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State Key Laboratory of
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滨海湿地生态系统教育部重点实验室（厦门大学）
Key Laboratory of the Coastal and Wetland Ecosystems
(Xiamen University)，Ministry of Education

T-SMART

福建台湾海峡海洋生态系统国家野外科学观测研究站

2025年度报告

厦門大學
XIAMEN UNIVERSITY

T-SMART
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

2025 Annual Report 年度报告

T-SMART INTRODUCTION
台海站简介

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、漳江口三个观测区，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 three observation areas including Taiwan Strait Upwelling, Dongshan Bay and Zhangjiang Estuary. 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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Message from Director

序言

2025年是台海站入列国家野外站的第五年。这一年，台海站与国家战略同频，与科技前沿共振。我们秉持“观测、研究、示范、服务”的初心使命，以山海为卷，以勤勉为笔，从漳江口红树林到东山湾珊瑚礁，再到台湾海峡上升流，在这片蔚蓝疆域镌刻下坚实而闪光的印记。

深耕观测，筑牢数据之基。全年组织实施台湾海峡上升流、东山湾、漳江口三大核心区季度航次11次，全面推进与自然资源部海西站的协同观测航次。湿地涡度通量塔、冠层高光谱仪、地下河口、渔排基生态环境等自动观测系统持续运转，完成湿地样方、鱼类、底栖生物、鸟类及造礁珊瑚多样性观测，织密“海–陆–空–天”智能观测网络，为解析亚热带典型生态系统对全球变化的响应积累了扎实数据。

聚力科研，勇攀创新之峰。全年在*Nature Geoscience*等国际主流期刊发表研究论文70余篇，授权发明专利9项。新获批纵向科研项目25项，包括国家重点研发计划课题、基金委重点项目等。从揭示海洋生态系统与气候变化的互馈作用，到近海生态环境智能探测技术，创新的火花持续迸发。

拓展合作，共绘开放之图。召开台海站学术委员会会议暨中国海洋生态系统联网观测战略规划研讨会，举办国际咨询委员会会议。正式加入DRAGNet全球性合作观测研究计划，共同牵头发起“海岸带系统科学观测伙伴计划（CoastPOS）”。全年接待50余所高校、科研院所及企事业单位来访交流，从访问香港大学太古海洋研究所、马来亚大学巴赫克海洋研究站，到协办全球华人海洋科学研讨会，台海站的“朋友圈”持续扩大。

薪火相传，点亮科普之光。“苏峰讲坛”三场讲座串起科普传播、卫星遥感与海岛智慧；东山实验场首场海洋科学开放日、“世界红树林日”主题活动、第十四届海洋科学开放日等科普活动，让公众沉浸式触摸海洋科学的脉动。全年主办协办科普活动15场，站内接待公众超3700人次，科学之桥连接你我，海洋意识深入人心。

示范引领，担当服务之责。纪录片《海边有片红树林》在央视播出，台海站多位成员深度参与，让红树林的生态故事从论文走向荧屏，让科学“看得见、听得懂、记得住”。全年培养博硕士研究生54人，服务PIs及研究生来站开展实验研究达2618人天，保障本科生野外综合实习达792人天。在东山，创新珊瑚原位固定与电子标签追溯技术，断枝修复成功率超95%；在漳江口，持续服务国际红树林中心建设。科研成果正逐步转化为守护“蓝色家园”的切实行动。

征程万里风正劲，重任千钧再扬帆。我们将坚守国家野外科学观测研究站的战略定位，深化长期观测、强化前沿研究、拓展示范应用、提升公共服务，在支撑海洋生态文明建设、服务国家可持续发展的伟大事业中，奋力书写新的篇章。

站长：

2026年3月

In 2021 T-SMART was established as a National Marine Station. The year 2025 marks its fifth anniversary. Over the past year, T-SMART has aligned itself with national strategies and resonated with the frontiers of science and technology. Guided by the mission of "Observation, Research, Demonstration, and Outreach," we have taken the mountains and seas as our canvas and diligence as our brush — from the mangroves of the Zhangjiang Estuary, to the coral reefs of Dongshan Bay, and to the upwelling zone of the Taiwan Strait — etching solid and shining marks across this vast blue territory.

Deepening Observations, Strengthening the Foundation of Data. In 2025 we conducted 11 quarterly research cruises across the three core observation areas: the Taiwan Strait upwelling zone, Dongshan Bay, and the Zhangjiang Estuary. Automated observation systems, including eddy covariance flux towers, canopy hyperspectrometers, subterranean estuary monitoring wells, and fishery raft-based ecological platforms, operated continuously. We also conducted systematic surveys of mangrove/salt marsh vegetation plots, fish, benthic organisms, birds, and reef-building corals, weaving a dense "sea-land-air-space" intelligent observation network. These efforts have amassed solid data for understanding the responses of subtropical typical ecosystems to global change.

Advancing Research, Scaling the Peaks of Innovation. Throughout the year, we published over 70 research papers in leading international journals and were granted 9 invention patents. A total of 25 new scientific research projects were approved, including National Key Research and Development Program and NSFC key projects. From revealing the interactions between marine ecosystems and climate change, to developing intelligent detection technologies for coastal environments, sparks of innovation continue to ignite.

Expanding Collaboration, Painting a Picture of Openness. We convened the Academic Committee Meeting and the Strategic Planning Symposium on China Marine Ecosystem Network Observation and hosted the International Advisory Committee Meeting. We officially joined the DRAGNet global collaborative research network and co-launched the Coastal System Scientific Observation Partnership (CoastPOS). Throughout the year, we hosted visits and exchanges with over 50 universities, research institutes, and enterprises. We conducted visits to the Swire Institute of Marine Sciences at The University of Hong Kong and the Bachok Marine Research Station in Malaysia, to co-organizing the Global Chinese Marine Science Symposium, T-SMART's "circle of friends" continues to expand.

Passing the Torch of Knowledge, Illuminating the Light of Science Communication. The Sufeng Forum featured three lectures spanning science communication, satellite remote sensing, and island culture and wisdom. Public engagement events — including the inaugural Marine Science Open Day at D-SMART, the World Mangrove Day themed event, and the 14th Marine Science Open Day — immersed the public in the pulse of marine science. Throughout the year, we organized or co-organized 15 science outreach activities, welcoming over 3,700 visitors to T-SMART. Through these efforts, the bridge of science connects us all, and ocean awareness has taken root in the public consciousness.

Demonstrating Leadership, Fulfilling the Duty of Service. Our research efforts deeply contributed to the national project on ecological civilization and visual documentation. The documentary “Mangroves by the Sea” was broadcast on CCTV, with several T-SMART members deeply involved, bringing the ecological story of mangroves from academic papers to the screen and making science "visible, understandable, and memorable." Over the year, we trained 54 master's and doctoral students, supported 2,618 person-days of experimental research conducted by principal investigators (PIs) and graduate students, and supported 792 person-days of undergraduate field internships. At Dongshan, we innovated in-situ coral fixation and electronic tagging technologies, achieving a coral fragment restoration success rate of over 95%. At the Zhangjiang Estuary, we continued to support the development of the International Mangrove Center. Our research achievements are steadily being transformed into concrete actions to protect our "blue home."

The journey stretches far before us, and the wind is strong. With heavy responsibilities, we set sail once more. We will remain steadfast in our strategic role as a National Observation and Research Station, deepening long-term observations, strengthening cutting-edge research, expanding demonstration applications, and enhancing public services. In doing so, we will strive to write a new chapter in supporting the construction of a marine ecological civilization and advancing sustainable development.

Bangqin Huang
Director of T-SMART
March 2026

数字台站2025

3.2GB
DATA PRODUCED

11
RESEARCH CRUISES

78
RESEARCH PAPERS

9
Authorized Invention Patent

2618
PIs & Grads (Research)
(Unit: person-days)

792
Undergrads
(Integrated Field Internship)
(Unit: person-days)

15
OUTREACH EVENTS

50
INSTITUTIONS AND UNIVERSITIES REPRESENTED

2630+
VISITORS

25项
新增纵向项目
Newly Funded Projects

2项
国家自然科学基金重点项目
NSFC Key Projects

2项
国家自然科学基金联合基金项目
NSFC Joint Key Projects

1项
国家重点研发计划课题
National Key Research and Development Programs

4项
国家自然科学基金面上项目
NSFC General Projects

2025 Headlines
年度焦点

1月 / January

- 协办第七届厦门海洋环境开放科学大会
  The 7th Xiamen Symposium on Marine Environmental Sciences is co-organized by T-SMART
- 美国马萨诸塞大学波士顿分校Robert Chen教授主讲“科普能力拓展工作坊”
  Professor Robert Chen from the University of Massachusetts Boston Led a "Science Communication Capacity Building Workshop"

3月 / March

- 台海站第一届学术委员会第三次会议暨中国海洋生态系统联网观测战略规划研讨会召开
  The Third Meeting of the First Academic Committee of T-SMART and the Strategic Planning Symposium on China Marine Ecosystem Network Observation Were Held
- 台海站东山实验场首场海洋科学开放日举办
  D-SMART Held Its Inaugural Marine Science Open Day

4月 / April

- 台海站第二届国际咨询委员会第二次会议召开
  The Second Meeting of the Second International Advisory Committee of T-SMART Was Held
- 国际红树林中心调研台海站漳江口实验场
  International Mangrove Center Delegation Visited M-ECORS
- “书香润海岛 · 法韵传闽南”世界读书日主题教育活动在东山实验场举办
  "Bookish Island, Legal Charm of Minnan" World Book Day Themed Educational Activity Held at D-SMART

5月 / May

- *Nature Geoscience*发表全球红树林生长变异研究：气候振荡驱动海平面波动的影响
  Nature Geoscience Published a Study on Global Mangrove Growth Variability: Impacts of Sea-Level Fluctuations Driven by Climatic Oscillations

6-7月 / June-July

- 承办福建省生态质量综合监测站工作交流研讨会
  Hosted the Fujian Provincial Ecological Quality Comprehensive Monitoring Stations Exchange Seminar
- 第十届MEL研究生学术论坛在东山实验场举办
  The 10th MEL Graduate Academic Forum Held at D-SMART
- 校长张宗益带队调研台海站建设发展情况
  President Zongyi Zhang Led a Delegation to Investigate the Construction and Development of T-SMART
- 举办“世界红树林日”主题科普活动
  T-SMART Held a "World Mangrove Day" Themed Science Popularization Event
- “2025苏峰讲坛”如期举办
  The 2025 Sufeng Forum Held as Scheduled
- 台海站东山实验场正式获批海域使用权（科研教学用海）14.6244公顷
  D-SMART was officially granted a sea use right of 14.6244 hectares for scientific research and teaching purposes

8月 / August

- 2025少年蓝色先锋培养计划举办
  The 2025 Junior Blue Pioneers Training Program Held
- “河海连续体氮循环跨界面耦合调控机制”“互花米草大规模除治背景下南方滨海湿地的修复与保护”两项国家自然科学基金重点项目获批
  Two Key Projects of the NSFC were approved: "Cross-interface Coupling and Regulation of Nitrogen Cycling in the River-Estuary-Bay Continuum" and "Restoration and Protection of Southern Coastal Wetlands in the Face of Large-scale Elimination of *Spartina alterniflora* in China"

11月 / November

- 协办第十四届厦门大学海洋科学开放日
  The 14th Xiamen University Marine Science Open Day is co-organized by T-SMART
- 协办2025年全球华人海洋科学研讨会（厦门大学马来西亚分校）
  T-SMART Co-organized the 2025 Global Chinese Marine Science Symposium (Xiamen University Malaysia)
- 台海站加入DRAGNet全球性合作研究计划
  T-SMART Joined the DRAGNet Global Collaborative Research Network
- “海峡西岸典型蓝碳生态系统对环境演变的响应及韧性机制”“台湾海峡浮游生态系统对极端冷暖事件的响应过程及效应”两项国家自然科学基金联合基金重点支持项目获批
  Two Key Projects of the NSFC Joint Fund were approved: "Response and Resilience Mechanisms of Typical Blue Carbon Ecosystems to Environmental Evolution in the Western Taiwan Strait" and "Response Processes and Effects of the Planktonic Ecosystem in the Taiwan Strait to Extreme Cold and Warm Events"

12月 / December

- “海岸带系统科学观测伙伴计划（CoastPOS）”成立大会召开
  Inaugural Meeting of the Coastal System Scientific Observation Partnership (CoastPOS) Held

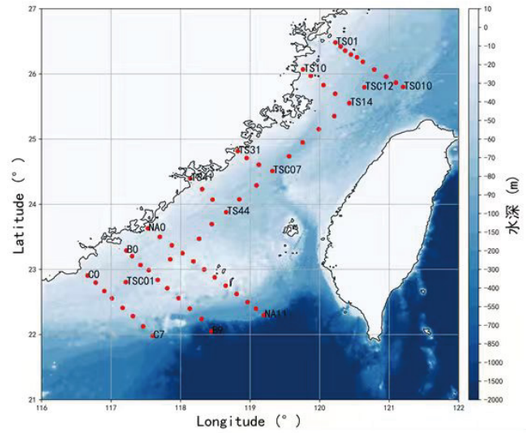
T-SMART
福建台湾海峡海洋生态系统国家野外科学观测研究站
National Observation and Research Station for the Taiwan Strait Marine Ecosystem

Observation & Experiment
科学观测与实验

台湾海峡上升流观测区调查航次

台海站台湾海峡上升流观测区位于台湾海峡南部，台海站在东山外海至南澳岛以东海域设置2条断面，进行长期观测，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。

2025年，台海站完成台湾海峡上升流观测区春季（5月）、夏季（7-8月）、秋季（12月）3次大面站航次调查。研究东山外海和台湾浅滩上升流的特征，分析台湾海峡南部南海北部陆坡物质交换关键过程、动力机制及其生态环境效应。



◉ 夏季站位
Summer Stations

Cruises of the T-SMART in the Taiwan Strait Upwelling Observation Area

The Taiwan Strait Upwelling Observation Area is located in the southern part of the Taiwan Strait. T-SMART has established two transects in the waters east of Dongshan to the east of Nan'ao Island for long-term observation to obtain physical, chemical, and biological parameters of the seawater in the upwelling region, aiming to investigate the ecosystem characteristics, dynamic changes, and driving mechanisms of the upwelling area in the Taiwan Strait.

In 2025, T-SMART completed three large-scale survey cruises in the Taiwan Strait Upwelling Observation Area during spring (May), summer (July-August), and autumn (December). The research focused on identifying upwelling signals in the waters east of Dongshan and the Taiwan Bank, analyzing key processes and dynamic mechanisms of material exchange between the southern Taiwan Strait and the northern slope of the South China Sea, as well as their ecological and environmental effects.

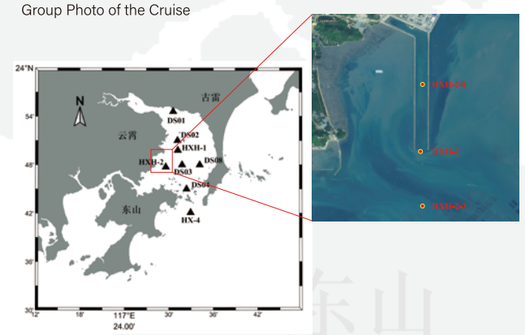
东山湾观测区

东山湾观测区位于福建省漳州市东山湾及邻近海域，以上升流、珊瑚保护区、水产养殖密集区、核电站及石化基地附近海域为重点观测区域，观测项目包括物理要素、化学要素、底质生化要素、生物要素等内容。2025年，台海站与自然资源部海西站协同合作，在东山海域共同开展季度航次调查，累计完成冬季（2月）、春季（5月）、夏季（8月）、秋季（11月）4个季度的航次调查。双方充分发挥各自优势，高效整合了在该海域的科研团队、调查船舶及专业仪器设备等资源，形成了资源互补、数据共享的合作机制。此次联合调查不仅提升了数据获取的效率和覆盖范围，也为深入研究东山湾海域生态环境演变、资源可持续利用提供了重要的科学数据基础。

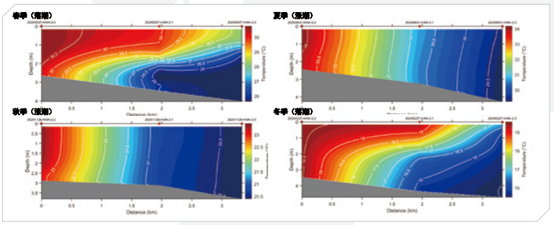
Dongshan Bay Observation Area

The Dongshan Bay Observation Area is located in Dongshan Bay and its adjacent waters in Zhangzhou City, Fujian Province. It focuses on key observation areas including upwelling zones, coral protection areas, intensive aquaculture zones, and waters adjacent to nuclear power plants and petrochemical bases. Observation parameters encompass physical, chemical, sediment biochemical, and biological elements. In 2025, T-SMART collaborated with the Haixi Field Station of the Ministry of Natural Resources to conduct quarterly survey cruises in the Dongshan waters, completing investigations in winter (February), spring (May), summer (August), and autumn (November). By fully leveraging their respective advantages, both parties efficiently integrated resources including scientific research teams, survey vessels, and specialized instruments and equipment, establishing a cooperation mechanism characterized by resource complementarity and data sharing. This collaborative survey not only enhanced the efficiency and coverage of data acquisition but also provided an important scientific data foundation for in-depth research on the ecological and environmental evolution and sustainable resource utilization in the Dongshan Bay area.

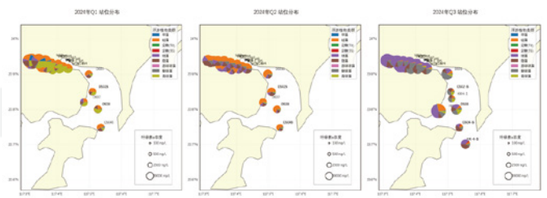
航次完成合影
Group Photo of the Cruise



东山实验场站位
D-SMART Cruise Station



核电排水口水温剖面图
Temperature Profile at the Nuclear Power Plant Discharge Outlet



漳江口–东山湾浮游植物类群
Phytoplankton Communities in Zhangjiang Estuary-Dongshan Bay

东山湾观测航次照
Photos from the Dongshan Bay Observation Cruise

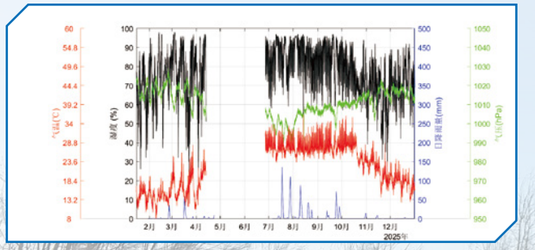
岸基气象观测
Land-based Meteorological Observation

东山实验场目前使用的自动气象站为DZZ4型区域自动气象站，是完全满足中国气象局《新型自动气象（气候）站功能规格书（业务试用版）》的新一代自动气象站，其技术指标完全满足或优于业务化部门的要求，并获得气象专用技术装备使用许可证和国家高新技术产品认证。该气象站采用当今成熟的、稳定的、先进的电子测量、数据传输和控制系统技术，能满足现有气象观测站的气候观测、天气观测和区域观测业务的需要，具有高可靠性、高准确性、易维护等特点。

2025年1月1日零时起，截止至2025年12月31日，数据接收率在75%以上，系统运行情况稳定。系统观测参数包含：风速、风向、温度、相对湿度、大气压强及雨量。

根据观测，东山实验场在春、秋、冬季受东北风影响为主；在夏季则是以西南偏南风为主，不过东北风在夏季的势力依然不弱，常有东北风出现。其中春季主要风力为5级及以下，夏季以2~4级风为主，秋季天气多变，各等级风力出现频率相近；在冬季以四级以上风力居多。

◉ 2025气象观测时序图
2025 Meteorological Observation Time Series Chart



The D-SMART currently uses the DZZ4 regional automatic weather station, a next-generation automatic weather station fully compliant with the "Functional Specifications for New Automatic Weather (Climate) Stations (Trial Operational Version)" issued by the China Meteorological Administration. Its technical indicators fully meet or exceed the requirements of operational departments, and it has obtained the Meteorological Specialized Equipment Usage License and National High-Tech Product Certification. This weather station employs mature, stable, and advanced electronic measurement, data transmission, and control system technologies, meeting the needs of climate observation, weather observation, and regional observation operations at existing meteorological stations. It features high reliability, high accuracy, and ease of maintenance.

From January 1, 2025 to December 31, 2025, the data reception rate remained above 75%, and the system operated stably throughout the year. Observed parameters include wind speed, wind direction, temperature, relative humidity, atmospheric pressure, and precipitation.

Observations indicate that D-SMART is primarily influenced by northeasterly winds in spring, autumn, and winter. In summer, south-southwesterly winds dominate, although northeasterly winds remain relatively frequent and substantial during this season. In spring, wind forces are mainly level 5 and below; summer is characterized by winds of levels 2 to 4; autumn weather is variable, with similar frequencies across all wind levels; and in winter, winds above level 4 are most common.

◉ 东山气象观测场
Dongshan Meteorological Observation Field

地下河口观测
Subterranean Estuary Observation

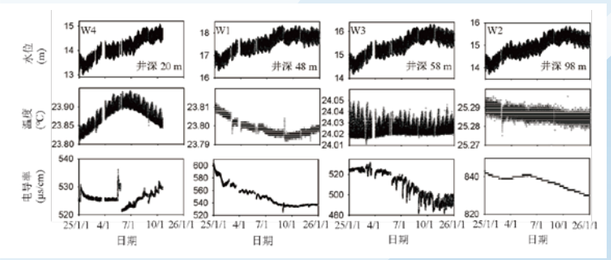
2025年地下水观测结果如下：井深20m的地下水监测井W4有效观测的时间范围是1月1日到10月18日，井深依次是48m、58m和98m的地下水监测井W1、W3和W2有效观测的时间范围是1月1日到12月31日。观测参数包括水位、温度和电导率的高精度连续观测（如图）。

W4地下水水位在2025年逐渐抬升，其变化范围为13.00–15.09m，平均值为14.14±0.44m。温度（℃）呈现明显的季节特征，高值见于5月、6月，应是夏季较强的太阳辐射导致。温度（℃）变化范围为23.810–23.943，平均值为23.878±0.028。电导率（μs/cm）的变化趋势较复杂，其变化范围为521.1–536.2，平均值为525.9±2.1，5月的变化幅度最大。从10月18日起，20m含水层的数据突然全部归零，猜测是地层内部应力突然改变，引起含水层塌陷。自此，W4水文参数的高精度观测结束。

和W4水位变化趋势类似，W1地下水水位也在2025年呈上升趋势，其变化范围为16.33–18.32，平均值为17.54±0.41。温度（℃）从1月开始下降，在9月初开始升高，其变化范围为23.786–23.812，平均值为23.799±0.004。电导率（μs/cm）的变化类似于温度，从1月下降到8月后，趋于稳定，其变化范围为524.6–603.4，平均值为550.9±16.8。

W3水位变化趋势和W4、W1相同，从14.18m上升到16.29m，均值是15.42±0.44m。水温没有明显的季节特征，其变化范围为24.005–24.049℃，平均值为24.024±0.005℃。W3电导率（μs/cm）的变化和W1相同，随时间下降。其变化范围为481.8–531.9，平均值为510.0±13.1。

W2水位变化趋势和其他3口井相同，从13.72m上升到15.83m，均值是14.95±0.43m。温度（℃）呈下降趋势，其变化范围为25.210–25.296，平均值为25.286±0.003。电导率(μs/cm)在1月到5月期间缓慢下降后逐渐抬升，6月后下降速度加快。总的来说，电导率的变化范围为830.0–843.0，平均值为835.2±1.0。



监测井W4, W1 ,W3 和 W2水位、温度和电导率在2025的连续观测

Time-series observations of groundwater level, temperature and conductivity at W4 from 1st January to 18th October, 2025 and at W1, W3 and W2 from 1st January to 31st December, 2025

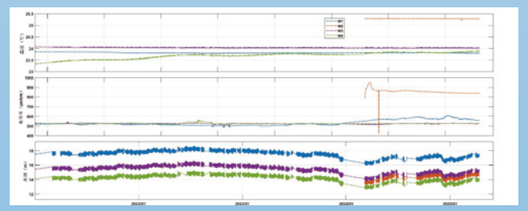
Time-series observations of groundwater level, temperature and conductivity at W4 with well depth 20m from 1st January to 18th October, 2025 and at W1, W3 and W2 with well depth 48m, 58m and 98m, respectively, from 1st January to 31st December are illustrated in Figure.

The groundwater level at W4 generally exhibited an increasing trend, ranging from 13.00m to 15.09m, with an average of 14.14±0.44m. Groundwater temperature displayed a noticeable seasonal change influenced by strong solar radiation in summer, peaking between May and June. Specifically, the temperature varied from 23.81 to 23.94℃, with a mean value of 23.88±0.03℃. The variation in conductivity was more intricate, ranging from 521.1 to 536.2μs/cm, with an average of 525.9±2.1μs/cm. The fluctuation of conductivity in May was the largest. The sudden change of crustal stress on 18th October caused the collapse of the 20m aquifer, leading to the termination of the high-frequency observation at W4.

Similar to W4, the groundwater level of W1 also showed a rising tendency over time, ranging from 16.33m to 18.32m, with an average value of 17.54±0.41m. Temperature started to drop from January and began to rise in early September, ranging from 23.79℃ to 23.81℃, with a mean value of 23.80±0.004℃. The conductivity exhibited a similar pattern to the temperature, decreasing from January to August and then tending to stabilize, and varied from 524.6 to 603.4 μs/cm, with a mean value of 550.9±16.8μs/cm.

The variation of groundwater level in W3 shared the same pattern as W4 and W1, ranging from 14.18 to 16.29m, with an average of 15.42±0.44m. Groundwater temperature didn't show an obvious seasonal change, ranging from 24.005 to 24.049℃, with an average of 24.024±0.005℃. The variation in conductivity at W3 shared the same pattern as W1, gradually increased after a slow decline from January to September. In general, the conductivity varied from 481.8 to 531.9μs/cm, with an average of 510.0±13.1 μs/cm.

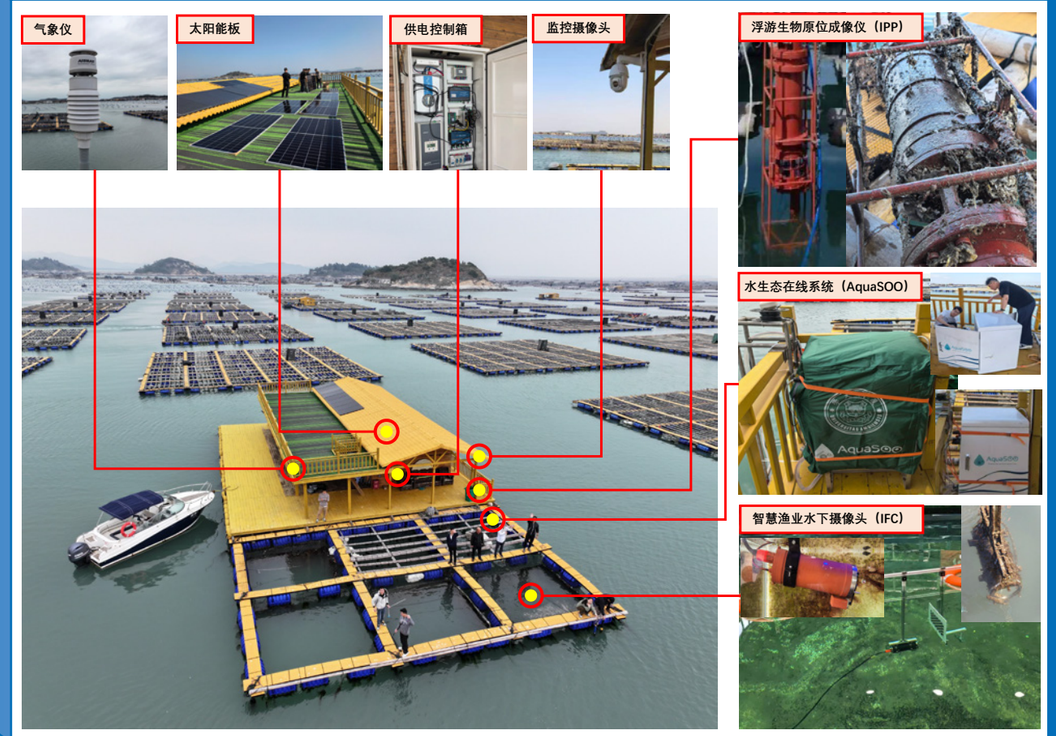
The variation in level of W2 resembled that of other three, ranging from 13.72m to 15.83m, with an average value of 14.95±0.43m. Groundwater temperature presented a decreasing pattern, ranging from 25.210 to 25.296℃, with an average of 25.286±0.003℃. The variation in conductivity gradually increased after a slow decline from January to May, and the rate of decline accelerated after June. In general, the conductivity varied from 830.0 to 843.0μs/cm, with an average of 835.2±1.0μs/cm.



2021–2026年东山实验场地下水井水文数据
Hydrological Data of Well at D-SMART, 2021-2026

渔排基海洋观测系统

东山实验场依托渔排式海洋观测平台，结合物联网与智能传感技术，在东山湾养殖密集海域构建海洋环境综合观测系统。系统布设超声波气象站、水质多参数观测仪、浮游动物水下显微成像仪及鱼类水下成像设备，实现海洋环境多要素的实时在线观测。观测内容涵盖水文要素（水温、盐度、水深）、水质要素（浊度、pH、溶解氧、叶绿素）、气象要素（气温、风向、风速、降水、气压、相对湿度）以及海洋生物要素（藻类类群组成及总藻量、浮游动物类群组成及丰度、鱼类数量等），形成集数据采集、传输与管理于一体的海洋观测网络，为东山湾养殖区生态环境评估、渔业生产管理及海洋生态预警提供基础数据支撑。



渔排基海洋观测系统
Fishery Raft-Based Marine Observation System

Fishery Raft–Based Marine Observation System

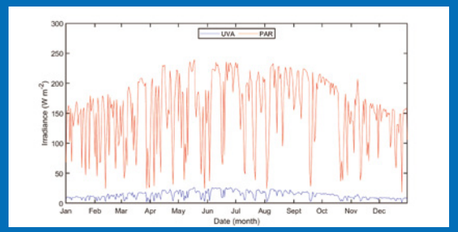
Based on the fishery raft-based marine observation platform, D-SMART has established an integrated marine environmental observation system in the intensive aquaculture waters of Dongshan Bay, utilizing the Internet of Things and intelligent sensing technologies. The system is equipped with an ultrasonic weather station, multi-parameter water quality monitors, an underwater microscopic imager for zooplankton, and underwater imaging devices for fish, enabling real-time online monitoring of multiple marine environmental elements. Observation parameters encompass hydrological elements (water temperature, salinity, water depth), water quality elements (turbidity, pH, dissolved oxygen, chlorophyll), meteorological elements (air temperature, wind direction, wind speed, precipitation, air pressure, relative humidity), and marine biological elements (algal community composition and total algal biomass, zooplankton community composition and abundance, fish abundance, etc.). This forms a marine observation network integrating data acquisition, transmission, and management, providing fundamental data support for ecological environment assessment, fishery production management, and marine ecological early warning in the Dongshan Bay aquaculture area.

东山阳光紫外辐射数据

Solar Ultraviolet Radiation Observation Data

通过对每日平均阳光紫外辐射强度进行作图，结果表明，从1月到7月PAR和UVA总体呈增加趋势，从7月份到12月份呈现降低趋势。PAR和UVA的最大日平均辐射强度分别为239.41Wm^{-2}（5月18日）和26.31Wm^{-2}（5月18日）；最小日平均辐射强度分别为18.32 W m^{-2}（12月25日）和1.31 W m^{-2}（12月25日）。

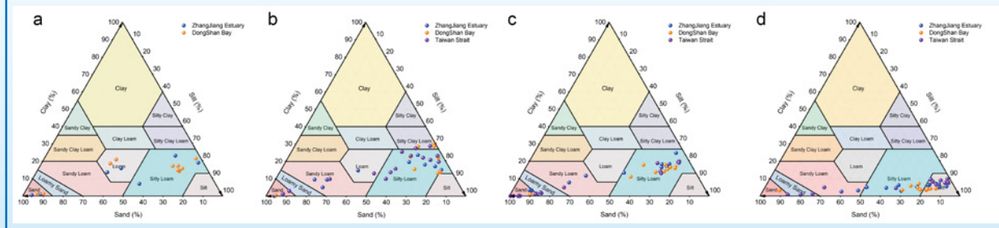
Analysis of daily average solar ultraviolet radiation intensity shows that both PAR and UVA generally increased from January to July, followed by a decreasing trend from July to December. The maximum daily average radiation intensities for PAR and UVA were 239.41Wm^{-2} (May 18) and 26.31Wm^{-2} (May 18), respectively. The minimum daily average radiation intensities were 18.32Wm^{-2} (December 25) for PAR and 1.31Wm^{-2} (December 25) for UVA.



2025年阳光PAR和UVA辐射的日平均变化
Average Daily Changes in Solar PAR and UVA Radiation in 2025

漳江口–东山湾–台湾海峡沉积物粒度分布图（Lei et al., 未发表）

Sediment Grain Size Distribution in the Zhangjiang Estuary, Dongshan Bay, and Taiwan Strait (Lei et al., unpublished)



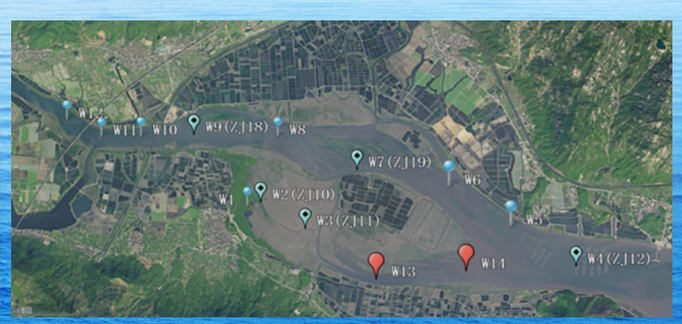
漳江口观测区航次调查

Survey Cruise in the Zhangjiang Estuary Observation Area

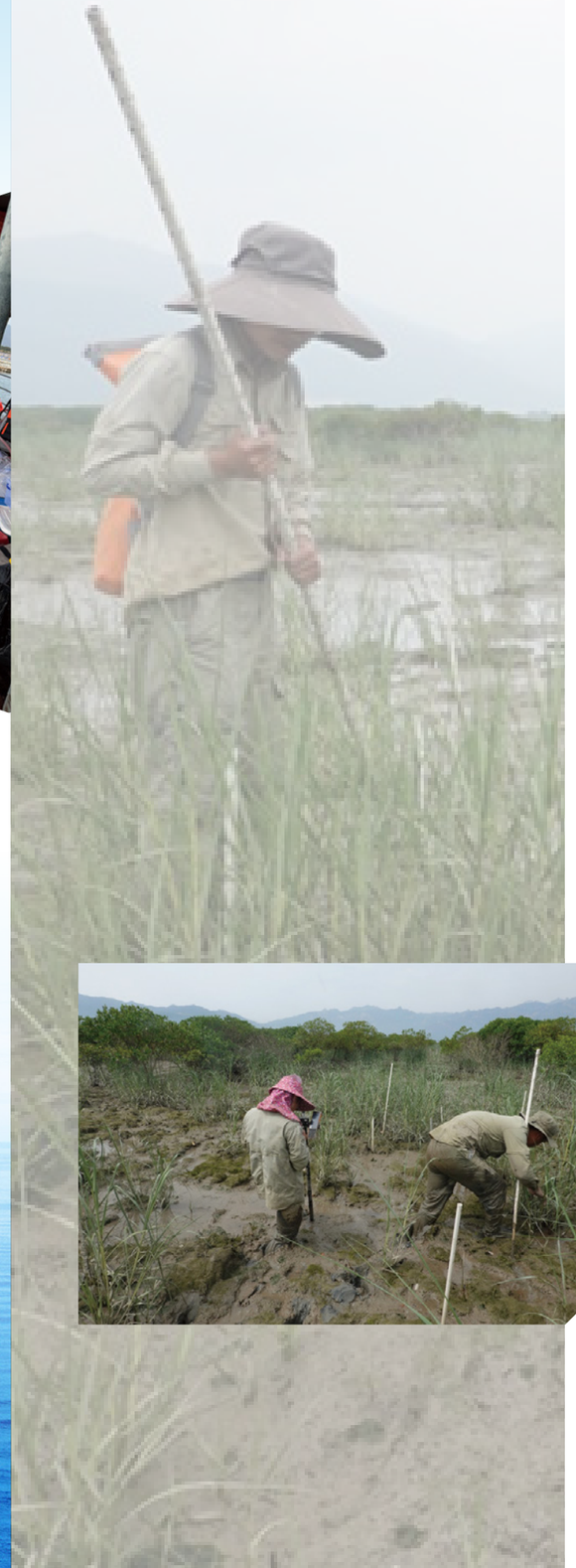
航次现场照片
On-site Photos of the Cruise

漳江口滨海湿地的长期定点观测是台海站的核心任务之一，为研究人类活动与全球变化对滨海湿地生态系统的长期影响提供了重要基础。该观测区位于福建省漳州市云霄县漳江口，覆盖红树林潮沟及漳江下游至入海口水域。2025年，台海站结合潮汐周期，在漳江口观测区顺利完成了冬季（2月）、春季（5月）、夏季（8月）和秋季（11月）的航次调查。调查获取了涵盖水体理化参数、底质理化参数、浮游生物及底栖生物等多方面的观测数据。这些数据不仅服务于漳江口生态系统长期变化的观测，也为量化地表水–地下水垂向交换通量、以及红树林/互花米草–河口系统横向物质交换通量提供了关键支撑，有力推动了滨海湿地生态系统动态变化的深入研究。

Long-term fixed-point observation of the Zhangjiang Estuary coastal wetland is a core mission of T-SMART, providing an essential foundation for studying the long-term impacts of human activities and global change on coastal wetland ecosystems. The Zhangjiang Estuary Observation Area is located in Yunxiao County, Zhangzhou City, Fujian Province, encompassing mangrove tidal creeks and the waters from the lower reaches of the Zhangjiang River to its estuary. In 2025, T-SMART successfully completed survey cruises in the Zhangjiang Estuary Observation Area during winter (February), spring (May), summer (August), and autumn (November), with sampling conducted manually in coordination with tidal cycles. The surveys collected comprehensive monitoring data encompassing water physicochemical parameters, sediment physicochemical parameters, plankton, and benthic organisms. These data not only support the monitoring of long-term ecological changes in the Zhangjiang Estuary but also provide critical support for quantifying vertical water and material fluxes between surface water and groundwater, as well as lateral material exchange fluxes within the mangrove/*Spartina alterniflora*-estuary system. This work significantly advances in-depth research on the dynamic changes of coastal wetland ecosystems.



漳江口航次站点图
Map of Cruise Stations in the Zhangjiang Estuary



@ Hao Huang

滨海湿地植物样方观测

Flora Biodiversity Surveys for Coastal Wetlands

为持续观测红树林及盐沼湿地植被的生长状况、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，漳江口实验场设立了6个红树林永久样地，每年进行1次观测。观测内容包括红树植物群落的种类、高度、密度、胸径，以及红树植物凋落物的类别和质量等。此外，实验场还设置了10个盐沼植物样地。

2025年，漳江口实验场完成了红树林和盐沼固定样方的各1次观测，观测指标涵盖盐沼植物群落的种类、高度、密度和基径等。这些观测数据为红树林生态系统研究、红树林湿地蓝碳研究，以及互花米草入侵红树林的格局、过程和机制研究提供了重要的科学依据。

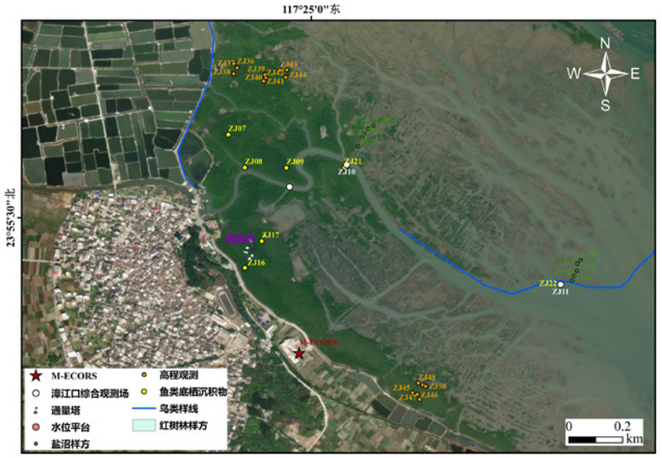
To continuously monitor the growth dynamics of mangrove and salt marsh vegetation, changes in wetland area, the status of invasive species, and their responses to global climate change and human activities, M-ECORS has established six permanent mangrove plots for annual observations. Monitoring parameters include the species composition, height, density, and diameter at breast height of mangrove communities, as well as the types and biomass of mangrove litter. Additionally, ten salt marsh vegetation plots have been established at the station.

In 2025, M-ECORS completed the annual monitoring of both mangrove and salt marsh fixed plots. Observed indicators for salt marsh communities encompass species composition, height, density, and basal diameter. These long-term observational datasets provide crucial scientific evidence for research on mangrove ecosystem dynamics, blue carbon assessment in mangrove wetlands, and the patterns, processes, and mechanisms of *Spartina alterniflora* invasion.

盐沼观测照片
Salt Marsh Observation in Zhangjiang Estuary

滨海湿地动物样方观测
Faunal Biodiversity Surveys for Coastal Wetlands

为长期跟踪观测漳江口红树林湿地的动物多样性，漳江口实验场为鸟类、鱼类和潮间带底栖动物等动物的多样性观测设置了观测样线、样点和样方，观测指标包括动物的种类、数量、生物量和分布等。2025年，漳江口实验场完成鸟类多样性观测4次、鱼类和潮间带底栖动物多样性观测各1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、鱼类、底栖动物等调查，掌握了动物类群长期的种群动态和分布，为生物多样性保护提供了重要的基础数据支撑。



漳江口观测图
Zhangjiang Estuary Observation Map

To conduct long-term monitoring of animal diversity in the mangrove wetlands of the Zhangjiang Estuary, M-ECORS has established transects, sampling points, and quadrats for observing birds, fish, and intertidal benthic animals. Monitoring indicators include species, population, biomass, and distribution of these animals. In 2025, M-ECORS completed seasonal bird surveys. In addition, both fish and intertidal benthic animals were surveyed once. With the support of the Zhangjiang Estuary Mangrove National Nature Reserve, M-ECORS has conducted multi-year surveys on birds, fish, and benthic animals, capturing long-term population dynamics and distribution patterns of animal groups. These efforts provide essential foundational data for biodiversity conservation.

鸟类观测现场照片
On-site Photos of Bird Monitoring

水位梯度控制实验系统
Water Level Gradient Control Experimental System

@ Wenwen Liu

水位梯度控制实验
Water Level Gradient Control Experiment

实验系统位于云霄漳江的河口区域，通过沿流域水位梯度控制平台实现自然水—盐梯度的调控，旨在探究海平面上升背景下，淹水时长与海水盐度协同变化对红树植物幼苗更新与生长的驱动机制。2025年，该系统顺利完成全年持续观测任务。

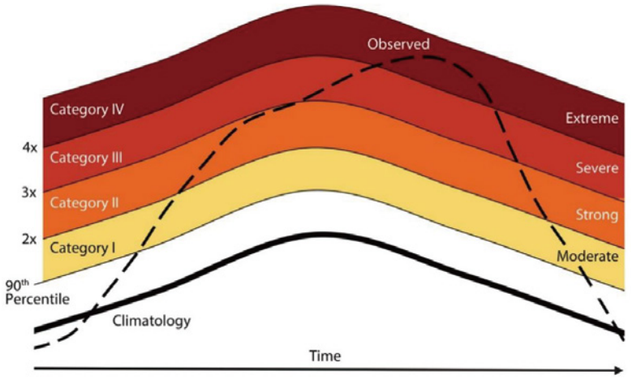
The experimental system is located in the estuary area of the Zhangjiang River in Yunxiao. Through a water level gradient control platform along the watershed, it achieves the regulation of natural water-salinity gradients. The system aims to investigate the driving mechanisms of the synergistic effects of inundation duration and seawater salinity on the regeneration and growth of mangrove seedlings under the context of sea-level rise. In 2025, the system successfully completed its annual continuous monitoring tasks.

中尺度模拟热浪对海洋浮游生物群落的影响及其响应机制研究

The Impact of Simulating Heatwaves on Marine Plankton Communities and Their Response Mechanisms: A Mesocosm–Based Study

该研究由刘凯琳和黄邦钦课题组依托东山实验场开展，基于中宇宙培养体系探究近岸海洋浮游生物群落对海洋热浪的响应。全球气温升高使以海洋热浪（Marine heatwaves, MHWs）为主的极端气候事件变得更频繁和更极端。海洋浮游植物贡献全球约50%初级生产，同时在食物网中也担任着调节有机质与养分循环的关键作用。研究不同强度MHWs对浮游植物与浮游动物的丰度、多样性、初级生产力、呼吸速率及碳流效率的影响，为预测未来海洋生态系统对极端气候事件的响应提供实验依据。

This study, conducted by the research groups of Kailin Liu and Bangqin Huang at D-SMART, investigated the response of coastal marine plankton communities to marine heatwaves using a mesocosm cultivation system. Rising global temperatures have made extreme climate events, particularly marine heatwaves (MHWs), more frequent and intense. Marine phytoplankton contribute to approximately 50% of global primary production while playing a critical role in regulating organic matter and nutrient cycling within food webs. Investigating the effects of MHWs of varying intensities on the abundance, diversity, primary productivity, respiration rates, and carbon flow efficiency of phytoplankton and zooplankton provides experimental evidence for predicting the responses of future marine ecosystems to extreme climate events.



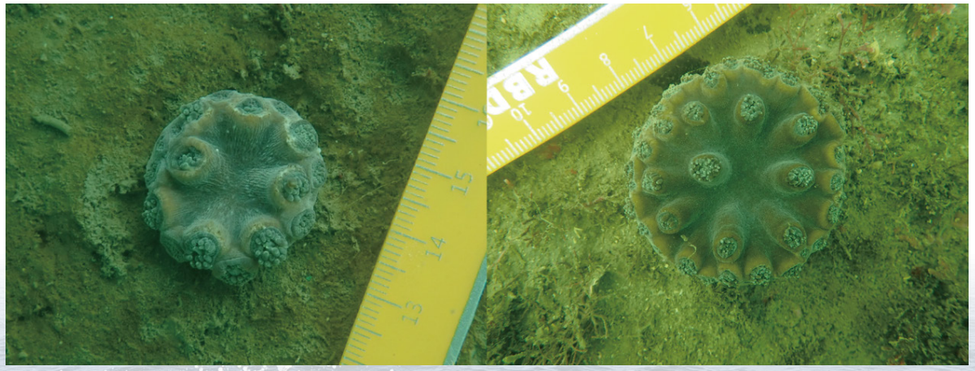
海洋热浪强度分类图（Hobday et al., 2018）
Classification of Marine Heatwave Intensity (Hobday et al., 2018).

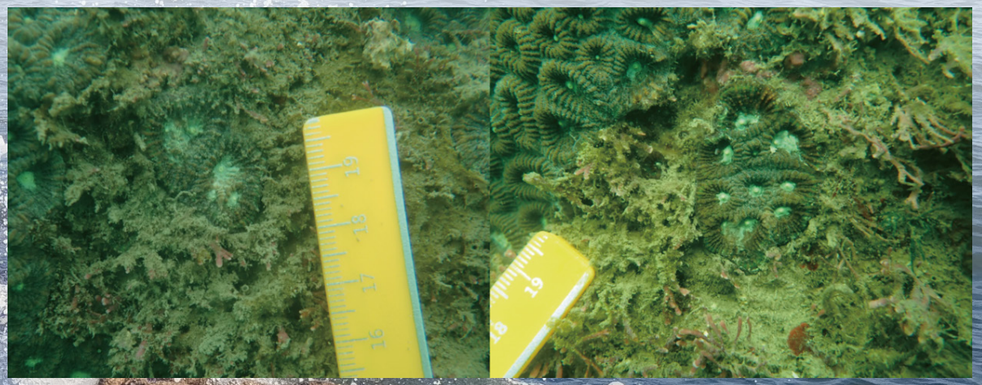
东山珊瑚生长速率监测与三维建模研究

Monitoring and 3D Modeling of Coral Growth Rates in Dongshan

该研究由刘敏课题组依托东山实验场开展，对东山珊瑚保护区造礁石珊瑚生长速率进行追踪和三维建模研究。东山珊瑚保护区位于中国造礁石珊瑚分布的北缘，具有独特的生态环境，其珊瑚群落尚未发育成成熟的珊瑚礁。研究团队通过定期拍摄和3D建模技术，在头屿片区开展了为期一年的生长速率追踪，获取了珊瑚生长对比数据，为促进珊瑚生态恢复及保护提供了基础。

This study, conducted by Min Liu's research group at D-SMART, tracked the growth rate and conducted 3D modeling of reef-building corals in the Dongshan Coral Protection Zone. Located at the northernmost distribution limit of reef-building corals in China, the Dongshan Coral Protection Zone features a unique ecological environment where coral communities have not developed into mature coral reefs. Through regular photography and 3D modeling techniques, the research team conducted one-year growth rate tracking in the Touyu area, obtaining coral growth comparison data that provides a foundation for advancing coral ecological restoration and protection efforts.





东山珊瑚保护区头屿片区的珊瑚生长对比图（一年期）
Coral Growth Comparison in Dongshan Coral Protection Zone (One-Year Period)

东山实验场中宇宙培养体系实景图
Realistic Picture of the Mesocosm Cultivation System at D-SMART

研究人员正在进行每日取样
Researchers Conducting Daily Sampling

中国东南部地区臭氧层消耗物质和含氟温室气体原位观测

In-situ Observations of Ozone Depleting Substances and Fluorinated Greenhouse Gases in Southeast China

该研究由吕永龙课题组依托东山实验场开展，对中国东南部地区臭氧层消耗物质（Ozone Depleting Substances, ODS）和含氟温室气体（Fluorinated Greenhouse Gases, F-gases）进行长期原位观测。消耗臭氧层物质主要用于制冷、清洗和发泡剂等领域，能在平流层释放卤素原子催化臭氧光解反应，目前已受《蒙特利尔议定书》管控。含氟温室气体包括氢氟碳化物（Hydrofluorocarbons,HFCs）、全氟化碳（Perfluorocarbons,PFCs）、六氟化硫（Sulfur Hexafluoride, SF_6）和三氟化氮（Nitrogen Trifluoride, NF_3），具有极高的全球增温潜势，目前占长寿命温室气体辐射强迫的11%，受《京都议定书》管控。研究团队在苏峰山顶每日采集空气样品，采用预浓缩系统结合气相色谱-质谱联用仪（Gas Chromatography-Mass Spectrometry, GC-MS）进行测试，获得该区域ODS和F-gases日尺度浓度数据，为评估我国国际公约履约成效和管控违规排放提供科学依据。

This study, conducted by Lu Yonglong's research group at D-SMART, performed long-term in-situ observations of ozone-depleting substances (ODS) and fluorinated greenhouse gases (F-gases) in southeastern China. ODS, primarily used in refrigeration, cleaning, and foaming agents, release halogen atoms in the stratosphere catalyzing ozone photolysis and are regulated under the Montreal Protocol. F-gases, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3), have extremely high global warming potential and currently account for 11% of the radiative forcing of long-lived greenhouse gases, regulated under the Kyoto Protocol. The research team collects daily air samples on the top of Su Feng Mountain, analyzing them using a pre-concentration system coupled with Gas Chromatography-Mass Spectrometry (GC-MS) to obtain daily concentration data of ODS and F-gases in the region, providing scientific basis for evaluating China's compliance with international conventions and supporting government agencies in controlling non-compliant emissions.

该项目得到了国家自然科学基金重点项目（42192524）的支持

This project was supported by the NSFC Key Program (Grant No. 42192524).

测试空气样品中的ODS和F-gases
Test of ODS and F-gases in Air Samples

采集苏峰山顶空气样品（2）
Air Sample Collection at the Top of Su Feng (2)

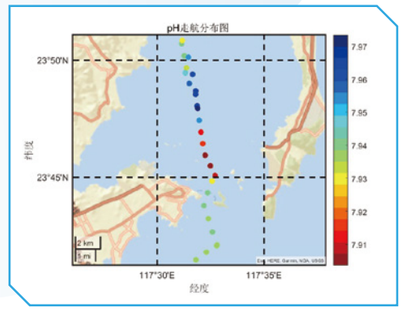
采集苏峰山顶空气样品（1）
Air Sample Collection at the Top of Su Feng (1)

海水pH和总碱度（TA）在线同步观测技术研究

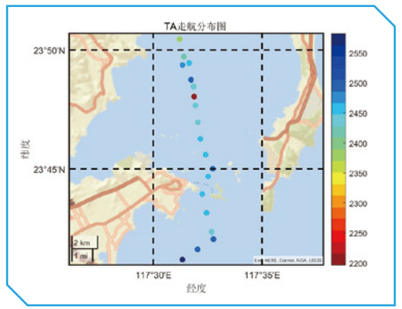
Synchronous On-line Determination of Seawater pH and Total Alkalinity

该研究由马剑课题组依托东山实验场开展，对海水pH和总碱度（TA）在线同步观测技术进行应用研究。海洋碳酸盐系统通常由pH、CO_2分压（pCO_2）、溶解无机碳（DIC）和总碱度4个参数表征，其中pH与总碱度组合因误差传递效应较小，是较优的测定参数组。研究团队研制了pH与TA分析仪，搭载于东山湾秋季航次开展走航测定，成功捕获约0.07个pH单位的微小波动幅度及380μmol/kg的TA变化范围；同时在珊瑚缸系统开展定点高频在线监测，获取碳酸盐参数周日变化特征。后续将结合东山实验场立体观测体系建设需求，拓展在线观测技术的多场景应用能力。

pH、TA分析仪在东山湾航次中的应用现场图
Field Application Images of pH and TA Analyzers during the Dongshan Bay Cruise

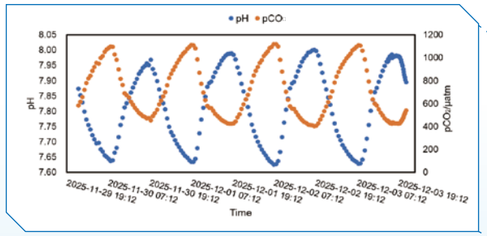


东山湾2025秋季航次的pH现场观测结果
In-Situ pH Observation Results from the 2025 Autumn Cruise in Dongshan Bay

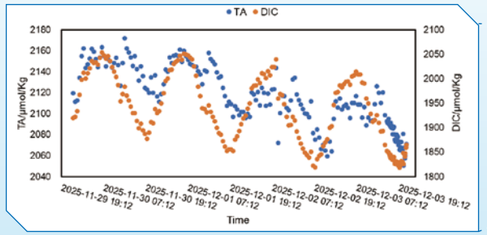


东山湾2025秋季航次的TA现场观测结果
In-Situ TA Observation Results from the 2025 Autumn Cruise in Dongshan Bay

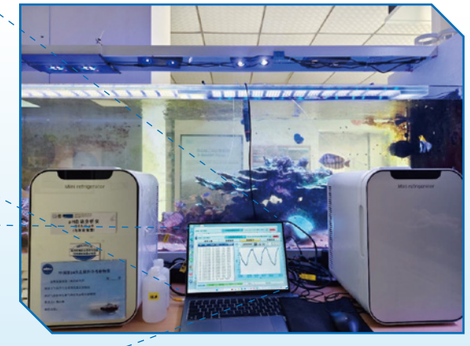
This study, conducted by Jian Ma's research group at D-SMART, applied synchronous on-line observation technology for seawater pH and total alkalinity (TA). The carbonate system is typically defined by four parameters: pH, partial pressure of CO_2 (pCO_2), dissolved inorganic carbon (DIC), and TA, with the combination of pH and TA preferred due to lower error propagation. The research team developed a pH and TA analyzer, deployed for underway measurements during the autumn cruise in Dongshan Bay, successfully capturing minor fluctuations of approximately 0.07 pH units and a TA variation of 380 μmol/kg. Meanwhile, fixed-site high-frequency online monitoring was conducted using the coral tank system, revealing diurnal variation characteristics of carbonate parameters. Future work will address the construction requirements of the three-dimensional observation system at D-SMART to expand multi-scenario applications of online observation technologies.



珊瑚缸系统pH、pCO_2周日变化图
Diurnal Variation Plots of pH and pCO_2 in the Coral Tank System



珊瑚缸系统TA、DIC周日变化图
Diurnal Variation Plots of TA and DIC in the Coral Tank System



pH、TA分析仪在珊瑚缸系统应用现场图
Field Application Images of pH and TA Analyzers in the Coral Tank System

日本囊对虾多性状测评选育研究

Multi-trait Evaluation and Selection of Kuruma Shrimp, *Penaeus japonicus*

该研究由毛勇课题组依托东山实验场的场地与实验资源开展，开发设计了对虾高通量行为表型监测平台及对虾心率监测装置。基于这两套装置，采用传统测评方法及高通量表型监测方法相结合的方式，对日本囊对虾抗白斑综合征病毒（White Spot Syndrome Virus，WSSV）、耐低盐、耐亚硝酸盐及耐高温等性状进行了研究探索，制定了基于计算机视觉技术高效筛选优良性状个体的新方法并应用在对虾选育工作中。当前已成功选育出能够稳定性状遗传的耐高温日本囊对虾新品系，耐热性能显著提升。团队还研制出日本对虾40K SNP基因芯片“鹭江芯1号”，为日本对虾基因组亲缘关系鉴定、遗传结构与多样性分析、多性状基因组选择等提供了重要工具。

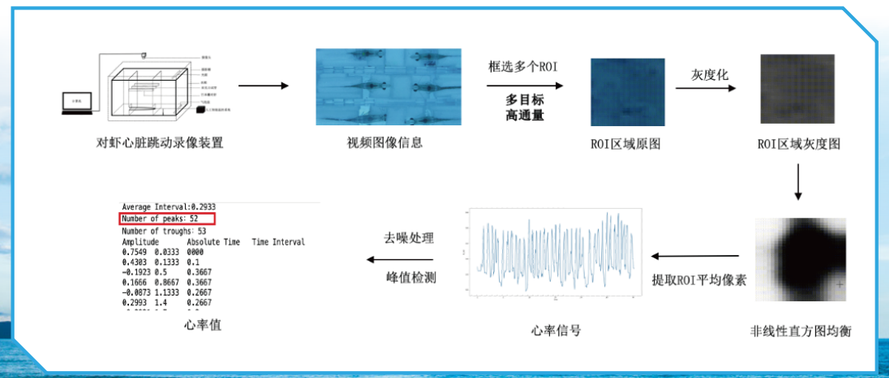
日本囊对虾
Penaeus japonicus

This study, conducted by Yong Mao's research group at D-SMART, utilizing the facilities and experimental resources developed a high-throughput behavioral phenotype monitoring platform and a heart rate monitoring device for shrimp. Based on these two systems, the research team adopted a combination of traditional evaluation methods and high-throughput phenotypic monitoring techniques to investigate traits of *Penaeus japonicus*, including resistance to White Spot Syndrome Virus (WSSV), low salinity, nitrite toxicity, and high temperatures. A new method for efficiently screening individuals with desirable traits based on computer vision technology was established and applied in the shrimp breeding process. To date, the team has successfully bred a new *P. japonicus* line with stable genetic inheritance of high-temperature resistance, significantly improving heat tolerance. The team also developed the *P. japonicus* 40K SNP gene chip "Lujiangxin I," providing an important tool for assessing genetic relationships, analyzing genetic structure and diversity, and conducting genomic selection of multiple traits in *P. japonicus*.

鹭江芯1号
Lujiangxin Ⅰ

该项目得到了国家虾蟹产业技术体系岗位专家项目的支持
The project is mainly supported by the Agriculture Research System of China (Grant No. CARS-48).

对虾心率数据识别软件
Software for Identifying Heart Rate Data of Shrimp



Research Projects
科研课题

新增项目

河海连续体氮循环跨界面耦合调控机制

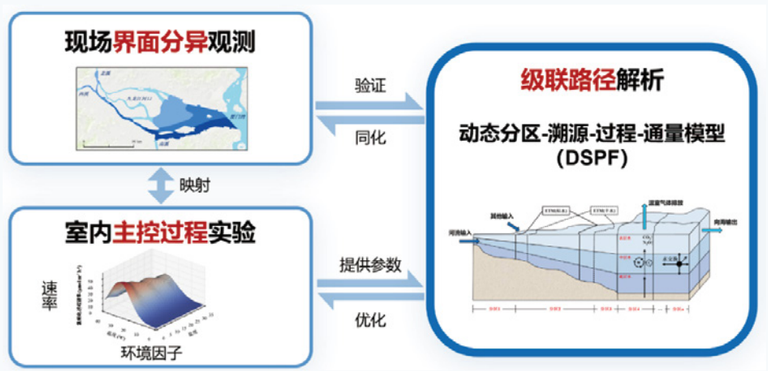
Cross-interface Coupling and Regulation of Nitrogen Cycling in the River-Estuary-Bay Continuum

国家自然科学基金重点项目 2026-2030 | 项目负责人：陈能汪

NSFC Key Program 2026-2030 | PI: Nengwang Chen

项目聚焦全球变化下海陆界面氮循环失衡问题，以九龙江河口连续体为典型区，创建动态分区溯源-过程-通量模型（DSPF）。通过多维嵌套观测揭示空间分异规律，建立非线性响应参数矩阵，实现跨尺度映射。基于图神经网络与高分辨数据解析“多源输入-河口转化-海气输出”级联路径，阐明“减氮降碳”协同机制，为陆海统筹系统治理提供新范式。

Focusing on nitrogen cycle imbalance at the land-sea interface under global change, this project targets the Jiulong River Estuary continuum as a representative system. A Dynamic Segmentation-Source-Process-Flux (DSPF) modeling framework will be developed to advance understanding of estuarine differentiation and system regulation. Using multi-dimensional nested observations, spatial heterogeneity across discontinuous interfaces will be characterized. A parameter matrix of nonlinear environmental responses will be established to link micro-scale mechanisms with macro-scale fluxes. Graph neural networks and high-resolution data will support dynamic estuarine segmentation to trace cascading pathways from multi-source inputs, through estuarine transformation, to air-sea outputs. Scenario simulations integrating climate and management options will reveal synergistic mechanisms for nitrogen reduction and carbon mitigation, offering a new paradigm for integrated land-ocean governance.



研究技术框架
Research Technology Framework

新增项目

互花米草大规模除治背景下南方滨海湿地的修复与保护

Restoration and Protection of Southern Coastal Wetlands in the Face of Large-scale Elimination of *Spartina alterniflora* in China

国家自然科学基金重点项目 2026-2030 | 项目负责人：张宜辉

NSFC Key Program 2026-2030 | PI: Yihui Zhang

本项目聚焦中国南方滨海湿地“红树林—互花米草生态交错带”，针对红树林保护恢复的关键技术瓶颈及核心生态学问题，采用定位对比，结合原位控制实验和稳定同位素技术，深入研究互花米草入侵特性及扩散动态、乡土植物生长响应、生物多样性及营养级关系，旨在揭示低纬度红树林区互花米草扩散蔓延机理并预测复发趋势，阐明多重环境梯度下湿地植物生长分布规律，量化评估互花米草大规模除治和生态修复生态效应，综合从立地条件、物种选择和修复方式提升乡土植被修复关键技术体系，为滨海湿地保护与修复等国家重大需求提供科学支撑。

This project focuses on the "mangrove-*Spartina alterniflora* ecotone" in the southern coastal wetlands of China. It addresses the key technical bottlenecks and the essential scientific questions in ecology in the protection and restoration of mangrove wetlands. Through a targeted comparative study and in combination with in-situ manipulated experiments and stable isotope technology, the project will conduct in-depth research on the invasive characteristics and spread dynamics of *Spartina alterniflora*, native plant growth response, biodiversity and their trophic relationships, aiming to reveal the mechanism of spread and prediction of the second invasion trend of *Spartina alterniflora* in low-latitude mangrove areas, clarify the distribution pattern of wetland plants under multiple environmental gradients, quantify and evaluate the ecological effects of large-scale elimination of *Spartina alterniflora* and ecological restoration of native species, and comprehensively improve the key technical system for native vegetation restoration from the aspects of site conditions, species selection, and restoration methods. The project will provide scientific support for the protection and restoration of coastal wetlands and other national major needs.

互花米草大规模除治背景下南方滨海湿地的修复与保护
Restoration and Protection of Southern Coastal Wetlands in the Face of Large-scale Elimination of *Spartina alterniflora* in China

@ Qingxian Lin

新增项目

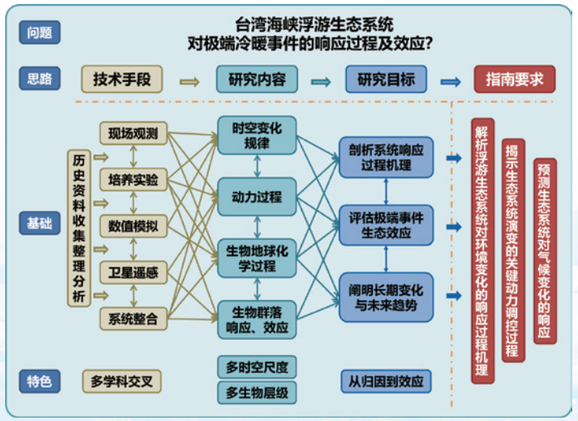
台湾海峡浮游生态系统对极端冷暖事件的响应过程及效应

Response Processes and Effects of the Planktonic Ecosystem in the Taiwan Strait to Extreme Cold and Warm Events

国家自然科学基金联合基金项目 2026–2029 | 项目负责人：柳欣

NSFC Joint Fund Project 2026-2029 | PI: Liu Xin

本项目针对台湾海峡区域生态系统动力过程及效应，基于申请人团队近四十年长期现场观测数据积累和前期研究成果，进一步聚焦“极端冷暖事件如何影响浮游生物群落演变及其生态效应”这一关键科学问题，搭建跨学科团队开展生态系统整合研究。项目团队以“响应机理—生态效应—长期变化”为研究主线，在集成分析历史资料基础上，通过针对性开展现场多学科航次观测，并校验、同化、融合卫星遥感和数值模式数据，从多时空（气候态基准、极端事件过程、长期变化趋势）、多生物层级（浮游细菌、浮游植物、浮游动物等）和多学科交叉视角，在生态系统水平进行系统整合、案例剖析和综合评估。预期成果从多尺度动力过程、生物地球化学循环及生物响应适应机理等多个视角，系统阐明海洋极端冷暖事件对台湾海峡浮游生物群落结构和功能时空变化的影响，揭示全球变暖影响下极端冷暖事件对台湾海峡生态系统演变过程机理及其生态效应，为区域生态管理和保护提供科学依据。



研究方案和技术路线

Research Plan and Technical Approach

Aligned with the research guideline "Ecosystem Dynamics and Effects in the Taiwan Strait Region," this project, based on the long-term accumulation of field observation data over nearly four decades by the applicant's team and the previous research results, further focuses on the key scientific issue of "how extreme cold and warm events affect the changes of plankton communities and their ecological effects", and establishes an interdisciplinary team to carry out integrated research on the ecosystem. Taking "response mechanism - ecological effect - long term change" as the main research line, based on integrated analysis of historical data, the project team conducts targeted field multi-disciplinary cruise observations, and validates, assimilates and fuses satellite remote sensing and numerical model data. From multiple spatial-temporal perspectives (climatological benchmark, extreme event processes, long-term change trends), multiple biological levels (bacteria, phytoplankton, zooplankton, etc.) and interdisciplinary perspectives, it conducts systematic integration, case analysis and comprehensive evaluation at the ecosystem level. The expected results will systematically clarify the impacts of marine extreme cold and warm events on the spatial and temporal changes of the structure and function of plankton communities in the Taiwan Strait from multiple perspectives such as multi-scale dynamic processes, biogeochemical cycles and the mechanisms of biological response and adaptation. It will reveal the mechanisms of the evolution process of the ecosystem in the Taiwan Strait and its ecological effects caused by extreme cold and warm events under the influence of global warming, and provide a scientific basis for regional ecological management and protection.

新增项目

海峡西岸典型蓝碳生态系统对环境演变的响应及韧性机制

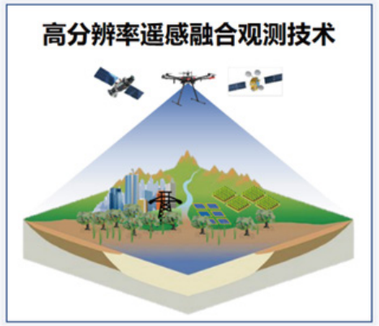
Response and Resilience Mechanisms of Typical Blue Carbon Ecosystems to Environmental Evolution in the Western Taiwan Strait

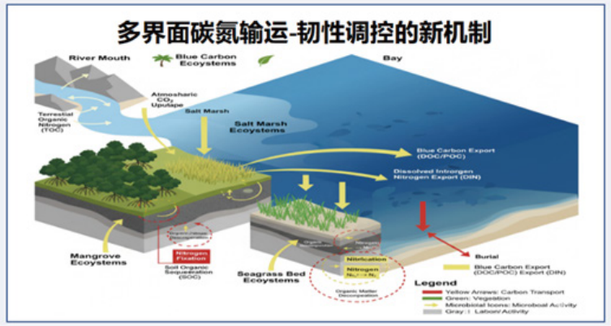
国家自然科学基金区域创新发展联合基金重点项目 2026–2029 | 项目负责人：李杨帆

NSFC Joint Fund for Regional Innovation and Development Key Program 2026-2029 | PI: Yangfan Li

本项目计划在海峡西岸，通过高分辨遥感融合技术、模拟实验和现场观测，研究高氮负荷下蓝碳植物的退化格局与碳氮输运过程，揭示“以氮促碳”的调控机制及其与生态系统韧性的关系，进而构建蓝碳植被生态演变模型，探索提升固碳减氮能力的韧性策略。研究旨在创新碳氮耦合过程理论与高分辨率遥感观测技术，为海岸带生态保护与可持续发展提供科学支撑。

To provide a scientific reference for the sustainable development of coastal zones along west coast of Taiwan Strait, this project integrates high-resolution remote sensing fusion techniques to accurately identify degradation patterns of blue carbon plant communities in nitrogen-enriched areas. Through in-situ measurement and simulations, this project further examines the multi-interface processes of carbon and nitrogen transport under identified degradation scenarios, revealing nitrogen-driven carbon regulation mechanisms and their interactions with ecosystem resilience. Based on carbon-nitrogen coupling effects, a vegetation evolution model for blue carbon continuums will be developed to explore resilience enhancement strategies for carbon sequestration and nitrogen reduction.





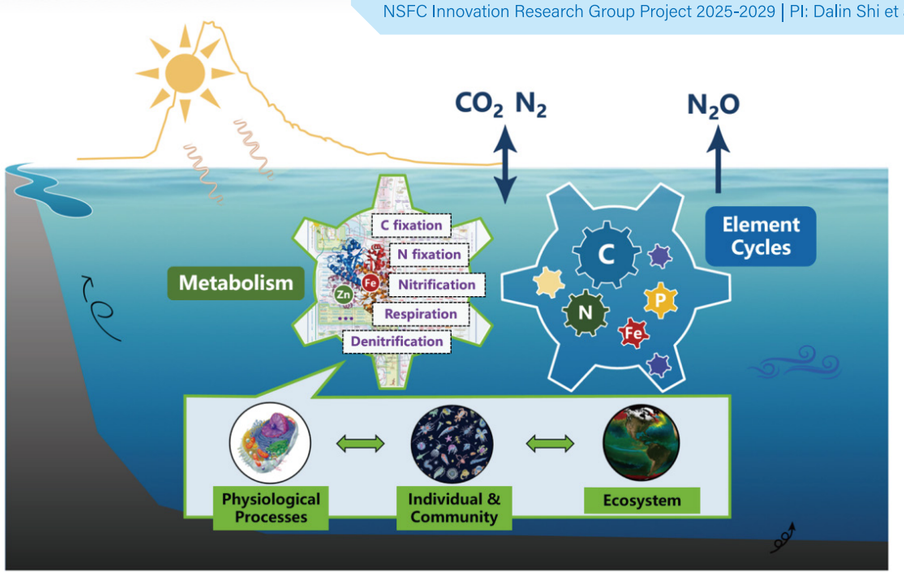
项目研究思路图

Framework of the Research Project

在研项目

海洋新陈代谢与元素循环
Marine Metabolism and Element Cycles

国家自然科学基金创新研究群体项目 2025–2029 | 史大林（等）
NSFC Innovation Research Group Project 2025-2029 | PI: Dalin Shi et al.



◉ 群体研究方向：海洋新陈代谢与元素循环
The Research Direction of the Group: Marine Metabolism and Element Cycles

群体汇聚海洋生理生态学、微生物海洋学、海洋生物地球化学的优势力量，围绕“海洋新陈代谢与元素循环”这一前沿研究方向，在海洋微生物代谢与碳氮循环、浮游植物碳氮及能量代谢、痕量元素生物地球化学循环等方面取得一系列重要进展。群体成员将进一步深化合作研究，揭示海洋浮游生物新陈代谢的时空格局和调控因子，阐明其与元素循环的耦合关系和机制，进而评估和预测其对全球变化的响应和反馈，以期在海洋浮游生物新陈代谢与元素循环领域取得突破性成果，在国际上占有一席之地。

The group brings together expertise in marine ecophysiology, microbial oceanography, and marine biogeochemistry, united by a shared research interest in marine metabolism and element cycles. Through collaboration, group members have made important advancements in understanding marine microbial carbon and nitrogen metabolism, phytoplankton carbon, nitrogen, and energy metabolism, and the biogeochemical cycling of trace elements in the ocean. Looking ahead, the group aims to deepen collaborations to unveil spatiotemporal patterns and regulatory mechanisms of marine plankton metabolism, reveal its coupling relationships and mechanisms with element cycling, and evaluate and predict its responses and feedbacks to global change. The ultimate goal is to achieve breakthroughs and establish international prominence in the field of marine plankton metabolism and elemental cycles.

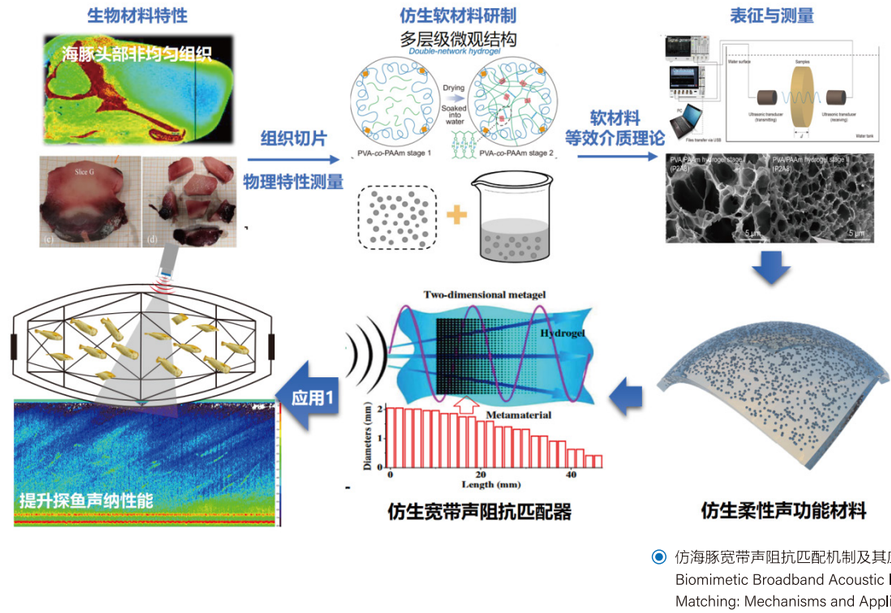
在研项目

受海豚生物声纳启发的宽带声阻抗匹配机制研究
Broadband Impedance Matching Inspired by Dolphin Biosonar

国家自然科学基金国际(地区)合作与交流项目 2025–2029 | 项目负责人：张宇（等）
NSFC International (Regional) Cooperation and Exchange Programs 2025-2029 | PI: Yu Zhang et al.

声纳广泛应用于海洋科考、资源勘探与水下对抗，但现有固体声学器件因匹配层厚度限制，难以实现宽带声传输。海豚生物声纳的软组织通过高效声阻抗匹配实现宽带特性，为仿生设计提供关键启示。本项目聚焦揭示其匹配机制，以水凝胶、硅胶等柔性材料为基础，调控微观网络结构与填充比，研制声阻抗可调的仿生柔性材料，探究声学参数理论及结构–阻抗关联规律。进而构建仿生声阻抗匹配器，提升宽带声传输性能，提升深远海养殖平台探鱼声纳的探测能力。研究成果为声纳宽带传输提供新路径，对水下智能声传感与海洋新材料开发具有重要科学价值与应用前景。

Sonar systems are widely used in ocean research, resource exploration, and underwater operations. However, conventional solid-state acoustic devices face broadband transmission limitations due to quarter-wavelength or odd-multiple-thickness impedance matching layers. Dolphins' evolved biological sonar uses soft tissues for efficient water impedance matching and broadband transmission, offering key insights for underwater acoustic material design. This project uncovers broadband acoustic impedance matching mechanisms in dolphin sonar tissues. Using biomimetic principles, hydrogels and silicone rubbers will be tailored in microstructure and filler ratio to develop flexible materials with tunable acoustic impedance. We will investigate acoustic parameter theory and microstructure-impedance relationships to clarify sound propagation impact. A bioinspired impedance matcher will validate broadband transmission, enhancing sonar detection for deep-sea aquaculture platforms. This research provides innovative strategies to enhance sonar broadband transmission, with scientific and application value for underwater acoustic sensing and marine materials.



◉ 仿海豚宽带声阻抗匹配机制及其应用
Biomimetic Broadband Acoustic Impedance Matching: Mechanisms and Applications

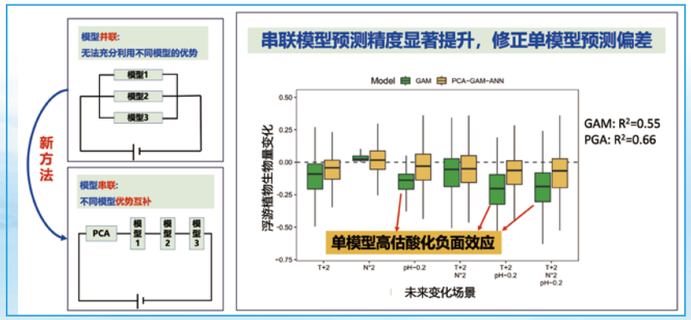
Research Highlights
成果亮点

多模型串联提升浮游植物对多重环境胁迫响应的预测精度

Novel Sequential Modeling Framework Improves Phytoplankton Biomass Predictions in Response to Multiple Environmental Stressors

传统统计模型面临高度非线性和多重共线性等挑战，导致难以准确预测浮游植物生物量，也难以揭示多重环境变化综合影响。为此，该研究创新提出“模型串联”新思路，构建了融合主成分分析、广义加性模型和人工神经网络的PGA顺序建模框架，同时解决了非线性和共线性的统计学难题，显著提升了复杂海洋环境下浮游植物生物量的预测能力，尤其增强了对高生物量和藻华峰值的识别效果。基于台湾海峡长期观测资料，该研究进一步评估了升温、酸化和富营养化等未来典型环境胁迫的生态效应，结果表明气候变化因素将导致浮游植物生物量整体下降，且多重胁迫叠加会进一步放大这种负面影响。相比之下，传统广义加性模型（GAM）在酸化情景下更容易高估其负面生态效应，而PGA模型由于更好处理了环境因子共线性和非线性交互，预测结果更为稳健可靠（如图）。该研究为海洋生态过程预测提供了新的技术路径，也为认识全球变化背景下边缘海初级生产力响应机制提供了科学依据。

Understanding the impacts of multiple environmental stressors on phytoplankton biomass is crucial for predicting marine ecosystem responses under global climate change. This study employed a sequential modeling framework integrating Principal Component Analysis (PCA), Generalized Additive Models (GAM), and Artificial Neural Networks (ANNs) to improve predictions of phytoplankton chlorophyll a concentrations in the Taiwan Strait. Analyzing a decadal dataset, we found that a 2°C rise in sea surface temperature and a 0.2 pH decline will each lead to an 11.3% reduction in chlorophyll a biomass, whereas nitrogen enrichment is expected to increase it by only 2.8%. The combined effects of these stressors will result in an 18.3% reduction, with the most significant declines occurring in high-chlorophyll areas during algal blooms. Compared to simpler models, our approach improved accuracy by reducing overestimation biases, particularly under acidification scenarios, highlighting the need for advanced, multivariate models in forecasting phytoplankton dynamics under global changes.



串联模型框架及PGA模型与GAM模型在未来情景下预测结果的比较
Fig. Sequential Modeling Framework and Comparison of PGA and GAM Predictions Under Future Scenarios.

以上工作于2025年8月发表于*Limnology and Oceanography Letters*期刊，2022级博士生佟竺殷和2019级博士生郭嘉宇共同担任第一作者，肖武鹏副教授为通讯作者。

Reference:
Tong, Z., Guo, J., Liu, Y., Lin, L., Chen, J., Liu, X., Huang, B., Laws, E.A. and Xiao, W. Novel sequential modeling framework improves phytoplankton biomass predictions in response to multiple environmental stressors. *Limnology and Oceanography Letters* 2025. doi: 10.1002/lol2.70031

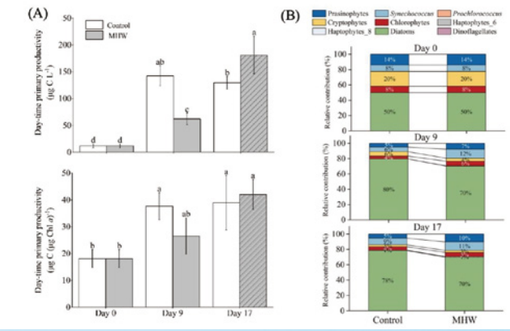
海洋热浪降低东山近海初级生产力却不影响浮游植物群落的韧性和恢复力

Reduced Primary Productivity and Notable Resilience of Phytoplankton Community in the Coastal Water of Southern China Under a Marine Heatwave

海洋热浪（MHW）的频率、强度和持续时间的增加会对不同地区生物产生不同程度的影响。为认知海洋热浪如何影响沿岸初级生产过程，评估浮游植物恢复力和时间稳定性的变化，我们在厦门大学东山太古海洋观测与实验站，开展了中尺度围隔实验，探究了海洋热浪（MHW）对初级生产力、浮游植物群落结构及关键和生理指标的影响，以期揭示全球海洋变化下浮游植物群落功能变化趋势。

研究结果表明，MHW（比原位水温升高3℃）降低了浮游植物群落生物量，单位水体的初级生产力下降了约 56%。然而，热浪后，生理学特征和群落构成展现出显著恢复与稳定特征。尽管MHW降低了硅藻的丰度，增加了聚球藻和绿藻纲的相对占比，但主要浮游植物功能类群表现出显著的正向恢复力，使其在MHW后能够恢复至原有群落状态。说明，MHW消失后，浮游植物群落表现出较高的韧性，生物量和初级生产力得到了恢复，主要功能类型展现出明显的恢复力。然而，MHW期间初级生产力的降低，以及生物量密度的下降，可能会对次级生产者产生显著影响。此外，浮游植物群落结构的改变，至少在热浪发生期间，可能会影响沿海食物网的动态过程。

Increasing frequency, intensity and duration of marine heatwaves (MHWs) are supposed to affect coastal bio logical production in different regions to different extents. To understand how MHWs impact coastal primary productivity and community succession of phytoplankton and assess the changes in resilience of phytoplankton communities, we conducted a mesoscale enclosure experiment simulating a MHW in the coastal water of southern China. After 8 days of the MHW (+3˚C) treatment, community biomass was significantly lower than the control's, and primary productivity per volume of water was reduced by about 56%. Nevertheless, the phytoplankton community retrieved its biomass and primary productivity after the temperature was subse quently reset to that of the control. Although the MHW treatment decreased the abundance of diatom and increased the percentages of *Synechococcus* and Prasinophytes, the main phytoplankton functional types showed positive resilience that allowed the recovery of the phytoplankton community after the MHW. Our results indicate that key phytoplankton functional types in the southern coastal waters of China exhibited significant resilience, recovery, and temporal stability under the influence of the marine MHW by 3˚C rise. However, reduced primary productivity during the MHW period, along with decreased biomass density, might significantly influence secondary producers. In addition, the altered phytoplankton community structure may affect coastal food web processes at least during the MHW period.



初级生产力（A）和浮游植物群落（B）在培养开始、第9天和17天的变化规律；control，空白组；MHW，热浪处理组；MHW第9天结束，第17天代表恢复状态

Changes in Daytime Primary Productivity (A) and Taxonomic Composition of Phytoplankton Assemblages (B) in the Control and Heatwave Groups on Days 0, 9 (End of HW Treatment) and 17 (End of the Experiment).

以上工作于2024年11月发表于*Environmental Research*期刊，2021届博士生张玉坤为第一作者，高坤山教授为通讯作者。

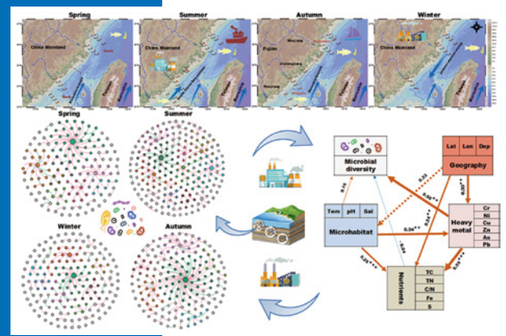
Reference:
Zhang YK, Gao G, Xue HJ, and Gao KS*. 2025. Reduced primary productivity and notable resilience of phytoplankton community in the coastal water of southern China under a marine heatwave. *Environmental Research* 264: 120286. doi: 10.1016/j.envres.2024.120286

台湾海峡沉积物微生物群落和多样性的季节变化

Seasonal Variation of Microbial Community and Diversity in the Taiwan Strait Sediments

台湾海峡的人类活动和海洋流场呈现出显著的季节性变化，但海洋微生物在气候变化和人为压力下对海洋变化的响应仍不明确。通过16SrRNA基因扩增子测序，我们研究了沉积物样本中微生物群落的时空动态和功能变化。研究结果揭示了微生物多样性和组成的明显季节性模式。在门水平上，变形菌门、硫酸盐还原菌门和古菌门占主导地位，而在属水平上，*Candidatus Nitrosopumilus*，*Woeseia*，and *Subgroup 10*较为常见。铁浓度、重金属和碳氮比是特定季节影响微生物群落的主要因素，而硫含量、温度波动和重金属则塑造了整个微生物结构和多样性。核心微生物群体，包括*Desulfobulbus*，*Subgroup 10*，*Unidentified Latescibacterota*，and *Sumerlaea*，在调节群落结构和功能转变中发挥了重要作用。标志性物种，如*Aliidiomarina sanyensis*，*Spirulina platensis*，*Croceimarina litoralis* and *Sulfuriflexus mobilis*，作为季节性指示物种。细菌表现出类似于高等生物的生存策略，涵盖了合成、增长、休眠和抗病性等过程，贯穿整个季节周期。特定季节的核心微生物群体和标志性物种可作为监测和评估台湾海峡生态系统健康状况的重要指标。

Human activities and ocean currents in the Taiwan Strait exhibit significant seasonal variation, yet the response of marine microbes to ocean changes under anthropogenic and climatic stress remains unclear. Using 16SrRN A gene amplicon sequencing, we investigated the spatiotemporal dynamics and functional variations of microbial communities in sediment samples. Our findings revealed distinct seasonal patterns in microbial diversity and composition. Proteobacteria, Desulfobacterota, and Crenarchaeota dominated at the phylum level, while *Candidatus Nitrosopumilus*, *Woeseia*, and *Subgroup 10* were prevalent at the genus level. Iron concentrations, heavy metals and C/N ratio were primary factors influencing microbial communities during specific seasons, whereas sulfur content, temperature fluctuations, and heavy metals shaped the entire microbial structure and diversity. Core microbial groups, including *Desulfobulbus*, *Subgroup 10*, *Unidentified Latescibacterota*, and *Sumerlaea*, played essential roles in regulating community structure and functional transitions. Marker species, such as *Aliidiomarina sanyensis*, *Spirulina platensis*, *Croceimarina litoralis* and *Sulfuriflexus mobilis*, acted as seasonal indicators. Bacteria exhibited survival strategy akin to higher organisms, encompassing process of synthesis, growth, dormancy, and disease resistance throughout the seasonal cycle. Core microbial groups and marker species in specific seasons can serve as indicators for monitoring and assessing the health of the Taiwan Strait ecosystem.



图示摘要
Graphical Abstract

以上工作于2025年3月发表于*Environmental Research*期刊，2021级博士生李家龙为第一作者作者，吕永龙教授为通讯作者。

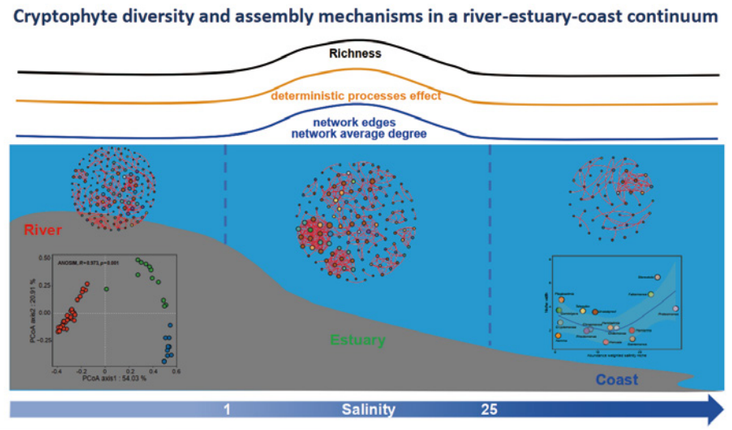
Reference:
Li Jialong, Lu Yonglong*, Chen Xueting, Wang Lianghui, Cao Zhiwei, Lei Haojie, Zhang Zhenjun, Wang Pei, Sun Bin. Seasonal variation of microbial community and diversity in the Taiwan Strait sediments. *Environmental Research* 2025, 268: 1-11. doi: 10.1016/j.envres.2025.120809

流域—河口—近海连续体中的隐藻多样性和群落构建机制

Cryptophyte Diversity and Assembly Mechanisms Reveal Ecological Discontinuities in a River–Estuary–Coast Continuum

河流汇入海洋的过程中，河口常被视为由淡水向海水平滑过渡的连续地带，但其中微型生物多样性如何变化、群落如何组装，仍缺乏清晰认识。围绕这一问题，我们沿九龙江流域—河口—近岸连续体，系统追踪了一类体型微小却在食物网结构和物质循环中发挥重要作用的藻类——隐藻。研究发现，隐藻多样性并未遵循传统生态学中“河口最低”的经典预期，反而在河口区域达到峰值，显示河口并非生物多样性的低谷，而可能是重要热点。进一步分析表明，盐度变化显著影响了隐藻群落的分化与重组，使河口成为淡水与海洋类群交汇、筛选和重构的关键区域。该研究不仅加深了我们对流域—河口—近海生态梯度中微型真核生物分布规律的理解，也揭示出看似连续的环境梯度背后存在显著生态不连续性，表明河口是连接陆海生态过程、维持生物多样性与驱动群落转换的关键节点。

Cryptophytes, a group of microalgae, play crucial roles in aquatic ecosystems but have been relatively understudied, particularly in terms of their diversity and community assembly along environmental gradients. This study investigated the diversity patterns and assembly mechanisms of cryptophyte communities across a river-estuary-coast continuum in southeast China. Contrary to Remane's Artenminimum hypothesis, which predicts a minimum in species diversity at intermediate salinities, we observed a peak in cryptophyte richness within the estuarine zone. This finding suggests that cryptophytes may follow different ecological rules compared to macrozoobenthos, perhaps because of the complex habitat heterogeneity and the dynamic mixing of freshwater and marine species in estuaries. Our analyses also revealed significant ecological discontinuities along the continuum, particularly at the estuarine interface, where deterministic processes, such as salinity-driven selection, become more influential in community assembly across habitat boundaries. Co-occurrence network analyses further highlighted the estuary as a hotspot of biological interactions, characterized by a complex network structure that supports high species richness. These results underscore the importance of considering ecological discontinuities and habitat-specific processes in the management and conservation of connected aquatic ecosystems, particularly in transitional environments like estuaries that are subject to rapid environmental changes.



河流河口近海连续生境中的隐藻群落多样性和构建机制概念图
Fig. Conceptual diagram of cryptophyte diversity and assembly mechanisms in the river-estuary-coast continuum

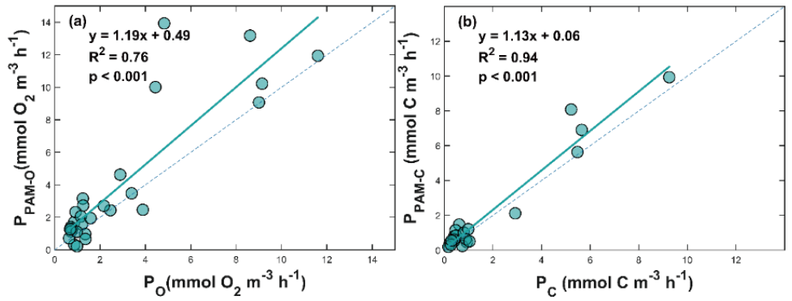
以上工作于2025年2月发表于*Ecological Indicators*期刊，2019级博士生王昌运为论文第一作者，肖武鹏副教授为通讯作者。

Reference:
Wang Changyun, Yao Liu, Zhuyin Tong, Shujie Cai, Yichong Wang, Nengwang Chen, Bangqin Huang, Wupeng Xiao*, Cryptophyte diversity and assembly mechanisms reveal ecological discontinuities in a river-estuary-coast continuum. *Ecological Indicators* 2025, 171: 113114. doi:10.1016/j.ecolind.2025.113114

通过脉冲振幅调制与培养法相结合估算浮游植物初级生产力

Estimating Phytoplankton Primary Production by Coupling Pulse Amplitude Modulation and Incubation Methods

浮游植物初级生产力是水生生态系统核心指标，传统测定方法与遥感技术在河口、海湾复杂水体中存在局限。本研究建立基于脉冲振幅调制（PAM）快速光曲线的初级生产力估算新方法，耦合周日变化叶绿素与盐度推算的可变光合熵，提升了估算结果的可靠性与准确性。利用该方法，揭示了两处典型河口—海湾水域浮游植物初级生产力的时空分布特征与季节变化规律。该方法提升了时空分辨率与适用性，为小尺度水域生态系统评估、保护及碳循环研究提供支撑。



基于脉冲振幅调制估算的初级生产与黑白瓶氧释放速率（a）和碳固定速率（b）的关系

The relationship between pulse amplitude modulation-derived primary production and oxygen release rates (a) and carbon fixation rates (b)

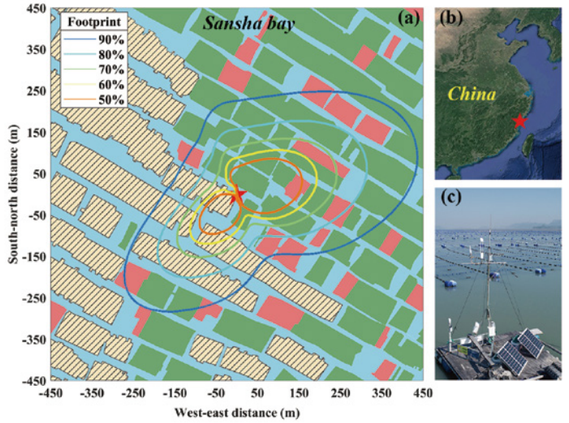
Phytoplankton primary productivity is a core indicator of aquatic ecosystems. Traditional measurement methods and remote sensing techniques have limitations in complex estuarine and bay waters. This study established a new method for estimating primary productivity based on rapid light curves derived from pulse amplitude modulation (PAM) fluorometry, by incorporating diel variations in chlorophyll and the variable photosynthetic quotient estimated from salinity, thereby improving the reliability and accuracy of estimations. Using this method, we revealed the spatiotemporal distribution characteristics and seasonal variation patterns of phytoplankton primary productivity in two typical estuary-bay systems. The proposed method enhances spatiotemporal resolution and applicability, providing support for the evaluation, protection of small-scale aquatic ecosystems and relevant carbon cycle research.

以上工作于2025年2月发表于*Limnology and Oceanography: Methods*期刊，2023级博士生王义冲为第一作者，肖武鹏副教授和陈纪新高级工程师为共同通讯作者。

Reference:
Yichong Wang, Wupeng Xiao*, Chengwen Xue, Yaqin Zhang, Chao Xu, Weinan Li, and Mingwang Xiang, Yang Chun; Chen Jixin*; Huang Bangqin. 2025. Estimating phytoplankton primary production by coupling pulse amplitude modulation and incubation methods. *Limnology and Oceanography: Methods* 2025, 23(4): 293-308. doi: 10.1002/lom3.10678

原位高频连续观测揭示大型海藻养殖区甲烷通量特征

Methane Emission Intensifies the Warming Effect of Carbon Dioxide Efflux from a Subtropical Coastal Macroalgae Aquaculture Ecosystem



大型海藻养殖区水气界面温室气体通量原位高频连续观测：通量观测区（a）、地理位置（b）及通量塔观测配置（c）

The Eddy Covariance Flux Tower (Red Star) Was Deployed over the Macroalgae Aquaculture Area Overlaid by the Flux Footprint Climatology (a) in a Subtropical Enclosed Bay in Southeast China (b). The Tower Was Fixed to a Large Fish Raft to Reduce Potential Swaying Issue (c).

以上工作于2025年12月发表于*Limnology and Oceanography*期刊，2025级博士生邓月婷为第一作者，朱旭东教授为通讯作者。

Reference:
Yueting Deng, Xianghui Guo, Dengjin Hu, Hui Luo, Yougan Chen, Xudong Zhu*. Methane emission intensifies the warming effect of carbon dioxide efflux from a subtropical coastal macroalgae aquaculture ecosystem. *Limnology and Oceanography* 2025, 71: e70293. doi: 10.1002/lno.70293

大型海藻养殖作为一种基于自然的气候解决方案已受到广泛关注，然而其生态系统CH_4排放常常被低估或者忽视。这主要受限于人力和观测条件，导致难以获得CH_4通量的原位连续观测数据。基于涡度相关法测定的全年逐半小时高频连续观测，该研究首次证实大型海藻养殖区CH_4排放加剧了CO_2排放所产生的增温效应。CH_4和CO_2通量所呈现的强时间变异及两者的非同步变化特征，也凸显了高频连续观测对于准确评估大型海藻养殖区温室气体源汇动态及净辐射效应的重要性。

Macroalgae aquaculture ecosystems have been increasingly recognized as coastal biogeochemical hotspots of air–sea net ecosystem carbon dioxide (CO_2) exchange; however, their roles in regulating the temporal variability of net ecosystem methane (CH_4) exchange (NME) receive little attention mainly due to very limited data availability. Here, we applied the eddy covariance (EC) technique to acquire 1-yr (June 2023 to May 2024) NME measurements, over a subtropical macroalgae aquaculture ecosystem in southeast China, to examine the temporal variability of NME across time scales and its contribution to net radiative forcing. The results indicated that (a) this ecosystem acted as a CH_4 source in most months with the summer accounting for about two-thirds of annual NME of 0.40 g C m^{-2} yr^{-1}; (b) the inclusion of annual NME increased the sustained-flux global warming potentials (SGWPs) by 11.0% from 219.3 (CO_2 only) to 243.4 g CO_2-eq. m^{-2} yr^{-1} for a 100-yr time horizon; (c) NME and its radiative contribution varied across seasons, farming periods, and growth stages, with the temporal fluctuations mainly controlled by temperature and tidal activities; (d) bimodal varying patterns across tidal levels were identified with larger fluxes occurring when tidal level changed most rapidly. This is the first EC study to confirm that CH_4 emission intensifies the warming effect of CO_2 efflux from macroalgae aquaculture ecosystems. The observed strong temporal variability of CH_4 and CO_2 fluxes and their asynchrony highlight the importance of high-frequency and continuous flux measurements in accurately assessing their net radiative forcing at both short- and long-term scales.

@ Qingxian Lin

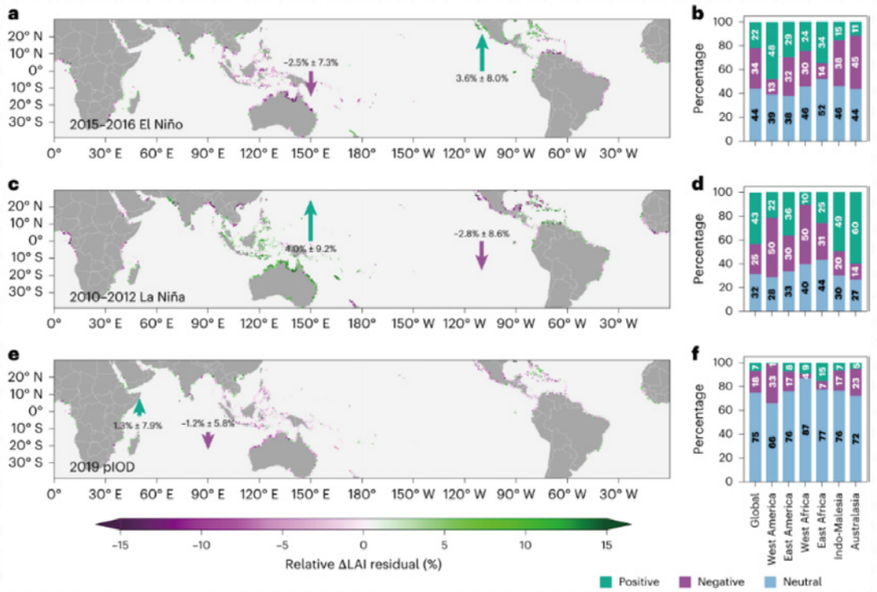
气候振荡引起的海平面波动驱动的全球红树林生长变异

Global Mangrove Growth Variability Driven by Climatic Oscillation–Induced Sea–Level Fluctuations

红树林生长于潮间带，对环境扰动极为敏感。气候振荡模式（如ENSO与IOD）通过降水、温度等对红树林生长产生影响，它们在全球尺度上如何影响红树林目前尚缺乏系统认知。

团队基于20年红树林叶面积指数与气候数据，揭示了红树林对ENSO/IOD事件的“跷跷板”响应模式。厄尔尼诺事件导致太平洋西岸红树林退化，东岸红树林生长；拉尼娜事件则相反。正IOD事件促进西印度洋西岸红树林生长、东岸红树林退化，但强度弱于ENSO。

The impact of Climatic oscillations like the El Niño–Southern Oscillation (ENSO) on mangrove growth at the global scale remains uncertain. Here, we used satellite observations across 20 years to show that more than 50% of global mangrove areas experience significant variations during ENSO events, exhibiting a seesaw-like pattern across the Pacific Basin where mangrove leaf area decreases in the western Pacific but increases in the eastern Pacific during El Niño, with the reverse occurring during La Niña. The Indian Ocean Dipole affects mangroves across the Indian Ocean similarly but with a lower magnitude relative to ENSO.



红树林在厄尔尼诺、拉尼娜和正向IOD时期的异常情况

Zonal Seesaw-Like Pattern of Mangrove LAI Anomaly Corresponding to Three Climate Oscillation Events.

以上工作在2025年5月发表于*Nature Geoscience*期刊，2023届博士张振为第一及共同通讯作者，李杨帆教授为共同通讯作者。

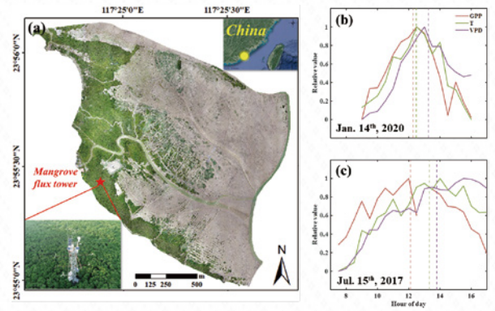
Reference:
Zhen Zhang*, Xiang Zhong Luo, Daniel A. Friess, Yangfan Li*. Global mangrove growth variability driven by climatic oscillation-induced sea-level fluctuations. *Nature Geoscience* 2025, 18: 488–494. doi: 10.1038/s41561-025-01701-8

大气干燥加剧了红树林碳水通量的解耦

Increasing Atmospheric Dryness Exacerbates Mangrove Carbon–Water Decoupling

红树林即便在生理性干旱胁迫下，也能通过节水型的水分利用方式维持高生产力。然而，这种独特的碳水关系在不同时间尺度上的变异性，目前仍缺乏深入研究。本研究基于七年的涡度相关观测数据发现，大气干燥度的上升会加剧红树林碳水通量的解耦，且其碳水通量的时滞效应对饱和水汽压差高度敏感。研究提出的红树林碳水通量时滞效应公式为未来气候变暖变干背景下红树林生态系统的碳水通量模拟与预测提供了科学支撑。

Mangroves maintain high productivity due to conservative water use, even under physiological drought stress. However, the temporal variability of this unique carbon-water relation across time scales remains less explored. Here, seven-year eddy covariance measurements were used to examine ecosystem-level gross primary productivity (GPP), transpiration (T), water use efficiency (WUE), and their environmental controls in a subtropical mangrove in China. We found mangrove WUE followed a U-shaped seasonal pattern (i.e., lower in summer) over years, while its diurnal pattern changed from a U-shaped one (i.e., lower at noon) in winter to a L-shaped one (i.e., low and stable in afternoon) in summer. Asynchronous GPP and T with higher morning WUE led to diurnal hysteresis or decoupling, the degree of which co-varied seasonally and annually with vapor pressure deficit (VPD). This diurnal hysteresis between GPP and T can be well reduced by applying a VPD-adjusted hysteresis formulation (i.e., $T \propto GPP \cdot VPD^{0.78}$). These results suggest increasing atmospheric dryness exacerbates mangrove carbon-water decoupling, with their diurnal hysteresis being highly sensitive to VPD. This study also proposes a validated diurnal hysteresis formulation of mangrove carbon-water relation, which helps to project mangrove carbon and water fluxes in future warmer and drier climate.



红树林涡度通量塔位置（a）以及总初级生产力（GPP）、蒸腾（T）和饱和水汽压差（VPD）的典型日间变化曲线：低日均VPD（b）和高日均VPD（c）

Landscape overview of the estuarine wetland in southeast China with the eddy covariance flux tower established within mangroves (a) and two typical diurnal cycles of daytime gross primary productivity (GPP), transpiration (T), and vapor pressure deficit (VPD) (b: low daytime-mean VPD and c: high daytime-mean VPD).

以上工作于2025年10月发表于*New Phytologist*期刊，2025届硕士生王相学为第一作者，朱旭东教授为共同通讯作者。

Reference:
Xiangxue Wang, Yueting Deng, Yanjie Liu, Nengwang Chen, Yougan Chen, Hui Luo, Lulu Song*, Xu Wang, Xudong Zhu*. Increasing atmospheric dryness exacerbates mangrove carbon-water decoupling. *New Phytologist* 2025, 249(1): 169-180. doi: 10.1111/nph.70693

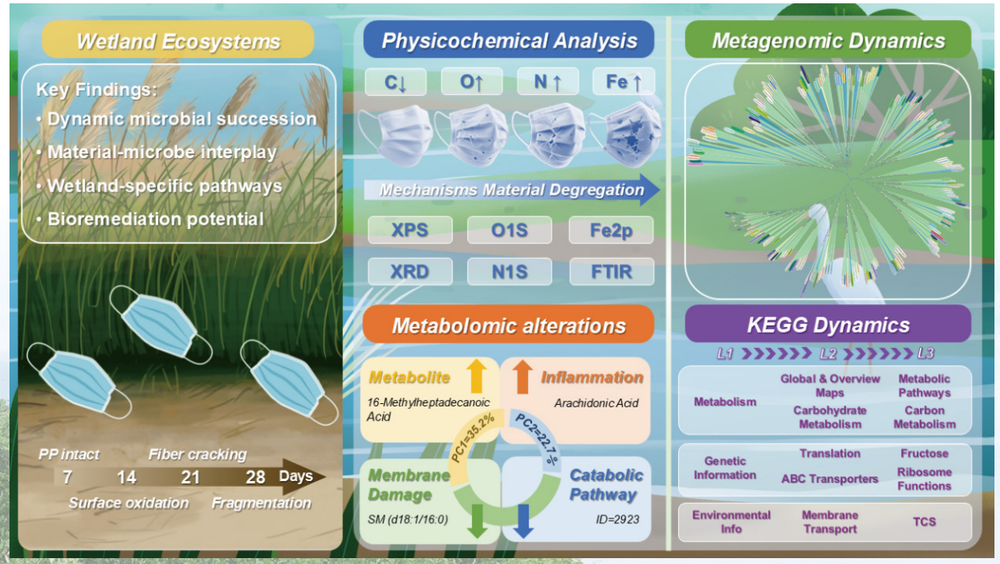
微生物演替动态驱动河口湿地网状微纤维转变：宏基因组与代谢组学揭示的氧化应激适应

Microbial Succession Dynamics Drive Mesh-Structured Microfibers Transformation in Estuarine Wetlands: Metagenomic and Metabolomic Evidence of Oxidative Stress Adaptation

聚丙烯网状微纤维（MS-MFs）因具有高孔隙率和大比表面积，表现出更强的污染物吸附能力和生态穿透性，已成为河口与沿海湿地中不可忽视的新型微塑料污染源。湿地生态系统具有潮汐驱动的氧化还原波动、丰富有机质以及活性金属离子富集等特征，为微塑料的环境老化和微生物定殖提供了独特条件。然而，目前对湿地环境中MS-MFs的环境归趋仍缺乏系统认识，尤其是微塑料理化转化过程如何与微生物群落演替、功能调控及代谢适应相互耦合尚不清楚。已有研究多将材料老化与微生物作用割裂开来，难以解释微塑料在湿地中呈现出的持续转化与高生态活性特征，因此亟需在真实环境条件下，从“材料－微生物－环境”整体视角揭示其协同演化机制。

本研究以河口红树林湿地为研究对象，依托福建台湾海峡海洋生态系统国家野外科学观测研究站开展聚丙烯网状微纤维原位暴露实验，系统追踪网状微纤维在自然潮汐条件下的环境转化过程。研究综合采用扫描电镜、XRD、FTIR和XPS等材料表征手段，解析微纤维形貌、结晶结构及表面化学特征的动态变化，并结合宏基因组学与非靶向代谢组学分析，揭示微生物定殖、金属催化氧化与聚合物老化之间的耦合关系，从而构建湿地环境中MS-MFs转化的整体过程框架。

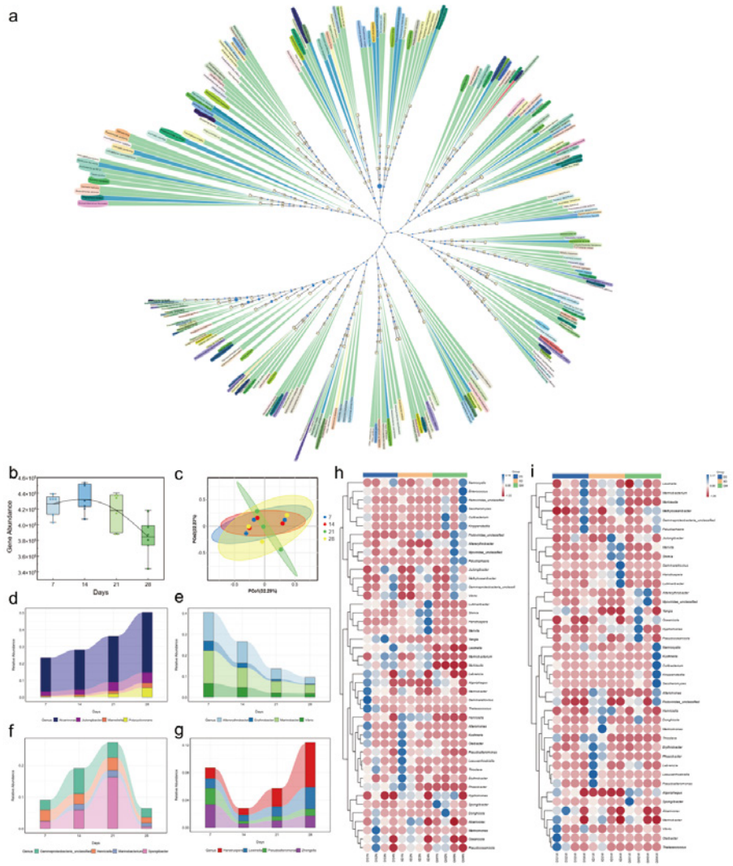
结果表明，网状微纤维在湿地环境中发生了显著的氧化老化和结晶度降低，并伴随铁元素富集诱导的类Fenton反应，从而加速聚合物链断裂和结构破碎。在此过程中，微生物群落由早期以烃降解为主的先锋类群逐渐演替为对氧化胁迫和金属环境更具适应性的功能型类群，生物膜形成和氧化还原相关代谢显著增强，同时出现以脂质代谢重塑为特征的代谢适应响应。非生物氧化过程与微生物活动相互促进，形成加速微塑料转化的正反馈机制。本研究从材料—微生物—环境协同作用角度揭示了湿地中微塑料转化的内在机制，为理解其长期环境行为及发展基于微生物过程的生态修复策略提供了重要理论支撑。



研究图片摘要

Graphic Abstract of This Research.

Mesh-structured microfibers (MS-MFs), with high surface area and strong ecological penetrability, are an emerging source of microplastic pollution in coastal wetlands. However, the coupled processes linking physicochemical aging of these microfibers with microbial succession and metabolic adaptation in wetland environments remain poorly understood. Here, an in situ exposure experiment was conducted in a mangrove-dominated estuarine wetland, integrating material characterization with metagenomic and metabolomic analyses to elucidate the environmental transformation of MS-MFs. The results revealed pronounced surface oxidation, reduced crystallinity, and iron-induced Fenton-like reactions that collectively accelerated polypropylene chain scission. Microbial communities exhibited clear successional dynamics, shifting from early hydrocarbon-degrading pioneers to taxa tolerant of oxidative stress and metal-enriched conditions, accompanied by functional enrichment in biofilm formation and redox-related metabolisms. Metabolomic profiling further indicated lipid remodeling, including upregulation of arachidonic acid and suppression of sphingolipid pathways, reflecting microbial adaptation to an oxidative microenvironment. These findings demonstrate a self-reinforcing feedback loop between abiotic oxidation and microbial activity that governs microfiber transformation in wetlands, providing new mechanistic insights into the environmental fate of microplastics and informing microbiome-driven remediation strategies in coastal ecosystems.



宏基因组揭示微生物群落时空动态

Spatiotemporal Dynamics of Microbial Communities Revealed by Metagenomic Profiling.

以上工作于2025年8月发表于*Chemical Engineering Journal*期刊，2024级硕士生雷一鸣为第一作者，洪华龙助理教授为通讯作者。

Reference:
Yiming Lei, Lujian Lin, Yue Ke, Xiaoting Zhang, Hanyi Li, Guanglong Zhang, Jingchun Liu, Haoliang Lu, Chongling Yan, Hualong Hong*. Microbial succession dynamics drive mesh-structured microfibers transformation in estuarine wetlands: Metagenomic and metabolomic evidence of oxidative stress adaptation. *Chemical Engineering Journal* 2025, 522: 167746. doi: 10.1016/j.cej.2025.167746

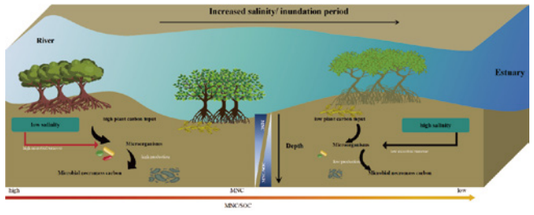
盐度与淹水驱动改变河口红树林湿地微生物残体碳分布模式

Salinity and Inundation Drivers Shift Microbial Necromass Carbon Distribution Patterns in Estuarine Mangrove Wetlands

红树林作为重要的蓝碳生态系统，其土壤碳长期稳定性对全球碳平衡至关重要。本研究围绕红树林湿地微生物残体碳（MNC）的积累机制展开，MNC是土壤有机碳（SOC）持久固存的关键载体。然而，海平面上升引起的盐度升高和淹水时间延长如何影响MNC的分布与积累，目前尚不清楚。因此，阐明其环境驱动机制，对于准确评估气候变化背景下蓝碳生态系统的固碳功能及制定有效保护策略具有迫切科学意义。

本研究选取福建省漳江口典型河口红树林湿地，沿盐度（7.4‰, 15.6‰, 21.2‰）和淹水时长（5, 7, 11, 13 h/d）梯度采集0－50cm土壤剖面样品。本研究采用基于氨基糖的生物标志物技术定量区分细菌与真菌残体碳，并计算MNC对SOC的贡献率。结合冗余分析（RDA）和偏最小二乘路径模型（PLS-PM）系统解析了MNC分布与多种环境因子（如盐度、淹水时长、总氮、土壤含水量、黏粒含量等）之间的驱动关系。

研究发现，红树林湿地MNC平均贡献了27.1%的SOC，且贡献率随土壤深度增加而上升（表土22.2－28.1%，底土24.3－36.5%），其中真菌残体碳是主要来源。本研究的核心突破在于明确了高盐度与长时间淹水是抑制MNC积累的关键胁迫因子，分别导致MNC含量下降达30.2%和28.6%。从机制上来看，盐度和淹水胁迫通过抑制微生物生物量、引发代谢转向以及改变土壤理化性质（如降低养分有效性、提高pH和土壤含水量）间接削弱MNC的累积。本研究系统揭示了海平面上升情景下红树林湿地微生物残体碳的响应规律，强调深层土壤碳库对水文化学变化的高度敏感性，为修正蓝碳模型、预测碳汇稳定性及优化红树林适应性管理提供了关键科学依据。



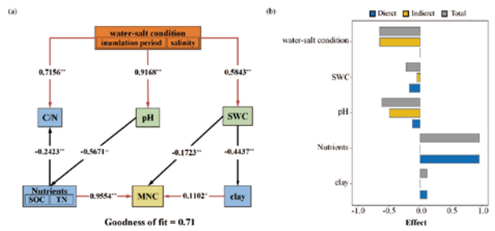
滨海红树林湿地MNC积累影响示例

Example of MNC Accumulation Effects in Coastal Mangrove Wetlands.

以上工作于2025年6月发表于*Geoderma*期刊，2023级硕士生郑琳柯为第一作者，卢豪良教授为共同通讯作者。

Reference:

Linke Zheng, Manlin Su, Xiaoting Zhang, Lei Wang, Hualong Hong, Qian Zhang, Lijuan Zhong*, Haoliang Lu*. Salinity and inundation drivers shift microbial necromass carbon distribution patterns in estuarine mangrove wetlands. *Geoderma* 2025, 460: 117413. doi: 10.1016/j. geoderma.2025.117413



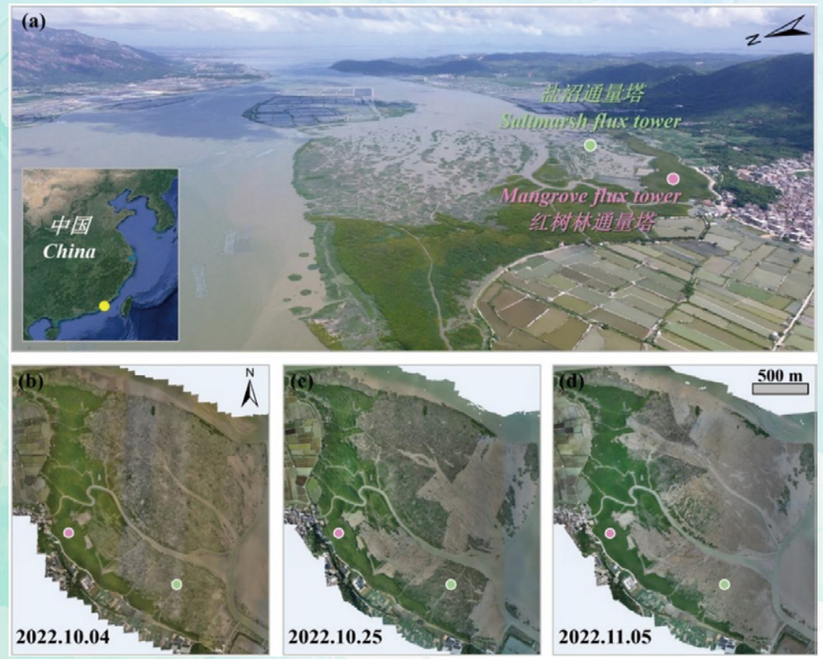
水盐条件和土壤特性对MNC含量影响的偏最小二乘法路径模型（PLS-PM）

Partial Least Squares Path Modeling (PLS-PM) for the Effects of Inundation Period and Soil Properties on MNC (Goodness of Fit = 0.71).

Microbial necromass carbon (MNC) plays an important role in the long-term preservation of soil organic carbon (SOC) in coastal wetlands. However, the impact of increased salinity and inundation due to sea-level rise on MNC remains unclear. Here, we established a gradient experiment with three salinity levels (7.4 ‰, 15.6 ‰, 21.2 ‰) and four inundation periods (5 h/d, 7 h/d, 11 h/d, 13 h/d) across six mangrove sampling sites to investigate vertical distribution patterns of MNC and the environmental factors influencing its dynamics. Depth-resolved analyses revealed distinct MNC distribution patterns, and the topsoil (0–20 cm) exhibited considerably higher MNC concentrations (4.6–8.2 mg g^{-1}) than the subsoil (3.0–5.4 mg g^{-1}, 40–50 cm), whereas the proportional contribution of MNC to SOC showed opposite trends (topsoil: 22.2 %–28.1 %; subsoil: 24.3 %–36.5 %). This inverse relationship suggests differential preservation mechanisms across soil depths. Different salinity and inundation periods induced pronounced responses. Under high salinity condition (21.2 ‰), MNC concentrations decreased by 30.2 % relative to those under low salinity conditions (7.4 ‰), and MNC/SOC showed a 13.6 % reduction. Prolonged inundation (13 h/d) further worsened these effects, leading to a 28.6 % decline in MNC relative to intermittent inundation (5 h/d). In addition, fungal necromass carbon (FNC) is the main component of MNC in coastal estuary mangrove wetlands. Redundancy analyses revealed that SOC, total nitrogen (TN), soil water content (SWC) and clay had a substantial impact on MNC. Elevated salinity and inundation period were identified as the main factors hindering MNC accumulation in mangrove sediments. Our research demonstrates that MNC is a crucial component of the soil carbon pool in mangroves, contributing 27.1 % of SOC. However, high salinity and prolonged inundation severely disrupt this carbon sequestration process, thereby suppressing MNC production by nearly 30 %. Additionally, sea-level rise and saltwater intrusion lead to the decomposition of recalcitrant carbon components and the loss of existing carbon pools.

滨海湿地“退草还林”生态修复的隐性气候成本

Coastal Restoration May Not Necessarily Enhance Blue Carbon Sink



通量塔所在研究区的低潮期无人机航拍图（a）以及呈现互花米草除治过程（2022年10月底开始）的三幅不同日期无人机航拍拼接图（b：除治前；c和d：除治中）

The location of flux towers shown with (a) an aerial photo and three successive orthophotos, mosaiced from unmanned aerial vehicle photos collected at low tide, (b) before and (c, d) during the first intensive removal of *S. alterniflora* occurring in late October of 2022.

通过清除互花米草并恢复红树林的“盐沼–光滩–红树林”生态修复，被认为是增强滨海湿地蓝碳碳汇功能的重要措施。研究发现采用挖填法清除互花米草会引发甲烷脉冲式排放，带来的气候债务至少需要30年才能还清，揭示了滨海湿地“退草还林”生态修复的隐性气候成本。

Large-scale restorations involve replacing *Spartina alterniflora* with mangroves, yet the full effects of such saltmarsh-mudflat-mangrove land-use change on the blue carbon sink are largely unknown. This study reveals that such restoration efforts through excavation and burial of *S. alterniflora* inadvertently cause pulse methane emission and a significant climate debt, potentially taking over three decades to offset. These findings highlight the potential risk of methane emission from coastal restoration in neutralizing blue carbon sink.

以上工作于2025年6月发表于*Geophysical Research Letters*期刊，朱旭东教授为第一兼共同通讯作者，戴民汉院士为共同通讯作者。

Reference:

Xudong Zhu*, Zhangcai Qin, Wenwen Liu, Matthew Kirwan, Haoliang Lu, Shing Yip Lee, Minhan Dai*. Coastal restoration may not necessarily enhance blue carbon sink. *Geophysical Research Letters* 2025, 52(11): e2025GL114614. doi: 10.1029/2025GL114614

量化河口有机碳来源：脂肪酸同位素模型揭示关键过程

Quantifying the Origins of Labile Estuarine Particulate Organic Matter of Varying Reactivity Using a Fatty Acid Isotope Model Based on a Genetic Algorithm

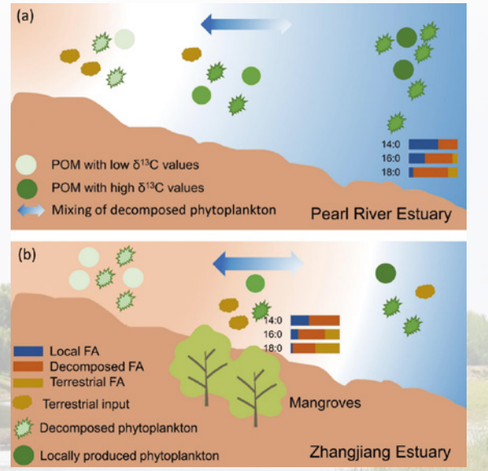
河口每年向近海输送超过2亿吨颗粒有机碳（POC），其中仅25%–50%能被封存在沉积物中，其余部分则通过降解重新释放到大气或海洋。这种选择性保存使河口有机碳的归宿受其来源与活性的双重调控。然而，相关研究面临两大挑战：一是不同来源有机碳的同位素范围重叠，传统稳定碳同位素方法难以精确区分；二是易降解化合物（如短链脂肪酸）的停留时间较短，放射性碳分析难以适用。此外，人类活动导致的土地利用变化、筑坝及农业活动等干扰，进一步加剧了河口碳收支的不确定性。

研究团队选取我国亚热带两个典型河口——珠江口和漳江口作为研究区域，创新性地建立了基于脂肪酸同位素质量平衡的活性模型，通过遗传算法优化参数，量化了三类不同来源的有机碳贡献：本地产生的浮游植物、分解的浮游植物以及陆地输入物质。结果表明，浮游植物及其分解产物对脂肪酸的贡献占比高达63%–99%，在珠江口下游等高生物量区域尤为突出。同时，陆地来源有机碳主要富集于河口上游及受红树林潮汐交换影响的区域，且红树林输出的有机碳具有更强的难降解性，利于长期封存。此外，研究证实了分解浮游植物的脂肪酸组成遵循一级分解反应动力学，为评估河口有机碳周转速率提供了新方法。研究指出，在人类活动干扰强烈的河口，浮游植物来源的易降解有机碳累积明显，易加剧海岸带缺氧风险、降低碳埋藏效率；而红树林输出的难降解有机碳则有助于增强海岸带碳封存能力。本研究为海岸带碳管理提供了重要科学支撑，表明平衡人类活动与生态保护是维持河口碳汇功能的关键。

以上工作于2025年9月发表于*Geochimica et Cosmochimica Acta*期刊，2024届博士生王腾腾为第一作者，唐甜甜副教授为通讯作者。

Reference:
Tengteng Wang, Han Zhang, Jiachen Li, Nengwang Chen, Lifang Wang, Wei-lei Wang, Jie Liu, Junhui Chen, Jiaheng Shen, Tiantian Tang*. Quantifying the origins of labile estuarine particulate organic matter of varying reactivity using a fatty acid isotope model based on a genetic algorithm. *Geochimica et Cosmochimica Acta* 2025, 410: 73-84. doi:10.1016/j.gca.2025.09.030

As a major link between oceanic and terrestrial carbon reservoirs, estuarine particulate organic matter (POM) exhibits highly dynamic molecular and isotope compositions due to intensive mixing and selective decomposition of compounds with a wide range of reactivity. It is thus challenging to quantitatively predict the geochemical fate of estuarine POM, particularly more labile compounds. In this study, we investigated the stable carbon isotope distribution of fatty acids in suspended particles from two subtropical estuaries in southeast China, the Pearl River Estuary and the Zhangjiang Estuary. Three major short-chain fatty acids, 14:0, 16:0, and 18:0 show progressive but varied increases in δ13C values along the estuaries as a response to the dissolved inorganic carbon δ13C gradient. Accordingly, a lability model using genetic algorithm parameter optimization was established based on the isotope mass balance of individual fatty acids, which quantified POM from three origins with distinctive molecular composition and isotopic values: locally produced phytoplankton, decomposed phytoplankton, and terrestrial materials. A dominant contribution of phytoplankton and its decomposed products ranging from 63 % to 99 % was found higher in regions with more phytoplankton biomass. Relatively higher terrestrial input was found in upstream estuaries as well as areas influenced by tidal exchange with mangroves. The modeled fatty acid composition of decomposed phytoplankton can be best described by a first-order decomposition reaction. Elevated labile POM from phytoplankton may exacerbate coastal hypoxia and reduce burial efficiency in areas with amplified anthropogenic perturbation, whereas more recalcitrant POM exported from mangroves favors long-term preservation in the adjacent coastal ocean.



脂肪酸活性模型揭示的珠江口 (a) 和漳江口 (b) 颗粒有机物来源与活性示意图

Schematic Diagram of the Source and Lability of POM in Pearl River Estuary (a) and Zhangjiang Estuary (b) as Implicated by Fatty Acid Lability Model.

一种用于模拟和升尺度的红树林碳生产力的机器学习框架（ML–MCP）

A Machine Learning Framework for Modeling and Upscaling Mangrove Carbon Productivity (ML–MCP)

全球变暖加剧了人们对碳中和的需求，红树林因其在碳汇和CO_2吸收中的关键作用而受到日益关注。尽管已开发出多种利用卫星数据估算红树林生态系统总初级生产力（GPP）的模型，但在每日碳吸收预测方面仍存在不确定性。红树林生态系统受环境梯度与胁迫因素影响，复杂性高，对精确模型预测构成挑战。由于涡度协方差（EC）通量塔分布稀疏且足迹有限，生成区域和全球网格化的GPP数据至关重要。机器学习（ML）方法为捕捉多种环境驱动因素与GPP之间的非线性相互作用提供了一个灵活、高精度的建模框架。

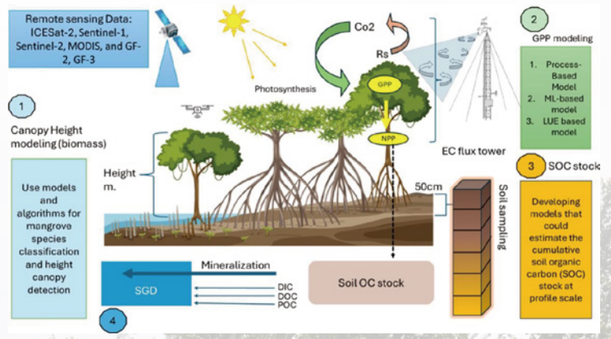
本研究引入了基于机器学习的红树林碳生产力（ML–MCP）模型，该模型集成了过程驱动和遥感方法，利用一系列遥感环境胁迫指标（如海水位SWL、昼夜温度范围DTR、盐度指数SI、蒸汽压赤字VPD、温度影响指数TI、冠层量子产量E0和光限制光合速率PI），旨在显著提高红树林GPP预测的准确性和空间可扩展性。

研究结果表明，需要采用针对特定区域的方法来有效模拟和管理红树林生态系统。改进数据收集（如土壤盐度观测、LAI数据）、纳入更多解释变量、采用更复杂的建模技术以捕捉环境因素与GPP之间复杂的非线性关系，对于提高预测精度、支持有效的红树林生态系统管理和气候适应战略至关重要。机器学习模型与多源数据（遥感、再分析、实地观测）的结合，为在全球尺度上估算和升尺度红树林碳生产力提供了一个强大而灵活的框架。

以上工作于2025年9月发表于*Agricultural and Forest Meteorology*期刊，博士后Karam Alsafadi为第一作者，曹文志教授为通讯作者。

Reference:
Karam Alsafadi*, Amit Kumar Srivastava, Krishnagopal Halder, Feifei Wang, Shengchang Yang, Wenzhi Cao*, A machine learning framework for modeling and upscaling mangrove carbon productivity (ML-MCP). *Agricultural and Forest Meteorology* 2025, 375: 110821. doi: 10.1016/j.agrformet.2025.110821

Global warming has intensified the pursuit of carbon neutrality, drawing increased attention to mangroves for their critical role in carbon sequestration and CO_2 uptake. Various models have been developed to estimate the Gross Primary Productivity (GPP) of mangrove ecosystems using satellite data; however, uncertainties persist in daily carbon uptake predictions. This study addresses this gap by introducing the Machine Learning-based Mangroves Carbon Production (ML-MCP) model, which integrates process-driven and remote sensing-based approaches. Among the tested machine learning models, XGBoost performed the best, achieving an R^2 of 0.67 across four sites and 0.78 at the Fujian Zhangjiangkou Mangrove Nature Reserve. However, the complexity of mangrove ecosystems—shaped by environmental gradients and stressors—poses challenges for accurate model predictions. SHapley Additive exPlanations (SHAP) analysis identified the light-limited photosynthetic rate (PI) as the most critical factor influencing GPP, while the soil salinity index (SI) also played a significant role when data was aggregated. Additionally, temperature index (TI) emerged as the second most important factor affecting GPP at the SKR-US and ZJ-CN sites. These findings highlight the necessity of adopting context-specific approaches for effective ecosystem management. While machine learning models show great potential for predicting GPP, the unique challenges of mangrove ecosystems call for enhanced data collection, specialized modeling techniques, and a deeper understanding of mangrove-specific processes to improve model performance in these vital coastal environments.



红树林碳通量的示意图，包括固存、储存和通过潮汐交换流入邻近沿海水域。该图还说明了观察和建模的方法，以及分析中使用的常见数据。缩写：EC =涡度相关；GPP =总初级生产量；NPP =净初级生产量；Rs =冠层呼吸；DIC =溶解无机碳；DOC =溶解性有机碳；POC =颗粒有机碳；SGD =海底地下水排泄量

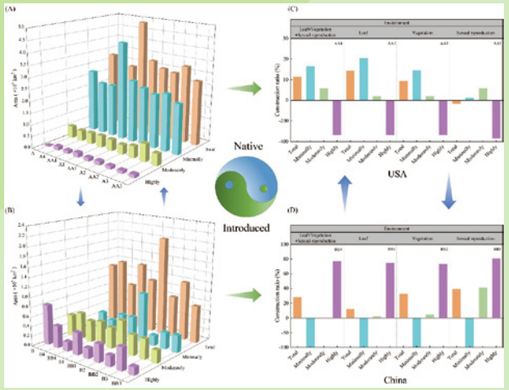
Schematic Representation of Mangrove Carbon Fluxes, Including Sequestration, Stock, and Outwelling into Adjacent Coastal Waters via Tidal Exchanges. The Figure Also Illustrates the Methodology of Observation and Modeling, as Well as Common Data Used in the Analysis. Abbreviations: EC, Eddy Covariance; GPP, Gross Primary Production; NPP, Net Primary Production; Rs, Canopy Respiration; DIC, Dissolved Inorganic Carbon; DOC, Dissolved Organic Carbon; POC, Particulate Organic Carbon; SGD, Submarine Groundwater Discharge.

From Native Habitats to Invasion Frontiers: Understanding Spatial Niches of Invasive Plants Through Functional Traits

Functional traits that affect plant performance and adaptation strategies are critical for shaping the distribution of invasive plants under global change. However, quantitative assessments of functional traits on spatial niche predictions are still lacking. In this study, we aimed to understand how functional traits alter the distribution of invasive plants across native and introduced ranges. We developed a new integrated framework using structural equations and ecological niche models to determine the causal relationships among plant functional traits in the field, presence distribution data, and environmental variables. This framework was used to predict the latitudinal distribution and spatial dynamics of *Spartina alterniflora* Loisel across its native (USA) and introduced (China) ranges. We found that functional traits were variable and remarkably altered the distribution of *S. alterniflora*, especially in mid- and low-latitudes of China. Furthermore, leaf, vegetative, and sexual reproductive traits had different effects on the distribution of *S. alterniflora*, with approximately –2% to 15% and 10% to 40% of the distribution areas influenced by functional traits in the native and introduced ranges, respectively. Notably, sexual reproductive traits affected plant distribution more than leaf and vegetative traits. Additionally, hump-shaped relationships were observed between habitat suitability and most of the functional traits, thus demonstrating that moderately suitable areas had better plant performance. These findings suggest that plant functional traits influence the prediction of species distribution and thus need to be accounted for when performing niche modelling of invasive species. Furthermore, we suggest that global change may threaten the habitat in the native range but will improve the spatial niche of species in the introduced range. This study highlights the focus areas for conservation and prevention efforts.

从原产地到入侵地：基于植物功能性状来理解入侵植物生态位

植物功能性状对于全球变化下入侵植物的分布格局形成至关重要。然而，目前仍缺乏关于功能性状如何影响空间生态位预测的定量评估。本研究旨在探究功能性状如何改变入侵植物在原生地与入侵地的分布。我们构建了一个结合结构方程模型与生态位模型的新框架，用以厘清野外实测植物功能性状、物种分布数据与环境变量之间的因果关系。该框架被应用于预测互花米草（*Spartina alterniflora* Loisel）在其原产地（美国）与入侵地（中国）的纬度分布及空间动态。研究发现，功能性状显著改变了互花米草的分布，尤其是在入侵地的中低纬度地区。此外，叶片性状、营养性状和有性繁殖性状对互花米草分布的影响各异：在原产地与入侵地，分别约有1%–15%及10%–40%的分布区域受到功能性状的影响。值得注意的是，有性繁殖性状对植物分布的影响大于叶片和营养性状。同时，大多数功能性状与栖息地适宜性之间呈现驼峰型关系，表明中等适宜性区域入侵植物表现更佳。这些结果表明，植物功能性状影响物种分布预测，在构建入侵物种的生态位模型时需予以考虑。



互花米草在原产地与入侵地的分布面积及其变化动态。（A、B）不同模型条件下原生与引种范围内的分布面积。（C、D）与仅包含环境变量的模型结果相比，原生与引种范围内构建分布区面积的占比情况。

Distribution areas and change dynamics in the native and introduced ranges for *S. alterniflora.* (A, B) Distribution area in native and introduced ranges under different modelling conditions. (C, D) Proportion of constructed distribution areas in native and introduced ranges when compared with that in modelling involving only environmental variables.

以上工作于2025年4月发表于*Journal of Biogeography*期刊，2023级博士生何平为第一作者，刘文文教授为通讯作者。

Reference:

Ping He, Renping Jiang, Wenwen Liu*, Jingke Ye, Guanxiong Huang, Hao Wu, Yihui Zhang. From Native Habitats to Invasion Frontiers: Understanding Spatial Niches of Invasive Plants Through Functional Traits. *Journal of Biogeography* 2025, 52(7): e15145. doi: 10.1111/jbi.15145

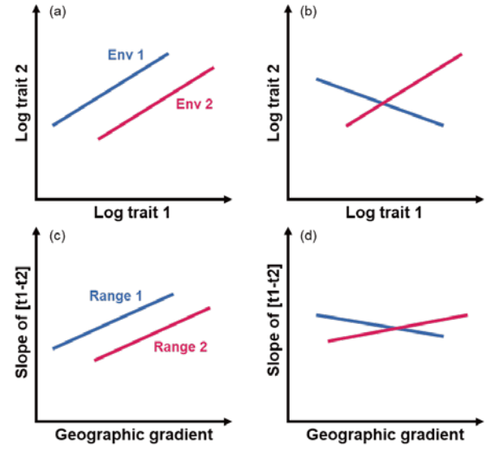
盐沼入侵植物在其入侵地和原产地维持稳定的异速生长关系

Stable Allometry Between Invasive and Native Populations of a Global Invasive Plant Revealed by Allometric Relationships Comparison Among Multiple Traits

异速生长关系描述了植物不同器官或功能性状间的相对生长规律，可反映植物的形态发育轨迹和资源分配策略。入侵植物常因天敌释放或资源水平的变化而调整自身的资源分配策略，演化出更具竞争力的性状，但是，其性状变异是遵循稳定的异速生长轨迹（即仅由个体大小差异驱动），还是由异速生长关系的变异所导致，目前仍存在争议。因此，本研究以中国滨海湿地典型入侵植物互花米草为研究对象，通过在入侵地中国和原产地美国对其多个功能性状进行野外跨纬度种群调查，对比分析入侵地和原产地之间互花米草的异速生长关系、异速生长关系纬度变异格局及其驱动因子的差异。

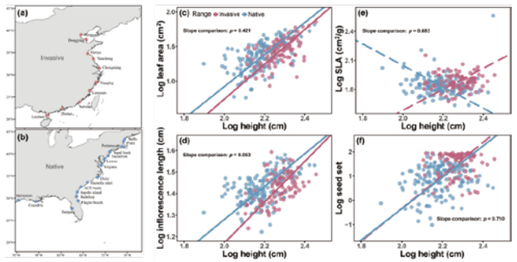
互花米草种群多个功能性状在入侵地和原产地具有相似的异速生长关系。异速生长关系表现出一定的纬度波动，且在两个地区呈现相似的线性纬度变异模式。然而，异速生长关系的地理变异在两个地区受不同环境因子驱动：叶片的异速发育在入侵地受潮差和盐度共同影响，较大潮差和盐度会增加叶面积的相对生长速率，但在原产地无此效应。这一发现强调了在研究入侵植物的性状变异和快速进化之前，优先解析其异速生长关系的重要性；同时表明，异速生长关系的地理预适应模式可能促进了外来植物在新地区的入侵和扩散。

The allometric relationships among plant traits designate the morphological developmental trajectories and resource allocation strategies of plants. Invasive plants can develop more competitive traits due to enemy release, occupying a wide range of latitudes, but it remains unclear whether these traits still follow the similar allometric trajectories and how allometry responds to environmental changes and contributes to invasion. Here we conducted field sampling of multiple traits to examine variations in the allometry of the salt marsh grass *Spartina alterniflora* across latitudes in the invasive (20–41° N) and native (27–43° N) ranges. We found that the invasive and native populations maintained similar allometric relationships among multiple traits. Furthermore, allometric relationships exhibited substantial latitudinal fluctuation, and neither significant latitudinal patterns nor differences of the patterns between ranges were observed. Notably, geographical variation in allometric relationships, particularly leaf development, were driven by different environmental factors in the two ranges. The size-dependance of leaf area was affected by tide range and salinity in the invasive range, with greater tide range and higher salinity enhancing the relative increase in leaf area with respect to plant size. These results indicate that stable plant allometry and its pre-adaptation pattern across latitudes may facilitate invasion in novel environments.



异速生长关系在不同环境下的稳定性或变异，及其在不同分布区间沿地理梯度变异格局。异速生长关系的斜率是研究中广泛关注的核心参数

Stability or Variation of Allometric Relationship in Response to Environmental Change and the Variation Patterns Across Geographic Gradients Within Different Distribution Ranges. Slope of Allometric Relationship Is the Primary Parameter of Interest in Studies.



入侵地和原产地跨纬度采样位置及互花米草稳定的多性状间异速生长关系

Sampling Locations Across Latitudes in the Invasive and Native Ranges, Along With Stable Allometric Relationships Among Multiple Traits of *Spartina alterniflora.*

以上工作于2025年7月发表于*Biological Invasions*期刊，2025级博士生姜仁平为第一作者，刘文文教授、张宜辉教授为通讯作者。

Reference:

Renping Jiang, Ping He, Jingyang Cheng, Hao Wu, Wenwen Liu*, Yihui Zhang*. Stable allometry between invasive and native populations of a global invasive plant revealed by allometric relationships comparison among multiple traits. *Biological Invasions* 2025, 27(8): 176. doi: 10.1007/s10530-025-03634-0

红树林等面叶高生产力形成的分子基础

Molecular Foundation Underlying the Formation of Highly Productive Isobilateral Leaves in Mangroves

红树林是重要蓝碳生态系统，其高生产力机制尚未明晰，等面叶是红树植物适应潮间带高光环境的关键性状，但该叶片形成的分子调控机制仍待解析。本研究以无瓣海桑（等面叶）和白骨壤（异面叶）为研究对象，结合解剖学、转录组、比较基因组学等技术，解析红树林等面叶形成的分子基础。

研究发现等面叶红树光合效率显著更高，其形成受生长素、赤霉素、油菜素内酯协同调控，生长素合成与转运基因显著上调；叶背腹极性基因中，近轴端身份基因高表达、叶边界识别基因 LEUNIG 下调，导致栅栏组织双侧分布。同时鉴定到 Indole-3-acetic acid carboxylmethyltransferase1（IAMT1）基因存在氨基酸收敛替换，其启动子区存在赤霉素响应元件特化，是等面叶形成的关键基因。

本研究揭示了红树植物等面叶形成的激素调控与基因调控网络，首次发现 IAMT1 基因的序列和调控区特化参与该过程，为解析红树林高光适应机制和蓝碳积累的分子基础提供新见解，也为植物叶型演化研究提供了典型案例。

Photosynthesis in mangroves contributes to one of the most carbon-rich ecosystems on Earth and plays a significant role in mitigating global climate change. However, the mechanisms underlying the high productivity of mangroves remain largely unexplored. Through anatomical analyses, we found that mangrove species with higher biomass production, such as *Sonneratia apetala,* exhibit isobilateral leaves, which enhance light harvesting and reduce light inhibition, resulting in higher photosynthetic yields. Ranscriptomic and genomic analyses revealed the molecular processes underlying the formation of isobilateral leaves. We found that auxin is rapidly synthesized and works in coordination with gibberellin and brassinosteroid in the isobilateral leaves of *S. apetala.* Interestingly, we identified a group of genes related to adaxial-abaxial leaf polarity in *S. apetale,* with upregulated genes associated with chlorophyll synthesis, adaxial cell identity and erect leaf growth, while genes related to the recognition of adaxial cell boundaries-possibly related to the lower palisade tissues-were down regulated. Additionally, we identified amino acid substitutions and changes in promoter sics-acting elements in *Indole-3-acetic acid carboxy/methyltransferase 1* (AMT1) in *Someratie* species. These findings provide new insights into the formation of isobilateral leaves in mangroves and their adaptation to intertidal high-light coastal conditions.

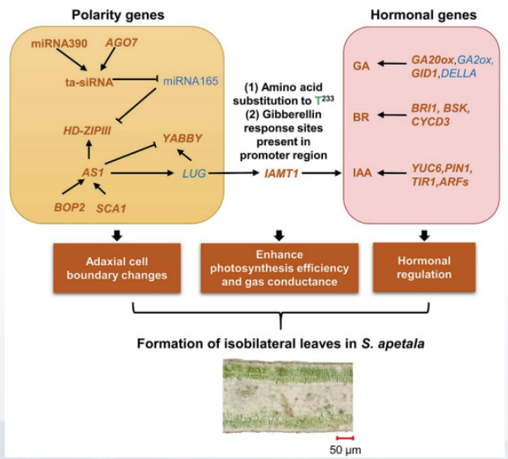


图. 无瓣海桑等面叶形成机制的作用模型

粗体（红色）和常规字体（蓝色）的基因名称分别代表上调和下调的基因。GA，赤霉素；BR，油菜素内酯；IAA，生长素。此外，IAMT1 基因还表现出收敛性氨基酸替换以及启动子区域的特异性改变

Figure. Working model of the isobilateral leaf formation in *S. apetala.*

Gene names in bold font (red) and regular font (blue) figure at up- and down-regulated genes, respectively. GA, gibberellin; BR, brassinosteroid; IAA, auxin. Additionally, IAMT1 also showed convergent amino acid substitution and specific promoter region changes.

以上工作于2025年7月发表于*Tree Physiology*期刊，2024届博士生殷俊杰、2023届硕士生李晓和2022届博士生顾肖璇为共同第一作者，陈鹭真和李庆顺教授为共同通讯作者。

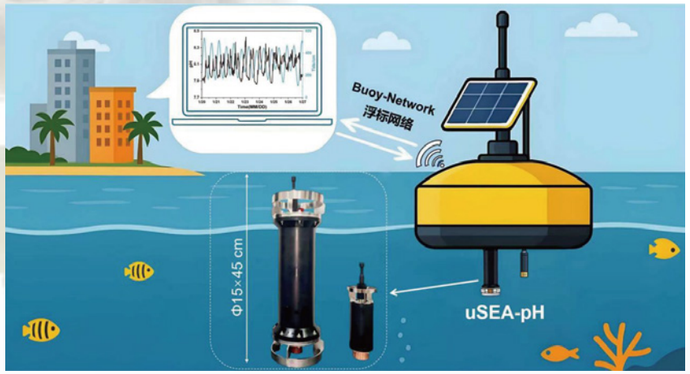
Reference:
Junjie Yin#, Xiao Li#, Xiaoxuan Gu#, Saiqi Hao, Jingding Dai, Luzhen Chen*, Qingshun Q Li*. Molecular foundation underlying the formation of highly productive isobilateral leaves in mangroves. *Tree Physiology*, 2025, 45: tpaf074. doi:10.1093/treephys/tpaf074

自主研发pH传感器：实现河口近岸海域酸化实时高频监测

An Autonomous pH Sensor for Real-Time High-Frequency Monitoring of Ocean Acidification in Estuarine and Coastal Areas

原位pH传感技术是海洋酸化监测与碳循环机制研究的关键支撑。本研究基于ISFET研发的uSEA-pH传感器，具有响应快、精度高、支持高频采样、适配多平台等特点。经高频走航监测与长期原位观测验证，uSEA-pH成功捕捉了水体pH的细微变化，获超230万条数据，为河口海岸连续高分辨率pH测定提供可靠技术方案。

In situ pH sensing is crucial for real-time ocean acidification monitoring and carbon cycle research. This study developed the uSEA-pH sensor based on ISFET, featuring rapid response, high precision, supporting high-frequency sampling, and multi-platform compatibility. Through high-frequency underway monitoring and in situ deployments, uSEA-pH successfully detected subtle pH variations, generating over 2.3 million field measurements. This study presents a viable, robust, and high-resolution approach for continuous pH monitoring in estuarine and coastal areas.



uSEA-pH双构型设计及其在近岸浮标实时监测中的应用

Dual-Configuration Design of uSEA-pH and Its Application in Real-Time Coastal Buoy Monitoring.

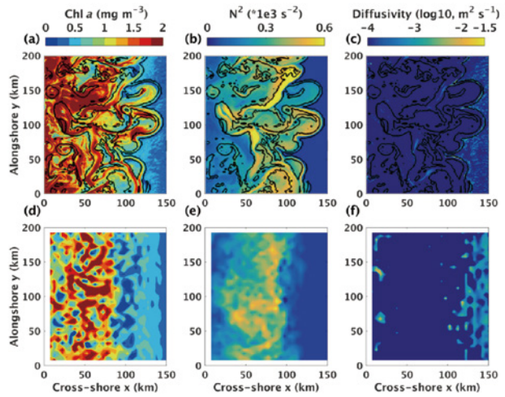
以上工作于2025年12月发表于*Analytical Chemistry*期刊，2023级博士生郑书露和2025级博士生杨帆为共同第一作者，马剑教授为通讯作者。

Reference:
Zheng, Shulu#; Yang, Fan#; Huang, Shikun; Li, Hangqian; Chen, Zhaoying; Zhu, Ming; Yao, Hongming; Li, Jianping; Ma, Jian*. An autonomous pH sensor for real-time high-frequency monitoring of ocean acidification in estuarine and coastal areas. *Analytical Chemistry* 2025, 97(49): 27113–27121. doi: 10.1021/acs.analchem.5c04323

斜压不稳定在富营养化海域触发水华的亚中尺度动力机制

Baroclinic Instability–Induced Intensification of Phytoplankton Blooms at Submesoscales in Eutrophic Frontal Regions

研究聚焦台湾海峡冬季离岸浮游植物水华现象，基于该区域卫星观测与现场航资料，系统解析了斜压不稳定在富营养化海域触发水华的多尺度动力机制。通过构建ROMS物理–生物耦合模型并进行系列敏感性实验，研究量化比较了亚中尺度与中尺度BCI对水华强度的差异化贡献。三维细网格模拟（水平分辨率0.5km）结果表明，当冬季东北风驱动的下风风应力于第35天松弛后，空间尺度约3公里的亚中尺度BCI通过高效的次级环流再层化作用，显著提升上层10米水体的稳定性，湍流扩散系数提前1–2天降至临界阈值（约$10^{-4}m^2s^{-1}$）以下，有效将浮游植物细胞滞留于光照充足层，驱动叶绿素a浓度峰值达2.0mg/m³，水华范围延伸至离岸140公里。相比之下，空间尺度约20公里的中尺度BCI因再层化效率较低，致使其控制区域的Chl a浓度较亚中尺度锋面区低约20%。二维实验通过抑制沿锋方向变化完全移除BCI效应，证实无BCI时水体层结无法有效建立，湍流扩散始终高于临界值，水华无法触发。研究同时评估了对称不稳定与潮汐强迫的作用：对称不稳定虽在持续风期产生垂直运动，但其再层化效应短暂且有限；潮汐虽能增强锋面强度，但对水华总体强度影响不显著。综上，亚中尺度BCI是富营养化近海水华空间异质性形成与强度增强的核心动力机制，其塑造的斑块状生产力格局不仅使浮游植物生物量净增一倍，更通过调控光合作用效率、有机碳输出路径及浮游动物摄食模式，深刻影响食物网结构与碳循环过程，为全球海洋生态模型中亚中尺度过程的参数化改进提供了重要的理论依据。



第42天，三维高分辨率模拟（上图）与粗分辨率模拟（下图）中上层10米平均叶绿素浓度（a, d）、浮力频率（b, e）及湍流扩散系数（c, f）的水平分布

Horizontal Distributions of Upper 10 m Averaged Chlorophyll-a Concentration (a, d), Buoyancy Frequency (b, e), and Turbulent Diffusion Coefficient (c, f) on Day 42 in High-Resolution (Upper Panel) and Coarse-Resolution (Lower Panel) 3D Simulations.

Off-coast phytoplankton blooms occur frequently in the frontal region of the eutrophic Taiwan Strait during the northeasterly monsoon relaxation period, as consistently revealed by extensive cruise and satellite observations. Realistic model simulations have shown that restratification by frontal baroclinic instability (BCI) plays a crucial role in triggering blooms under nutrient-rich conditions. This study deciphered the distinct contributions of submesoscale and mesoscale BCIs to bloom development using sensitivity tests of an idealized model of the Taiwan Strait featuring an intense alongshore front with ample nutrients. In three-dimensional fine simulations with both submesoscale and mesoscale BCIs present, blooms were triggered by the cessation of a down front wind. Chlorophyll a was higher in submesoscale front regions than in mesoscale regions, primarily because of the higher upper-ocean stability resulting from more effective restratification by submesoscale BCI. In three-dimensional coarse simulations, mesoscale BCI led to relatively lower upper-ocean stability and weaker blooms following wind relaxation, consistent with those in mesoscale regions in corresponding three-dimensional fine simulations. In two-dimensional simulations without submesoscale and mesoscale BCIs, blooms could not be triggered despite the cessation of a down-front wind, primarily because of the absence of significant near-surface restratification by BCIs. Furthermore, although symmetric instability was present in two dimensional fine simulations, its contribution to blooms was limited because of its minimal restratification effect. These results show that BCIs play the predominant role in triggering off-coast blooms in eutrophic coastal front regions such as the Taiwan Strait.

以上工作于2025年5月发表于*Limnology and Oceanography*期刊，博士后赵中华为第一作者，蔡锋、江毓武为共同通讯作者。

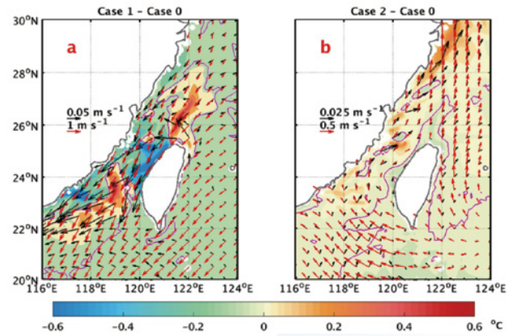
Reference:
Zhonghua Zhao, Lie-Yauw Oey, Zhaoyun Chen, Bangqin Huang, Huijie Xue, Shuh-Ji Kao, Feng Cai*, and Yuwu Jiang*. Baroclinic instability-induced intensification of phytoplankton blooms at submesoscales in eutrophic frontal regions. *Limnology and Oceanography* 2025, 70: 925–940. doi: 10.1002/lno.12816

太平洋年代际振荡对台湾海峡极端寒冷事件频率的影响

Impact of Pacific Decadal Oscillation on the Extremely Cold Event Frequency in the Taiwan Strait

本研究聚焦台湾海峡冬季极端冷事件频发及其对珊瑚礁生态系统和渔业资源（如高经济价值的鲳鱼）的严重威胁，揭示了太平洋年代际振荡（PDO）通过调制厄尔尼诺–南方涛动（ENSO）影响区域海气耦合过程的关键机制。基于1982–2017年高分辨率海表温度和风场（CCMP）数据，结合1948–2017年NCEP再分析资料，采用奇异值分解（SVD）方法系统解析了台湾海峡SST与风场的时空协变特征，并通过ROMS数值模式开展敏感性实验验证物理机制。研究发现，极端冷事件（SST降至14℃）并非仅由ENSO独立驱动，而是取决于La Niña与PDO的特定相位组合：当强La Niña（Niño3.4指数<–1.5℃）发生在负PDO相位时，东亚低层气旋式环流显著增强，通过强化东北季风驱动中国沿岸流输送大量冷水南下，直接威胁澎湖岛附近珊瑚礁区；相反，在正PDO相位下，阿留申低压南移占据整个北太平洋，抑制了ENSO影响向中纬度传播，导致La Niña对台湾海峡风场影响微弱，难以形成冷事件。SVD分析识别出两个主导模态：模态1（方差贡献率SST占16.08%、风场占60.35%）呈现ENSO调控的沿岸风–SST偶极子结构，模态2（SST占34.93%、风场占15.30%）反映PDO主导的跨海峡风场与大尺度SST同步变化。回归分析进一步揭示PDO的时空调制机制——在正PDO相位，ENSO相关的反气旋/气旋异常限缩于30°N以南，北太平洋海平面压强（SLP）呈南北偶极型，通过阻碍副热带环流导致台湾海峡大尺度降温；负PDO相位下，ENSO异常北扩至45°N，风场呈现更强的沿岸分量，显著增强中国沿岸流。敏感性实验证实，模态1为局地过程，东北风增强直接降低海峡SST；模态2为非局地过程，跨海峡风无法独立驱动SST变化，实际受PDO与ENSO共同调控。基于该机制，研究提出以前一年12月Niño3.4指数<–1.5℃且限于负PDO相位作为1–2月极端冷事件的预测判据，成功回测1974–2017年间5次生态灾害事件（1974、1976、2000、2008、2011），并排除了1985、1989、1999等强La Niña但因正PDO相位未引发冷事件的情形。研究深化了对年代际–年际气候模态相互作用的理解，为台湾海峡的寒害事件预警提供可行框架。

The southern Taiwan Strait is inhabited by a large amount of coral reef, but experienced the largest sea surface temperature (SST) variability in winter along the China coast. The strait often suffers extremely cold event with an increasing fre quency in the recent decades. The SST falls as low as 14 °C during the extremely cold event which threatens the survival of coral reef and fish, the economically highly-prized grey mullet (Mugil cephalus L.) for example. The unclear relation ship between the local extremely cold event and large-scale climate variability (El Niño-Southern Oscillation, ENSO, and Pacific Decadal Oscillation, PDO) and growing global warming still confound our understanding and prediction of the extremely cold event. With the Singular Value Decomposition (SVD) method, we find that the ENSO and PDO could drive the cold event in a specific phase combination that is a strong La Niña in conjunction with a negative PDO phase. The strong La Niña can largely strengthen the local northeasterly wind through the low-level cyclone over East Asia and further intensify the China Coastal Current which transport large amount of cold water to the coral reef area in the Taiwan Strait. In the La Niña year of the negative PDO phase, the cyclone over East Asia is able to develop with weak influence from Aleutian Low which moves to the northeastern corner in the North Pacific Ocean. However, in the La Niña year of the positive PDO phase, the La Niña influence is suppressed to the tropical Pacific Ocean and only drive a weak influence on the local wind in the Taiwan Strait as the Aleutian Low occupies the entire North Pacific Ocean. This mechanism is validated by the numerical models and could well explain the increasing frequency of cold event in the recent decade.



奇异值分解模态验证的模型敏感性实验结果：SVD模态1（a）和SVD模态2（b）。颜色阴影、红色矢量和黑色矢量分别表示时间1月1日至1月15日（15天）平均海表温度、风场及表层流场相对于控制案例的差异值

Results of Model Sensitivity Experiments for Singular Value Decomposition Mode Validation: SVD Mode 1 (a) and SVD Mode 2 (b). Color Shading, Red Vectors, and Black Vectors Represent the Differences in the 15-Day Mean Sea Surface Temperature, Wind Field, and Surface Current Field from January 1 to January 15 Relative to the Control Run, Respectively.

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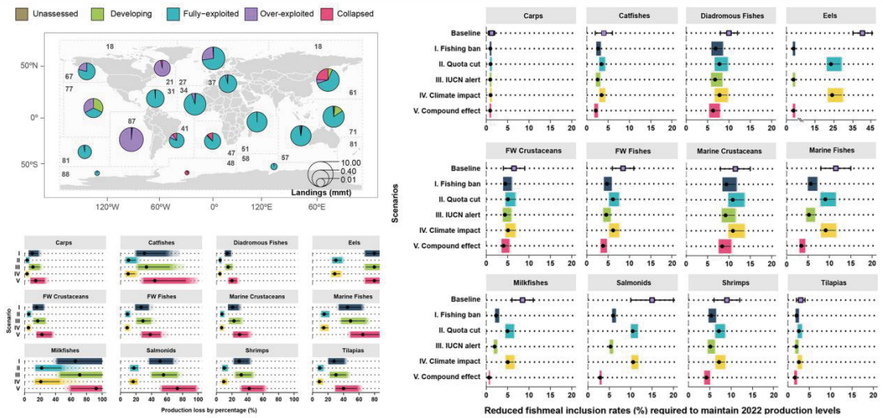
以上工作于2025年8月发表于*Climate Dynamics*期刊，2023届博士生张义敏为第一作者，江毓武、廖恩惠为共同通讯作者。

Reference:
Yimin Zhang, Yuwu Jiang*, Enhui Liao*, Wenfang Lu, Yaozhao Zhong, Haowei Sun, Xing Liu, Zhaoyun Wang, and Xiaoran Shi. Impact of Pacific decadal Oscillation on the extremely cold event frequency in the Taiwan Strait. *Climate Dynamics* 2025, 63: 9.

饵料鱼供给波动对全球投饲性养殖的影响评估与韧性提升路径

Unstable Supply and Future Shortages of Wild Forage Fish Heighten Risks to Global Fed Aquaculture Production

当前全球水产养殖业的快速发展，极大地依赖外源饲料供给，其中关键蛋白与脂肪来源鱼粉和鱼油主要提取自海洋捕捞的“饵料鱼”资源。统计数据显示，全球水生动物养殖产量中已有超过一半需要外源饲料支持。过度依赖这一单一来源不仅带来了资源消耗和生态风险，也使产业链暴露在供给侧的不稳定之中。以往研究大多集中于养殖需求的增长导致“饵料鱼”过度捕捞的问题，而较少关注气候变化、渔业管理政策调整、国际贸易波动等多重外源压力共同作用下，饵料鱼供给端出现系统性扰动所引发的连锁影响。鉴于此，本研究评估了全球主要饵料鱼种群状况，并建立短缺预测模型，从全球尺度量化了饲料供应链的脆弱性。结果显示，在未来环境变化及人类活动等多重压力叠加下，“饵料鱼”资源可能出现显著下降，这将直接冲击依赖鱼粉和鱼油的高价值养殖物种，如鲑鱼、鳗鱼等，其潜在减产幅度最高可达35%。若要维持现有养殖业的产量水平，全球每年需新增约180万吨可替代蛋白原料。该研究不仅揭示了水产饲料供应体系的结构性风险，也为推动饲料配方多元化、拓展植物蛋白等新型原料的开发提供了重要科学依据，对提升全球水产养殖产业的韧性与可持续发展提供了关键的科学依据。



饵料鱼供给波动对全球投饲性养殖的影响评估与韧性提升路径
Unstable Supply and Future Shortages of Wild Forage Fish Heighten Risks to Global Fed Aquaculture Production.

Over half of global aquatic animal production relies on external feed, with key ingredients like fishmeal and fish oil derived from wild-caught “forage fish.” While existing research has focused on over exploitation driven by aquaculture expansion, systematic assessments of how multiple external pressures disrupt forage fish supply and affect fed aquaculture remain lacking. This study evaluates global forage fish stocks and develops a shortage model to quantify, for the first time, the vulnerability of the feed supply chain at a global scale. Findings indicate that under combined pressures, future forage fish supply could decline substantially, leading to yield reductions of up to 35% for high-value species such as salmon and eel. Maintaining current production levels would require an additional 1.8 million tonnes of alternative ingredients annually. This research provides critical scientific support for advancing feed diversification and developing novel proteins to enhance the resilience of the aquaculture sector.

以上工作于2025年11月发表于*Nature Food*期刊，2024级博士后刘岳为第一作者，曹玲教授为通讯作者。

Reference:
Liu, Yue; Jiang, Ziyu; Cottrell, Richard Scott; Tlusty, Michael; Fitzsimmons, Kevin; Cao, Ling*. Unstable supply and future shortages of wild forage fish heighten risks to global fed aquaculture production. *Nature Food* 2025, 6(10), 1068–1078. doi: 10.1038/s43016-025-01254-4

低氧耐受与高温耐受之间的弱相关加剧了鲍对气候变化的敏感性

The Weak Association Between Hypoxia Tolerance and Thermal Tolerance Increases the Susceptibility of Abalone to Climate Change

自工业时代以来，人类活动导致的气候变化正在以史无前例的速度改变着海洋生态系统，包括全球变暖使得海水升温、热浪频率增加，以及全球变暖和富营养化废水过度排放使得全球开阔大洋和近岸海域溶解氧浓度降低。作为全球广泛养殖的海产经济贝类，鲍保留着许多腹足类祖先的形态和生理特征、对高温和低氧等环境胁迫非常敏感，其养殖业的可持续发展日益受到环境扰动的巨大挑战。研究鲍的低氧耐受能力、高温耐受能力及其关系对于在全球气候变化背景下预测鲍种群动态、发展养殖业至关重要。

本研究首先基于鲍附着能力（低氧吸附时长HYAD、高温吸附时长HAD）和心率变化指标（心率拐点溶解氧浓度BPDO、阿伦尼乌斯拐点温度ABT）等高通量精准测评方法，检测和比较了皱纹盘鲍（*Haliotis discus hannai*）的低氧耐受能力和高温耐受能力，发现其在个体水平上的低氧耐受能力和高温耐受能力之间相关性极弱（Spearman correlation, r = −0.09, *P* = 0.2069; Pearson correlation, r = −0.04, P = 0.3313）。进一步，基于全基因组重测序和全基因组关联分析（GWAS），共鉴定出与皱纹盘鲍低氧耐受能力显著相关的21个多核苷酸多态性（SNPs）和19个候选基因（如*cubn*、*lrp6*、*gria2*、*rft2*和*casp8*），而这些基因与高温耐受能力相关候选基因之间并不存在重合，进一步证实了皱纹盘鲍低氧耐受能力和高温耐受能力之间的弱相关性，这与以往认知大不相同。

以上研究结果强调，具有更强低氧耐受能力的皱纹盘鲍个体并不一定具有更强的高温耐受能力，在今后的养殖鲍综合抗逆育种工作中，要分别对两种性状进行选育。同时，全球变暖和低氧问题对鲍等水生动物的种群规模和遗传多样性造成的威胁可能比之前认为的更为严重，需要引起高度重视。

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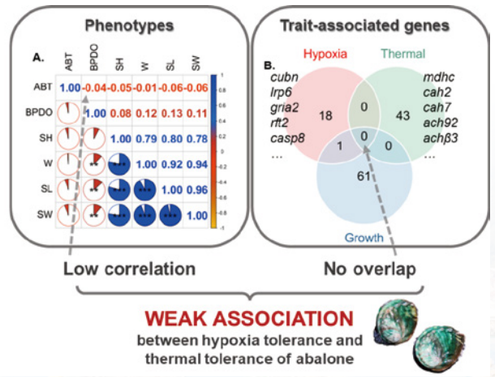
以上工作于2025年1月发表于*Environmental Research*期刊，博士后沈雅威为第一作者，柯才焕教授和陈楠副教授为通讯作者。

Reference:
Yawei Shen, Yue Dai, Feng Yu, Wenzhu Peng, Junyu Liu, Weiwei You, Xuan Luo, Caihuan Ke*, Nan Chen*. The weak association between hypoxia tolerance and thermal tolerance increases the susceptibility of abalone to climate change. *Environmental Research* 2025, *264:* 120324. doi: 10.1016/j.envres.2024.120324

The simultaneous occurrence of high temperatures and hypoxia events caused mass die-offs of aquatic animals. It is crucial to investigate the relationship between hypoxia tolerance and thermal tolerance of aquatic animals to predict the biological and ecological outcomes under global climate change scenarios. In this study, the hypoxia tolerance and thermal tolerance of Pacific abalone, *Haliotis discus hannai,* were measured by methods based on adhesion capacity (hypoxia adhesion duration and heat adhesion duration) and heart rate fluctuations (breakpoint of dissolved oxygen and Arrhenius breakpoint temperature). Weak correlations were found between hypoxia tolerance and thermal tolerance (Spearman correlation, r = -0.09, P = 0.2069; Pearson correlation, r = -0.04, *P* = 0.3313). Furthermore, a total of 21 significant SNPs and 19 candidate genes (*such as cubn, lrp6, gria2, rft2,* and *casp8*) were identified to be associated with hypoxia tolerance of Pacific abalone by conducting whole genome resequencing and genome-wide association study (GWAS). But there was no overlap between candidate genes associated with hypoxia tolerance and candidate genes associated with thermal tolerance, validating the weak correlation between hypoxia tolerance and thermal tolerance. This study highlights that individuals with greater hypoxia tolerance do not necessarily have greater thermal tolerance. Global warming and hypoxia may pose a greater threat to population size and genetic diversity of some aquatic animals than previously believed.



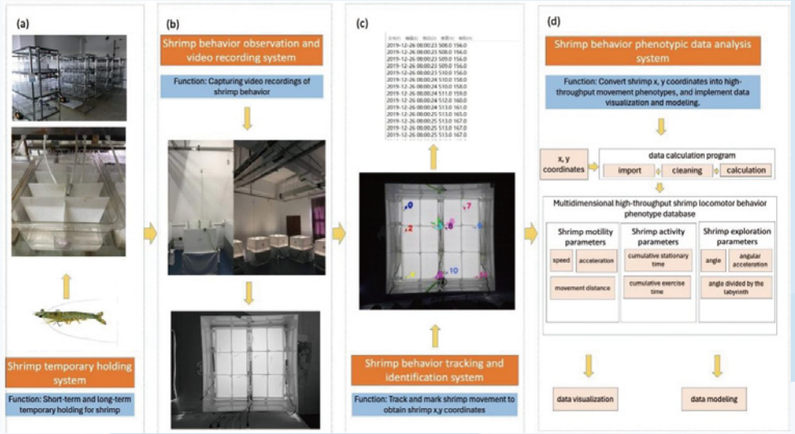
皱纹盘鲍的低氧耐受能力与高温耐受能力之间的相关性极低，并且与两种抗逆性状显著关联的基因之间不存在重合（图片摘要）

The Correlation between the Hypoxia Tolerance and the Thermal Tolerance of Pacific Abalone Is Extremely Low, and There Is No Overlap between Candidate Genes Associated with Hypoxia Tolerance and Candidate Genes Associated with Thermal Tolerance (Graphical Abstract).

HTBPPS：对虾的高通量行为表型平台

HTBPPS: A High-Throughput Behavioral Phenotyping Platform for Shrimp

具有中等至高遗传力的行为性状被认为是对虾育种中极具潜力的新型选育指标，但对其测定高度依赖耗时且易出错的人工观察，难以满足长时间、多个体与跨品系的大规模精准评估需求，严重制约了行为表型在育种实践中的应用。本研究借鉴植物高通量表型平台理念，构建了集暂养装置、表型监测装置、shrimp.tracker行为追踪算法及数据分析系统于一体的对虾高通量行为表型平台（HTBPPS）。该平台可实现多品种、多个体、长时间及高温胁迫等多应用场景下稳定追踪对虾行为，在sMOTSA（92.4）、MOTA（99.5）、MOTSP（95.5）及检测准确率（99.79%）等指标上均优于传统经典算法Track-RCNN。研究进一步揭示了在长期观测中对虾行为存在显著的24 h周期性节律，以及升温过程中呈现“M”型运动模式，其最后一次峰值与对虾耐热性呈中等相关。本研究突破了对虾行为表型高通量测定的技术瓶颈，为将行为表型引入耐热等抗逆性状育种提供了关键技术支撑和数据基础，对推动对虾精准育种具有重要意义。



高通量对虾行为表型平台的结构示意图

The Architecture of the High-Throughput Shrimp Behavioral Phenotyping Platform.

In shrimp breeding, phenotypic measurement is crucial for identifying key traits. Meanwhile, behavioral traits typically exhibiting moderate to high heritability are gaining recognition as novel traits in aquatic species breeding. However, traditional shrimp behavioral phenotype measurement is unsuitable for large-scale evaluations as it relies primarily on time-consuming and error-prone manual observations. With advances in computer vision, various behavior recognition and tracking algorithms have effectively overcome these limitations. Yet, such algorithms often prove inadequate for long-duration behavioral video data. Inspired by high-throughput phenotyping platforms in plant research, this study designed specialized temporary housing and observation apparatus to track shrimp behavior and the shrimp.tracker software based on a boundary-constrained Kalman filter algorithm. Additionally, this study established an analysis system for shrimp behavioral phenotypic data and a framework for long-term high-throughput behavioral data acquisition. Ultimately, these hardware and software systems form a high-throughput behavioral phenotyping platform for shrimp. The platform's algorithm scored 92.4 in sMOTSA, 99.5 in MOTA, and 95.5 in MOTSP, with a detection accuracy of 99.79 %, surpassing the deep learning-based Track-RCNN algorithm. Case studies illustrated the platform's capability to track various shrimp species, multiple individuals over extended periods, and shrimp under high- temperature stress. The experimental results revealed significant behavioral phenotype differences among different types and sizes of shrimp. During long-term behavioral observations, shrimp behaviors exhibited 24-h cyclical rhythm changes. Different types of shrimp exhibited the same M-shaped trend in mobility during linear temperature increases, with the last peak of the M shape moderately correlating with shrimp heat tolerance. These findings emphasize the importance of behavioral phenotypes in shrimp breeding, serving as potential indicators for assessing heat tolerance in shrimp breeding. Thus, the proposed platform has significant potential for future applications in shrimp breeding.

以上研究于2025年发表于*Aquaculture*期刊，2021届博士研究生程文志为第一作者，刘向荣教授和毛勇正高级工程师为共同通讯作者。

Reference:
Wenzhi Cheng, Huimin Peng, Chuanxi Chen, Heqian Zhang, Yiming Wei, Jinqian Yang, Xiaojie Deng, Yiling Hou, Siqi Li, Tingting Huang, Yougen Chen, Chichi Liu, Shengyao Sun, Huiyang Huang, Xiangrong Liu*, Yong Mao*. HTBPPS: A high-throughput behavioral phenotyping platform for shrimp. *Aquaculture* 2025, 597: 741932. doi: 10.1016/j.aquaculture.2024.741932

Data Management

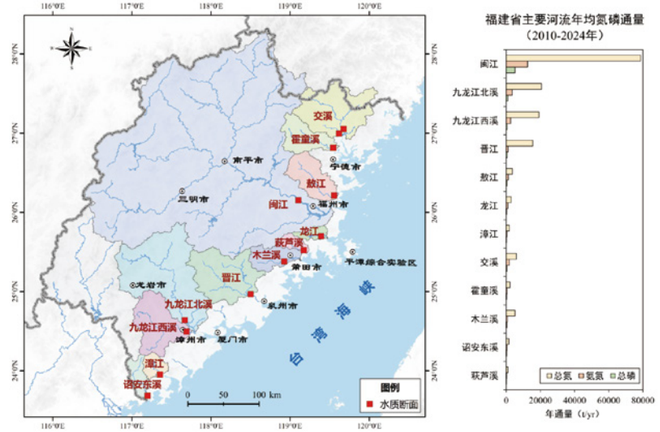
数据管理

2025年，厦门大学海洋监测与信息服务中心暨台海站数据中心持续推进台海站数据库建设、数据管理与数据应用服务。基于厦门大学海洋云“生态环境数据共享服务平台”，持续开展数据资源开放与共享服务，本年度台海站服务了校内外近20个课题组，提供了36批次的数据共享业务。

In 2025, the Marine Monitoring and Information Service Center of Xiamen University, together with the T-SMART Data Center, continued to advance the construction of the T-SMART database, data management, and data application services. Based on the "Ecological Environment Data Sharing Service Platform" on the Xiamen University Ocean Cloud, the center continued to provide open access and data sharing services. This year, T-SMART served nearly 20 research groups from both within and outside the university, providing 36 batches of data sharing services.

厦门大学海洋云“生态环境数据共享服务平台”
Xiamen University Ocean Cloud "Ecological Environment Data Sharing Service Platform"

在数据融合与应用方面，依托福建省高等学校科技创新团队项目“海岸带生态环境大数据与决策支撑”，推动建立政务网跨部门数据在线共享与应用机制，融合台湾海峡国家野外站科学观测数据、业务化监测数据和专业算法模型，初步建成“台湾海峡区域生态环境与绿色发展数据专题库”，包含生态环境、气象水文、社会经济、果渔产业、遥感地理等专题数据集，同时开发了支撑业务化决策的系列数智化应用系统，并已在福建、广西等多个省市的海洋、生态环境、水利部门业务化应用，为生态环境保护、海洋防减灾等提供了技术支撑。相关成果入选福建省生态云平台应用典型案例和工信厅人工智能典型应用场景。新华社报道“海洋云” 平台“有效提升科技基础资源开放服务能力”，福建日报以《用算法打造“海洋医生”》为题做专栏报道。



福建省主要入海河流氮磷通量数据集（2010–2024）
Nitrogen and Phosphorus Flux Dataset of Major Rivers Flowing into the Sea in Fujian Province (2010-2024)

In terms of data integration and application, supported by the Fujian Provincial University Science and Technology Innovation Team Project "Big Data and Decision Support for Coastal Ecological Environment," the center promoted the establishment of an online cross-departmental data sharing and application mechanism within government networks. By integrating scientific observation data from the T-SMART, operational monitoring data, and professional algorithm models, a preliminary "Taiwan Strait Regional Ecological Environment and Green Development Data Thematic Database" was established. This database includes thematic datasets on ecological environment, meteorological and hydrological conditions, socioeconomics, fruit and fishery industries, and remote sensing geography. A series of digital intelligent application systems supporting operational decision-making were also developed and have been applied in marine, ecological environment, and water resources departments in Fujian, Guangxi, and other provinces, providing technical support for ecological environment protection and marine disaster prevention and mitigation. Related achievements were selected as typical application cases for the Fujian Ecological Cloud Platform and recognized as typical application scenarios for artificial intelligence by the Provincial Department of Industry and Information Technology. Xinhua News Agency reported that the "Ocean Cloud" platform "effectively enhances the open service capability of basic scientific and technological resources," while Fujian Daily featured a special column titled "Using Algorithms to Create 'Ocean Doctors.'"

闽江口碳氮通量智能监控系统（应用单位：福州环境监测中心站）
Minjiang Estuary Carbon and Nitrogen Flux Intelligent Monitoring System (Applied by: Fuzhou Environmental Monitoring Center Station)

广西近岸海域赤潮智能监测预警系统（应用单位：自然资源部广西第四海洋研究所）
Guangxi Coastal Red Tide Intelligent Monitoring and Early Warning System (Applied by: Fourth Institute of Oceanography, Ministry of Natural Resources, Guangxi)

Team Building and Talent Development
团队建设与人才培养

台海站现有

53人
固定人员

16人
流动研究人员

12人
技术人员与管理人员

11人
新增固定人员

1人
新增流动研究人员

2025年，台海站现有固定人员53人，其中研究人员42人（包括教授29名、副教授11名）。研究人员中，国家青年科学基金项目（A类）获得者2人、国家青年科学基金项目（B类）获得者3人、国家优秀青年科学基金（海外）获得者1人、国家高层次人才1人、国家重点研发计划首席科学家4人、教育部长江学者特聘教授1人。现有流动研究人员16人，包括中国科学院院士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，以及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1人、国家高层次人才2人、神农英才计划入选者1人。

台海站另有技术人员与管理人员12人，由4名高级工程师、2名工程师、2名助理工程师、1名驻站科学家、2名驻站科研助理、1名秘书组成。

台海站不断加强队伍建设，新增固定人员11人，包括9名研究人员，2名科研助理；新增流动研究人员1名。焦念志院士团队成果获“2024年度中国海洋与湖沼十大科技进展”，张彩云、陈能汪团队成果获福建省工信厅“2025年度人工智能典型应用场景”荣誉。焦念志院士获“福建省科学技术重大贡献奖”。

In 2025, T-SMART had 53 permanent staff members, including 42 researchers (29 professors and 11 associate professors). Among the researchers, there were 2 recipients of the National Science Fund for Distinguished Young Scholars, 3 recipients of the National Science Fund for Excellent Young Scholars, 1 recipient of the National Science Fund for Excellent Young Scholars (Overseas), 1 national high-level talent, 4 principal investigators of National Key Research and Development Programs, and 1 Changjiang Scholar Distinguished Professor. There were 16 visiting researchers, including 2 academicians of the Chinese Academy of Sciences, 1 academician of the European Academy of Sciences / Russian Academy of Sciences / Academy of Sciences for the Developing World, as well as 5 recipients of the National Science Fund for Distinguished Young Scholars, 1 recipient of the National Science Fund for Excellent Young Scholars, 2 national high-level talents, and 1 recipient of the Shennong Talent Program.

T-SMART also had 12 technical and administrative staff members, consisting of 4 senior engineers, 2 engineers, 2 assistant engineers, 1 resident scientist, 2 resident research assistants, and 1 secretary.

T-SMART continuously strengthened its team. In 2025, 11 new permanent staff members were added, including 9 researchers and 2 research assistants, along with 1 new visiting researcher. The team led by Academician Nianzhi Jiao was recognized as one of the "Top 10 Scientific and Technological Advances in Oceanology and Limnology of China in 2024." The achievements of the teams led by Caiyun Zhang and Nengwang Chen were selected as a "2025 Typical Application Scenario for Artificial Intelligence" by the Fujian Provincial Department of Industry and Information Technology. Academician Nianzhi Jiao received the "Fujian Provincial Science and Technology Outstanding Contribution Award."

新增人员 / New Members

固定科研人员 / Permanent Research Staff

2011年获得德国耶拿大学博士学位。2015年入职厦门大学，2025年加入台海站，研究方向为海洋生物医学材料、海洋生物制药。

Dr. Ming Chen received his Ph.D. from Friedrich Schiller University Jena, Germany in 2011. He joined Xiamen University in 2015 and became a member of T-SMART in 2025. His research focuses on marine biomedical materials and marine biopharmaceutics.

Dr. Ming Chen
Professor

陈铭 博士 教授

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Dr. Yuxin Chen
Professor

陈宇新 博士 教授

E-mail: yuxin.chen@xmu.edu.cn

2016年获得中山大学博士学位。2019年入职厦门大学，国家青年科学基金项目（B类）获得者，2025年加入台海站，研究方向为气候变化背景下的生物多样性与生态系统功能和植物生态学。

Dr. Yuxin Chen received his Ph.D. from Sun Yat-sen University in 2016. He joined Xiamen University in 2019. He is a recipient of the National Science Fund for Excellent Young Scholars (Category B). He became a member of T-SMART in 2025. His research focuses on biodiversity and ecosystem functioning under climate change, and plant ecology.

2004年获得厦门大学博士学位。2015年入职厦门大学，2025年加入台海站，研究方向为环境分析化学。

Dr. Kunde Lin received his Ph.D. from Xiamen University in 2004. He joined Xiamen University in 2015 and became a member of T-SMART in 2025. His research focuses on environmental analytical chemistry.

Dr. Kunde Lin
Professor

林坤德 博士 教授

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Dr. Jie Su
Professor

苏婕 博士 教授

E-mail: jiesu@xmu.edu.cn

2022年获得东京大学博士学位。国家优秀青年科学基金（海外）获得者，2025年入职厦门大学并加入台海站，研究方向为可持续社会–生态系统，环境经济学。

Dr. Jie Su received her Ph.D. from The University of Tokyo in 2022. She is a recipient of the National Excellent Young Scientists Fund (Overseas). She joined Xiamen University and became a member of T-SMART in 2025. Her research focuses on sustainable social-ecological systems and environmental economics.

@Hui Luo

Dr. Kailin Liu
Associate Professor

刘凯琳 博士 副教授

E-mail: kailinliu@xmu.edu.cn

2020年获得香港科技大学博士学位。2022年入职厦门大学，2025年加入台海站，研究方向为浮游生物生态学。

Dr. Kailin Liu received her Ph.D. from The Hong Kong University of Science and Technology in 2020. She joined Xiamen University in 2022 and became a member of T-SMART in 2025. Her research focuses on plankton ecology.

2020年获得厦门大学博士学位。2023年入职厦门大学，2025年加入台海站，研究方向为海洋生物声学、水声信号处理。

Dr. Zhongchang Song received his Ph.D. from Xiamen University in 2020. He joined Xiamen University in 2023 and became a member of T-SMART in 2025. His research focuses on marine bioacoustics and underwater acoustic signal processing.

Dr. Zhongchang Song
Associate Professor

宋忠长 博士 副教授

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Dr. Zhi Wang
Associate Professor

王智 博士 副教授

E-mail: zhiwang00kxy@xmu.edu.cn

2019年获得香港浸会大学博士学位。2024年入职厦门大学，2025年加入台海站，研究方向为海洋底栖生物对环境变化和人类活动的响应。

Dr. Zhi Wang received his Ph.D. from Hong Kong Baptist University in 2019. He joined Xiamen University in 2024 and became a member of T-SMART in 2025. His research focuses on the responses of marine benthic organisms to environmental changes and human activities.

2015年获得夏威夷大学马诺阿分校博士学位。2022年入职厦门大学，2025年加入台海站，研究方向为环境健康与安全、新型微生物污染物。

Dr. Qian Zhang received her Ph.D. from the University of Hawai'i at Mānoa in 2015. She joined Xiamen University in 2022 and became a member of T-SMART in 2025. Her research focuses on environmental health and safety, and emerging microbial contaminants.

Dr. Qian Zhang
Associate Professor

张千 博士 副教授

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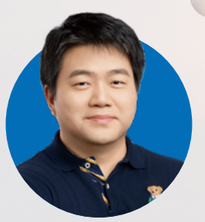

Dr. Hongtao Zhong
Associate Professor

钟宏韬 博士 副教授

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2017年获得林肯大学博士学位。2022年入职厦门大学，2025年加入台海站，研究方向为退化生态系统的修复、土壤磷循环。

Dr. Hongtao Zhong received his Ph.D. from Lincoln University in 2017. He joined Xiamen University in 2022 and became a member of T-SMART in 2025. His research focuses on restoration of degraded ecosystems and soil phosphorus cycling.

新增人员 / New Members

流动科研人员 /Visiting Research Staff

Dr. Ling Cao
Professor

曹玲 博士 教授

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2012年获得美国密西根大学博士学位。2023年入职厦门大学，国家青年科学基金项目（A类）获得者，2025年加入台海站，研究方向为渔业系统与全球变化。

Dr. Ling Cao received her Ph.D. from the University of Michigan in 2012. She joined Xiamen University in 2023. She is a recipient of the National Science Fund for Distinguished Young Scholars (Type A). She became a member of T-SMART in 2025. Her research focuses on fishery systems and global change.

科研助理 /Research Assistant

Gaoming Xu
许高铭

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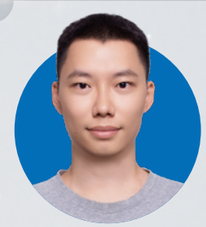
2025年获暨南大学海洋生物学与生物技术专业硕士学位，2025入职厦门大学并加入台海站，从事驻站研究助理工作。

Gaoming Xu received his Master's degree in Marine Biology and Biotechnology from Jinan University in 2025. He joined Xiamen University and became a member of T-SMART in 2025, serving as a resident research assistant.



Hongze Lin
林鸿泽

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2021年获河南科技大学机械设计制造及其自动化专业学士学位，2025年入职厦门大学并加入台海站，从事驻站科研助理工作。

Hongze Lin received his Bachelor's degree in Mechanical Design, Manufacturing and Automation from Henan University of Science and Technology in 2021. He joined Xiamen University and became a member of T-SMART in 2025, serving as a resident research assistant.

2025年，台海站为厦门大学海洋、生态等相关学科的科研和教学实习实践提供了硬件支撑和保障。依托台海站培养博士研究生19名，硕士研究生35名；服务PIs及研究生来站开展实验研究达2618人天。此外，来自汕头大学、西藏民族大学、厦门大学海洋与地球学院、环境与生态学院、生命科学学院及社会与人类学院等的学生在站开展野外综合实习达792人天。

In 2025, T-SMART provided hardware support and essential facilities for scientific research and teaching practices in marine and ecological sciences at Xiamen University. Through T-SMART, 19 doctoral students and 35 master's students were trained, and 2,618 person-days of experimental research were conducted by principal investigators and graduate students. Additionally, 792 person-days of field comprehensive internships were completed by students from various institutions, including Shantou University, Xizang Minzu University, and the College of Ocean and Earth Sciences, the College of the Environment and Ecology, the College of Life Sciences, and the College of Sociology and Anthropology at Xiamen University, among others.

依托台海站培养

19 名
博士研究生

35 名
硕士研究生

2618 人天
开展实验研究

792 人次
野外综合实习

@Hui Luo

Exchanges & Collaborations
合作交流

台海站第一届学术委员会第三次会议暨中国海洋生态系统联网观测战略规划研讨会召开

The Third Meeting of the First Academic Committee of T-SMART and the Strategic Planning Symposium on China Marine Ecosystem Network Observation Were Held

2025年3月26日至28日，台海站第一届学术委员会第三次会议暨中国海洋生态系统联网观测战略规划研讨会在台海站东山实验场召开。会议由学术委员会主任傅伯杰院士主持，焦念志、戴民汉、于贵瑞等院士及多位委员、特邀专家出席。国家科技基础条件平台中心、福建省科技厅相关负责人到会指导，厦门大学副校长尤延铖出席会议并致辞。来自全国多家野外台站、科研院所、高校及企业的90余位代表参会。

会议听取了台海站年度工作汇报及代表性成果报告，委员们对台海站在观测体系构建、科学研究、社会服务等方面取得的成效予以充分肯定，并就未来建设方向提出指导意见。战略规划研讨会聚焦海洋野外站伙伴计划及近海生态系统智能观测研究网络等议题，与会代表一致认为，应进一步加强全国海洋野外台站的协同观测与开放合作，共同构建覆盖近海–海岸带的智能观测研究网络，以科技创新支撑海洋可持续发展。

From March 26 to 28, 2025, the Third Meeting of the First Academic Committee of T-SMART and the Strategic Planning Symposium on China Marine Ecosystem Network Observation were held at the Dongshan Experimental Field of T-SMART. The meeting was chaired by Academician Bojie Fu, Director of the Academic Committee. Academicians Nianzhi Jiao, Minhan Dai, Guirui Yu, along with committee members and invited experts, attended the meeting. Representatives from the National Science and Technology Infrastructure Center and the Fujian Provincial Department of Science and Technology provided guidance. Yancheng You, Vice President of Xiamen University, attended and delivered a speech. More than 90 representatives from field stations, research institutions, universities, and enterprises across the country participated in the meeting.

The meeting reviewed the annual work report and representative achievements of T-SMART. Committee members fully affirmed the progress made in observation system construction, scientific research, and social services, and provided guidance for future development. The strategic planning symposium focused on topics including the marine field station partnership program and the intelligent observation research network for coastal ecosystems. Attendees agreed that collaborative observation and open cooperation among national marine field stations should be further strengthened to jointly build an intelligent observation research network covering the coastal-offshore continuum, supporting sustainable marine development through technological innovation. Some representatives conducted field visits to the Dongshan and Zhangjiang Estuary Experimental Fields of T-SMART.

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台海站第二届国际咨询委员会第二次会议召开

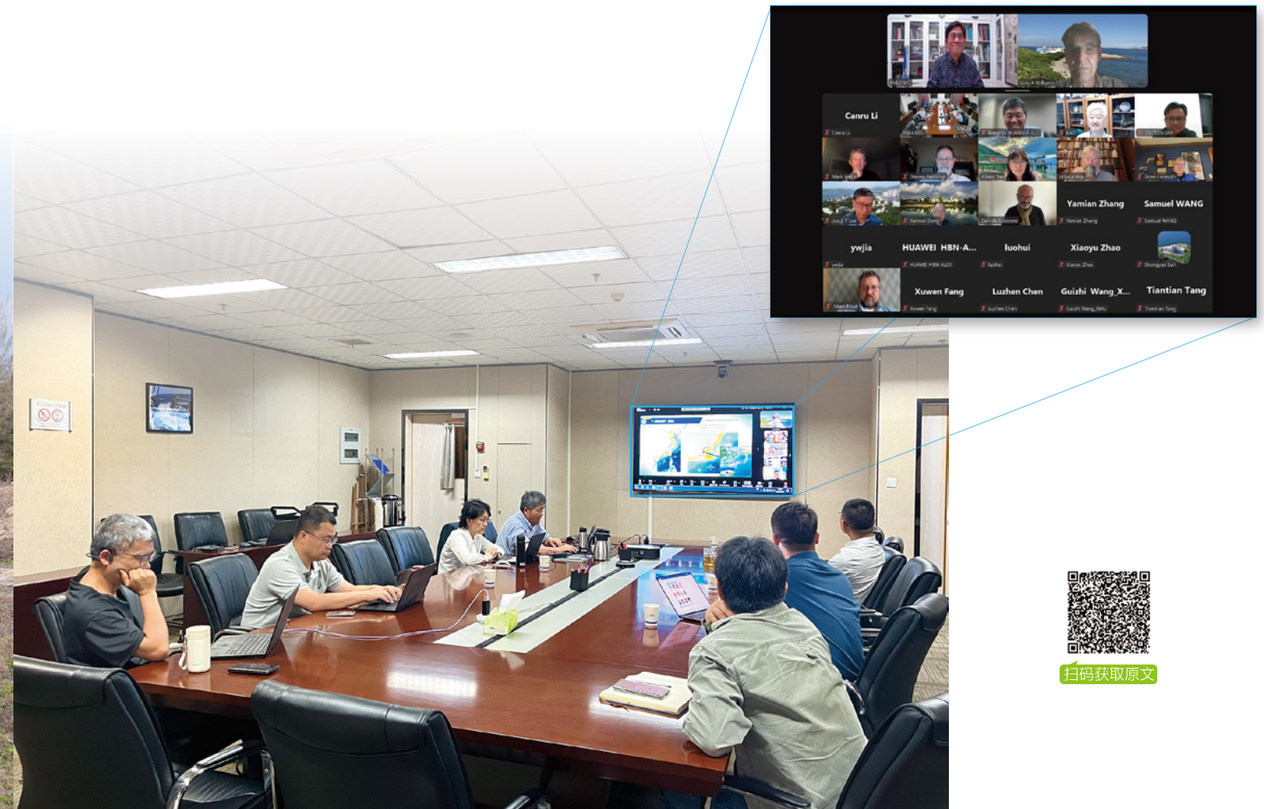
The Second Meeting of the Second International Advisory Committee of T-SMART Was Held

2025年4月16日，台海站第二届国际咨询委员会第二次会议在线上成功召开。本次会议汇聚了来自全球多所知名高校及研究机构的11位委员及专家。特邀专家中国海洋大学董云伟教授、厦门大学戴民汉院士参会。来自台海站、海洋生物地球化学全国重点实验室、海洋与地球学院、环境与生态学院的师生以及线上专家共计35人参加会议。

与会委员们听取了台海站站长黄邦钦作的2024年台海站工作汇报，以及游伟伟教授作的台海站战略发展规划（2025–2030），并就台海站的未来发展展开深入讨论。委员们对台海站2024年在观测、研究、科普和社会服务等方面取得的显著成绩给予充分肯定，认为台海站在区域海洋科学研究与应用方面发挥了重要作用。围绕台海站战略规划，委员们就未来发展方向提出多项建设性意见。

On April 16, 2025, the Second Meeting of the Second International Advisory Committee (IAC) of T-SMART was successfully held online. The meeting brought together 11 committee members and experts from renowned universities and research institutions worldwide. Invited experts including Professor Yunwei Dong from Ocean University of China and Academician Minhan Dai from Xiamen University attended the meeting. Approximately 35 participants, including faculty members and students from T-SMART, MEL, the College of Ocean and Earth Sciences, and the College of the Environment and Ecology, as well as online experts, attended the meeting.

The committee members listened to the 2024 T-SMART work report delivered by Professor Bangqin Huang, Director of T-SMART, and the T-SMART Strategic Development Plan (2025-2030) presented by Professor Weiwei You, engaging in in-depth discussions on the future development of T-SMART. Committee members fully affirmed the remarkable achievements of T-SMART in observation, research, science popularization, and social services in 2024, recognizing its important role in regional marine scientific research and application. Focusing on the strategic planning of T-SMART, members put forward numerous constructive suggestions for future development directions.



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福建省生态质量综合监测站工作交流研讨会

Fujian Provincial Ecological Quality Comprehensive Monitoring Stations Exchange Seminar

2025年7月3日，福建省生态质量综合监测站工作交流研讨会在台海站东山实验场召开。福建省生态环境厅监测处，以及第一、二批综合站和拟申报第三批综合站的代表约30人参会。

漳州东山海洋站汇报2024年监测工作开展情况及2025年工作计划；台海站介绍了野外站基本情况等。与会代表就综合站的建设及有序发展进行了深入交流研讨。会议强调，生态质量综合监测站是生态质量监测网络的重要组成部分，各综合站需进一步提升生态环境监测能力，强化对生态监管的支撑作用。

On July 3, 2025, the Fujian Provincial Ecological Quality Comprehensive Monitoring Stations Exchange Seminar was held at T-SMART. Approximately 30 representatives from the Monitoring Division of the Fujian Provincial Department of Ecology and Environment, the first and second batches of comprehensive stations, and units planning to apply for the third batch attended the meeting.

The Zhangzhou Dongshan Marine Station reported on its 2024 monitoring work and 2025 work plans. T-SMART introduced the basic situation of the field station. Participants engaged in in-depth discussions on the construction and orderly development of comprehensive stations. The meeting emphasized that ecological quality comprehensive monitoring stations are crucial components of the ecological quality monitoring network, and all stations need to further enhance their ecological environment monitoring capabilities and strengthen support for ecological quality assessment and ecological supervision.

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2025年全球华人海洋科学研讨会在厦门大学马来西亚分校举办

2025 Global Chinese Marine Science Symposium Held at Xiamen University Malaysia

2025年11月27日至30日，2025年全球华人海洋科学研讨会暨第十四届海峡两岸海洋科学研讨会、第十一届海洋环境监测及预报技术研讨会在厦门大学马来西亚分校举行，本次会议由台海站协办，来自海峡两岸及海外华人逾130位专家学者与会。本次会议是两大系列研讨会首次协同联合举办，旨在深化全球华人学者在海洋科学领域的学术交流，开展多方位合作。

会议以“智能化时代下的海洋科学与技术”为主题，围绕四大专题展开研讨。会议邀请了8位专家作特邀报告，并安排了77个口头报告和11个海报展示。本次研讨会不仅延续并深化了海峡两岸三十余年的学术交流传统，更将交流平台从两岸拓展至全球华人海洋科学家群体，为打造开放、融合、活力的全球华人海洋科学交流平台奠定了坚实基础。

From November 27 to 30, 2025, the 2025 Global Chinese Marine Science Symposium, together with the 14th Cross-Strait Marine Science Symposium and the 11th Marine Environmental Monitoring and Forecasting Technology Symposium, was held at the Xiamen University Malaysia, co-organized by the T-SMART. More than 130 experts and scholars from across the Strait and overseas Chinese attended the conference. This marked the first collaborative joint organization of the two symposium series, aiming to deepen academic exchanges and promote multifaceted cooperation among global Chinese scholars in marine sciences.

Under the theme "Marine Science and Technology in the Intelligent Era," the symposium focused on four major topics. Eight experts were invited to deliver keynote speeches, and the symposium also featured 77 oral presentations and 11 poster displays. This event not only continued and deepened the thirty-year tradition of cross-strait academic exchanges but also expanded the exchange platform from across the Strait to global Chinese marine scientists, laying a solid foundation for creating an open, integrated, and vibrant global Chinese marine science exchange platform.

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“海岸带系统科学观测伙伴计划（CoastPOS）”成立大会召开

Inaugural Meeting of the Coastal System Scientific Observation Partnership (CoastPOS) Held

2025年12月29日，“海岸带系统科学观测伙伴计划（CoastPOS）”在厦门正式揭牌成立。该伙伴计划由中国科学院海洋研究所胶州湾国家野外站和厦门大学台海站共同牵头发起，旨在整合涉海国家野外站、部省站等优势观测资源，构建我国海岸带系统科学协同研究新体系。成立仪式上，科学技术部基础研究与科研条件司、国家科技基础条件平台中心、中国科学院及厦门大学等分别致辞。CoastPOS的启动，标志着我国在海岸带地球系统科学研究进入了多机构协作、系统性推进的新阶段。该计划将聚焦海岸带系统环境演变、生态安全、生物多样性、陆海统筹等问题，通过跨学科、跨平台的深度合作，为我国海岸带可持续管理、生态安全屏障构建与高质量发展提供科学支撑。

On December 29, 2025, the Coastal System Scientific Observation Partnership (CoastPOS) was officially inaugurated in Xiamen. The partnership was jointly initiated by the Jiaozhou Bay National Marine Ecosystem Research Station of the Institute of Oceanology, Chinese Academy of Sciences, and T-SMART of Xiamen University. It aims to integrate the advantages of national and provincial observation stations to establish a new collaborative research system for coastal system science in China. At the inauguration ceremony, representatives from the Department of Basic Research and Scientific Conditions of the Ministry of Science and Technology, the National Science and Technology Infrastructure Center, the Chinese Academy of Sciences, and Xiamen University delivered speeches. The launch of CoastPOS marks a new phase of multi-institutional collaboration and systematic advancement in China's coastal earth system science research. The partnership will focus on key issues such as coastal environmental evolution, ecological security, biodiversity, and land-sea integration. Through interdisciplinary and cross-platform collaboration, it will provide scientific support for sustainable coastal management, ecological security, and high-quality development in China.

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中国海洋保护智库联盟2025年会

China Marine Protection Alliance (ChinaMPA) 2025 Annual Meeting

2025年11月5日，中国海洋保护智库联盟在厦门国际海洋周期间召开2025年会。来自科研院所、高校、管理部门和社会组织的近百位代表参会，围绕海洋保护与可持续渔业开展交流研讨，凝聚推进协同治理的共识与行动。

On November 5, 2025, the China Marine Protection Alliance (ChinaMPA) held its 2025 Annual Meeting during the Xiamen International Ocean Week. Nearly 100 representatives from research institutions, universities, management departments, and social organizations attended the meeting, engaging in exchanges and discussions on marine conservation and sustainable fisheries, and building consensus and actions to advance collaborative governance.

台海站代表团赴香港太古海洋科学研究所开展交流

T-SMART Delegation Visited the Swire Institute of Marine Sciences (SWIMS) in Hong Kong for Exchanges

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2025年4月27日至30日，台海站站长黄邦钦教授一行6人赴香港参加由厦门大学海洋生物地球化学全国重点实验室（MEL）与香港大学太古海洋科学研究所（SWIMS）联合举办的专题研讨会。会议汇聚两校近30名专家学者，围绕海洋科学研究、生态环境保护、创新人才培养等议题展开深入交流，并就深化合作形成初步计划。

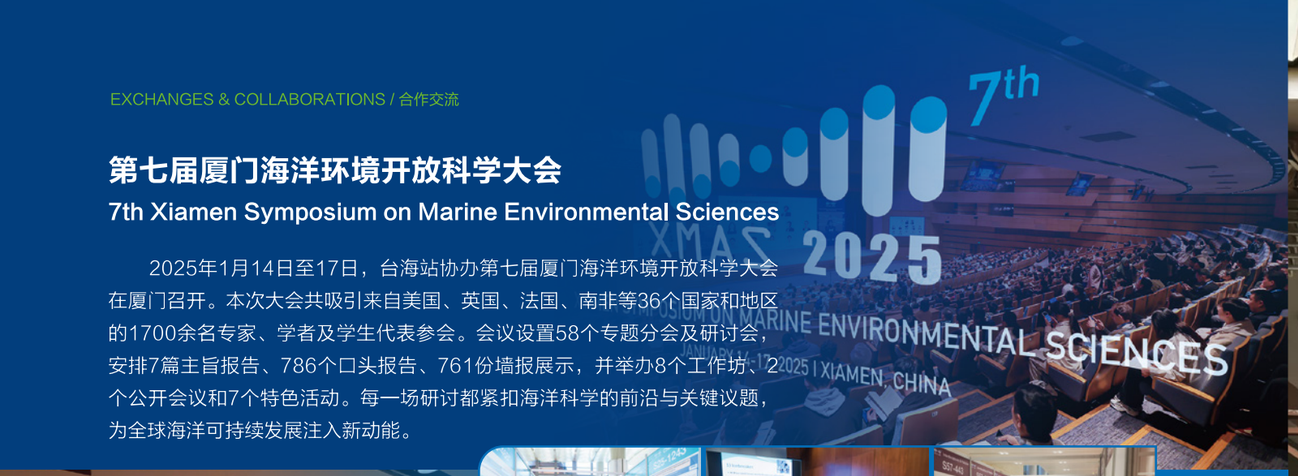
访问期间，代表团考察了SWIMS的改扩建工程、实验海水系统等设施，双方就海洋站运行管理、人才培养等经验进行交流。未来，双方将依托两校合作框架，深化在水产养殖、生态修复、公众科普等领域的联合研究。

From April 27 to 30, 2025, a six-member delegation led by Professor Bangqin Huang, Director of T-SMART, visited Hong Kong to participate in a symposium jointly organized by the State Key Laboratory of Marine Biogeochemistry (MEL) of Xiamen University and the Swire Institute of Marine Sciences (SWIMS) of The University of Hong Kong. The symposium brought together nearly 30 experts and scholars from the two universities for in-depth exchanges on marine scientific research, ecological environment protection, and innovative talent cultivation, forming preliminary plans for further cooperation.

During the visit, the delegation inspected the progress of SWIMS' renovation and expansion project and experimental seawater system. Both parties exchanged experiences on field station operation management and talent cultivation. In the future, both sides will continue to deepen joint research in areas such as aquaculture, ecological restoration, and public science education under the collaboration framework between Xiamen University and The University of Hong Kong.

第七届厦门海洋环境开放科学大会

7th Xiamen Symposium on Marine Environmental Sciences



2025年1月14日至17日，台海站协办第七届厦门海洋环境开放科学大会在厦门召开。本次大会共吸引来自美国、英国、法国、南非等36个国家和地区的1700余名专家、学者及学生代表参会。会议设置58个专题分会及研讨会，安排7篇主旨报告、786个口头报告、761份墙报展示，并举办8个工作坊、2个公开会议和7个特色活动。每一场研讨都紧扣海洋科学的前沿与关键议题，为全球海洋可持续发展注入新动能。

From January 14 to 17, 2025, the 7th Xiamen Symposium on Marine Environmental Sciences was held in Xiamen, co-organized by the T-SMART. The symposium attracted over 1,700 experts, scholars, and students from 36 countries and regions, including the United States, the United Kingdom, France, and South Africa. The event featured 58 sessions and workshops, 7 keynote speeches, 786 oral presentations, 761 poster presentations, as well as 8 workshops, 2 open meetings, and 7 special events. Each session focused on frontier and critical issues in marine science, injecting new momentum into global ocean sustainability.

台海站赴三明开展生态环境保护交流活动

T-SMART Delegation Visited Sanming for Ecological Environment Protection Exchanges

2025年6月23日至24日，台海站站长黄邦钦教授一行赴福建三明森林生态系统国家野外站与三明市生态环境局开展交流。

调研团实地参观了三明站土壤增温、模拟降水变化等控制试验平台，双方围绕野外站平台建设、森林与滨海碳汇协同研究等议题深入探讨。团队还拜访三明市生态环境局，交流生态环境监测与数智化应用技术。此次交流为未来跨生态系统协同研究与校地合作奠定了基础。

From June 23 to 24, 2025, Professor Bangqin Huang, Director of T-SMART, led a delegation to visit the Fujian Sanming Forest Ecosystem National Observation and Research Station and the Sanming Municipal Bureau of Ecology and Environment for exchanges.

The delegation visited Sanming Station's control experiment platforms, including soil warming and simulated precipitation change facilities. Both parties engaged in in-depth discussions on field station platform construction and collaborative research on forest and coastal carbon sinks. The team also visited the Sanming Municipal Bureau of Ecology and Environment to exchange views on ecological environment monitoring and digital intelligence application technologies. This exchange laid a foundation for future cross-ecosystem collaborative research and university-local cooperation.

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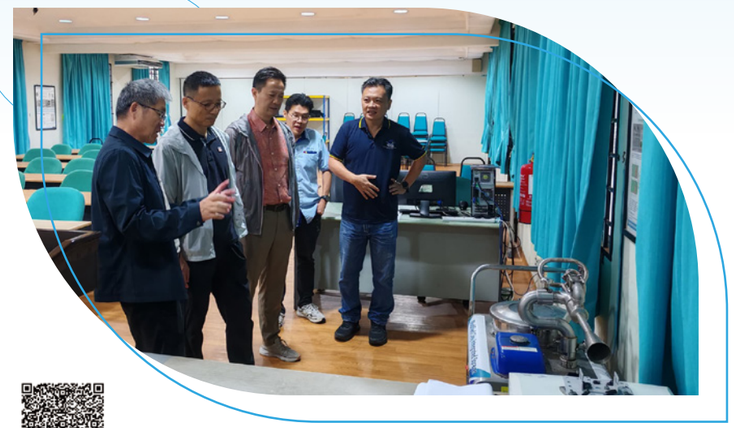
台海站赴马来西亚巴赫克海洋研究站（BMRS）开展访问交流

T-SMART Delegation Visited Bachok Marine Research Station in Malaysia

2025年11月26日至27日，台海站站长黄邦钦教授一行赴马来西亚马来亚大学海洋与地球科学研究所和巴赫克海洋研究站（Bachok Marine Research Station, BMRS）开展访问交流。

访问期间，台海站访问团受到巴赫克海洋研究站站长Po Teen Lim教授等的热忱接待，实地考察了BMRS的大气观测平台、营养盐分析实验室等科研设施，双方就野外站运行管理机制、人才培养等展开深入交流。BMRS依托热带海洋区位优势打造的海洋生态灾害特色研究方向给访问团留下深刻印象。围绕热带海洋有害藻华发生机制等共同关切领域，双方达成初步合作意向。

During the visit, the T-SMART delegation received warm reception from Professor Po Teen Lim, Director of BMRS, and her team, and conducted field inspections of BMRS's research facilities, including the atmospheric observation platform and nutrient analysis laboratory. Both parties engaged in in-depth exchanges on field station operation and management mechanisms and talent cultivation. BMRS's distinctive research direction on marine ecological disasters, built upon its tropical marine location advantages, left a profound impression on the delegation. In-depth discussions were conducted on areas of common concern, such as the mechanisms of harmful algal blooms in tropical oceans, laying a foundation for future cooperation.



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“气候变化与海洋健康”暑期学校成功举办

Summer School on “Climate Change and Ocean Health” Successfully Held

2025年6月30日至7月9日，2025年度“气候变化与海洋健康”暑期学校在厦门大学翔安校区举行。活动吸引来自海峡两岸暨香港多所高校及研究机构的近70名博士生、硕士生及博士后参加，围绕气候变化与海洋健康议题开展系列课程与讲座。

7月6日，师生赴台海站漳江口实验场和东山实验场实地参观，深入了解亚热带海湾生态特征、红树林湿地生物多样性及其生态服务功能，加深了对海洋生态系统长期观测重要性的认识。

From June 30 to July 9, 2025, the Summer School on "Climate Change and Ocean Health" was held at Xiang'an Campus of Xiamen University. The event attracted nearly 70 doctoral and master's students and postdoctoral fellows from universities and research institutions across the Strait and Hong Kong, featuring a series of courses and lectures on climate change and ocean health.

On July 6, participants visited M-ECORS and D-SMART, gaining insights into subtropical bay ecological characteristics, mangrove wetland biodiversity, and the importance of long-term observation of marine ecosystems.

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国际红树林中心调研漳江口实验场

International Mangrove Center Delegation Visited M-ECORS

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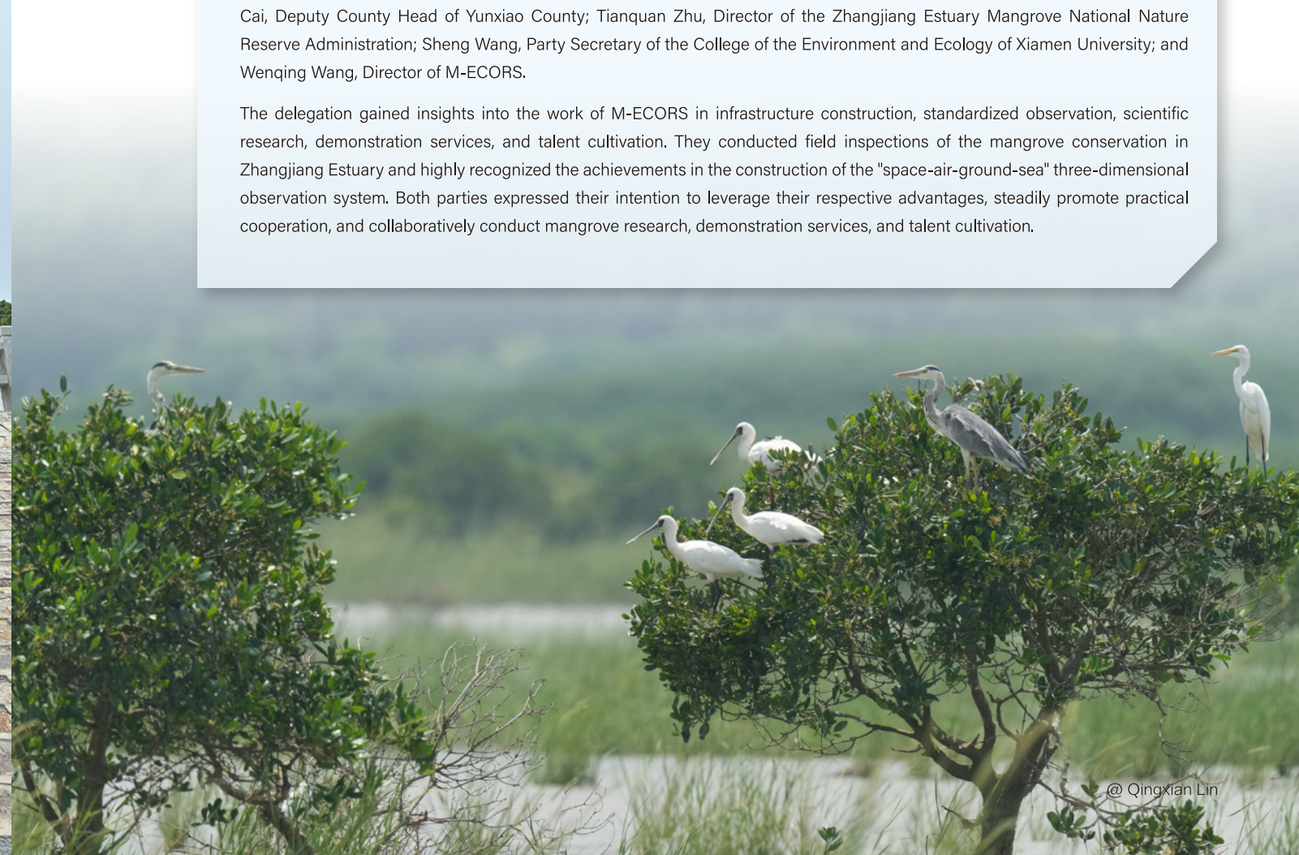
2025年4月7日，国际红树林中心临时秘书处处长彭鹏一行调研台海站漳江口实验场。福建省湿地保护中心主任周冬良、云霄县副县长蔡权城、漳江口红树林国家级自然保护区管理局局长朱添泉、厦门大学环境与生态学院党委书记王晟、漳江口实验场站长王文卿等陪同调研。

调研团详细了解漳江口实验场在基础建设、规范观测、科学研究、示范服务及人才培养等方面的工作情况，实地考察漳江口红树林保护管理情况，对台站“空-天-地-海”立体观测体系建设成效给予高度认可。双方表示，将依托各自优势，稳步推进务实合作，协同开展红树林调查研究、示范服务及人才培养等工作，共同拓展国际合作与交流。

On April 7, 2025, a delegation led by Peng Peng, Director of the Interim Secretariat of the International Mangrove Center, visited M-ECORS. The delegation was accompanied by Dongliang Zhou, Director of the Fujian Wetland Protection Center; Quancheng Cai, Deputy County Head of Yunxiao County; Tianquan Zhu, Director of the Zhangjiang Estuary Mangrove National Nature Reserve Administration; Sheng Wang, Party Secretary of the College of the Environment and Ecology of Xiamen University; and Wenqing Wang, Director of M-ECORS.

The delegation gained insights into the work of M-ECORS in infrastructure construction, standardized observation, scientific research, demonstration services, and talent cultivation. They conducted field inspections of the mangrove conservation in Zhangjiang Estuary and highly recognized the achievements in the construction of the "space-air-ground-sea" three-dimensional observation system. Both parties expressed their intention to leverage their respective advantages, steadily promote practical cooperation, and collaboratively conduct mangrove research, demonstration services, and talent cultivation.

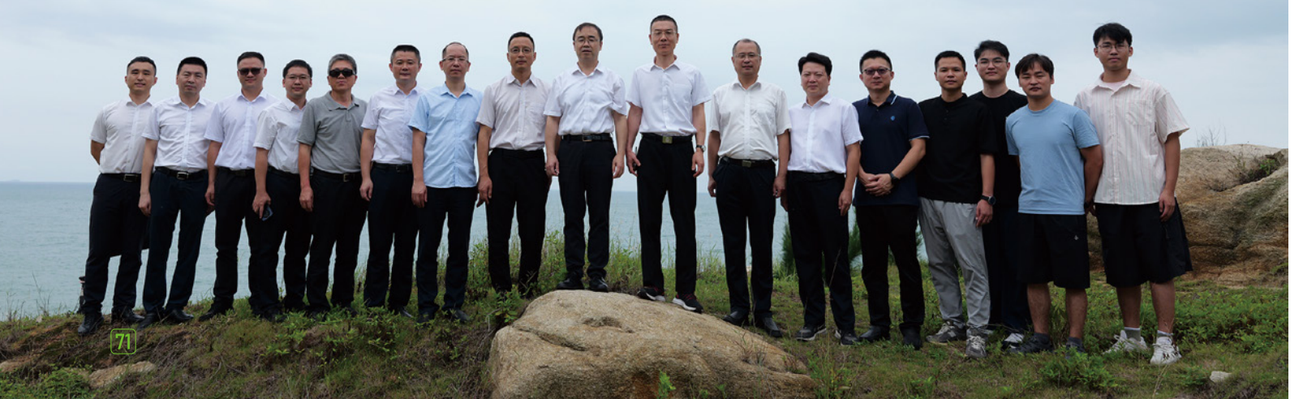


校长张宗益带队调研台海站建设发展情况

President Zongyi Zhang Led a Delegation to Investigate the Construction and Development of T-SMART

2025年7月10日，校长张宗益带队赴台海站实地调研建设发展情况。台海站站长、南强特聘教授黄邦钦，副站长江毓武教授、王文卿教授详细介绍了台海站的建设进展及存在的问题，生动展示了厦门大学打造“海-陆-空-天”海洋立体观测实验体系布局的长期探索与成效。

On July 10, 2025, Zongyi Zhang, President of Xiamen University, led a delegation to conduct a field investigation on the construction and development of T-SMART. Bangqin Huang, Director of T-SMART and Nanqiang Distinguished Professor, along with Deputy Directors Professor Yuwu Jiang and Professor Wenqing Wang, provided a detailed overview of the station's progress and existing challenges, vividly demonstrating Xiamen University's long-term efforts and achievements in building an integrated "sea-land-air-space" marine observation and experimental system.



东山县委书记调研台海站东山实验场

Dongshan County Party Secretary Visited D-SMART

2025年4月1日，东山县委书记何霭带队调研台海站东山实验场，推进二期项目相关事宜。自落地东山以来，东山实验场在海洋生态保护、珊瑚保育、科普宣传等方面取得积极成效。

何霭详细了解珊瑚调查、生物多样性保护等工作情况，现场协调解决项目用地用海等要素保障问题，并希望实验场继续发挥科研平台优势，在育种研发、成果转化等方面积极创新，有力支持东山海马、对虾、鲍鱼等养殖业发展。

On April 1, 2025, Ai He, Party Secretary of Dongshan County, led a delegation to D-SMART for a research visit to discuss matters related to the Phase II project. Since its establishment in Dongshan, D-SMART has achieved positive results in marine ecological protection, coral conservation, and science popularization.

Secretary He gained insights into the station's work in coral surveys and biodiversity conservation, coordinated solutions for land and sea use guarantees, and expressed the hope that D-SMART would leverage its scientific platform advantages to innovate in breeding research and achievement transformation, effectively supporting the development of aquaculture industries such as seahorses, shrimp, and abalone in Dongshan.

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国际专家调研台海站漳江口实验场

International Experts Visited M-ECORS

2025年11月24日，受厦门大学环境与生态学院院长吕永龙教授邀请，美国国家科学院院士Scott Edwards教授与哥伦比亚大学Shahid Naeem教授一行到访台海站漳江口实验场，围绕红树林生态保护与可持续发展进行学术交流与实地考察。

漳江口实验场站长王文卿教授、副站长朱旭东教授介绍了实验场在基础建设、观测系统、科学研究及人才培养等方面的进展。专家团队实地考察了漳江口红树林保护管理情况，对台站“空-天-地-海”立体观测体系建设及科普宣教成效给予高度评价。此次访问为漳江口实验场打造国际合作基地注入前沿理念，搭建了跨国学术合作桥梁。

On November 24, 2025, at the invitation of Professor Yonglong Lu, Dean of the College of the Environment and Ecology of Xiamen University, Professor Scott Edwards, member of the National Academy of Sciences of the United States from Harvard University, and Professor Shahid Naeem from Columbia University visited M-ECORS for academic exchanges and field investigations on mangrove ecological protection and sustainable development.

Professor Wenqing Wang, Director of M-ECORS, and Professor Xudong Zhu, Deputy Director, introduced the progress of the experimental field in infrastructure construction, observation systems, scientific research, and talent cultivation. The expert team conducted field investigations on the mangrove conservation in Zhangjiang Estuary and highly praised the achievements in the construction of the "space-air-ground-sea" three-dimensional observation system and science popularization. This visit brought cutting-edge concepts to M-ECORS in building an international cooperation base and established a bridge for transnational academic collaboration.

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全球海洋负排放计划（Global–ONCE）

Global Ocean Negative Carbon Emissions (Global–ONCE) Programme

海洋负排放（ONCE）国际大科学计划，由厦门大学焦念志院士发起，直面全球气候治理和碳中和需求，已有 35 个国家的 104 个科研院所参与，并在亚洲、欧洲、美洲建立分中心。

ONCE 活跃于国际舞台，向全球同行展示了其在相关领域的重要研究进展与成果。

联合国第十届“可持续发展目标SDG科学技术与创新多方利益相关者论坛”

The Global Ocean Negative Carbon Emissions (Global-ONCE) Program, led by Nianzhi Jiao, Academician of the Chinese Academy of Sciences and Professor at Xiamen University, addresses the needs of global climate governance and carbon neutrality. It has been incorporated into the IPCC Special Report. Currently, the program involves 104 research institutions from 35 countries, with sub-hubs set up in Asia, Europe, and America.

ONCE also actively participated on the global stage, showcasing its key research progress and achievements to international peers.

The 10th UN Multi-Stakeholder Forum on Science, Technology and Innovation for the SDGs.

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联合国气候变化框架公约第30次缔约方大会

The 30th Conference of the Parties (COP30) to the United Nations Framework Convention on Climate Change.

ONCE《科学–政策简报》是STI论坛启动科学–政策简报机制以来，唯一由中国科学家领衔发布的应对气候变化政策文件。

ONCE *Science-Policy Brief*, the only science-policy document by Chinese scientists addressing climate change since the inception of the science-policy brief mechanism at the UN STI Forum.

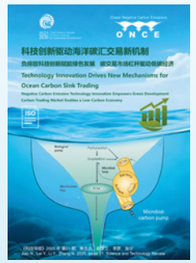
https://sdgs.un.org/documents/nianzhi-jiao-et-al-2025-integrating-oceanic-carbon-sequestration-strategies-high-impact

发布《ONCE集成报告：从科学到治理》

The Global-ONCE Compendium: From Science to Governance

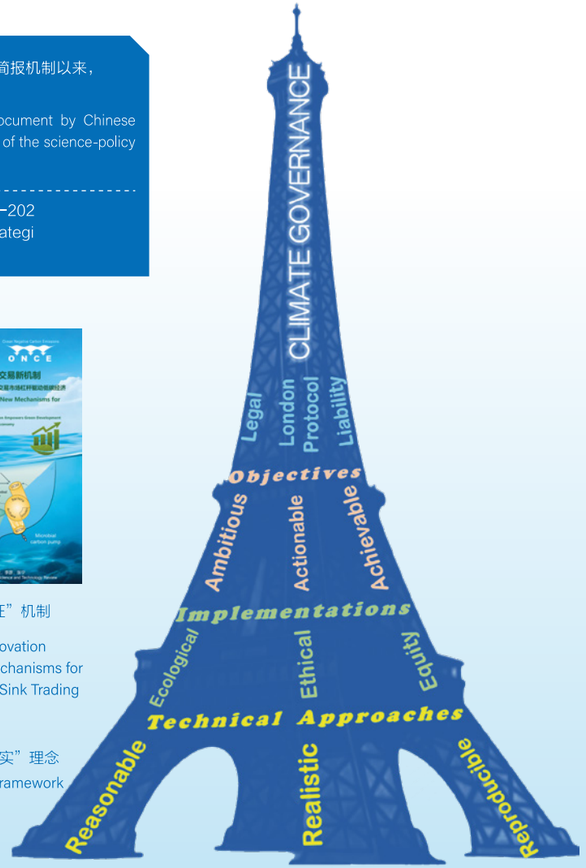
发布《海洋科学–政策接口》

Marine Science-Policy Interface for Transformative Governance



提出“过程认证”机制

Technology Innovation Drives New Mechanisms for Ocean Carbon Sink Trading



确立“三重务实”理念

The “Triple REAL”Framework

融通科学、管理和社会参与：助力海岸带可持续发展（COASTAL–SOS）

Coastal Zones Under Intensifying Human Activities and Changing Climate: A Regional Programme Integrating Science, Management and Society to Support Ocean Sustainability (COASTAL–SOS)

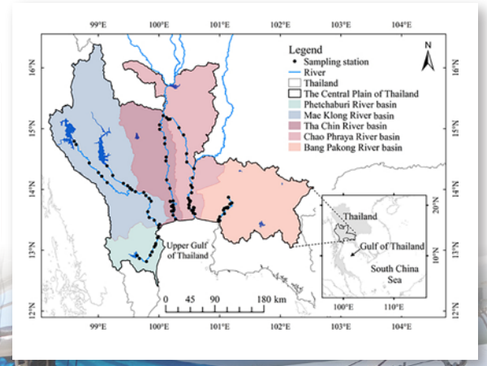
2021 UN OCEAN DECADE ENDORSED PROJECT 2030 COASTAL-SOS

项目拟建立利益相关者之间的新型伙伴关系，通过共同设计、执行科学研究方案，通过多学科、跨领域、跨区域的合作、科学创新实践及其成果的有效转化，促进科学、管理和社会参与的切实融合，为海岸带的可持续发展提供解决方案。

发表论文《影响泰国主要河流水质的经济社会与水文因子时空变化》 凸显了泰国当地社会经济发展对水质空间分布格局的主导性影响，为指定可持续的水资源管理策略提供参考。

This project aims to establish new partnerships among stakeholders by jointly designing and implementing scientific research programs, promoting effective integration of science, management, and social participation through multidisciplinary, cross-field, and cross-regional collaboration, scientific innovation practices, and the effective application of their results, providing solutions for the sustainable development of coastal zones.

The article “Spatiotemporal Variations in Socioeconomic and Hydrological Factors Impacting Water Quality in Thailand’s Major Rivers” underscores the dominant role of local socioeconomic development in shaping the spatial pattern of water quality. These insights can thus inform strategies for sustainable water resource management.



参观泰国农业大学1号科考船

Visited the Kasetsart University Research Vessel No.1

Outreach & Social Services
公众教育与社会服务

2025台海站东山实验场首场海洋科学开放日
2025 Inaugural Marine Science Open Day at D-SMART

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2025年3月21日至22日，台海站东山实验场联合多单位举办首场海洋科学开放日活动，吸引百余名当地中小学生、28组亲子家庭及部分企业代表参与。活动设置科普展区与互动实验区，通过科研成果展示、现场科学实验与海洋知识讲解，向公众生动介绍海洋观测与生态保护一线工作，有效提升了参与者对海洋科学的兴趣与认知。

From March 21 to 22, 2025, D-SMART collaborated with multiple organizations to host its inaugural Marine Science Open Day, attracting over 100 local primary and secondary school students, 28 parent-child families, and enterprise representatives. The event featured science popularization exhibition areas and interactive experimental zones, showcasing research achievements, hands-on scientific experiments, and marine knowledge explanations. The activities effectively enhanced participants' interest and understanding of marine science by vividly introducing frontline work in ocean observation and ecological conservation.

2025年台海站举办“世界红树林日”主题科普活动
T-SMART Held "World Mangrove Day" Themed Science Popularization Event

2025年7月26日，在第十个“世界红树林日”到来之际，台海站联合多家单位在漳江口实验场及漳江口红树林国家级自然保护区举办主题科普活动，吸引来自厦门、漳州两地的120余名中小学生、家长与教师参与。活动涵盖专家讲座、互动问答、自然笔记征集颁奖及环保倡议等环节，系统普及了红树林的生态价值与保护意义。本次活动有效提升了公众尤其是青少年对红树林生态系统的认知和保护意识。

On July 26, 2025, the tenth World Mangrove Day, T-SMART collaborated with multiple organizations to host a themed science popularization event at M-ECORS and the Zhangjiang Estuary Mangrove National Nature Reserve. The event attracted over 120 primary and secondary school students, parents, and teachers from Xiamen and Zhangzhou. Activities included expert lectures, interactive Q&A, awards ceremony for nature notes collection, and environmental protection initiatives, systematically disseminating knowledge about the ecological value and conservation significance of mangroves. The event effectively enhanced public awareness, especially among young people, of mangrove ecosystem conservation.

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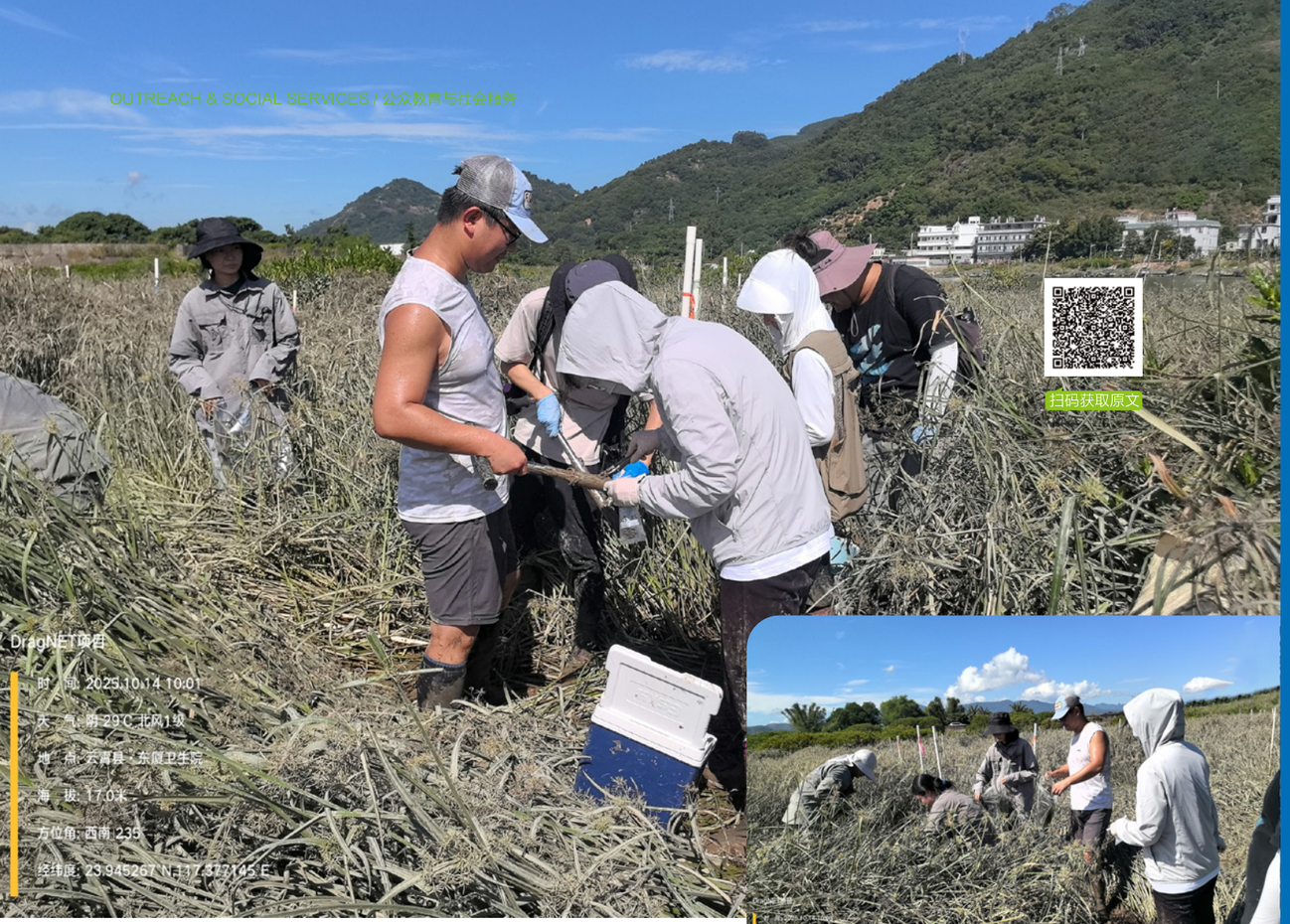
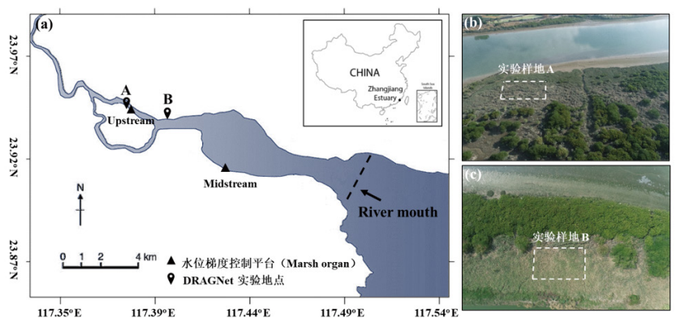


台海站加入DRAGNet全球性合作研究计划

T–SMART Joins DRAGNet Global Collaborative Research Network

2025年，台海站正式加入DRAGNet (Disturbance and Recovery Across Global Grasslands) 全球性合作研究计划。台海站是该计划在东亚亚热带滨海湿地类型中首批入选的野外台站之一，也是我国在滨海湿地干扰与恢复研究领域首个加入该国际网络的重要平台。通过参与DRAGNet，台海站将获取全球可比的标准化生态数据，共享国际先进的实验方法与分析平台，系统探究全球变化下滨海湿地的响应与恢复机制，提升我国滨海湿地生态学研究的国际影响力。

In 2025, T-SMART officially joined DRAGNet (Disturbance and Recovery Across Global Grasslands), a global collaborative research network. T-SMART is among the first field stations selected for this program in the East Asian subtropical coastal wetland category, and represents China's first important platform joining this international network in the field of coastal wetland disturbance and recovery research. Through participation in DRAGNet, T-SMART will access globally comparable standardized ecological data, share internationally advanced experimental methods and analytical platforms, systematically investigate the responses and recovery mechanisms of coastal wetlands under global change, and enhance the international influence of China's coastal wetland ecology research.



第十四届厦门大学海洋科学开放日成功举办

The 14th Xiamen University Marine Science Open Day Successfully Held

2025年11月15日“海洋开放日”期间，台海站开展了形式多样的沉浸式科普活动。东山实验场以珊瑚保护为主题，通过“珊瑚密探”“珊瑚衰亡”“知识竞答”等环节，借助活体珊瑚缸、骨骼标本及互动问答，生动展现珊瑚的生态价值；漳江口实验场推出“认识底栖动物”专题展示，介绍不同底栖动物种类及其生态作用；海洋环境生态学课题组围绕浮游植物生活史，设计“显微镜下的海洋森林”“硅藻艺术”“海洋疑云”“穿越深海迷宫”等互动项目；马剑课题组提供iSEA营养盐等四种国产海洋监测仪器，供公众观摩体验；厦门海洋监测与信息服务中心暨台海站数据中心推出AI数字人“小海同学”，向公众介绍赤潮、海漂垃圾等海洋现象。活动以多元形式向公众普及海洋科学知识，传递海洋保护理念。

During the "Marine Science Open Day" on November 15, 2025, T-SMART organized diverse immersive science popularization activities. D-SMART focused on coral conservation through interactive sessions including "Coral Detective," "Coral Decline," and knowledge quizzes, utilizing live coral tanks and skeletal specimens to vividly demonstrate the ecological value of corals. M-ECORS featured a "Meet the Benthic Animals" exhibition introducing various benthic species and their ecological roles. The Marine Environmental Ecology group designed interactive projects centered on phytoplankton life cycles, including "Ocean Forest Under Microscope," "Diatom Art," "Marine Mystery," and "Deep Sea Maze Adventure." Professor Jian Ma's group showcased four domestically produced marine monitoring instruments including *i*SEA nutrients for public observation and hands-on experience. The Xiamen Marine Monitoring and Information Service Center, together with the T-SMART Data Center, launched an AI digital human "Xiao Hai" to explain marine phenomena such as red tides and marine debris. The event effectively disseminated marine science knowledge and promoted ocean conservation concepts through diverse formats.

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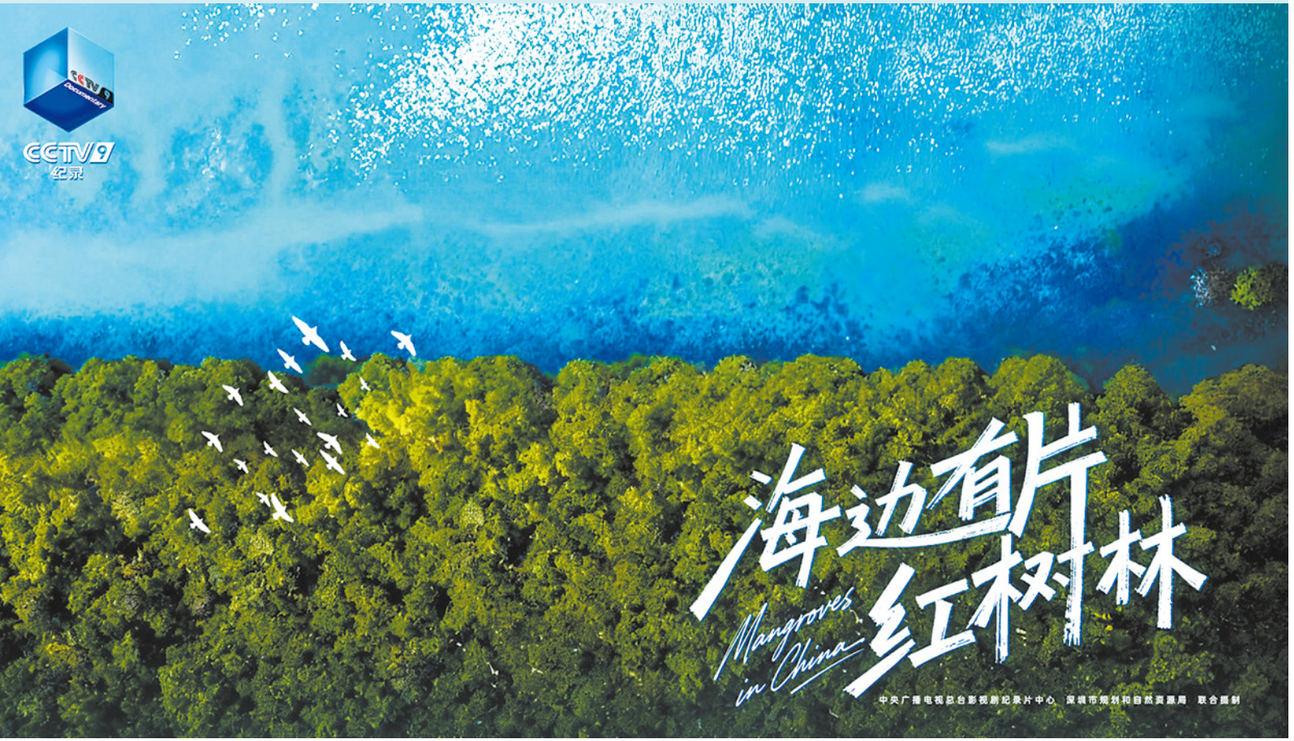

台海站多位教师参与央视纪录片《海边有片红树林》摄制工作

T-SMART Faculty Participate in CCTV Documentary "Mangroves by the Sea"

2025年3月，中央广播电视总台影视剧纪录片中心邀请厦门大学为纪录片《海边有片红树林》提供科学指导和技术支持。台海站多位成员深度参与本片科学策划、实地拍摄与影像记录工作。台海站副站长王文卿教授受邀担任科学顾问，并与陈鹭真教授在第二集《潮汐之间》和第五集《生生不息》中参与实地拍摄，从碳汇功能、生物多样性等角度阐释红树林的“蓝色价值”；林清贤副教授在第三集《如约而至》中担任特约摄影，捕捉候鸟迁徙与红树林共生的关键瞬间。该纪录片通过通俗语言解读复杂生态过程，让科学“看得见、听得懂、记得住”。

In March 2025, the Drama and Documentary Center of China Media Group invited Xiamen University to provide scientific guidance and technical support for the documentary "Mangroves by the Sea." Multiple T-SMART members deeply participated in the scientific planning, field shooting, and footage recording of this documentary. Professor Wenqing Wang, Deputy Director of T-SMART, was invited to serve as scientific advisor and participated in field shooting together with Professor Luzhen Chen in Episode 2 "Between Tides" and Episode 5 "Endless Life," explaining the "blue value" of mangroves from perspectives of carbon sink function and biodiversity. Associate Professor Qingxian Lin served as special photographer in Episode 3 "Arriving as Promised," capturing critical moments of migratory birds coexisting with mangroves. The documentary interprets complex ecological processes in accessible language, making science "visible, understandable, and memorable."

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2025少年蓝色先锋培养计划

2025 Junior Blue Pioneers Training Program

2025年7月，第四届“少年蓝色先锋培养计划”举办。来自北京、上海、南京、重庆、深圳、厦门、东山及美国、加拿大等地的20名高中生齐聚漳江口实验场和东山实验场，围绕“新能源开发”“数智化养殖”“海洋可持续发展”三大前沿领域开展研究实践。学员们在科学导师团队指导下，从实验室与野外考察站走向光伏发电站、渔业龙头企业、海洋生物标本馆等平台，在探索中点燃科学热情，在实践中塑造科学思维，根植可持续发展理念。

In July 2025, the fourth "Junior Blue Pioneers Training Program" was held. Twenty high school students from Beijing, Shanghai, Nanjing, Chongqing, Shenzhen, Xiamen, Dongshan, as well as the United States and Canada, gathered at M-ECORS and D-SMART to conduct research practice in three frontier areas: "new energy development," "digital intelligence aquaculture," and "marine sustainable development." Guided by scientific mentors, participants extended their footprint from laboratories and field stations to photovoltaic power stations, leading aquaculture enterprises, and marine biological specimen museums, igniting scientific passion through exploration, shaping scientific thinking through practice, and planting the concept of sustainable development.

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2025年度“苏峰讲坛”三讲回顾：从科普传播、卫星遥感到海岛人文

2025 Sufeng Forum: Three Lectures Spanning Science Communication, Satellite Remote Sensing, and Island Humanities

2025年，台海站东山实验场“苏峰讲坛”全年举办三场跨领域讲座。第一讲聚焦科学家如何有效传播海洋科学；第二讲展示国产卫星在海洋水色遥感监测中的技术突破；第三讲从人类学视角探讨海岛社区传统生态知识与可持续发展路径。系列讲座围绕“科学–技术–社会”三位一体展开，拓展了海洋科学公共传播的深度与广度。

In 2025, the "Sufeng Forum" at D-SMART held three cross-disciplinary lectures throughout the year. The first lecture focused on how scientists can effectively communicate marine science. The second lecture showcased technological breakthroughs in domestic satellite marine color remote sensing. The third lecture explored traditional ecological knowledge and sustainable development paths of island communities from an anthropological perspective. The lecture series embodied the trinity of "science-technology-society," expanding the depth and breadth of marine science public communication.

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第十届MEL研究生学术论坛

The 10th MEL Graduate Academic Forum Successfully Held

由台海站东山实验场承办的第十届MEL研究生学术论坛于2025年7月9日至12日成功举办。本届论坛以“Seize the time, 'Sea' the future”（遇见时代，照见蔚蓝）为主题，汇聚52名学生、8位特邀嘉宾，围绕5大前沿专题开展37场专题报告，并设置破冰活动、技能工作坊、圆桌讨论、科普活动等环节。论坛吸引了60余名厦门大学海洋环境科学领域师生参与，聚焦海洋环境挑战下可持续发展等热点议题展开讨论，增进了跨学科学术互动，为探寻创新路径与合作契机提供了助力。

The 10th MEL Graduate Academic Forum (MEGA), hosted by D-SMART, was successfully held from July 9 to 12, 2025. Under the theme "Seize the time, 'Sea' the future," the forum brought together 52 students and 8 invited guests, featuring 37 presentations across 5 frontier topics, along with ice-breaking activities, skills workshops, roundtable discussions, and science popularization events. The forum attracted over 60 faculty and students from marine and environmental sciences at Xiamen University, engaging in discussions on hot topics such as sustainable development under marine environmental challenges. The event promoted interdisciplinary academic interaction and provided impetus for exploring innovative pathways and cooperation opportunities.

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苏峰读海：对话历史，探寻未来

Sufeng Reads the Ocean: Dialogues with History, Explorations of the Future

苏峰，作为台海站东山实验场所在地，承载着厦门大学海洋研究的深厚历史底蕴。为追溯海洋科学发展的源头，跟随历史的足迹，读懂老一辈海洋人的坚守与奉献，并探寻野外站的未来发展方向，我们特别开设了“苏峰读海”专栏。

该专栏以虚拟观测员“小苏”与资深海洋人——台海站驻站科学家李炎教授（笔名“老海”）的对话形式，带领读者走近那段波澜壮阔的海洋科研历程。自2023年8月专栏开设以来，已累计发布21期，其中2025年发布10期，通过生动的故事与深刻的洞察，展现了海洋科研的传承与创新。

Sufeng, home to D-SMART, carries the profound historical legacy of Xiamen University's marine research. To trace the origins of marine science development, follow the footsteps of history, understand the dedication and contributions of senior marine scientists, and explore the future direction of the field station, we have launched the "Sufeng Reads the Ocean" column.

This column is presented through dialogues between a virtual observer "Xiao Su" and a seasoned marine scientist—Professor Yan Li, a resident scientist at T-SMART (under the pen name "Lao Hai")—guiding readers through the magnificent journey of marine scientific research. Since its inception in August 2023, the column has published 21 issues in total, with 10 released in 2025, showcasing the heritage and innovation of marine research through vivid stories and profound insights.

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“书香润海岛 · 法韵传闽南”世界读书日主题教育活动

"Bookish Island · Legal Charm of Minnan" World Book Day Themed Educational Activity

2025年4月23日，东山县法院联合台海站东山实验场等单位开展“书香润海岛 · 法韵传闽南”主题活动。50余名师生和法院干警走进东山实验场，通过观看珊瑚生态影像、参观科研成果展示、聆听海洋生态保护科普，深入了解珊瑚礁生态系统保护的重要性。法院干警以《珊瑚保护区的司法保护》为题，通过趣味问答等方式，向师生介绍东山珊瑚省级自然保护区的司法保护机制。活动还融入非遗南音表演和经典诵读，推动全民阅读与海洋文化深度融合。

On April 23, 2025, Dongshan County People's Court, together with D-SMART and other organizations, held the "Bookish Island · Legal Charm of Minnan" themed activity. Over 50 teachers, students, and court officials visited D-SMART, gaining in-depth understanding of the importance of coral reef ecosystem protection through watching coral ecological footage, visiting research achievement exhibitions, and listening to science popularization on marine ecological protection. Court officials delivered a lecture on "Judicial Protection of Coral Reserves," introducing the judicial protection mechanisms of Dongshan Coral Provincial Nature Reserve through interactive Q&A. The activity also featured intangible cultural heritage Nanyin performances and classic recitations, promoting the integration of reading and marine culture.

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第十七届高校研究生水环境科学研讨会(UCAS)

The 17th University Consortium on Aquatic Sciences Symposium (UCAS)

2025年7月14日至18日，第17届UCAS研讨会在基隆和厦门以线上与线下结合方式举行。本届研讨会由台湾海洋大学主办，厦门大学、香港大学及台湾中山大学联合参与，来自4所高校的53位师生围绕生态毒理学、生物多样性、渔业与水产养殖、气候变化适应与技术、生物地球化学循环、水文地质与古气候科学等主题开展学术交流。会议期间，48位学生进行了个人学术展示，在互动中拓展专业视野、建立深厚友谊。

From July 14 to 18, 2025, the 17th UCAS Symposium was held in Keelung and Xiamen through a combination of online and offline formats. Hosted by Taiwan Ocean University and co-organized by Xiamen University, The University of Hong Kong, and Taiwan Sun Yat-sen University, the symposium brought together 53 faculty and students from four universities for academic exchanges on topics including ecotoxicology, biodiversity, fisheries and aquaculture, climate change adaptation and technology, biogeochemical cycles, hydrogeology, and paleoclimate science. During the symposium, 48 students delivered individual academic presentations, expanding professional horizons and building deep friendships through interactions.

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Journal Article

期刊文章

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