军为论文的第一作者，郑海雷教授、李庆顺教授和沈英嘉教授为论文的共同通讯作者。

Reference : GUO, Z., MA, D., LI, J., WEI, M., ZHANG, L., ZHOU, L., ZHOU, X., HE, S., WANG, L., SHEN, Y., LI, Q. Q. & ZHENG, H.-L. 2022. Genome-wide identification and characterization of aquaporins in mangrove plant Kandelia obovata and its role in response to the intertidal environment. Plant, Cell & Environment, 45, 1698-1718.

长期培养揭示海洋硅藻对海水升温的响应和适应机制

Metabolic Adaptation of a Globally Important Diatom following 700 Generations of Selection under a Warmer Temperature

硅藻是海洋中最重要的浮游植物类群之一，贡献了约40%的海洋初级生产力，固定了约20%的全球二氧化碳。随着人类排放CO_2等温室气体的增加，海洋吸收了大量热量致使海水升温，从而导致海洋暖化。据预测，在本世纪末海水温度将上升2.6−4.8° C，这一变动将对硅藻的生理代谢、生长繁殖和地理分布等造成显著影响。本文以海洋中一种具有重要生态学意义的硅藻—多尼骨条藻（*Skeletonema dohrnii*）为研究对象，运用定量蛋白质组学方法揭示了在短期（~300代）和长期（~700代）两种升温（24° C /20° C，28° C /20° C）培养条件下多尼骨条藻对升温的代谢适应性。

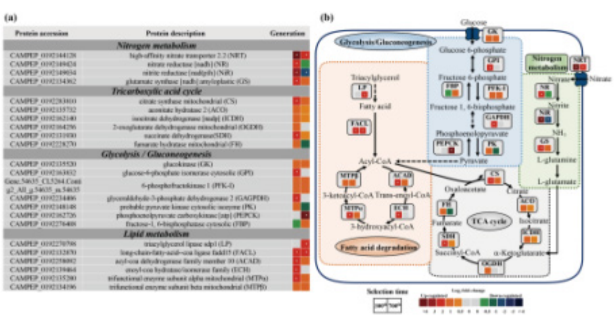
结果表明：

（1）两种升温条件下，多尼骨条藻细胞生长速率明显提高，叶绿素a含量降低；培养前期细胞POC和PON含量均明显降低，但后期均恢复正常水平，表明多尼骨条藻最终适应了升温。

（2）300代时，升温使多尼骨条藻通过提高糖酵解、三羧酸循环、脂肪酸氧化及氮代谢等相关途径来增强能量代谢，权衡之下代谢成本随之增加，物质储存减少，导致POC和PON含量降低。有趣的是，经过700代升温培养后，多尼骨条藻细胞表现出显著的蛋白可塑性，脂类分解代谢和葡萄糖积累增强，从而使POC和PON含量恢复正常水平。

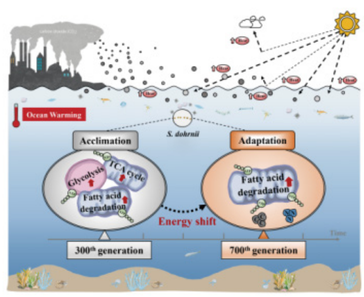
（3）多尼骨条藻对海水升温存在一个从响应到适应的过程，细胞内能量代谢的重新调整（多种能量代谢转为脂类分解代谢）是硅藻适应海水升温的一种重要策略。未来需要加强更多浮游植物种类对海水升温的长期适应性研究，为更加准确评估浮游植物对全球变暖的响应和适应提供依据。

Diatoms, accounting for 40% of the marine primary production and 20% of global carbon dioxide fixation, are threatened by ongoing ocean warming (OW). However, whether and how these ecologically important phytoplankton adapt to OW remains poorly unknown. Here, we experimentally examined the metabolic adaptation of a globally important diatom species *Skeletonema dohrnii* (*S. dohrnii*) to OW at two elevated temperatures (24 and 28 °C compared with 20 °C) under short-term (~300 generations) and long-term (~700 generations) selection. Both warming levels significantly increased the cell growth rate but decreased the chlorophyll a content. The contents of particulate organic carbon (POC) and particulate organic nitrogen (PON) decreased significantly initially (i.e., until 300 generations) at two temperature treatments but completely recovered after 700 generations of selection, suggesting that *S. dohrnii* ultimately developed thermal adaptation. Proteomic analysis demonstrated that elevated temperatures upregulated energy metabolism via glycolysis, tricarboxylic acid cycle, and fatty acid oxidation as well as nitrogen acquisition and utilization, which in turn reduced substance storage because of trade-off in the 300th generation, thus decreasing POC and PON. Interestingly, populations at both elevated temperatures exhibited significant proteome plasticity in the 700th generation, as primarily demonstrated by the increased lipid catabolism and glucose accumulation, accounting for the recovery of POC and PON. Changes occurring in cells at the 300th and 700th generations demonstrate that S. dohrnii can adapt to the projected OW, and readjusting the energy metabolism is an important adaptive strategy.



参与调控多尼骨条藻响应和适应海水升温的关键蛋白质及代谢途径

Regulation of key *S. dohrnii* proteins involved in warming after 300 and 700 generations of selection.



经过300和700代升温培养后多尼骨条藻细胞内的关键代谢过程示意图

Schematic illustration of the key molecular processes occurring in *S. dohrnii* cells after 300 and 700 generations of selection under warming conditions.

以上工作于2022年发表于*Environmental Science & Technology*期刊，博士生程路漫和厦门大学近海海洋环境科学国家重点实验室研究员张树峰为论文共同第一作者，王大志教授和王明华教授为共同通讯作者。

Reference： CHENG, L.-M., ZHANG, S.-F., XIE, Z.-X., LI, D.-X., LIN, L., WANG, M.-H. & WANG, D.-Z. 2022. Metabolic Adaptation of a Globally Important Diatom following 700 Generations of Selection under a Warmer Temperature. Environmental Science & Technology, 56, 5247-5255.

河流河口同步观测揭示洪水过程氮磷的陆海界面转运机制

Simultaneous observations revealed the effects of a tropical storm on the transformation and export mechanism of nitrogen and phosphorus through a river-estuary continuum

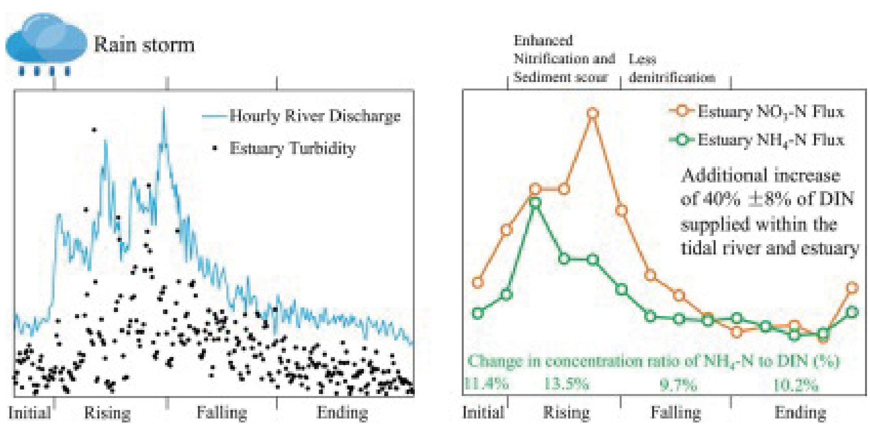
洪水期间河流向河口及近海输出大量的颗粒态和溶解态物质（如生源要素氮和磷）。近海水体中氮和磷的增加可加速富营养化，也是形成有害藻华（如赤潮）的必要条件。本研究采用河流与河口同步采样的观测策略，以获取洪水过程高频连续观测的多学科参数数据，从而系统研究氮和磷的陆海界面转运过程与机制，科学理解近海环境与生态对陆源氮磷污染输入的响应关系。

本研究于2019年6月在亚热带河流九龙江流域北溪与西溪出口、河口最大浑浊带分别设置定点观测站位，结合布放在九龙江口（鸡屿）和厦门湾南部海域两个浮标的观测资料，完整捕捉到一场洪水过程（初始、涨水、退水和结束四个阶段，历时14天）流量和营养盐等多个参数的脉冲信号。基于过程分析与关键界面通量计算，研究了河流-河口系统氮和磷的来源、转化与输出。研究发现：

洪水过程导致九龙江河流-河口连续体浊度表征的颗粒物、氨氮和硝氮浓度与通量发生显著变化。期间径流量快速增加，导致河口淡-咸水交汇界面（形成最大浑浊带的区域）向下游移动，快速改变了悬浮颗粒物（SPM）的空间分布和河口浊度最大值的位置。河流站位SPM和无机氮浓度的增加，与流域土壤侵蚀、土地利用和河床冲刷有关。观察整个洪水过程，河口站位的氨氮到达峰值的速度比硝氮到达峰值的速度更快，这与两种形态氮的来源与水文输移路径（地表与地下）不同有关。从流域出口（河流）到河口最大浑浊带之间（感潮河段与河口上游），溶解无机氮通量增加了约40%，推测其主要来自沉积物的再悬浮和沿岸面源污染输入（含地下水输入）。基流状态下，河口无机氮的主要形态为硝氮，而洪水期间氨氮和硝氮均有所增加，氨氮占无机氮比例在涨水期因初期雨水冲刷效应有所增加，在退水之后因稀释效应下降。基于氮的各个形态浓度、氮氧双同位素和氮功能菌基因丰度数据分析，发现洪水过程导致河口水中的硝化作用有所增强，但反硝化作用明显减弱。

洪水期间磷的输出也因形态而异。洪水导致河流的总颗粒态磷（TPP）浓度比降雨前增加约一倍（平均达100 μg/L），但单位颗粒物上的含磷量降低约三分之一，而溶解态无机磷（DIP）的浓度上升25%。从流域出口（河流）到河口最大浑浊带之间（感潮河段与河口上游），TPP通量增加了约60%，推测主要与沉积物的再悬浮和沿岸湿地沉积物的降雨径流冲刷有关。基流条件（无降雨）下河口沉积物是一个微生物驱动的生化反应器，洪水期间的强径流促进表层沉积物的冲蚀与再悬浮作用，使得沉积物中的还原性铁进入水柱，并被氧化为活性的铁氧化物，增强水中悬浮颗粒物对活性磷的吸附性能，最终增加向近海输出的活性颗粒态磷的通量。近海较高的盐度与pH值，有利于颗粒态磷解吸，导致水中活性磷酸盐增加。总之，洪水导致河流-河口系统无机氮和无机磷的输出通量均有显著增加，但由于无机磷的通量相对更大，导致向海输出的氮磷比值与基流相比有降低现象。与此同时，在河口和厦门南部海域观察到洪水结束后水中盐度回升、浊度下降、无机磷增加、叶绿素a上升的趋势。

以上研究表明，在基流条件下河口是陆源有机颗粒态氮和磷的临时沉积场所，通过矿化、硝化、反硝化等生物地球化学过程转化为浮游生物可直接利用的无机氮和无机磷。在洪水冲刷作用下，这些经转化的氮和磷被快速转运至近海，同进改变近海水体中营养盐的形态比例。洪水过程氮磷的陆海界面转运，会加剧近海富营养化并增加有害藻华发生的风险。



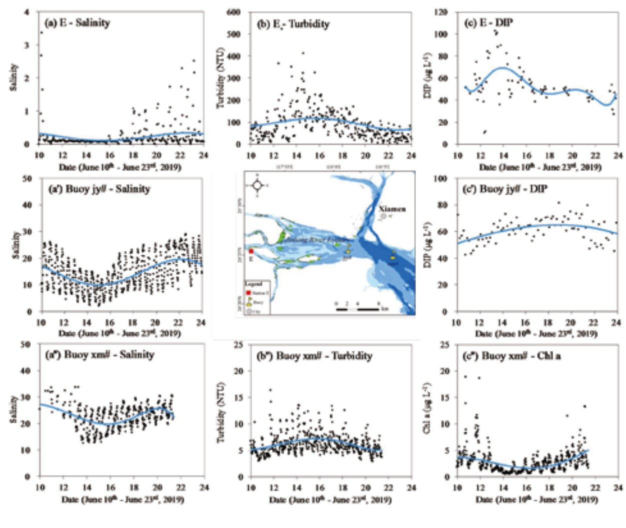
暴雨洪水过程九龙江河流-河口连续体中浊度和无机氮输出形态与通量变化

Turbidity and the export variation of particles and flux of inorganic nitrogen through the Jiulong River-estuary continuum during a storm

An important consequence of storms in river-estuary systems is major changes in hydrology and nutrients being fluxed from the land to the coastal ocean. However, the impacts of storms on the nature and amount of dissolved inorganic nitrogen (DIN) and phosphorus (P) in the river-estuary continuum are poorly understood. In this study, two weeks' continuous observations on two lower riverine fixed stations and an estuarine fixed station in the Jiulong River (SE China) were carried out during a complete storm event from June 10th to 23rd 2019. Suspended particulate matter (SPM), nitrogen species and their isotopic ratios, nitrifying and denitrifying functional genes were measured. The increased river discharge caused the freshwater-brackish water boundary to move downstream and altered the pattern of particle distribution and the location of the estuarine turbidity maximum. The increased river SPM and inorganic nitrogen were associated with watershed soil erosion, sediment scour and land use. Both in the river and estuary, the peak concentration of ammonium arrived faster than nitrate. Apart from river inputs, there was an additional increase of 40 ± 8% of DIN supplied within the tidal river and estuary. The additional DIN mostly came from resuspended sediments and catchment runoff, while increased nitrate also came from soil and ground waters, increased nitrification and decreased denitrification in the estuary.

During the storm, riverine total particulate phosphorus (TPP) more than doubled to approximately 100 μg P L^{-1} mainly from pollutant sources, while increased soil erosion reduced the TPP:SPM ratio by 1/3. The riverine DIP increase during the storm was only moderate (approximately 25%). As the storm intensified, the fresh-brackish water interface moved downstream. There was increased SPM and TPP flux (up to approximately 25,000 kg Pd^{-1}) from resuspended surficial sediment that had been deposited during normal flow in the adjacent tidal flats and mangrove areas. These sediments had acted as microbial incubators. Reduced Fe in the resuspended sediment was converted to labile Fe oxyhydroxides in the oxic water column, which adsorbed DIP (and probably also DOP) and increased labile TPP exported downstream. During the storm, the total flux of riverine dissolved nutrients increased while the TDN:TDP ratio decreased from 43:1 to 32:1.

These results suggest that estuaries are locations for temporary deposition of labile TPP during normal flow, which are flushed out during major storms, likely resulting in increased eutrophication, including encouraging harmful algal blooms in coastal zones.



注：E为九龙江口上游最大浑浊带站位，jy#和xm#分别为九龙江口（鸡屿）站位和厦门湾南部海域浮标站位

Note: E is the largest cite in the Jiulong River upstream, jy# and xm# are Jiulong estuary (Jiyu) site and southern Xiamen bay buoy site, respectively

洪水期间九龙江河流-河口-近海同步观测的盐度、浊度、无机磷（DIP）与叶绿素（Chl a）变化过程

Note: E is the The The variation process of salinity, turbidity, DIP, Chl a through Jiulong river-estuary continuum during a storm

以上工作分别于2022年发表于*Journal of Hydrology* 和 *Journal of Geophysical Research: Biogeosciences*期刊，博士生林静婕、硕士生张明真分别为第一作者，通讯作者均为陈能汪教授，共同作者包括厦门大学程鹏教授、余其彪博士和英国利兹大学Michael D. Krom教授。厦门大学海洋监测与信息服务中心黄水英高工为本研究提供了浮标观测支持。

Reference :

LIN, J., KROM, M. D., WANG, F., CHENG, P., YU, Q. & CHEN, N. 2022. Simultaneous observations revealed the non-steady state effects of a tropical storm on the export of particles and inorganic nitrogen through a river-estuary continuum. Journal of Hydrology, 606, 127438.

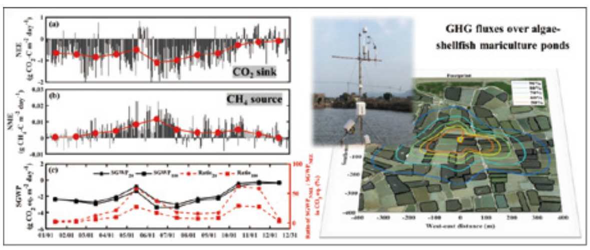
ZHANG, M., KROM, M. D., LIN, J., CHENG, P. & CHEN, N. 2022. Effects of a Storm on the Transformation and Export of Phosphorus Through a Subtropical River-Turbid Estuary Continuum Revealed by Continuous Observation. Journal of Geophysical Research: Biogeosciences, 127, e2022JG006786.

涡度通量连续观测研究揭示海水养殖塘温室气体通量源汇特征

Carbon dioxide uptake overrides methane emission at the air-water interface of algae-shellfish mariculture ponds: Evidence from eddy covariance observations

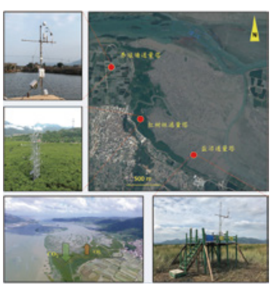
养殖塘是温室气体的重要排放源，但海水养殖塘的研究较为缺乏。受多种环境因子与人为管理活动的复合影响，海水养殖塘水气界面CO_2 和CH_4 通量存在很强的时间变化（如昼夜、季节、年际变化）和空间变异（如不同养殖塘之间、同一养殖塘内不同区域），以往的基于漂浮箱法测定的水气界面温室气体通量，难以实现时间上的连续测定，也难以刻画通量的空间异质性。基于涡度相关法的温室气体通量观测具有非破坏性、稳定性高、连续观测等优点，同时观测数据可以表征较大空间范围内的平均通量。

本研究对我国东南沿海亚热带河口海水养殖塘（缢蛏养殖：养蛏塘与养藻塘成对分布）水气界面CO_2、CH_4通量及环境因子开展涡度相关长期连续观测，基于2020年全年半小时通量观测数据的分析表明：（1）海水养殖塘水气界面表现为CO_2的强汇（−227.7g　cm^{-2}）和CH_4的弱源（1.44g　cm^{-2}），由CH_4源引起的辐射增温效应在20年（100年）时间尺度上可以抵消由CO_2汇引起的辐射冷却效应的25.9%（12.1%）；（2）CO_2和CH_4通量表现出不同的昼夜和季节变化规律，但两者在夏季均表现出最强的源汇通量，冬季通量强度小且波动大；（3）CO_2和CH_4通量分别受控于光合有效辐射和潮汐盐度，但两者的通量大小也受到养殖塘水温和通量风浪区养藻塘占比变化的影响。



海水养殖塘温室气体通量源汇特征

Seasonal variations in daily (bars) and monthly (dots) (a) net CO_2 exchange (NEE) and (b) net CH_4 exchange (NME) in 2020 over algae-shellfish mariculture ponds.



台海站漳江口滨海湿地涡度通量观测平台

Observation platforms in Zhangjiang Estuary

Mariculture ponds are widely distributed along the coastal regions and have been increasingly recognized as biogeochemical hotspots of air-water greenhouse gas (GHG) fluxes, but their source/sink dynamics and climate benefits have not been well understood. Due to strong temporal variations of GHG fluxes over mariculture ponds, previous studies based on short-term or discrete flux measurements have large uncertainty in assessing GHG budgets and their radiative effects. In this study, we examined the temporal variations of air-water GHG fluxes, net CO_2 exchange (NEE) and net CH_4 exchange (NME), and their environmental controls, based on one-year (2020) continuous eddy covariance (EC) measurements over algae-shellfish mariculture ponds (razor clam) in a subtropical estuary of Southeast China. The results showed that (a) annually the ponds acted as a strong CO_2 sink of −227.7 g CO_2-cm^{-2} and a weak CH_4 source of 1.44 g CH_4-cm^{-2}, and thus the NME-induced warming effect offset 25.9% (12.1%) of the NEE-induced cooling effect at a 20-year (100-year) time horizon using the metric of sustained-flux global warming potential; (b) two GHG fluxes showed different diurnal and seasonal variations but both had stronger source/sink capacity in summer and more fluctuating fluxes in winter; (c) temporal variations of NEE and NME tended to be more regulated by photosynthetically active radiation and tidal salinity, respectively, but both of them were affected by water temperature and area proportion of algae ponds within the EC footprint. This is the first study to disentangle temporal variations of air-water GHG fluxes over mariculture ponds based on simultaneous EC measurements of CO_2 and CH_4 fluxes. This study highlights the climate benefits of algae-shellfish mariculture ponds as biogeochemical hotspots by exerting a net radiative cooling effect dominated by the CO_2 sink.

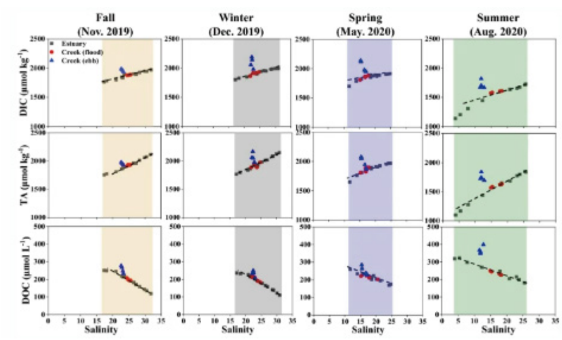
以上工作于2022年发表于*Science of the Total Environment*期刊，硕士研究生张一萍，中山大学覃章才教授和中国科学院大气物理研究所李婷婷副研究员为共同第一作者，朱旭东副教授为通讯作者。

Reference : ZHANG, Y., QIN, Z., LI, T. & ZHU, X. 2022. Carbon dioxide uptake overrides methane emission at the air-water interface of algae-shellfish mariculture ponds: Evidence from eddy covariance observations. Science of The Total Environment, 815, 152867.

在高氮输入的河口红树林湿地中的碳动态与温室气体排放

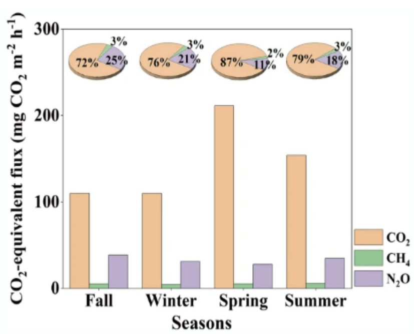
Carbon dynamics and greenhouse gas outgassing in an estuarine mangrove wetland with high input of riverine nitrogen

红树林湿地中埋藏着大量有机碳，但其横向溶解碳输出和温室气体排放往往被忽视。本研究对2019–2020年中国东南部高氮输入的河口红树林湿地溶解碳和温室气体进行了季节性观测。结果表明，潮差和季节是控制横向溶解碳输出的两个主要因素，包括总碱度(TA)、溶解无机碳(DIC)和溶解有机碳(DOC)。DIC、TA、DOC平均偏移量与潮差正相关，证明了水文变化控制着红树林湿地与河口溶解碳交换。温度、地下水输出和淡水输入的季节变化导致春季低潮差碳抵消量较大，秋季高潮差碳抵消量较小。DIC、DOC、TA和GHGs来源于红树林湿地是。当以CO_2当量计算温室气体排放量时，CO_2的平均排放量是N_2O的4倍，N_2O的平均排放量是CH_4的6倍。与原始红树林相比，高河流氮输入的红树林湿地反硝化在矿化过程中发挥了关键作用，其生物地球化学过程产生了DIC、TA和N_2O，不利于红树土壤蓝碳的固存。这些结果表明，在恢复红树林湿地和减少氮污染的同时，减少蓝碳流失与缓解水体富营养化之间存在着相互效益。



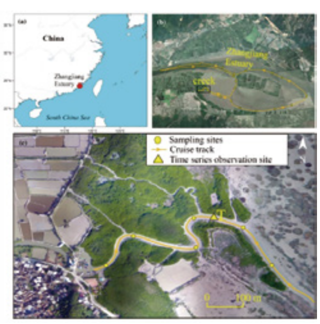
溶解无机碳，总碱度，溶解无机碳和盐度之间的线性关系

The linear relationship between measured DIC, TA, DOC and salinity



不同季节温室气体的二氧化碳当量通量

CO_2-equivalent fluxes of greenhouse gases in different seasons.



漳江口河口湿地采样点

Map of study areas showing sampling sites along Zhangjiang Estuary

The large amounts of organic carbon buried in mangrove wetlands are well recognized, but the lateral dissolved carbon export and greenhouse gas (GHGs) outgassing are often overlooked. In this study, we carried out seasonal observations of dissolved carbon and GHGs in an estuarine mangrove wetland with high input of riverine nitrogen in southeast China in 2019–2020. The results showed that the tidal range and season were the two main factors controlling the lateral dissolved carbon export including total alkalinity (TA), dissolved inorganic carbon (DIC) and dissolved organic carbon (DOC). The positive correlations between the average offsets of DIC, TA, DOC and tidal range confirmed the hydrological controls on the exchange of dissolved carbon between the mangrove creek and the estuary. The seasonal variability in temperature, groundwater export and freshwater input resulted in a larger carbon offset during low tidal range in spring and a smaller offset during high tidal range in fall. The mangrove creek acted as a net source of DIC, DOC, TA and GHGs. When the emissions of GHGs were calculated as CO_2-equivalents, the average emission of CO_2 was four times higher than that of N_2O and the average emission of N_2O was six times higher than that of CH_4. In contrast with pristine mangroves, denitrification in mangrove wetlands with high input of riverine nitrogen played a crucial role in mineralization processes, leading to the production of DIC, TA and N_2O. These biogeochemical processes may not be conducive to the blue carbon sequestration in mangrove soils. These findings suggested that there are mutual benefits between the reduced loss of blue carbon and the mitigation of eutrophication when restoring mangrove wetlands and reducing nitrogen pollution.

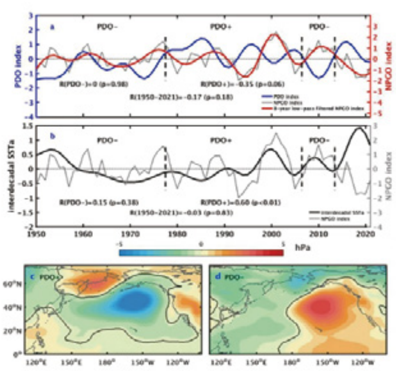
以上工作于2022年发表于*Biogeochemistry*期刊，博士研究生路则洋为第一作者，陈能汪教授为通讯作者。

Reference: LU, Z., WANG, F., XIAO, K., WANG, Y., YU, Q., CHENG, P. & CHEN, N. 2022. Carbon dynamics and greenhouse gas outgassing in an estuarine mangrove wetland with high input of riverine nitrogen. Biogeochemistry, 162, 221-235.

厄尔尼诺–南方涛动和太平洋年代际震荡相关的典型副热带海峡冬季海面温度的年际和年代际变化

ENSO and PDO-related interannual and interdecadal variations in the wintertime sea surface temperature in a typical subtropical strait

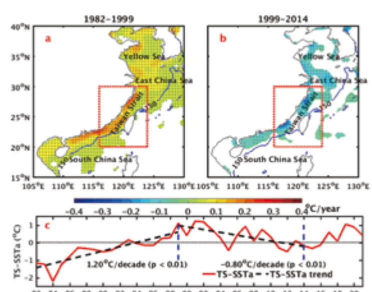
台湾海峡是中国沿海冬季海面温度年际–年代际变率最为显著的区域，台湾海峡是中国大陆沿岸冬季海表温度年际–年代际变率最为显著的区域，其冬季海表温度在1982至1999年呈现上升趋势，在1999至2014年呈现下降趋势，变化幅值达到约1°C/十年，为邻近海域的4倍之多。本研究重点关注太平洋年代际振荡（Pacific Decadal Oscillation, PDO）和厄尔尼诺 - 南方涛动（El Niño - Southern Oscillation，ENSO）等大尺度气候信号如何调控台湾海峡冬季海表温度的时间变化。使用滤波的方法，将海表温度时间序列分为三种不同时间尺度的信号，即年际信号、年代际信号和长周期信号（与全球变暖相关）。研究表明，在PDO正相位期，台湾海峡海表温度受到PDO的显著控制；而在PDO负相位时期，海峡海表温度受到ENSO的显著控制。在PDO正相位时期，北太平洋海域可以发展明显的海表压强偶极子，从而产生欧亚大陆东部沿岸的沿岸风异常，进而通过影响东亚冬季风和北太平洋亚热带环流影响台湾海峡冬季海表温度变化；相较而言，在PDO负相位时期，上述北太平洋的信号对台湾海峡的影响减弱，热带太平洋通过与ENSO有关的气旋或反气旋异常的北移影响东亚（包括台湾海峡）海域海表温度的年际变化。综上，由于1982至2014年的PDO主要呈现正相位，台湾海峡显著的增温和降温趋势主要受到PDO和长周期的全球变暖的信号控制。



1950–2021年间太平洋年代际震荡和厄尔尼诺–南方涛动的相关指数及其与台湾海峡冬季海温异常的相关指数

Correlations between the PDO and NPGO indexes from 1950 to 2021. (b) Correlations between the interdecadal TS-SSTa and NPGO index from 1950 to 2021.

The Taiwan Strait has the largest temporal variability in the wintertime sea surface temperature (SST) along the China coast. The warming and cooling trends reach about ± 1 °C per decade in winter during 1982–1999 and 1999–2014, respectively, which are about 4 times larger than neighboring coastal areas and open ocean. Previous studies have noted these opposite trends, but the cause remains unclear due to insufficient study on teleconnections of these local signals to large-scale climate signals (e.g., Pacific Decadal Oscillation, PDO; El Niño–Southern Oscillation, ENSO). Using different period filters, wintertime SST anomaly in the Taiwan Strait (TS-SSTa) of different timescales were separated and connected to the large-scale climate signals. Besides the impact of global warming, we also found that the interdecadal signal of PDO contributes significantly to the warming and cooling trends of the wintertime TS-SSTa during 1982–2014 (mostly the positive PDO phase). During the positive PDO phase, a sea level pressure (SLP) dipole develops at the North Pacific, leading to a northeasterly wind jet along the Eurasian eastern coast, and affecting the interdecadal wintertime TS-SSTa through the East Asia Winter Monsoon (EAWM) and North Pacific Subtropical Gyre. During the negative PDO phase, the influence from North Pacific weakens, and the tropical Pacific has a greater influence on the interannual wintertime TS-SSTa through the northward movement of the ENSO-related cyclone/anticyclone anomaly over East Asia. Thus, the influence from North Pacific (PDO) and tropical Pacific (ENSO) alternately control the TS-SSTa variation during the positive and negative PDO phases.



研究区海温(SST)变化趋势(来自OISST数据，° C/年)：1982–1999年(a)和1999–2014年(b)

Sea surface temperature (SST) anomaly trend (from the OISST data, color shading, ° C/year) in the China coastal seas during 1982 - 1999 (a) and 1999 - 2014 (b).

以上工作于2022年发表于Climate Dynamics期刊，博士生张义敏为第一作者，江毓武教授为通讯作者。

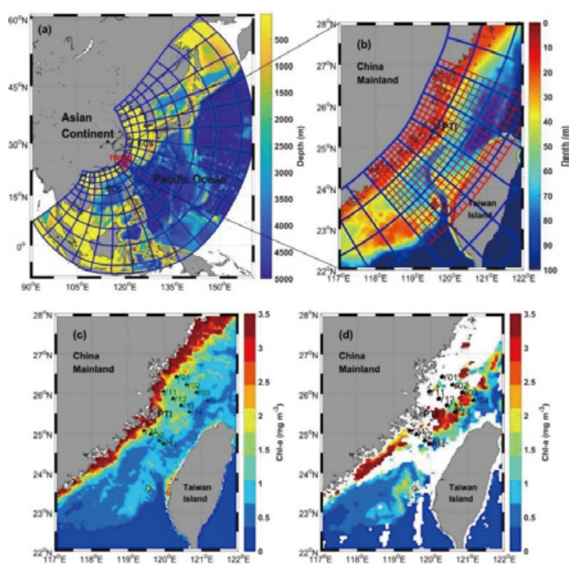
Reference： ZHANG, Y., ZHAO, Z., LIAO, E. & JIANG, Y. 2022. ENSO and PDO-related interannual and interdecadal variations in the wintertime sea surface temperature in a typical subtropical strait. Climate Dynamics, 59, 3359-3372.

东北风松弛时期的台湾海峡离岸藻华

Off-coast Phytoplankton Bloom in the Taiwan Strait During the Northeasterly Monsoon Wind Relaxation Period

台湾海峡冬、春季叶绿素含量整体呈现相对低值，且主要分布于大陆近岸海域。但走航和遥感观测资料显示，台湾海峡东北风松弛时，天气尺度的藻华现象可发生于大陆沿海的离岸海域，呈现明显的亚中尺度斑块状结构。本研究重点关注亚中尺度不稳定等锋面动力过程对台湾海峡冬、春季离岸藻华发生的影响及其动力机制。通过综合利用走航观测、数值模拟和卫星遥感等多种技术手段，本研究揭示了离岸藻华发生的物理环境条件以及其中的亚中尺度锋面不稳定动力机制。走航与遥感数据的合成分析和自组织映射分析表明，海峡离岸藻华通常伴随东北季风的松弛而发生于沿海峡的锋面海域，同时呈现明显的硝酸盐沿等密线离岸输运和近表层水体层化特征。高分辨率走航数据的分析与耦合模拟结果的诊断显示，亚中尺度锋面对称不稳定和斜压不稳定在台湾海峡锋面处均活跃存在，可以显著促进海峡离岸藻华的发生与发展。

This study applied cruise, model, and satellite data to analyze the off-coast phytoplankton blooming during the late fall to early spring monsoon period in the Taiwan Strait when northeasterly wind prevails. Based on the composite and self-organizing map analyses, the three data sets consistently show high chlorophyll-a concentration near the along-shore front during the down-front northeasterly wind relaxation period while lower concentration when relatively strong wind is persistent. Meanwhile, the off-coast blooming always coincides with intense near-surface stratification when the northeasterly wind relaxes. Diagnoses of balanced Richardson number, Ertel potential vorticity and instability energy budget from high-resolution cruise observations and model results demonstrate that vigorous submesoscale symmetric and baroclinic instabilities can develop near the along-shore front under the down-front NE wind. Diagnoses of modeled buoyancy and chlorophyll-a budget equations further suggest the submesoscale instabilities lead to rapid near-surface restratification and offshore stretching of the along-shore front within the upper 10-m of the mixed layer when the down-front NE wind relaxes, favoring the surface 10-m phytoplankton growth. As comparison, contribution of the larger-scale advection related with geostrophic adjustment and Ekman transport to the chlorophyll-a increment reached beyond the middle layer of ~ 20-m depth.



模拟区域及水深：粗网格(a)、细网格(b)；多年平均初春海表叶绿素分布(c)，2015年3月31日–4月4日的叶绿素分布(d)

(a) Nesting model domain of the parent (blue) and child (red) grids with a nesting scale of 5, and the bottom topography (color shading), the dashed black box shows the location of the zoomed-in view (b). ECS, SCS, and TWS denote the East China Sea, South China Sea, and Taiwan Strait, respectively. (b) The parent (blue) and child (red) grids with one line per 30 real grids, and bottom topography (color shading) in the TWS. PTI denotes the Pingtan Island. Composite maps of the OC-CCI sea-surface Chl-a in March and April from 1998 to 2018 (c), and from 31 March to 4 April 2015 (d). Cruise stations in late March of 2015 are presented as black dots.

以上工作于2022年发表于*Journal of Geophysical Research–Oceans*期刊，博士生赵中华为第一作者，通讯作者均为江毓武教授。

Reference：

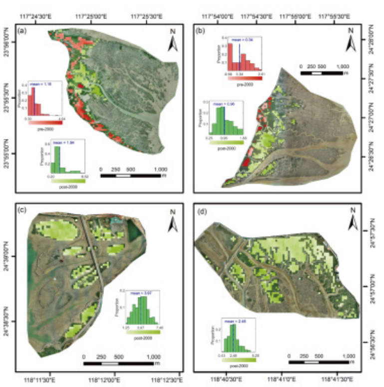
Reference：Zhao, Z., Oey, L.-Y., Huang, B., Lu, W., & Jiang, Y. 2022. Off-coast Phytoplankton Bloom in the Taiwan Strait During the Northeasterly Monsoon Wind Relaxation Period. *Journal of Geophysical Research: Oceans*, 127, doi.org/10.1029/2022JC018752.

无人机遥感助力红树林保护成效评估

Stronger conservation promotes mangrove biomass accumulation: Insights from spatially explicit assessments using UAV and Landsat data

上世纪后半叶我国红树林面积锐减，到90年代初已有一半以上的红树林消失，此后我国政府加大了红树林保护与恢复力度，红树林面积在近20年开始逐渐增加。以往的遥感研究大多关注红树林的总面积变化，较少聚焦与保护恢复密切相关的年轻红树林的生长动态，因而无法准确评估红树林保护与恢复成效。与传统的实地调查相比，无人机与卫星遥感在获取大范围、长时序红树林数据方面具有成本与效率优势。冠层高度是红树林地上生物量估算的核心参数，但卫星遥感往往难以获取冠层高度信息，而无人机航拍结合三维重构技术可以有效地获取冠层高度等结构信息，同时比机载激光雷达应用更具成本效益，因此通过结合无人机三维重构与卫星遥感长时序观测的优势，可以在保证较高精度的条件下实现长时序的红树林地上生物量估算，开展十年尺度上的红树林保护与恢复成效评估。

红树林冠层高度（CHM）与增强型植被指数（EVI）、地上生物量（AGB）均密切相关，因而CHM可作为从EVI估算AGB的桥梁。本研究结合无人机三维重构（UAV-SfM）反演CHM与Landsat卫星EVI长时序观测，提出了一种基于EVI-CHM-AGB经验方程的、可量化年轻红树林AGB累积速率的遥感评估方法，并以福建4个亚热带红树林湿地为例开展AGB时空演变分析与红树林保护成效评估。主要研究结果有：（1）利用低成本的UAV-SfM技术可以有效获取红树林CHM的空间异质性；（2）15岁以下的年轻红树林可采用指数方程形式的EVI-CHM关系来估算AGB，而不受光谱饱和效应的显著影响；（3）与2000年之前相比，近20年以来年轻红树林的AGB总体上呈现更快的累积速率。考虑到无人机与卫星遥感影像的易获取性，本研究提出的年轻红树林AGB累积速率遥感评估方法可适用于其他红树林湿地或大尺度的红树林保护成效评估。



红树林年轻时期（15岁以下）的AGB年累积速率（Mg DW ha^{-1} y^{-1}）

Spatial distributions of annual AGB accumulation rates (Mg DW ha^{-1} y^{-1}) during the young growth stage of mangroves in four sites

Chinese mangroves have been recovered in area over the past two decades from the previous declining trend, and about half of existing mangroves are still in their young growth stage. This provides a unique opportunity to assess mangrove conservation by examining the growth dynamics of young mangroves over different conservation periods. However, we are currently short of effective assessment tools for spatially explicit quantification of mangrove conservation effects. To fill up this gap, we proposed a novel remote sensing approach using readily available unmanned aerial vehicle (UAV) and Landsat enhanced vegetation index (EVI) data to assess the spatial evolution of aboveground biomass (AGB) of young mangroves. With the space-for-time hypothesis, the approach implemented with an empirical EVI-height-AGB equation was tested in four subtropical estuarine mangroves in the southeastern coast of China. The results indicated: (a) the UAV-based Structure from Motion (SfM) technology served as an effective and low-cost means for capturing the spatial heterogeneity of mangrove canopy heights; (b) a maximum stand age of 15 years could be used to define the young growth stage of mangroves, for which the EVI-height relationships could be described by exponential equations without suffering significant spectral saturation effects; (c) mangrove forests had overall faster annual AGB accumulation during the young growth stage over the post-2000 versus pre-2000 conservation period. This study is one of the first attempts to develop a remote sensing approach for quantifying spatially explicit AGB accumulation rates of young mangroves. It highlights the practicability and advantage of the UAV-SfM technology and confirms that stronger conservation efforts promote mangrove AGB accumulation over the past two decades. The developed EVI-height-AGB framework fueled with readily available UAV and Landsat data provides a unique tool for assessing mangrove conservation effects from landscape to regional scales.

以上工作于2022年发表于*Remote Sensing in Ecology and Conservation*期刊，硕士研究生朱珠为第一作者，朱旭东副教授为通讯作者。

Reference： ZHU, Z., HUANG, M., ZHOU, Z., CHEN, G. & ZHU, X. 2022. Stronger conservation promotes mangrove biomass accumulation: Insights from spatially explicit assessments using UAV and Landsat data. Remote Sensing in Ecology and Conservation, 8, 656-669.

红树林生态修复——退塘还湿研究取得新进展

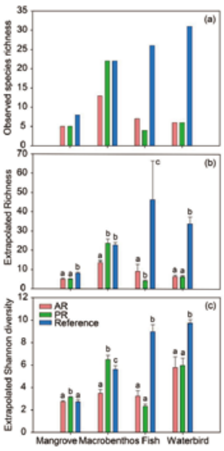
Biotic homogenization increases with human intervention: implications for mangrove wetland restoration

红树林是地球上生物多样性最丰富、生态系统服务功能价值最高的生态系统之一。然而，由于人类活动和全球气候变化的双重影响，全球大部分红树林均面临着面积下降、生态系统功能退化、保护不充分和修复手段不当等问题。其中，围塘养殖是造成红树林面积减少、生物多样性降低的最主要因素。退塘还湿已经成为中国红树林生态修复的主要任务。

本研究以海南东寨港国家级自然保护区1995年实施的退塘还湿区域为研究对象，从修复后红树林植被和生物多样性（鸟类、大型底栖动物、鱼类）角度比较了自然退塘（破堤恢复水文）和人工退塘（破堤恢复水文+人工种植无瓣海桑）两种退塘还湿方式的生态修复效果。

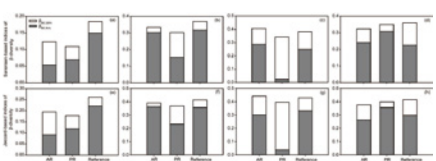
结果表明，经过20多年的恢复，自然退塘区和人工退塘区中多数生物类群的多样性基本无显著差异，说明人工种植在一定程度上并未起到促进红树植物及生物多样性恢复的作用。总体上，对照区的生物多样性高于退塘区，说明尽管经过20多年的恢复，退塘区的生物多样性依然无法达到天然红树林湿地的水平，表明人类活动导致的生物同质化现象仍然明显。此外，研究区内大多数生物类群的 β 多样性为周转大于嵌套，表明生物类群的生态过程由决定性过程占主导，β 多样性主要受环境过滤等因子的影响。

红树林湿地生态修复是一个漫长的过程；经过20年甚至更长时间的自然作用，投入较多人力物力和财力的人工修复带来的恢复效果并没有高于自然修复。研究结果从侧面证明了贯彻实施《湿地保护修复制度方案》强调的“坚持自然恢复为主、与人工修复相结合的方式”生态修复原则的必要性。



各生物类群在退塘区和对照区的 α 多样性指数对比

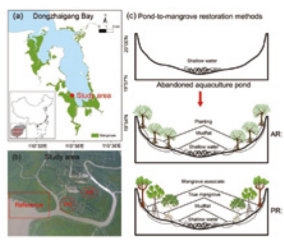
α−diversity in two active restoration site for different species compared with reference site



各生物类群在退塘区和对照区的 β 多样性指数

β−diversity in two active restoration site for different species compared with reference site

The large-scale conversion of natural mangroves to aquaculture reduces species richness and diversity. Large areas of abandoned aquaculture ponds in areas where mangroves formerly predominated in China and southeast Asia represent important potential effective targets for mangrove restoration. Here, we empirically assessed the α-diversity (species richness) and β-diversity (variation in community composition) of mangrove, macrobenthos, fish and waterbird in a tropical mangrove bay on Hainan Island, China. We compared sites subjected to different pond-to-mangrove restoration programs more than 20 years ago (passive restoration without planting and active restoration with planting) to nearby reference site with natural mangrove forests and mudflats. To better understand how β-diversity responds to restoration, we also distinguished between β-diversity turnover and nestedness (richness difference). In general, α-diversity values for both fish and waterbird communities and β-diversity values for the mangrove, macrobenthos and waterbird communities were lower at the restoration sites than at the reference site, suggesting that the strong homogenizing effects of anthropogenic habitat alternation were still apparent after more than 20 years since aquaculture ceased. In addition, spatial turnover, not nestedness, dominated total β-diversity both across the whole study area and at individual sites, suggesting that multiple processes, such as environmental filtering, helped to shape multi-taxa community structures. Moreover, we found no evidence that planting in the abandoned ponds, in addition to standard hydrological restoration, supported greater species diversity of taxa like macrobenthos and waterbird than the naturally regenerated site after more than 20 years' recovery. Our results underline the importance of avoiding the conversion of natural mangrove stands to aquaculture wherever possible and the urgent need to design effective mangrove restoration techniques in tropical Asia.



研究区和两种退塘方式示意图：人工退塘以及自然退塘

Study area and two active restoration overview: active restoration (AR) and passive restoration (PR)

以上工作于2022年发表于*Ecography*期刊，台海站固定研究人员张雅棉高级工程师为本文第一作者，王文卿教授和王瑁教授为共同通讯作者。

Reference： Zhang, Y., Zhang, L., Kang, Y., Li, Y., Chen, Z., Li, R., Tian, C., Wang, W. and Wang, M. 2022. Biotic homogenization increases with human intervention: implications for mangrove wetland restoration. Ecography,

海龟卫星定位追踪研究

Sea Turtle Satellite Tracking Research

2016年以来，刘敏教授带领课题组成员贾语嫣、宋稼豪等人，在东山县对救助的海龟进行定位仪安装，通过跟踪海龟的运动轨迹，以期获知其主要活动热点区域及迁移规律。

至今，刘敏教授研究团队共对13只在东山海域经救护康复的海龟（含4只绿海龟，6只红海龟及3只太平洋丽龟）进行了卫星定位追踪，最长追踪至291日。初步结果显示，在东山县放归的海龟运动轨迹十分多样，但是并未显示出由于海龟种类的不同而导致的运动差异。最南可到达菲律宾萨马岛附近，而最北可到达黄海海域，也有部分海龟一直在台湾海峡南部活动。这也表明在东山长期开展海龟救助及保护生物学研究的重要性。

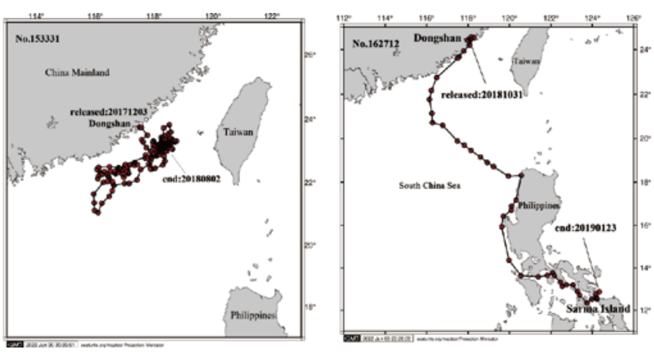
Since 2016, Professor Liu Min and her team members, JiaYuyan and Song Jiahao, conducted the satellite tracking for the rescued sea turtles in order to understand their movement routes, to identify their main hotspot areas and to analysis migratory patterns.

To date, Professor Liu's team has tracked 13 rescued sea turtles in Dongshan water (including 4 green turtles, 6 loggerhead turtles and 3 olive ridley turtles); the longest tracking time was 291 days. The preliminary results showed diverse movement patterns, and there is no movement difference among species. They reached either as far south as the Samar Island in the Philippines, or as far north as the Yellow Sea, or moved around southern Taiwan Strait. This revealed the importance to conduct long-term sea turtle rescue project and conservation biology study on sea turtles in Dongshan.

2022年10月即将放归的五只康复的海龟
Five sea turtles about to be released after recovery in October 2022.

研究人员在给一只太平洋丽龟安装卫星定位仪
The researchers are installing a satellite transmitter on the olive ridley.

一只康复的太平洋丽龟正在返回大海
A recovered olive ridley is crawling into the sea



两只东山海域放归的海龟轨迹图
Tracking maps of two released sea turtles from Dongshan water

本研究依托台海站东山实验场，得到东山县海洋与渔业局和东山县检察院的积极配合，获得农业农村部渔业渔政管理局、国家林业和草原局自然保护地管理司、北京市企业家环保基金会等单位的资金支持。

This research is based on D-SMART, collaborated with Ocean and Fishery Bureau and Procuratorate Office of Dongshan County, and financially supported by the Fisheries and Fisheries Administration of the Ministry of Agriculture and Rural Affairs, and the Department of Natural Reserve Management of the State Forestry and Grassland Administration, and the Beijing Entrepreneurs Environmental Protection Foundation (SEE).

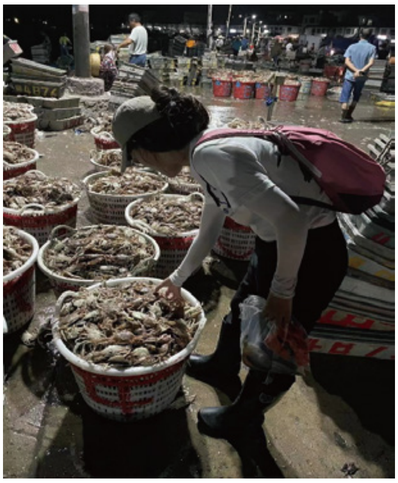
闽南-台湾浅滩渔场底拖网捕捞现状调查

Current status of capture fishery in the Minnan-Taiwan Bank fishing grounds

自2018年开始，刘敏教授课题组研究助理林柏岸和姜艳、硕士研究生刘彩莲和博士研究生许庆等人依托东山站，对闽南-台湾浅滩渔场的底拖网捕捞进行了持续的逐月调查研究。

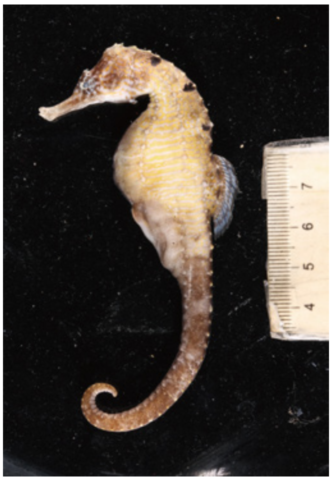
闽南-台湾浅滩渔场是我国沿海重要的渔场之一，支撑了包括东山县在内多个沿海行政地区的渔业经济。自上世纪九十年代中期，闽南-台湾浅滩渔场的渔业捕捞年产量约为65万吨，已超出最大持续产量。由于长期的高捕捞强度，闽南-台湾浅滩渔场的渔业资源衰退显著。通过逐月的渔获物卸货码头监测和采样、渔民访谈、捕捞日志收集等方式，估算闽南-台湾浅滩渔场的捕捞努力量和主要捕捞类群产量的占比，确定主要捕捞区域，跟踪主要捕捞物种的生物学变化等。利用这些数据进行渔业管理模型的分析，得出较优的渔业管理方法，为闽南-台湾浅滩渔场的渔业资源保护和可持续利用建言献策。

结果表明，闽南-台湾浅滩渔场渔获物多样性较高，累积记录212种鱼类、57种甲壳类、18种头足类。渔获物产量中，以小型低值的二长棘犁齿鲷（*Evynnis cardinalis*）、多鳞（*Sillago shihama*）、蓝圆鲹（*Decapterus maruadsi*）、大头狗母鱼（*Trachinocephalus myops*）、拥剑梭子蟹（*Monomia haanii*）、小杂鱼等为主。此外，本研究还发现闽南-台湾浅滩渔场是我国国家二级保护动物——三斑海马（*Hippocampus trimaculates*）和棘海马（*H. spinosissimus*）的重要栖息地。



东山码头的底拖网渔获物调查

Surveys of bottom trawl catches at a landing port of Dongshan.



底拖网兼捕的三斑海马

Seahorse (*Hippocampus trimaculatus*) bycatch by bottom trawlers

Since 2018, research assistants Baian Lin and Yan Jiang, and postgraduate students, Cailian Liu, Qing Xu and others from Professor Min Liu's research group have conducted bottom trawl fishery surveys monthly in the Minnan-Taiwan Bank fishing grounds based at D-SMART.

The Minnan-Taiwan Bank fishing grounds are important nearshore fishing grounds in China, supporting the fishery economics of multiple coastal administration districts. From the mid-1990s, the estimated annual capture production in the Minnan-Taiwan Bank fishing grounds was 650,000 t, exceeded the estimated maximum sustainable yield (MSY 520,000 t). Because of the long-term high fishing pressure, the fishery resources in the Minnan-Taiwan Bank fishing grounds have shown significant declines. Based on monthly monitoring and sampling at the landing ports, interviewing fishermen and collecting capture logbooks, we can estimate the capture per unit effort (CPUE) and the volume percentages of main capture species groups, identify the main fishing areas and examine the biological parameters of main fishery species. The data can be used in the fishery modeling analysis to obtain the optimal fishery management measures, which will support the fishery resource protection and sustainable use of the Minnan-Taiwan Bank fishing grounds for fishery administration authority.

The results showed that the Minnan-Taiwan Bank fishing grounds have high species diversity and about 212 fish species, 57 crustaceans and 18 cephalopods are recorded. The high capture production species and species groups are mainly small-sized and low-valued, such as *Evynnis cardinalis, Sillago shihama, Decapterus maruadsi, Trachinocephalus myops, Monomia haanii* and mixed feed-grade fishes. In addition, this study revealed that the Minnan-Taiwan Bank fishing grounds are important habitats for seahorses (*Hippocampus trimaculatus* and *H. spinosissimus*), the category II of the national protected animals.

该项目得到了福建省各级渔业主管部门、中国水产流通与加工协会、青岛市海洋生态研究会、北京市企业家环保基金会、美国环保协会、美国渔业协会——蟹类委员会等机构和组织的大力支持。

The project is mainly supported by Fujian fisheries administration offices, CAPPMA, QMCS, SEE, EDF and NFI-Crab Council.

性选择对中华乌塘鳢杂交带形成与维持的作用机制

the mechanism of sexual selection on the formation and maintenance of the hybrid zone of *Bostrychus sinensis*

2022年7月，丁少雄课题组硕士研究生杨宽，在台海站东山实验场开展中华乌塘鳢南北谱系间雌性配偶选择行为学研究。

性选择是物种形成和进化的重要驱动力，而配偶选择是性选择的重要组成部分。个体通过整合多方面信息评估配偶质量，选择优质配偶，是造成物种之间与物种内部巨大形态和行为多样性的重要进化力量。在各项特征中，化学信号是进行种间识别与配偶选择的重要指标，研究表明鱼类能够利用从周围的水环境中检测化学刺激，嗅觉输入是影响鱼类广泛行为的重要因素。本课题组之前的群体遗传学研究表明中华乌塘鳢的南北谱系已经处于物种形成的初级阶段，因此本实验目的旨在探究中华乌塘鳢基于嗅觉信号的谱系间性隔离程度，为中华乌塘鳢谱系间合子前生殖隔离的研究做出补充和完善，并为合子后的生殖隔离研究奠定基础。

本研究针对嗅觉信号对中华乌塘鳢谱系间配偶选择的影响设计行为学实验，采用析因设计法，以雄鱼的谱系为变量，以SCS、ECS、SCS(H)三种不同谱系的雌鱼作为受试个体，实验装置采用Y型迷宫，通过记录试验鱼的偏好时间，分别测试了雌鱼在面对两种不同谱系雄鱼的化学信号与单独面对一种谱系雄鱼的化学信号时的选择与偏好强度。结果表明南方谱系内雌性基于嗅觉的选择偏好差异较弱，基本不存在性隔离；南北谱系间基于嗅觉的性隔离程度较高。

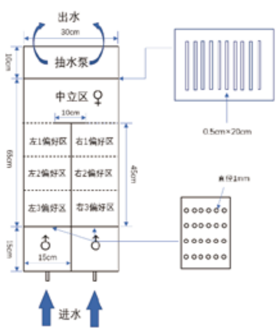
中华乌塘鳢

Bostrychus sinensis

In July 2022, Kuan Yang, a postgraduate student in Professor Shaoxiong Ding's research group, carried out research on the mate selection behavior of female between the north and south lineages of the Bostrychus sinensis at D-SMART.

Sexual selection is an important driver of speciation and evolution, and mate selection is an important part of sexual selection. Individuals evaluate the quality of mates and select high-quality mates by integrating multi-faceted information, which is an important evolutionary force that causes great morphological and behavioral diversity between and within species. Among the characteristics, chemical signals are important indicators for interspecific identification and mate selection, and studies have shown that fish can detect chemical stimuli from the surrounding aquatic environment, and olfactory input is an important factor affecting the extensive behavior of fish. The previous population genetics studies of this group have shown that the north-south lineage of Bostrychus sinensis is already in the initial stage of speciation, so the purpose of this experiment is to explore the degree of interlineal isolation of Bostrychus sinensis based on olfactory signals, supplement and improve the research on prezygotic pre-genital isolation between lineages of Bostrychus sinensis, and lay a foundation for the study of postzygotic reproductive isolation.

In this study, a behavioral experiment was designed for the influence of olfactory signals on mate selection between lineages of Bostrychus sinensis, and the differential design method was adopted, taking the lineage of male fish as the variable, taking female fish of three different lineages SCS, ECS, SCS(H) as the test individual, and the experimental device adopted a Y-maze, and the selection and preference intensity of female fish in the face of two different lineage male fish and the chemical signal of one lineage male fish alone were tested by recording the preference time of the test fish. The results showed that the selection preference of females based on smell was weak in the southern lineage, and sexual isolation was basically absent. There is a high degree of olfactory-based sexual isolation between the northern and southern lineages.



Y迷宫装置示意图

Schematic diagram of the Y-maze installation

配偶选择行为学实验

Experiment in the behavior of mate selection

项目发表的文章

Publications associated with this project

Research Projects

科学研究

2022年，台海站固定研究人员新增纵向科研项目24个，含国家重点研发项目2项、基金委区域创新基金重点项目4项。在研课题54项，含国家重点研发项目、国家基金重点项目等。

In 2022, specialist staff of T-SMART applied 24 government sponsored research projects, including two National Key Research and Development Programs, and four Joint Funds of NSFC Program. In addition, there are 54 on-going research projects, including National Key Research and Development Programs, NSFC Key Projects, and etc.

我国近海典型海域浮游生态系统演变、临界点与重构

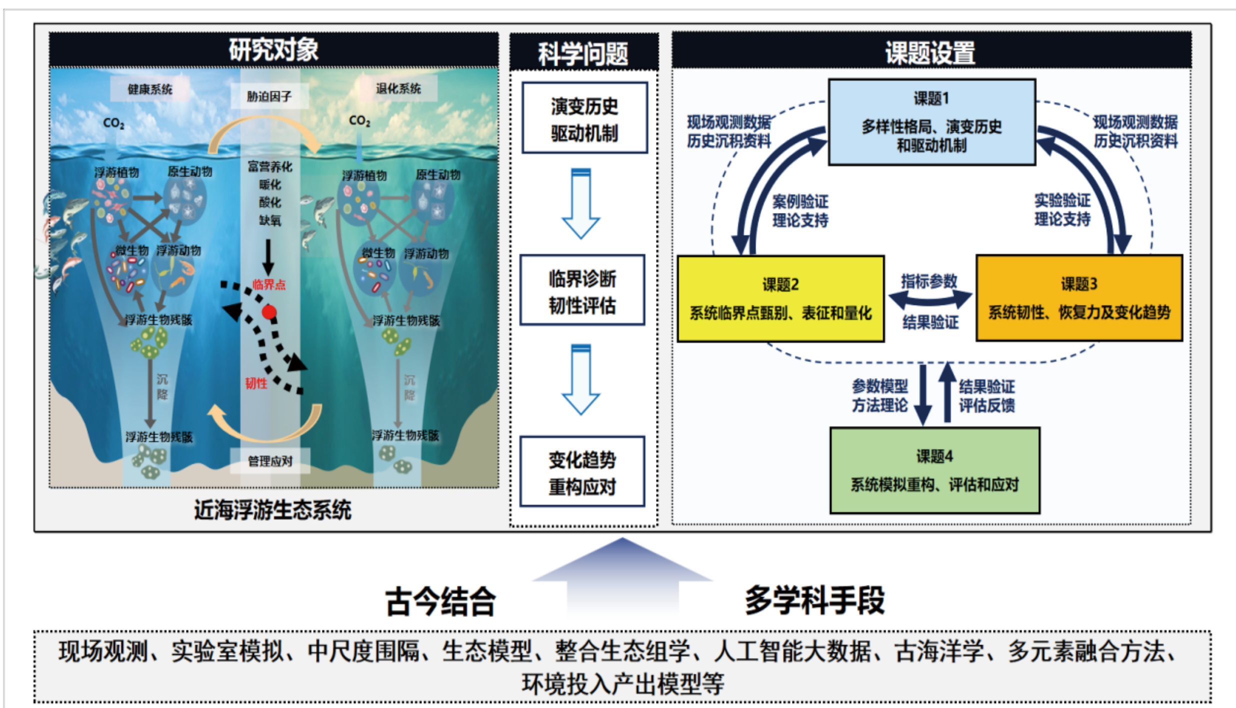
Tipping points, resilience and reconstructure of plankton ecosystem in typical marine areas of China

国家重点研发计划重点专项 | 2022–2025, 王大志

National Key Research and Development Programm | 2022-2025, Dazhi Wang

项目针对“人类活动和全球变化双重胁迫海域浮游生态系统的演变、临界点与重构”这一核心科学问题，以受人类活动和全球变化胁迫显著的长江口、珠江口及邻近海域的浮游生态系统为研究对象，综合浮游生物多样现存格局、历史数据、沉积记录以及不同胁迫环境和极端事件过程中系统稳态转化的集成分析，建立系统临界点表征量化的理论和方法，评估多重环境胁迫下系统韧性和恢复力，架构系统重建的理论和方法，研发系统演变趋势预测模型并实现智能化、情景化预测应用示范，提出适于我国近海经济、人类健康和生态环境协同发展的管理对策，夯实对浮游生态系统临界点、韧性和恢复力的科学认知，阐明全球变化和人类活动双重胁迫下浮游生态系统的演变历史、现存态势和驱动机制，为制定生物多样性保护和气候变化策略，实施陆海统筹及碳中和等国家战略提供理论与方法支撑。

This project aims at the core scientific question that is "Tipping points, resilience and reconstructure of plankton ecosystem in typical marine areas under dual stresses of human activities and global changes", The plankton ecosystems in the Yangtze River Estuary, the Pearl River Estuary and adjacent waters that are significantly stressed by human activities and global changes, are selected as the research objects. We will integrate the existing pattern, historical data, sediment records of plankton diversity, and the system's steady-state transformation in different stressed environments and extreme events, establish the theory and method of characterizing and quantifying the system's tipping points, evaluate the resilience and restoring ability under multiple environmental stresses, built the theory and method of system reconstruction, develop the prediction model of system evolution trend and realize the application demonstration of intelligent and situational prediction, and put forward management strategies suitable for the coordinated development of China's offshore economy, human health and ecological environment, strengthen the scientific understanding of the tipping points, resilience and restoring ability of plankton ecosystem, clarify the evolution history, existing situation and driving mechanism of planktonic ecosystem under the dual stress of global change and human activities. This project will provide theoretical and methodological supports for formulating biodiversity conservation and climate change strategies, and implementing national strategies such as land and sea integration and carbon neutrality.



滨海湿地生态系统蓝碳碳汇和综合生态服务功能

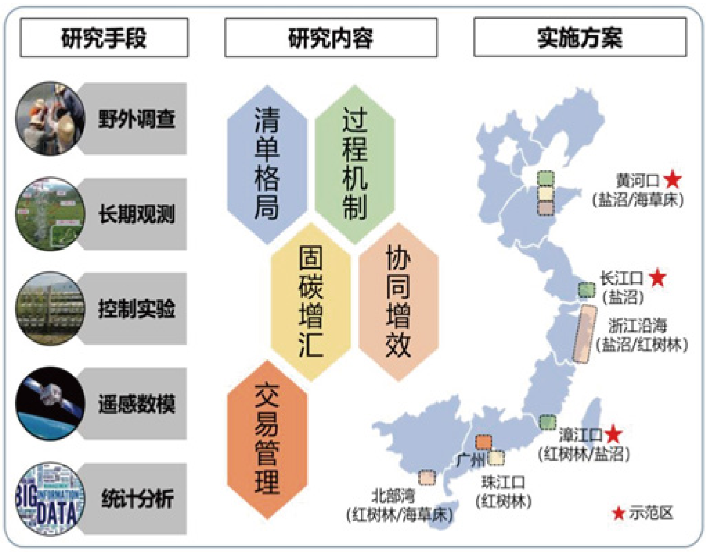
Coastal blue carbon and integrated ecosystem services

国家重点研发计划重点专项 | 2022-2025, 张宜辉

National Key Research and Development Programm | 2022-2025, Yihui Zhang

红树林、盐沼和海草床等滨海湿地是具有巨大碳汇功能的“蓝碳”生态系统，并具有生物多样性维持、防灾减灾等多种其他关键生态服务功能。本项目旨在揭示人类活动和生物入侵影响下滨海湿地碳汇形成新机制，创建滨海湿地-近海耦合的碳汇联网观测新体系，建立符合中国实际的蓝碳评估与核算新方法，开展固碳增汇技术示范和碳交易试点。本项目将按照“机理研究-技术示范-管理范式”的研究思路，首先从多时空尺度阐释滨海蓝碳碳汇清单格局与过程机制；进一步研发滨海湿地蓝碳的联网观测技术、固碳增汇技术及协同增效技术，并开展技术示范；最终，构建滨海蓝碳碳汇的评估与交易体系，推动碳汇交易与管理的有效实施。

Coastal wetlands, such as mangroves, salt marshes, and seagrass beds, are ecosystems stocking numerous “blue carbon”, protecting biodiversity, and preventing disaster damages. This project aims to reveal the new mechanism of carbon sequestration in coastal wetlands under the impacts of human activities and biological invasion; to create a new carbon sequestration observation system network coupling coastal wetlands and coastal areas; to establish a new method of assessing and calculating the actual blue carbon in China; and to establish demonstration area in terms of carbon sequestration and trading. This project will clarify the pattern and process mechanism of coastal blue carbon sink inventory from multiple spatial and temporal scales. Then it will develop the online observation technology for blue carbon, carbon sequestration technology, and apply these technologies. Eventually, the project will construct an evaluation and trading system of the coastal blue carbon sink, and promote carbon trading and management.



项目研究方法与内容

Research methodology and content

闽三角城市群生态安全格局构建关键技术与示范

Key Technologies and Associated Demonstrations for the Development of Ecological Security Patterns in the Min Delta Urban Agglomeration

国家重点研发计划重点专项（课题）| 2022–2026, 曹文志

National Key Research and Development Programm | 2022-2026, Wenzhi Cao

针对目前缺乏对生态安全格局的多尺度关联和生态过程耦合的系统性研究，格局演变的影响机制尚不明晰，评价体系的构建集中于陆域单一尺度且相对静态要素的组合等问题，本课题拟研发包含格局辨识—系统评价—规划设计—精准管控的生态安全格局系统构建技术：

①基于生态安全格局动态演化过程，分析水环境、地质环境中关键生态要素在地球系统中的耦合关系，辨识气候变化和城镇化影响下潜在敏感要素和影响格局演变的胁迫因子；

②有效关联不同尺度，分析生态过程机理，构建面向水源供给、固碳服务、生物多样性保护等生态系统服务的源—汇—廊道空间格局；

③统筹与整合水环境、关键生物类群与景观生态遥感监测，对闽三角城市群生态系统健康、可持续性、生物多样性、生态系统服务功能、景观连通性等进行多维度系统评价；

④利用模型预测未来城市群生态空间用地需求，模拟生态安全格局分布，进行陆海一体化分区，研发多目标协同的生态安全格局规划设计技术；

⑤针对城市群关键区域，进行水陆统筹的多尺度系统监测，实现水环境水生态分区3个，形成“一区一策”的精细化管控方案并开展技术示范。

Given a series of problems such as a lack of systematic studies on ecological security patterns (ESPs) across multi-scales and their coupling with ecological processes, unclear mechanism of pattern evolution, and the evaluation system usually focusing on land as well as relatively static factors. This project intends to develop a construction technology for ESPs with pattern identification, system evaluation, planning and designing, and precise control: 1) To analyze the coupling relationship between crucial factors in the aquatic and geological environment and the earth system based on the ESPs evolution process. Also, to recognize the potential the sensitive factors and stress factors affecting ESPs evolution under climate change and urbanization; 2) To construct spatial pattern combining source, sink, and corridors for water supply, carbon sequestration, and biodiversity protection through effectively correlation of multiple scales and analysis of ecological process; 3) To evaluate the health, sustainability, biodiversity, service function, connectivity of ecosystems in Min Delta Urban Agglomeration by coordinating and integrating remote sensing monitoring of water environment, essential species groups, and landscape ecology; 4) To develop ESPs designing technology across various objectives through predicting the future ecological space demand in agglomeration, simulating ESPs distribution, and delimiting the land-ocean integration into zones; 5) To delimit three zones for aquatic environment and implement refined management scheme according to different zone through multi-scale systematic monitoring of both water and land for crucial areas in agglomeration.

pH 传感器研制

Development of pH sensor

国家重点研发计划重点专项（课题）| 2022–2025, 马剑

National Key Research and Development Programm | 2022-2025, Jian Ma

海洋碳循环和海洋酸化研究是国际前沿科学热点，碳中和背景下的海洋负排放技术研发是国家战略需求，这些研究和技术推广过程中均需要对海水碳酸盐参数进行现场监测。海水pH是探究海洋酸化的重要指标参数，也是计算海气碳通量的关键参数。

目前深海pH传感器存在的主要问题：

（1）核心传感芯片的设计、加工、封装等系列技术为国外垄断，且受疫情影响，国外商品化深海pH传感器所用的芯片即将停产，全球BGC–Argo等国际观测计划面临pH传感器缺乏的困境；

（2）缺乏基于高纯度pH指示剂的海水pH传感器标定和比测设备，新研制pH传感器的准确度和可靠性受到影响；

（3）商品化深海pH传感器应用水深为2000m，深海（2000–4000m）pH原位数据缺乏。鉴于此，本课题针对海洋pH的原位测定需求攻克海洋环境要素干扰的消除与校正、离子敏感场效应管（ISFET）芯片的研制、pH传感器实验室标定与现场校准技术等关键技术问题，研制满足移动平台长时效、低功耗、小型化、快速准确测量的新型ISFET–pH原位传感器，将传感器搭载于移动载体实现水下4000m以浅海域pH的机动连续观测，为海洋酸化、海洋碳循环研究和海洋环境安全保障与岛礁可持续发展提供技术支持。

The research focused on marine carbon cycling and ocean acidification is considered a frontier science on an international scale. Further, developing technology to facilitate negative marine emissions is also becoming increasingly important in light of carbon neutrality efforts. Many studies and technological transfers need the on-site measuring of carbonate parameters in seawater. The pH of water is a crucial parameter not only for ocean acidification research but also for sea-air carbon flux calculation. Current dominate problems within pH sensors under deep-sea are: 1) that foreign companies hold monopolies on the technology required for the design, production, and encapsulation of core sensor chips slated for commercial use and these chips may go out of production due to COVID-19, resulting in slowdowns for scientific programs such as BGC-Argo. 2) Newly developed pH sensors may lack calibration and comparison equipment necessary for assessing the accuracy and reliability of readings when using high purity pH indicators. 3) Commercially available deep-sea pH sensors are only usable at depths up to 2,000 meters, and there is a lack of in-situ pH data from the deeper sea (2000-4000m). This study aims to improve the accuracy of traditional pH sensors by eliminating environmental interference, manufacturing an ion-sensitive field-effect transistor (ISFET) chip, and ultimately developing new ISFET-pH in-suit sensors that are smaller in size, more energy efficient, and highly accurate. These newly developed sensors can be attached to movable carriers, allowing flexible continuous pH observations to 4,000 meters underwater. This new technology will support research in areas such as ocean acidification, the carbon cycle, marine safety and security, and sustainable development of insular regions.

pH传感器研制技术路线图

Technical overview

滨海盐沼湿地与全球变化

Salt marsh and global change

国家自然科学基金委优秀青年科学基金项目 | 2023-2025, 刘文文

NSFC Excellent Young Scientists Fund | 2023-2025, Wenwen Liu

全球变化背景下，揭示和预测滨海湿地植被的时空格局、适应机制和演替趋势是应对气候变化的关键。

本项目围绕“滨海盐沼湿地与全球变化”，从个体、种群和群落水平开展长期研究：

(1) 厘清盐沼植物对滨海湿地主要环境梯度响应的时空格局和适应机制；

(2) 阐明滨海湿地入侵植物互花米草成功入侵的生态适应与进化机制；

(3) 揭示滨海盐沼植物群落动态的空间同步性格局及其驱动机制。

本项目计划结合野外沿流域水位梯度控制平台、跨纬度温室同质种植园以及中美多个滨海长期生态系统定位研究站观测，深入开展滨海盐沼湿地植物群落对全球变化的多尺度响应研究，为滨海湿地保护和管理提供科学支撑。

With ongoing global change, revealing and predicting the spatio-temporal pattern, mechanism of ecological adaptation, and succession trend of coastal wetland vegetation has become an urgent research need. This project focuses on "salt marsh and global change" at individual, population and community levels with three key findings: 1)To clarify the spatio-temporal pattern and the adaptive mechanism of salt marsh plants responding to major environmental gradients in saltmarsh wetlands. 2)To clarify the ecological adaptation and evolutionary mechanism of the successful invasion of Spartina alterniflora in saltmarsh wetlands. 3) Reveal the spatial synchronous pattern and mechanism of the dynamic of salt marsh plant communities along typical coastal estuaries. This project will conduct an in-depth study on the multi-scale response of salt marsh plant communities to global change by combining 1) marsh organs along estuarine gradients, 2) greenhouse common gardens across latitude, and 3) fieldwork at multiple coastal wetlands long-term ecological research stations in China and the United States, so as to provide scientific support for the protection and management of coastal wetlands.

红树林沉积物应对氮富集的缓冲体系组成、机制以及缓冲能力研究

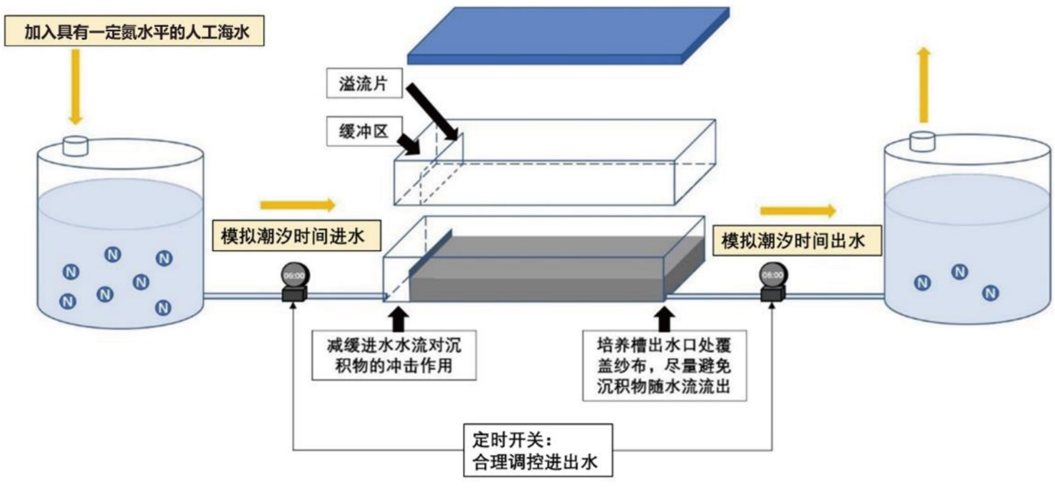
Study on buffering processes， mechanism， and buffering capacity of mangrove sediments in response to nitrogen enrichment in coastal area

国家自然科学基金委重点项目 | 2023–2027, 曹文志

NSFC Key Project | 2023-2027, Wenzhi Cao

红树林沉积物氮循环过程与全球碳循环密切相关，蕴藏着巨大的蓝碳碳汇。人类活动导致红树林沉积物受到外源氮输入胁迫，在环境因子与生物地球化学过程耦合条件下，形成复杂的氮迁移转化过程及机制。本项目以典型红树林沉积物为研究对象，通过遴选具有氮含量梯度的红树林沉积物样地，结合室内培养设计一系列的氮添加梯度，对比分别测定和同一体系下测定不同氮富集程度下硝化、反硝化、Anammox、DNRA、Feammox等过程的强度，解析其协同及竞争关系，分析红树林沉积物受外源氮输入胁迫的缓冲机制。揭示不同电子穿梭体对强化沉积物缓冲能力的介导作用，厘清其对红树林氮缓冲体系的影响过程及机理。同时研究红树林沉积物中微生物功能基因丰度和微生物群落的结构与多样性，揭示红树林沉积物缓冲体系的微生物调控机制。该研究对于丰富红树林沉积物碳氮循环过程、发挥红树林在近岸海域富营养化的缓冲和净化作用具有重要理论价值和生态环境意义。

The nitrogen cycle processes in mangrove sediments are closely related to the global carbon cycle, particularly, the blue carbon sinks in coastal areas. With the effects of human activities, mangrove sediments are stressed by increasing external nitrogen inputs. The coupling of biogeochemistry and environmental factors leads to a complex nitrogen migration and transformation mechanisms in mangrove sediments. This project takes typical mangrove sediments as the research object, selects typical sediment samples in different areas with obvious gradient of nitrogen contents, and designs a gradient of nitrogen addition concentrations. Comparing the reaction rates of nitrification, denitrification, Anammox, DNRA, Feammox and other processes under different nitrogen enrichment levels in the same incubation system with the above series reactions measured separately, the synergy and competition relationships between these reactions will be explored, and the buffer mechanisms in mangrove sediments under the stresses of a gradient of exogenous nitrogen inputs. Meanwhile, the mediation effects of different electron shuttles on the enhancement of buffer capacity in mangrove sediments will be revealed, and the influencing mechanisms on the nitrogen buffer capacity in mangrove sediments will be also clarified. Furthermore, the functional gene abundance, the structure, and diversity of microbial communities in mangrove sediments will be also explored to reveal the microbial regulating mechanisms for the nitrogen buffering capacity in mangrove sediments. This study will therefore provide new thoughts for updating and improving the nitrogen and blue carbon cycles in estuarine mangrove sediments, and will reveal the mangrove's roles in reducing coastal eutrophication and purifying coastal waters.



潮汐模拟培养装置

Tide simulation culturing instrument

台湾海峡冬季及初春离岸藻华的锋面不稳定机制研究

Frontal instability induced offshore phytoplankton bloom in winter and early spring Taiwan Strait

国家自然科学基金委联合基金重点项目 | 2023–2026, 江毓武

Joint Funds of NSFC | 2023-2026, Yuwu Jiang

离岸藻华在台湾海峡冬季及初春东北风盛行期经常发生，并与锋面联系紧密。锋面处通常伴随亚中尺度不稳定过程，可以将环境背景场的平均能量转化为扰动涡动能，强化从密跃层到混合层的物质输运及水体层化，从而调控海洋浮游植物的生长繁殖。本研究主要通过收集台湾海峡历史走航数据、观测浮标资料，多源的卫星遥感数据，结合现场观测分析总结冬季及初春离岸藻华的时空分布及变化规律。同时通过观测数据的验证优化、完善台湾海峡双向嵌套的物理生态模型,结合不稳定性动力分析，探究不稳定的特征及演化过程，给出离岸藻华发生发展的锋面不稳定动力学机制。

Offshore phytoplankton blooms often break out during the winter to early spring monsoon period in the Taiwan Strait, typically when northeasterly wind prevails and is associated with the front. This front is usually accompanied by sub-mesoscale unstable processes that can transfer the average energy of the environmental background to the energy of perturbed vortices, thereby intensifying material transmission and water stratification from pycnocline to mixed layer, and regulating the growth and reproduction of marine phytoplankton. This study aims to investigate the spatiotemporal characteristics and variation laws of offshore phytoplankton blooms during the winter and early spring by analyzing historical cruise data, buoy data, and multi-source satellite data collected in the Taiwan Strait, combined with field observation. Additionally, this study will verify and enhance the bidirectional coupled physical-ecological model using observation data. The dynamics mechanism of frontal instability-induced offshore algal blooms will be clarified through simulation, experiments, and improvement.

海平面上升与生物入侵叠加效应下福建典型河口湿地的生态脆弱性

Ecological vulnerability of Fujian estuarine wetlands under the superimposed effects of sea-level rise and biological invasions

国家自然科学基金委联合基金重点项目 | 2023–2026, 陈鹭真

Joint Funds of NSFC | 2023-2026, Luzhen Chen

全球河口海岸湿地广泛遭受海平面上升和互花米草入侵的复合影响。在致灾机制探究中，综合植被和沉积的反馈作用及其对生物地貌演变的贡献，对生态脆弱性的预测极为关键。本研究围绕“滨海湿地生物地貌演变与生态脆弱性”的主题，以福建漳江口和闽江口典型红树林–互花米草交错带的植被演替、地表高程、沉积速率和地貌特征为研究对象，应用国际标准化的滨海湿地植被和地表高程监测技术、高精度的机载雷达地形扫描技术和高分辨率遥感，量化互花米草入侵和入侵修复对生物地貌的物理学作用和生物学作用，剖析植物–沉积双向正负反馈作用驱动的潮间带地貌演变，预测海平面上升叠加生物入侵情景下的红树林生态系统稳定性和海岸带脆弱性，为福建河口海岸地区生态安全提供理论依据，为我国乃至全球河口海岸湿地管理与可持续发展提供研究范式。

Global estuarine coastal wetlands are extensively affected by the compound effects of sea level rise (SLR) and Spartina invasion. In the investigation on the disaster risk mechanisms, it is crucial to predict the ecological vulnerability by integrating the feedback effects of vegetation and sedimentation, and their contributions to the biogeomorphological evolution. This study focuses on the theme of "biogeomorphological evolution and ecological vulnerability in coastal wetlands", and takes the vegetation succession and surface elevation,sedimentation rate and geomorphological features in the typical mangrove-Spartina ecotones in Zhangjiang Estuary and Minjiang Estuary of Fujian as the research objectives. The techniques with international standardized coastal wetland vegetation permanent plot observation and the surface elevation monitoring,combined with high accurate Lidar UVA topography scanning and high resolution remote sensing techniques, will be applied to quantify the surface elevation change, vegetation succession, and to discover the mechanical and biological effects of Spartina invasion and Spartina removal on biogeomorphology in these ecotones, and then predict the ecological vulnerability in regional scare. The evolution of the intertidal geomorphology driven by bidirectional feedbacks with positive or negative plant-sedimentation interactions will be analyzed. Models will be used to predict the stability of mangrove ecosystems and coastal vulnerability under the scenario of SLR superimposed on biological invasion, and the theoretical basis for ecological security of Fujian estuaries will be provided. The results of this study will also provide a research paradigm for the restoration and sustainable development of estuarine coastal wetlands in China and also in the globe.

皱纹盘鲍食物转化率性状遗传解析及其分子育种基础研究

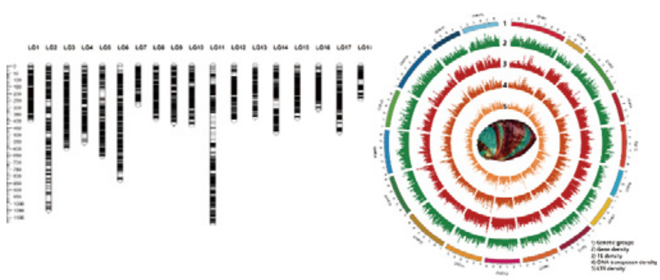
Ecological vulnerability of Fujian estuarine wetlands under the superimposed effects of sea-level rise and biological invasions

国家自然科学基金委联合基金重点项目 | 2023–2026, 柯才焕

Joint Funds of NSFC | 2023-2026, Caihuan Ke

提高食物转化率，减低饵料投喂是实现水产养殖业经济和环境可持续性发展的关键。当前我国鲍养殖总成本中饲料成本占比大的瓶颈问题不容忽视，随着我国鲍养殖产业进入中低利润、高中风险时代，培育高食物转化率养殖品种以降低饵料成本，对产业健康发展和降低养殖风险显得格外重要。此外，从环境角度讲，提高鲍食物转化率，可以减少动物排泄物的排出，减少对环境氮、磷等水体富营养化成分的输出，有利生态环境的保护。本项目拟通过开拓鲍类新的经济性状的遗传学和分子育种研究，为鲍高食物转化率新品种选育提供技术基础，也将获得对鲍遗传规律的新认知。

Considering the decreasing profit and increasing risks in the abalone industry, developing a new variety of abalone with a higher food conversion rate is necessary to reduce bait costs, decrease risks, and promote sustainable aquaculture practices. Moreover, a higher food conversion rate could help minimize excreta output, nitrogen and phosphorus levels in the water bodies, and benefits environmental protection. This project will focus on genetic and molecular breeding research to improve the economic value of abalone and provide technical support for breeding new abalone varieties with higher food conversion rates. Additionally, this study will enhance the understanding of the genetic principles that govern abalone production.



皱纹盘鲍染色体水平的全基因组精细图谱的构建

Construction of a detailed map of the Abalone cragnus genome at the chromosome level

全球变化背景下台湾海峡温度变异机制及其对东山珊瑚生态系统的影响

Impacts of temperature variation in the Taiwan Strait on coral ecosystems in the Dongshan Bay under climate changes

中央引导地方科技发展专项 | 2022–2025, 江毓武

The Central Guidance on Local Science and Technology Development Fund | 2022-2025, Yuwu Jiang

中国沿岸冬季海面温度在台湾海峡西岸表现出最大的时间变化，本项目旨在提出一个机制来解释在全球变暖的背景下，以PDO和ENSO等为表征的全球重要大气和海洋过程如何影响台湾海峡的海表温度。这一机制有助于解释在这样一个典型的亚热带海峡发生极端暖冷事件的原因，并有助于预测北太平洋西海岸的海表温度变化趋势。另外，本研究拟探究中国大陆造礁珊瑚分布最北缘的珊瑚种类如何应对冬季低温和极端低温事件，以及发生冷白化事件后的珊瑚生态系统的恢复能力。结果将有助于我们理解人类活动和全球变化趋势下高纬度珊瑚生态系统的生消，为珊瑚保育和环境决策提供科学支持，服务于生物多样性保护的国家战略需求。

The winter sea surface temperature (SST) along the coast of China exhibits the most significant temporal variation in the west coast of the Taiwan Strait. This project aims to propose a mechanism that explains how major atmospheric and oceanic processes worldwide, such as the Pacific Decadal Oscillation (PDO) and El Niño/Southern Oscillation (ENSO), influence SST in the Taiwan Strait under global warming. Such a mechanism could elucidate extreme warm and cold events in a typical subtropical strait and facilitate predicting SST trends along the west coast of the North Pacific Ocean. This project also focuses on exploring how coral species at mainland China's northernmost edge of reef-building coral distribution respond to extreme low temperatures and their resilience following cold bleaching events. The study may augment the understanding of high-latitude coral ecosystems affected by human activities and global changes, support coral conservation and guide environmental decision-making while serving essential national demands for biodiversity protection.

中国海生态系统固碳关键过程与调控机制

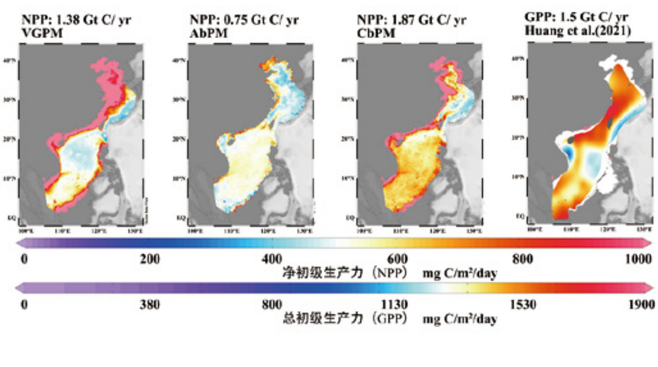
Key processes and regulation mechanisms of carbon sequestration in China Seas

国家自然科学基金委碳中和专项基金重点项目 | 2022-2025, 黄邦钦

NSFC Key Programs |2022-2025, Bangqin Huang

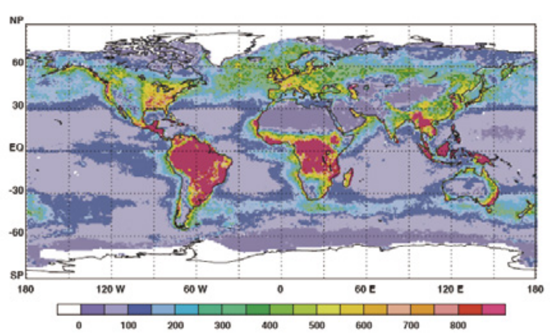
项目面向“国家碳中和的重大基础科学问题与对策”专项项目指南方向(二)：中国海生态系统固碳关键过程与调控机制，针对“如何准确评估中国海生态系统固碳速率？调控其时空变化的关键过程和机制是什么？”的核心科学技术问题开展研究。项目基于厦门大学和海洋二所联合团队大量现场实测数据和卫星遥感数据集成分析，在准确、全面、高时空分辨率地评估中国海生态系统固碳速率的基础上，探讨海水碳酸盐体系、浮游植物初级生产、群落净生产、浮游动物摄食和群落呼吸等关键碳汇过程的调控机制。评估近20年来中国海光合固碳速率的变化特征，揭示自然和人类活动（暖化和富营养化等）对生态系统碳汇功能的影响，最终阐明中国海典型生态系统结构和碳汇功能的关系。项目的实施将显著提升我国生态系统固碳研究水平，全面、准确评估中国海生态系统固碳速率，降低其不确定性，提供海洋碳汇清单，支撑国家碳中和路径优化和管理政策决策。目前，项目按照预期计划稳步推进中，主要开展历史资料收集、整理和数据分析工作，重点推进现场数据与卫星遥感数据的比对和验证分析工作。

This project aims at the special guidance direction (2)-key processes and regulation mechanisms of carbon sequestration in China Seas of the Special Project “Major Basic Scientific Problems and Countermeasures of National Carbon Neutralization”. Core scientific and technological questions are that "how to accurately assess the carbon sequestration rate in China Seas?" and “what are the key process and mechanisms of regulating its temporal and spatial changes? ". To answer these questions, the project will explore the regulation mechanism of key carbon sink processes such as seawater carbonate system, phytoplankton primary production, net community production, zooplankton feeding, and community respiration, based on the integration and analysis of a large number of field data and satellite remote sensing data from Xiamen University and the Second Institute of Oceanography, MNR and on the basis of accurate, comprehensive, and high spatial-temporal resolution assessment of carbon sequestration capacity in China Seas. The project will assess the long-term changes of photosynthetic carbon fixation rate in the past 20 years in China Seas. Also, the project will reveal the impact of natural and human activities, e.g., warming and eutrophication, on the carbon sequestration function of marine ecosystem. The ultimate goal is to clarify the relationship between the typical marine ecosystem structure and carbon sink function in China Seas. The implementation of the project will significantly improve the research level of carbon sequestration in China, comprehensively and accurately assess the carbon sequestration rate in China Seas, reduce its uncertainty, provide a list of marine carbon sinks, and support the optimization of national carbon neutralization scheme and the decision-making of management policy. At present, the project is progressing steadily according to the expected annual plan, focusing on the collection, collation and analysis of the historical data, especially the comparison, verification and analysis of field data and satellite remote sensing data.



基于主流遥感模型初步估算的中国海净初级生产力（NPP） 和总初级生产力（GPP）(团队未发表数据)

Net Primary Production(NPP) and Gross Primary Production(GPP) for the China Seas, calculated by 4 different mainstream remote sensing models (unpublished data)



卫星遥感估算全球海洋和陆地净初级生产力，gC m−2yr−1 (Field et al., 1998)

Global annual NPP (in grams of C per square meter per year) for the biosphere, calculated from the integrated CASA-VGPM model.（Field et al., 1998）

海洋荒漠生物泵固碳机理及增汇潜力

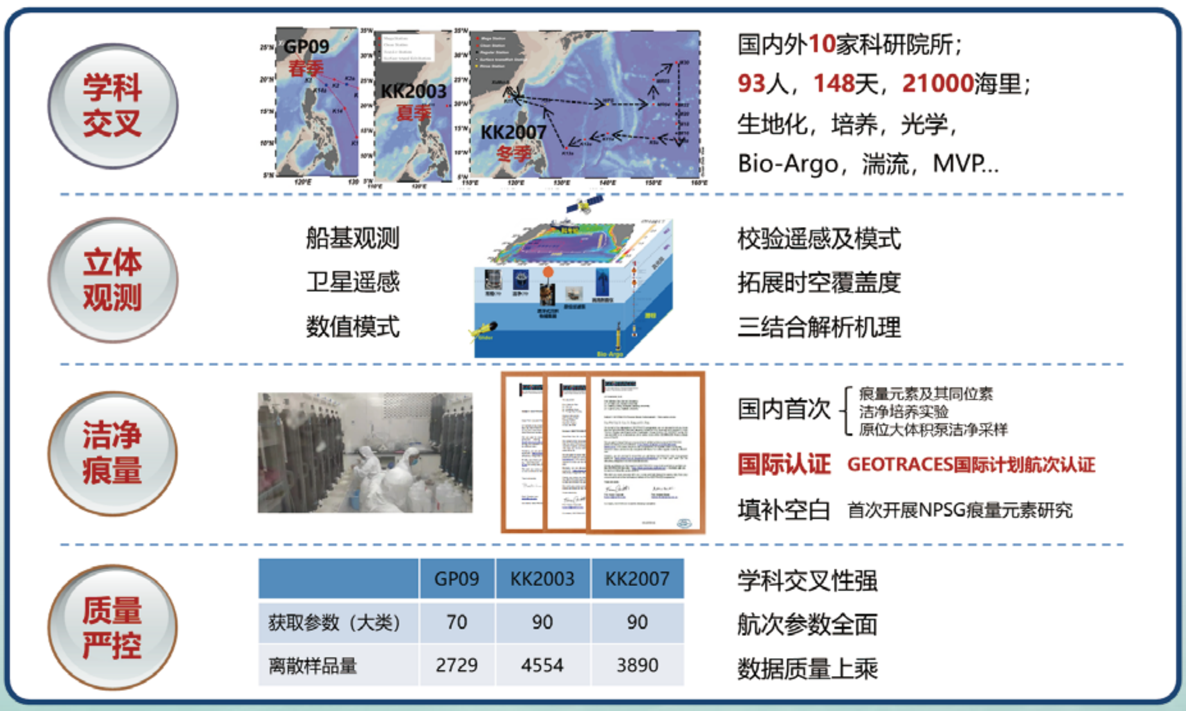
Carbon Fixation and Export in oligotrophic ocean

国家自然科学基金委重大项目 | 2019−2023, 戴民汉

Major program supported by NSFC | 2019-2023, Minhan Dai

全球表层海洋面积约30%为低生物量的寡营养海域，通常称为“海洋荒漠”。尽管单位面积的生产力很低，然而海洋荒漠面积巨大，故而对全球海洋碳汇具有潜在的重要贡献，可能具有增汇潜力，显然是全球海洋碳循环的重要环节，但却是研究最为匮乏的海域，也缺乏理论框架。项目聚焦北太平洋副热带流涡区（NPSG），围绕真光层双层结构下海洋荒漠生物泵的物质基础、结构、时空格局、效率及其固碳和增汇潜力，构架寡营养海域生物泵新理论框架，并为海洋荒漠的增汇途径及其有效性提供科学论证。

The oligotrophic ocean occupies about 30 % of the ocean surface and has been conventionally regarded as ocean deserts. It is characterized by nutrient depletion in the surface waters and extremely low net biological production and hence, per unit area, contributes little to carbon export from surface to deep waters. Emerging evidence, most notably based on ocean time-series studies such as those at the Hawaiian Ocean Time-series station, has shown a wider than previously assumed dynamic range of nutrient inputs and biological responses in this vast oceanic system. This project studies sources and fluxes of macronutrients (i.e., N, P, Si) and micronutrients (e.g., Fe) and their spatiotemporal distributions and how these factors support biological pump at the two distinct layers of the euphotic zone in the North Pacific Subtropical Gyre (NPSG), one of the world's largest oligotrophic regimes. It aims to frame new understandings on key mechanisms controlling the biological pump and efficiency of carbon storage in the ocean.

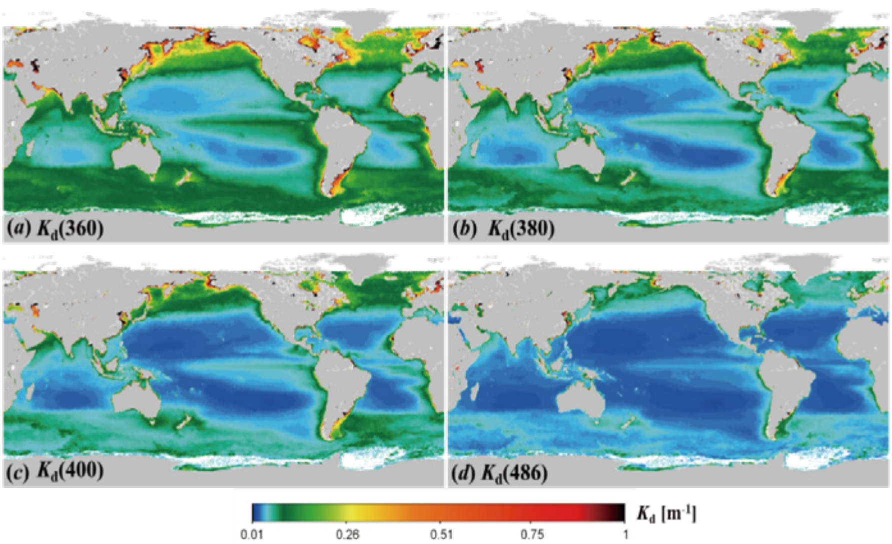


项目于2019年春、2020年夏冬实施的三个综合观测航次特色总结

Highlights of three multidisciplinary cruises conducted in the subtropical Northwest Pacific Ocean by Carbon-FE

该项目实施4年以来，在现场观测、遥感反演和数值模拟等方面开展了多项创新性的研究工作。项目组织实施了3个大型综合科考航次，采用严格的国际规范，并获得国际GEOTRACES研究计划认证，并在方法与技术的优化与创新、数据产品的构建和科学理论认知等三个方面均取得了一系列突出的进展与成果。（1）在方法与技术上，实现了若干个的开创性进展和成果，如国内首套痕量金属采样和分析系统的建立、首次获得全球海洋UV辐射遥感、构建适用于NPSG生物泵研究的三维高分辨率耦合模式等；（2）在数据产品上，项目初步建立了以现场观测数据和遥感反演为特色的数据库；（3）在科学认识上，本项目取得了若干新发现和新认识。如揭示了NPSG痕量（铁）和常量营养物质的来源、分布格局及通量，发现铁和氮输入真光层的主要来源途径存在不同；阐明NPSG固氮速率、固氮生物群落组成的时空格局，证实真光层有机质矿化驱动氮再生并释放温室气体氧化亚氮，从而部分抵消海洋生物泵碳封存的气候效应；发现海洋酸化使得束毛藻的磷需求增加，而固氮速率却显著下降。模型预测到本世纪末酸化和磷限制的协同作用将显著降低束毛藻的固氮作用；刻画NPSG颗粒有机碳输出通量在空间上的变异性，发现营养盐跃层变动可能是输出生产力的主控因子。上述新发现和新认识对厘清真光层双层结构下海洋荒漠生物泵的物质基础、结构、时空格局、效率这一核心科学问题具有重要意义，有望为进一步揭示海洋荒漠的增汇途径及其有效性提供科学论证。

By integrating in-situ and remote sensing observations, and numerical simulations, Carbon-FE has been carrying out innovative researches during the past four years since the launch of the project. Three multidisciplinary cruises were conducted in the subtropical Northwest Pacific, all of which are endorsed by GEOTRACES either as section cruise or process-study cruises. The project has achieved a series of breakthroughs in optimization and innovation of methods and techniques, generations of data products, and scientific understanding. We highlight some of the major achievements as follows. (1) Optimization and innovation of methods and technologies. A full suite of clean sampling and measurements of trace elements has been established. We developed a new scheme to obtain the remote sensing reflectance at near-blue and UV bands from ocean color measurements at visible bands and redefined the euphotic zone depth . A coupled physical-biogeochemical numerical model with constraints on iron cycle and nitrogen fixation has been developed. (2) Data products. Datasets of trace elements and oceanographic parameters, as well as remote sensing products in the NPSG have been generated. (3) Improvement of scientific understanding. We investigated the spatiotemporal distribution of dissolved Fe and nutrients in the NPSG. Their sources and fluxes into the euphotic zone have been clarified. The patterns of diazotrophs and nitrogen fixation rates have been described. Substantial nitrous oxide production in the epipelagic zone of the subtropical ocean partially offsets carbon sequestration by the marine biological pump, according to observation from the South China Sean and the Subtropical North Pacific Gyre. We found acidification enhanced phosphorus demands and decreased phosphorus-specific nitrogen fixation rates in Trichodesmium. And further predicted that acidification and phosphorus stress could synergistically cause an appreciable decrease in global Trichodesmium nitrogen fixation by the end of this century. Also, mechanisms of phosphorus limiting in the NPSG have been studied. At last, we constrained the POC export flux from the euphotic zone and analyzed its spatial variability associated with nutricline depths and N2 fixation rates.



根据VIIRS卫星获得的气候态Kd（λ)的全球分布：(a) Kd (360)，(b) Kd (380)，(c) Kd (400)和(d) Kd (486)（汪永超等，2022）

Global distribution of VIIRS Kd (λ) climatology data. (a) Kd (360), (b) Kd (380), (c) Kd (400), (d) Kd (486) (Wang et al., Optics Express, 2022).

Data Management

数据管理

2022年，厦门大学海洋监测与信息服务中心暨台海站数据中心围绕数据中心的总体建设框架和任务，积极推进台海站标准化数据库的建设。继续完善数据资源目录和元数据编制规范，包括数据资源的分类、元数据描述、代码规划和目录编制，以及相关工作的组织、流程、要求等方面的内容。通过建设数据资源目录体系，实现对数据资源的组织、存储、查找和定位，为数据资源汇聚、业务协同和开放共享服务奠定基础。初步构建了覆盖台湾海峡–海湾–河口–湿地–流域的生态环境数据库，并启动建设生态环境数据共享服务平台，预计于2023年投入正式使用。根据边建设边运用的原则，2022年数据中心提供了42批次的数据共享服务。

In 2022, the Marine Monitoring and Information Service Center of Xiamen University (MMIS), also the Data Center of T-SMART, actively promoted the construction of a standardized database for the T-SMART, based on the overall framework and tasks of the data center. We continued to improve the data resource catalog and metadata preparation standards, including the classification of data resources, metadata descriptions, code planning, and directory compilation, as well as the organization, processes, requirements, and other aspects of related work. By establishing a data resource catalog system, we were able to organize, store, search, and locate data resources, laying a foundation for data resource aggregation, business collaboration, and open sharing services. We also initially constructed an ecological environment database covering the Taiwan Strait, Gulf, estuary, wetland, and river basin, and began to construct an ecological environment data sharing platform, which is expected to be officially put into use in 2023. Following the principle of simultaneous construction and application, the data center provided 42 batches of data sharing services in 2022.

门类

门类（按领域）	
代码	门类名称
1	生态环境
2	自然资源
3	社会经济
4	地理信息
5	数值模拟
6	遥感遥测

门类->大类

门类（按领域）		大类（按地域）		
代码	门类名称	代码	大类名称	联合码
1	生态环境	01	水	101
		02	土	102
		03	气	103
		04	生	104
2	自然资源	...	...	...
3	社会经济	...	...	...
4	地理信息	...	...	...
5	数值模拟	...	...	...
6	遥感遥测	...	...	...

门类->大类->中类

门类（按领域）		大类（按地域）			中类（按学科）		
代码	门类名称	代码	大类名称	联合码	代码	中类名称	联合码
1	生态环境	01	水	101	01	水文	10101
					02	物理	10102
					03	化学	10103
		02	土	102	01	土壤物理	10201
					02	土壤化学	10202
		03	气	103	01	大气物理	10301
					02	大气化学	10302
		04	生	104	01	生物生产力	10401
					02	生物要素监测	10402
					03	生物代谢活性	10403

序号	元数据项
1	实体信息
2	标识信息
3	限制信息
4	约束信息
5	调查信息
6	数据来源
7	审批信息
8	维护信息
9	修订信息
10	数据源
11	参照系

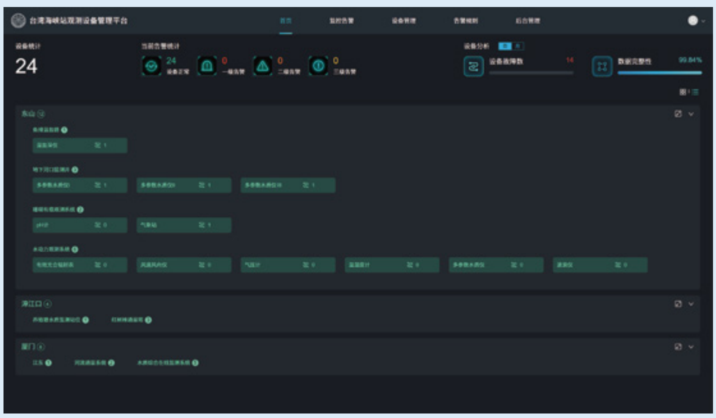
生态环境数据共享服务平台系统界面

The screenshot of the Ecological Environment Data Sharing Platform

生态环境数据共享服务平台系统界面
The screenshot of the Ecological Environment Data Sharing Platform

此外，为提升野外台站现场海洋环境观测设备的运行监控与运维保障水平，台海站数据中心正式上线“野外台站现场观测设备管理平台”，实现对东山湾、漳江口、厦门湾等区域24台套观测设备进行自动化与可视化监控，通过实时记录观测系统的运行状态，在设备、通讯、电力等故障发生时及时告警并处理，使得各自动化观测系统数据有效获取率达到87.3%，保障了科学观测仪器的正常运行和科学数据的连续产出。

In addition, to enhance the operational monitoring and maintenance level of marine environmental observation equipment, T-SMART Data Center has officially launched the "Management Platform for Field Station Observation Equipment". This platform enables automated and visual monitoring of 24 sets of observation equipment in areas such as Dongshan Bay, Zhangjiang Estuary, and Xiamen Bay. By recording the real-time operating status of the observation system, it can promptly alert and handle equipment, communication, power, and other faults, achieving an effective data acquisition rate of 87.3% for each automated observation system. This ensures the normal operation of scientific observation instruments and the continuous production of scientific data.



野外台站现场观测设备管理平台
The screenshot of the Management Platform for Field Station Observation Equipment

Personnel

团队人员

现有固定研究人员57人，其中中国科学院院士2人，欧洲科学院/俄罗斯科学院/发展中国家科学院院士1人，国家杰出青年科学基金获得者5人，国家优秀青年科学基金获得者5人，国家高层次人才1人。

2022年，刘文文获国家优秀青年科学基金项目资助，游伟伟入选农业农村部神农青年英才；戴民汉获亚洲-大洋洲地球科学学会“艾克斯福特奖”，刘志宇获第七届“曾呈奎海洋科技奖”青年科技奖；吕永龙当选俄罗斯科学院外籍院士、国际科学理事会会士。孙萍副教授晋升为教授。

There are 67 permanent staff in the station, including 57 researchers, 10 technical and managerial personnel. Among the regular researchers, there are two academicians of the Chinese Academy of Sciences, one academician of the Academy of Sciences for Developing Countries/European Academy of Sciences/Russian Academy of Sciences, 10 winners of National Science Fund for distinguished and excellent scientists, 40 professors and 16 associate professors.

In 2022, Dr. Wenwen Liu recieved the NSFC Award for Excellent Young Scientists; Prof. Weiwei You was selected as the Shennong China Agricultural Science and Technology Award of the Ministry of Agriculture and Rural Affairs. Prof. Minhan Dai received the Axford Medal Award from the Asia Oceania Geosciences Society (AOGS); Zhiyu Liu was awarded the “Zeng Cheng Kui Marine Science and Technology Award-Young Scientist Award”; Prof. Yonglong Lu was elected a foreign academician of the Russian Academy of Sciences in June and was elected a Fellow of the International Council for Science in December. Associate Professor Ping Sun was promoted to professor.

New Members

Faculty

周晓平
博士 副教授

Dr. Xiaoping Zhou
Associate professor
E-mail：xpzhou@xmu.edu.cn

2008年获厦门大学生态学博士学位，2009年入职厦门大学，并于2022年加入台海站，担任漳江口实验场常务副站长，从事鸟类生态，分子生态、分子进化等方面的研究。

Dr. Xiaoping Zhou received his PhD from Xiamen University in 2008 before he was employed by Xiamen University in 2009, and joined T-SMART in 2022. His research interests are avian ecology, molecular ecology, molecular evolution.

刘文文
博士 副教授

Dr. Wenwen Liu
Associate professor
E-mail: lww@xmu.edu.cn

2019年获厦门大学生态学博士学位，2019-2021年在厦门大学从事博士后研究。2021年入职厦门大学，于2022年加入台海站，从事滨海湿地植物群落生态学，生物入侵生态学等方面的研究。

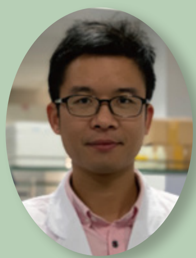
Dr. Wenwen Liu received his PhD in Ecology from Xiamen University in 2019, and worked as a postdoctoral in Xiamen unversity until 2021. He was then employed by Xiamen University in 2021, and joined T-SMART in 2022. His research interests are coastal and wetland plant community ecology and biological invasion ecology.

吴　浩
博士 副教授

Dr. Hao Wu
Associate professor
E-mail：haowu@xmu.edu.cn

2012年获厦门大学生态学博士学位，2013-2022年分别于清华大学、美因茨大学从事博士后研究。2022年入职厦门大学，并加入台海站，从事单体稳定同位素分析技术开发与应用、古海洋生态系统食物网评估与环境重建、基于稳定同位素技术的农产品真实性鉴别和产地溯源等方面的研究。

Dr. Hao Wu received his PhD in Ecology from Xiamen University in 2012. Between 2013 and 2022, he worked in Tsinghua Unversity and University of Mainz as a postdoctoral researcher. He joined Xiamen University and T-SMART in 2022. His research interests are development and application of compound specific Isotope analysis (CSIA), food web assessment and environmental reconstruction of paleo-marine ecosystems, authenticity identification and origin traceability of agricultural products based on stable isotope technology.



肖武鹏
博士 副教授

Dr. Wupeng Xiao
Associate professor
E-mail：wpxiao@xmu.edu.cn

2019年获厦门大学环境科学博士学位，2019-2021年在厦门大学从事博士后研究。2021年入职厦门大学，于2022年加入台海站，从事海洋生态学；浮游植物群落生态学；性状生态学；生态模型等方面的研究。

Dr. Wupeng Xiao received his PhD in Environmental science from Xiamen University in 2019, and worked as a postdoctoral in Xiamen unversity until 2021. He was then employed by Xiamen University in 2021, and joined T-SMART in 2022. His research interests are marine ecology; phytoplankton community ecology; trait-based ecology; ecosystem models.

张雅棉
博士 高级工程师

Dr. Yamian Zhang
Senior Engineer
E-mail：yamian_zhang@xmu.edu.cn

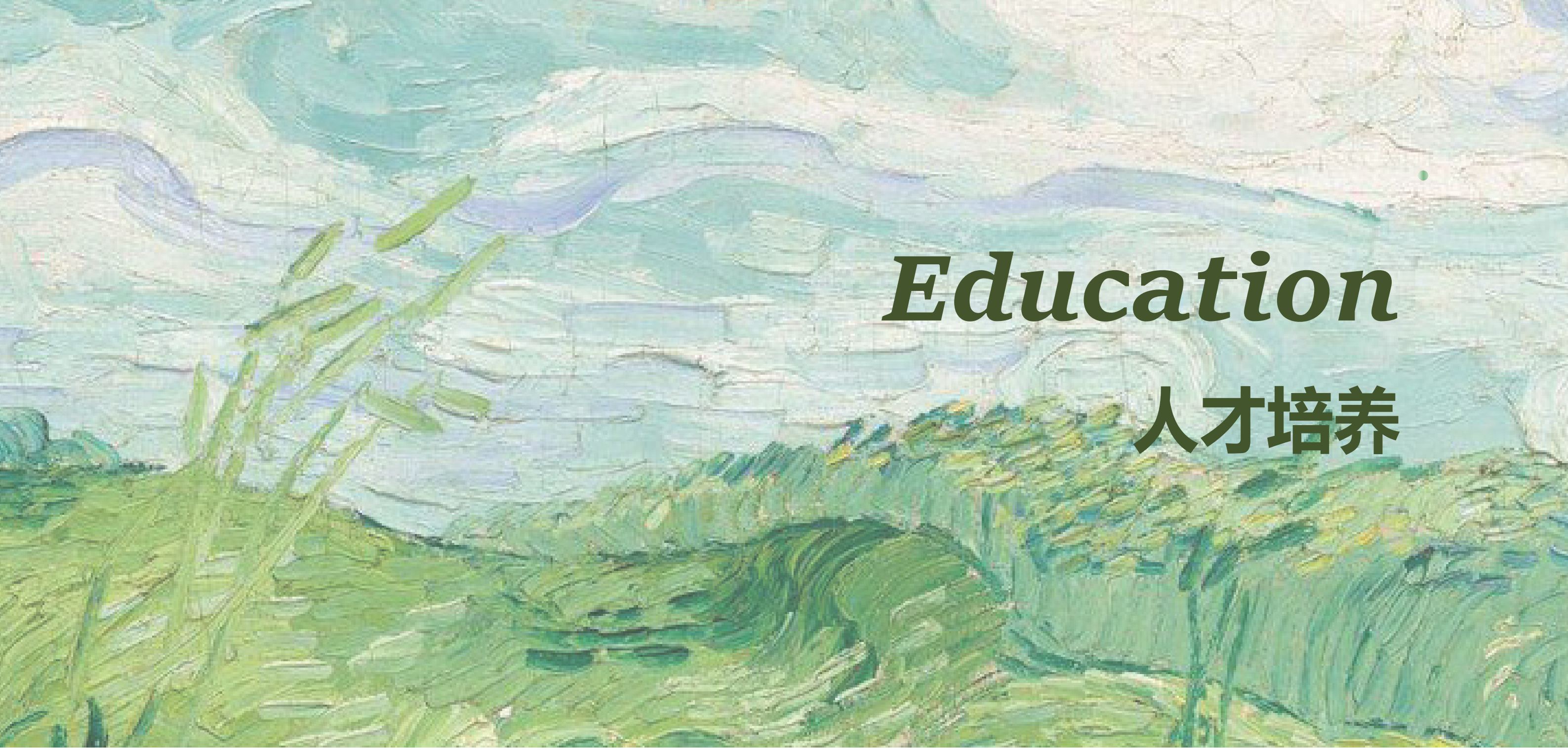
2017年获北京林业大学博士学位，曾在厦门大学从事博士后研究工作。2022年入职厦门大学，并加入台海站，从事湿地保护与管理、鸟类生态学、红树林生态修复等方面的研究。

Dr. Yamian Zhang received her PhD from Beijing Forestry University in 2017, and moved to Xiamen University as a postdoc before she was employed by Xiamen University in 2022 and majorly worked for T-SMART. Her research interests are wetland conservation and management, avian ecology, and mangrove restoration.

Administrative Staff

薛锦华
办公室秘书

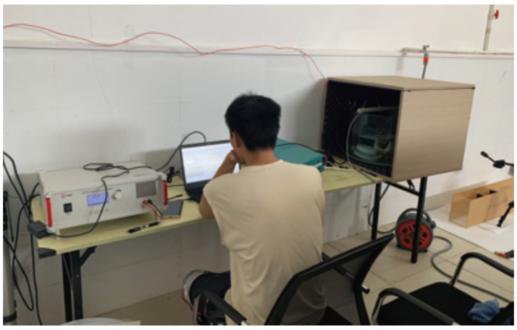
Jinhua Xue
Secretary
E-mail：tsmart@xmu.edu.cn



Education

人才培养

2022年，依托台海站培养博士研究生34名，硕士研究生54名。依托漳江口实验场对河口红树林湿地开展研究，2名博士研究生分别完成毕业论文“中国红树林蟹类多样性、群落构建及对造林的响应”，“沿纬度梯度全球性入侵植物互花米草生活史的适应性进化”，获得福建省生态学优秀博士论文；依托东山实验场开展对虾行为表型研究，1名博士后在*Fish and Shellfish Immunology*期刊发表1篇论文。



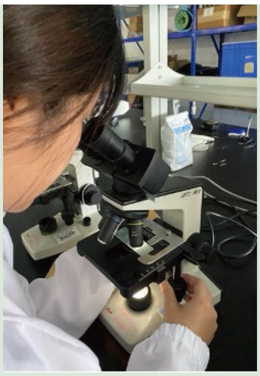
在东山实验场进行鱼类听觉特性测量实验

Acoustic characteristics measurement of different fish at D-SMART

In 2022，T-SMART supported 34 PhD students and 54 master students in their thesis. Among them, two PhD students and one master students finished their graduation thesis supported by the M-ECORS, and recieved the award of Excellent Graduation Thesis. One postdoctor continued his research on Marsupenaeus japonicus in the behavior laboratory at D-SMART, and published one paper in *Fish and shellfish Immunology.*

进入漳江口红树林开展野外调查

Conducting field surveys in the mangrove forests at Zhangjiang Estuary



对虾活体组织表型检测

Phenotyping for live shrimp tissues

地下水端元点采样

Sampling of groundwater

Outreach & Social Services

公众教育与社会服务

第七届MEL研究生论坛科普专场

The 7th MEL Graduate Forum

2022年7月20日下午，第七届MEL研究生论坛科普专场在东山实验场成功举办。论坛以“触摸 · 海洋”为主题，通过科普摊位游园与专题讲座方式进行科普宣讲，内容涉及海洋生物、海洋物理、海洋化学和海洋地质四个方向。论坛组委会特别邀请了来自东山二中的35名中学生共同参与，他们在充满趣味性的动手实验中收获了许多海洋科学知识，对于探索海洋、保护海洋有了更多的兴趣与热情。

On July 20, 2022, the 7th MEL Graduate Forum was successfully held at D-SMART. The theme of the forum was "Touching the ocean", and covered disciplines such as marine biology, marine physics, marine chemistry, and marine geology. 35 students from the Dongshan second middle school were engaged by station tours, hands-on experiments and special lectures and were initiated more interests and passion for marine protection.

研究生论坛合照

Group photo of the forum

学生参观东山实验场

Students visited D-SMART

“童心港湾 · 益梦启航”暑期邻里课堂海洋科普专场

Special Outreach Session - Encourage young people to explore their interest in the marine world

2022年8月12日，东山团县委和台海站东山实验场共同举办“童心港湾 · 益梦启航”暑期邻里课堂海洋科普专场。来自东山本地的20名1–4年级留守儿童参加了此次活动，探索了水下奇妙的藻类世界和五彩斑斓的珊瑚生态系统，此次海洋科普活动不仅让同学们认识了许多形态各异、习性不同的海洋生物以及神秘的海底世界，更增强了青少年保护环境、保护海洋的责任意识。

On August 12, 2022, Dongshan Youth League County Party Committee and Dongshan Station jointly held a summer neighborhood class Marine science special event entitled "Harbor of Childlike Innocence · Sailing of a Dream". Twenty left-behind children from grades 1-4 from Dongshan participated in the activity and explored the wonderful underwater algae world and colorful coral ecosystem. The Marine science activity not only made students know many Marine creatures with different forms and habits and the mysterious underwater world, but also enhanced their awareness of the responsibility to protect the environment and the ocean.

科普讲座照片

Photo of the lecture

活动现场合照

Group photo of the session

与海为邻 · 可持续海洋公益论坛

Sustainable Ocean Public Welfare Forum: Neighboring the sea

2022年3月25日，台海站东山实验场作为协办单位，全程参与《与海为邻 · 可持续海洋公益论坛》，围绕双碳目标下的海洋生态、可持续渔业的现状、海洋生物多样性及可持续旅行与自然教育，多维度共同交流海洋可持续发展。通过作《水下的热带雨林——珊瑚礁》主题讲座、供稿摄影展、开设“珊瑚科普&守护幼鱼”海洋公益互动体验专区，提升公众海洋环保意识，助力此次论坛圆满完成。

On March 25, 2022, D-SMART, co-organized the Sustainable Ocean Public Welfare Forum that communicated sustainable marine development focusing on marine ecology, sustainable fishery, marine biodiversity, and sustainable travelling and nature education with dual carbon goal. In this forum, D-SMART gave coral lectures, provided beautiful scenery photos of Dongshan, and designed interactive experience area, which encouraged marine protection.

活动现场照片

Event photos

全国红树林保护与修复会议

Mangrove Protection and Restoration Forum

7月25-26日，由红树林基金会与台海站漳江口实验场共同举办的“2022年全国红树林保护与修复会议”以线上的方式举行。来自全国各省市自然资源、林草相关部门，各红树林保护地、相关科研院所和企业单位500余人参与了本次活动。本次会议台海站针对我国红树林保护、修复和管理者“量身定制”，有效提高了我国各省市自然资源、林草相关部门，红树林保护地管理人员，以及一线工作者对红树林有效保护和修复的认识，同时增进了公众对红树林的了解和保护意识。

On 25-26th July, the online conference on the mangrove protection and restoration training was held by Mangrove Wetland Conservation Foundation (MCF) and M-ECORS. Over 500 people from mangrove reserve, relative institutes and enterprises attended and raised the awareness of effective mangrove conservation and restoration. The public knowledge of mangroves and their awareness of protection was also raised.

线上会议合照

Photo of the conference

第六届全国净滩公益活动

The 6th National Beach Cleaning Activity

2022年9月17日，由中国海洋发展基金会主办，东山县海洋保育志愿者协会承办，台海站东山实验场、东山县文化创意协会、东山县义工协会共同协办的第六届全国净滩公益活动（东山分会场）在东山金銮湾海滩顺利举行。台海站驻东山实验场技术人员孙圣垚及蔡其思、驻站博士后程文志及其余4位厦门大学研究生共同参与该活动，制作海洋科技成果宣传海报，设立科普摊位进行海洋环保科普宣讲和珊瑚生态VR视频互动体验，并积极参与净滩活动。

On September 17, 2022, sponsored by China Oceanic Development Foundation, organized by Donghai Sea Guardians and co-organized by D-SMART, Dongshan County Cultural Creative Association, and Dongshan County Volunteer Association, the sixth National Beach Cleaning Activity (Dongshan parallel sessions) was successfully held at Dongshan Jinluan Bay Beach. Our members Shengyao Sun and Qisi Cai, joined this acitivity with postdoc Wenzhi Chen and other 4 graduate students from Xiamen University. They interacted with public through talk and VR vedios, and actively cleaned the beach.

活动现场照片

Photo of the activity

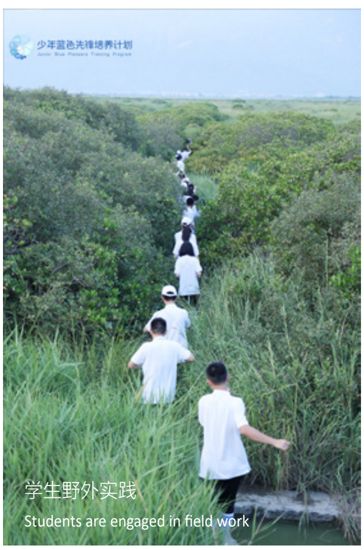
2022年首届少年蓝色先锋培养计划

2022 Junior Blue Pioneers Training Program

2022年7月18日至30日期间，由桃花源生态保护基金会、中华环境保护基金会联合发起的海洋教育重点项目，依托厦门大学近海海洋环境科学国家重点实验室、70.8海洋媒体实验室、“嘉庚”号科考船、东山实验场共同举办的首届“少年蓝色先锋培养计划”顺利结营。27位来自全国各地的少年们，集结东山实验场，完成海洋人才培养之旅。

学生参观东山实验场

Students visited D-SMART



学生野外实践

Students are engaged in field work

From July 18th to 30th, 2022, the first "Junior Blue Pioneers Training Program" was successfully concluded at the D-SMART. It is a key marine education project, jointly launched by theThe Paradise International Foundation and the China Environmental Protection Foundation, relied on the State Key Laboratory of Marine Environmental Science (Xiamen University), 70.8 Media Lab, the research vessel TAN KAH KEE, and the D-SMART. Twenty-seven youngsters from all over the country gathered at the D-SMART to complete their journey for marine talent cultivation.

监测漳江口红树林退塘还湿成效

Active Restoration for Mangroves in Zhangjiang Estuary

台海站漳江口实验场与漳江口红树林国家级自然保护区开展长期合作，为保护区内红树林保护管理提供科学依据和重要技术支撑。漳江口实验场对保护区退塘还湿的成效展开了持续的系统监测，为科学合理的红树林生态修复提供重要参考。

M-ECORS conducted long-term cooperation with the Zhangjiang Estuary Mangrove National Nature Reserve, supporting local mangroves conservation and management in science and technique. M-ECORS carried out consistent systematical monitoring in active restoration area of the nature reserve, which provides essential reference for mangrove restoration.

漳江口实验场进行动物多样性监测

M-ECORS are conducting the biodiversity monitoring

救护东山珊瑚与海龟

Safeguarding Coral and Turtles in the Dongshan Bay

东山实验场协助东山珊瑚省级自然保护区服务中心救助因翻覆而白化的珊瑚约10株，并转移严重白化的6株珊瑚至室内培养室，待其在稳定环境中恢复健康后回播至海区；实验场同时为海龟救护与放生活动提供技术支持和现场协助，累计放生海龟5只，并为其中一只太平洋丽龟的龟背安装定位仪，其他4只海龟安装带有放生相关部门、放生时间以及放生海龟品种的标识牌。

We provided assistance to Dongshan Coral Nature Reserve Service Centre in coral conservation. About Six severely bleached corals were transferred to indoor cultivation rooms to recover before they are reintroduced to the ocean. We also provided technical support and on-site assistance for turtle rescue and release activities. In 2022, we released a total of five sea turtles. One Pacific green turtles was equipped with a tracking device on its shell, while the other 4 turtles were tagged with identification signs indicating the releasing department, releasing time, and species.

工作人员救助翻覆白化珊瑚

The staff are transferring bleached corals to indoor.

放归已安装定位仪海龟

Release the turtle

研究人员给太平洋丽龟安装卫星定位仪

The researchers are installing a satellite transmitter on the olive ridley.

校检公益联盟守护海洋生态

Protect the Marine Ecology Allied with the Prosecution

东山实验场参与珊瑚保护区核心区造礁石珊瑚盗采事件现场处理，接收东山检查院查处的造礁石珊瑚非法买卖案件中的涉案珊瑚活体，并为执法人员完善监管措施提供建议。驻站科学家刘迟迟受聘为漳州蓝碳司法特约研究员，为东山县法院蓝碳司法工作提供技术咨询服务；驻站技术人员孙圣垚受聘为东山县检察院“公益诉讼观护员”，为“海滩保护、红树林保护、入海口排污保护、野生动物保护”等海洋生态保护公益诉讼案件提供线索。

活动现场合照

Group photo of the patrol activity

驻站技术人员孙圣垚受聘为东山县检察院“公益诉讼观护员”

Shengyao Sun is designating as the “observer for public interest litigation”

We participated in on-site processing of illegal harvesting of corals in the core area of the Dongshan Coral Nature Reserve. We received and cultivated live coral involved in illegal coral trading investigated by Dongshan Procuratorate, and provided suggestions for improving supervision measures. Our resident scientist, Chichi Liu, was appointed as a special researcher of Zhangzhou Blue Carbon Judiciary, providing technical advisory services for the judicial work of blue carbon at Dongshan County Court. Our technical personnel, Shenyao Sun, was designated as the 'observer for public interest litigation' of Dongshan County Procuratorate, providing clues for public interest litigation cases related to marine ecological protection such as beach and mangrove conservation, estuary discharge restriction, and wildlife protection.

协助设置科普宣传节目

Assisst in the production of public science education program

央视新闻频道《正点财经》栏目记者进驻漳江口进行节目摄制，漳江口站提供互花米草防治等方面的影像资料并进行拍摄协助。东南卫视“海洋季风”系列科普节目进驻东山进行节目摄制，东山实验场参与3期节目录制并提供技术协助和咨询服务，分别涉及珊瑚保护、海龟救护、日本对虾育种与养殖技术等内容，助力海洋科普与海洋文化传播。

The team behind "Punctuality Finance" on CCTV channel visited Zhangjiang for filming. M-ECORS provided recording materials about controlling of Spartina alterniflora and participate in recording. The team behind "Ocean Monsoon" on Southeast TV channel visited Dongshan for filming. The program focuses on promoting marine science and advocating for marine protection. D-SMART participated in recording three episodes and provided technical consulting services in areas such as coral protection, turtle rescue, Japanese prawn breeding, and breeding technology.

张宜辉协助央视摄制”正点财经“节目

Yihui Zhang assist in the production of "Punctuality Finance" Program on CCTV

刘迟迟协助东南卫视摄制“海洋季风”节目

Chichi Liu assist in the production of “Ocean Monsson” Program on South East TV

Exchange & Collaboration

合作交流

召开台海站第一届学术委员会第一次会议暨揭牌仪式

The first Academic Committee Conference was held

11月16日，由傅伯杰院士主持的台海站第一届学术委员会第一次会议暨战略规划研讨会在东山实验场召开，肯定了2021-2022年台海站的观测和研究成果，示范服务成效，以及学术交流、科普传播等方面的成绩，并对台海站的建设与发展提出了富有建设性的意见建议。台海站将进一步聚焦观测和科学目标，提高自主创新能力，产出更具特色的成果，持续深化与国内外野外站的交流合作。

The first Academic Committee Conference was held on 16th November. T-SMART reported the achievements in observation, research, demonstration and outreach over the past two years, which affirmed by members of Academic Committee. They also put forward constructive suggestions on the construction and development of T-SMART in terms of scientific focus, data management and innovation capability.

会议线上线下合影

Photo of the Conference

台海站揭牌仪式

Unveiling ceremony for T-SMART

领导关怀促进高质量发展

Leadership inspection promotes high-quality development

2022年4月20日，福建省省委常委、宣传部部长张彦赴台海站漳江口实验场调研，详细了解了基地建设、科学观测研究以及示范服务工作情况，对台站在观测体系建设、科学研究、社会服务、公众教育等方面的成效表示肯定。

同年12月15-16日，福建省副省长李建成赴台海站东山实验场调研，详细了解了基地海洋立体观测体系建设及示范服务工作等情况，强调要深化产学研用合作，加快数字化转型升级，做好海洋经济大文章。

On April 20, 2022, Zhang Yan, a member of the Standing Committee of the Fujian Provincial Party Committee and Minister of the Department of Publicity, along with his colleague, visited M-ECORS. They acknowledged the station's effective work in building the observation system, conducting scientific research, providing social services, and promoting public education.

Later, on December 15 and 16, 2022, Li Jiancheng, the vice governor of Fujian Province, visited D-SMART to investigate the construction progress of the Marine three-dimensional observation system and the ongoing demonstration work at the station. He emphasized the importance of deepening collaboration between production and research to foster the development of the marine economy.

领导视察照片

Inspection photos

拓展地方合作共建关系

Expand exchanges and cooperation with local government departments

2022年1月，台海站漳江口实验场与云霄县人民政府签订校地合作协议。同年11月，台海站与东山县县委书记洪泰伟、县委常委曹威等召开校地合作战略规划研讨会，共同商议研究加快推进国家野外台站建设，助力地方高质量发展，服务国家重大战略需求和生态文明等相关事宜。

M-ECORS signed the School-local cooperation agreement with Yunxiao government in January 2022. In October, 2022, T-SMART held a Strategy Seminar on school-local cooperation with Taiwei Hong, Secretary of Dongshan County Party Committee and Wei Cao, a member of the Standing Committee of the County Party Committee. There are deep discussions on promoting both T-SMART and local development of high quality to serve the national major strategic demand.

台海站漳江口实验场与云霄政府签订校地合作协议

M-ECORS signed the school-local cooperation agreement with the Yunxiao government

加强企事业单位交流合作

Strengthen exchanges and cooperation with institutes and enterprise

交流互鉴，促进协同发展。2022年，台海站与福建省气象局、福建省海洋预报台举行座谈交流，与武汉大学开展合作实验，接待来自厦门海洋环境监测中心站、福建省农业科学院、中国科学院南京土壤研究所、北京大学深圳研究生院、华东师范大学、华侨大学等高校和科研院所人员在站开展科研活动1600余人天次，面向公众开展科普教育、业务培训活动超过500人次，有效发挥国家台站对外开放和资源共享能力，社会影响力日益增强。

Interaction promotes mutual learning and further development. In 2022, T-SMART discussed in depth with Fujian Meteorological Administration and Fujian Marine Forecasts to explore further cooperation. T-SMART carried out cooperative experiments with Wuhan University, and also attracted scientists from different institutes, including Xiamen Environmental Monitoring Center Station, Fujian Academy of Agricultural Sciences, Institute of soil sciences, CAS，Peking University Shenzhen Graduate School, East China Normal University, Huaqiao University, coming and undertaking studies. In addition, over 500 people visited the station because outreach events and training activities hold in T-SMART.

科研实习照片

Group photo of practice

Publications

论文专著

70 篇学术论文
Papers in SCI journals

1 本专著
Books

4 个章节
Chapters

专著与期刊专辑

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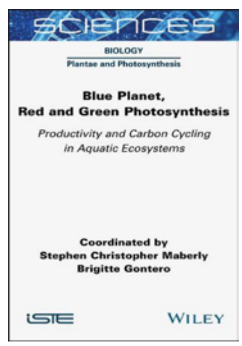

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主 编：黄邦钦、江毓武、王文卿、马　剑、朱旭东、游伟伟、周晓平
编 辑：薛锦华、张雅棉、孙圣垚、黄水英、刘迟迟、陈纪新、郑泽琦
设 计：薛锦华

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