

National Key R&D Program of China

Key Special Program on “Inter-governmental International
Science & Technology Innovation Cooperation”

Project Work Progress Briefing

Issue 1 (Dec. 2024 – Jun. 2025)

Project Title:	<u>Sino–French Joint Laboratory of Marine Microbial Ecology</u>
Grant Number:	<u>2024YFE0114300</u>
Project coordinator:	<u>Wuchang Zhang</u>
Leading Institution:	<u>Institute of Oceanology, Chinese Academy of Sciences (IOCAS)</u>
Project Duration:	<u>Dec. 2024 – Nov. 2027</u>

To systematically review the progress of the “Sino–French Joint Laboratory of Marine Microbial Ecology” project since its initiation, strengthen internal communication and collaboration, and provide timely updates to academic advisors and supervising agencies, this briefing summarizes the main achievements from December 2024 to June 2025. It covers project initiation, research progress, scientific activities, and comparison with planned tasks, aiming to provide a stage-wise evaluation and reference for the subsequent implementation of the project.

I. Project Initiation

The project was officially approved in December 2024, led by the Institute of Oceanology, Chinese Academy of Sciences (IOCAS), with Ocean University of China (OUC), Shanghai Jiao Tong University (SJTU), Xiamen University (XMU), and the Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou) (GML) as participating institutions. The first installment of funds was allocated to IOCAS in December 2024 and distributed to participating institutions by February 2025. During this period, Project Coordinator Wuchang Zhang held multiple discussions with task leaders to refine the research plan, clarify task allocation, and establish the budget plan. To strengthen academic guidance and quality control, five distinguished experts from China and abroad were appointed as academic advisors.

The kick-off meeting of the project was held online on March 6, 2025, with 22 participants, including academic advisors Prof. Hongbin Liu, Prof. Xue'en Chen, and Prof. Jun Sun, as well as the Project Coordinator, task leaders, and project members (Figure 1). The meeting reviewed the background of Sino–French cooperation in marine microbial ecology, outlined the framework for joint research, and emphasized two major research themes: (1) the response of microbial food webs to mesoscale oceanic processes, and (2) the spatial and temporal distribution of microbial food webs in typical coastal bays.

At the kick-off meeting, Project Coordinator Wuchang Zhang delivered a project report, reviewing the background and application process of the project, and outlining its research objectives, main tasks, and implementation plan. The academic advisors provided valuable feedback on project implementation, particularly offering constructive suggestions on potential technical issues related to in situ observation and on research output management. Task leaders of each research direction also engaged in in-depth discussions, linking the project foundation, current research status, and expected objectives.

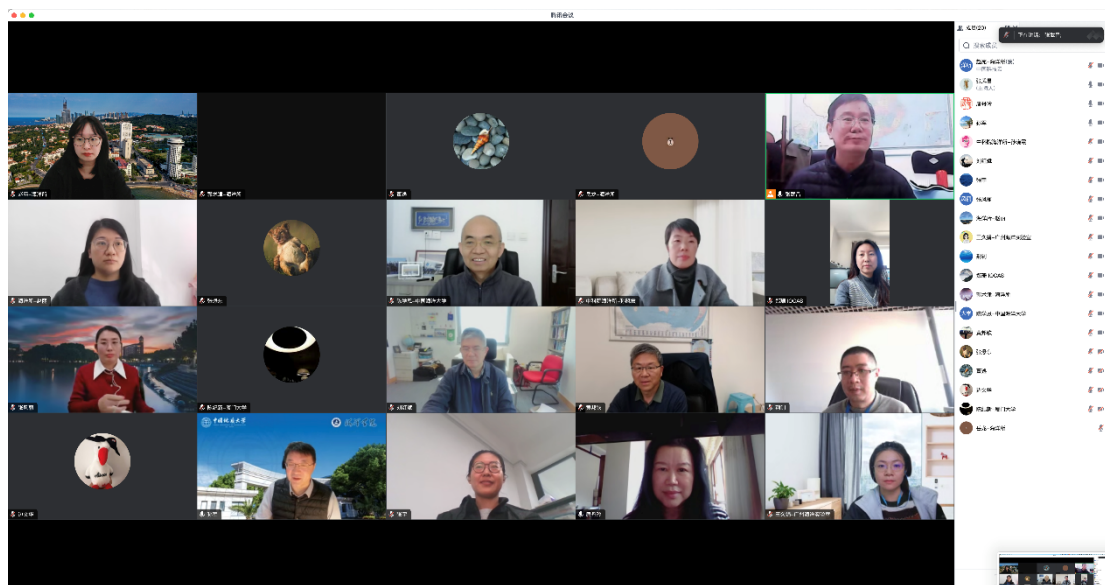


Figure 1 Online kick-off meeting of the project held on March 6, 2025

The meeting also underscored the significance of this project in strengthening long-term Sino–French collaboration in marine science, promoting the integration of advanced observation technologies, and fostering international talent exchange. It laid a solid foundation for subsequent research implementation and cooperative achievements.

II. Research Progress

During this stage, the project has advanced along two main research directions. The first focuses on the response of microbial food webs to mesoscale oceanic processes, based on field observations conducted in the Kuroshio Extension region. The second examines the distribution patterns of microbial food webs in typical coastal bays, with representative studies carried out in Dongshan Bay and Jiaozhou Bay. These efforts have provided a solid foundation for analyzing the environmental drivers of microbial food web dynamics and for comparing their characteristics across contrasting marine settings.

2.1 Response of Microbial Food Webs to Mesoscale Oceanic Processes

This research task was carried out during a comprehensive cruise in the western Pacific, organized by OUC with active participation from IOCAS as part of the Sino–French Joint Laboratory. Guided by SWOT satellite observations, sampling stations were positioned across mesoscale fronts and eddies in the Kuroshio Extension region, enabling targeted and intensified observations (Figure 2).

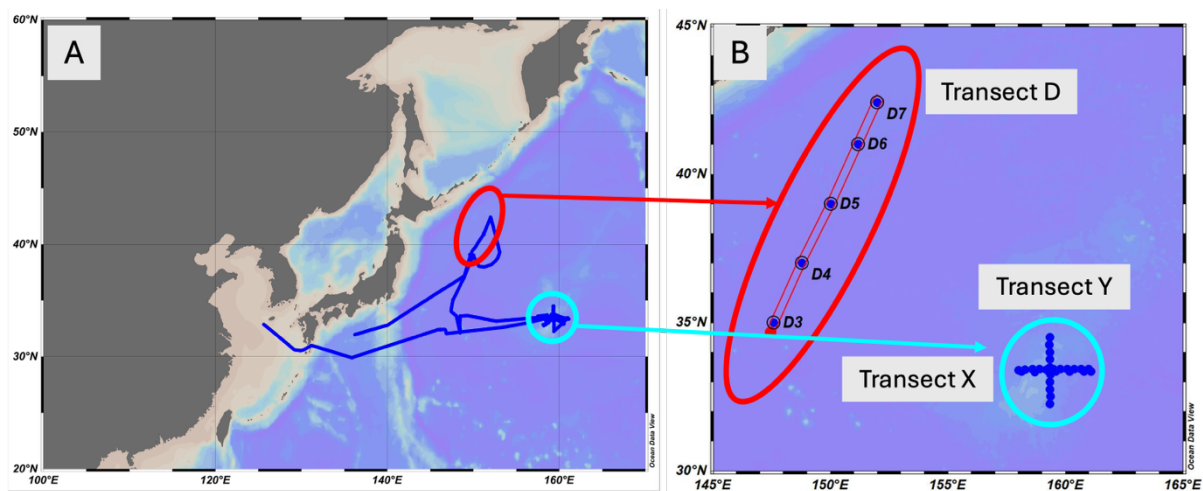


Figure 2 Cruise track and sampling stations in the Kuroshio Extension region. (A) Overall cruise route; (B) Distribution of sampling stations and transects across the eddy area.

1) Sampling and Observation Design

Sampling was performed using a combination of conventional and high-frequency methods to ensure both vertical and horizontal coverage. At major and eddy-associated stations, seawater was collected with the shipborne CTD rosette sampler. For ciliates, 1 L water samples were taken from multiple depths and fixed with Lugol's iodine solution for subsequent microscopic identification and enumeration. In parallel, surface seawater was continuously drawn from the ship's underway system, from which additional ciliate samples were taken to capture horizontal variability (Figure 3).

To achieve real-time measurements, the underway system was also connected to a portable onboard flow cytometer. Using this setup, *Synechococcus* (SYN), *Prochlorococcus* (PRO), picoeukaryotes (PEUK), and nanoeukaryotes (NEUK) were measured in near real-time. Measurements were conducted every 30 minutes throughout the cruise, resulting in approximately 1,000 individual cytometric datasets. These high-frequency data provided detailed information on the short-term and small-scale variability of microbial food web populations. The combination of CTD-based vertical sampling, underway ciliate collection, and continuous flow cytometry allowed for both fine-scale spatial resolution and broad-scale coverage, ensuring that the biological responses to mesoscale physical processes could be fully captured and subsequently analyzed (Figure 3).

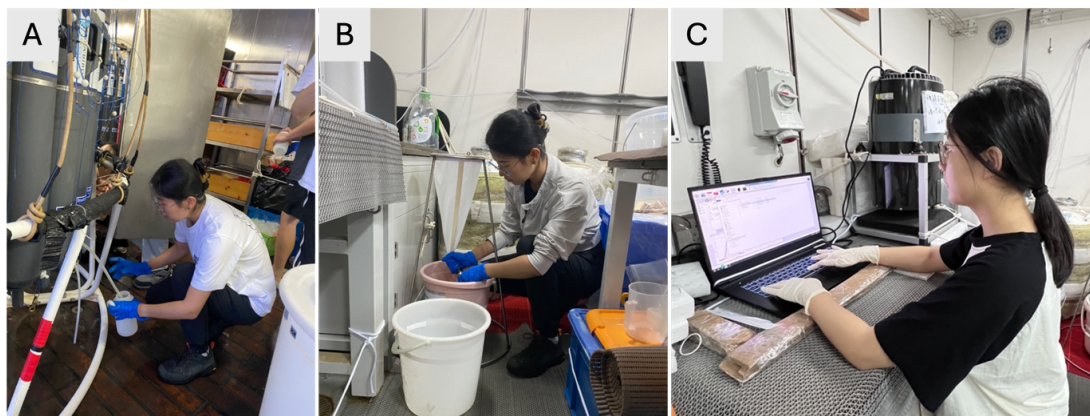


Figure 3 Field sampling and observation methods. (A): CTD rosette sampler used for vertical water collection; (B): underway surface seawater sampling system for tintinnid and aloricate ciliate collection; (C): portable onboard flow cytometer for real-time analysis of microbial plankton at 30-minute intervals.

2) Preliminary results from the eddy transects

In the eddy region, vertical sampling was conducted along the transects X and Y, covering 28 stations from the surface down to 800 m. The distributions of temperature and salinity showed that both the thermocline and halocline were significantly uplifted inside the eddy, with a clear disturbance of the water column structure. Correspondingly, chlorophyll *a* exhibited elevated values in the eddy core, suggesting that upwelling enhanced nutrient supply and created favorable conditions for microbial growth in the euphotic zone (Figure 4).

It is noteworthy that no significant uplift of the upper 60 m water column was observed within the eddy. The hydrographic properties of this upper layer differed markedly from those of the underlying waters, suggesting that it originated from a distinct water mass. Such a two-layer water mass structure may have further suppressed the upward flux of nutrients into the upper 60 m. Although the upwelling process enhanced nutrient supply from the middle and deeper layers, the pronounced stratification between the upper and lower water masses impeded further upward transport. As a result, chlorophyll *a* maxima were concentrated primarily in the 60–100 m depth range rather than extending into the surface layer.

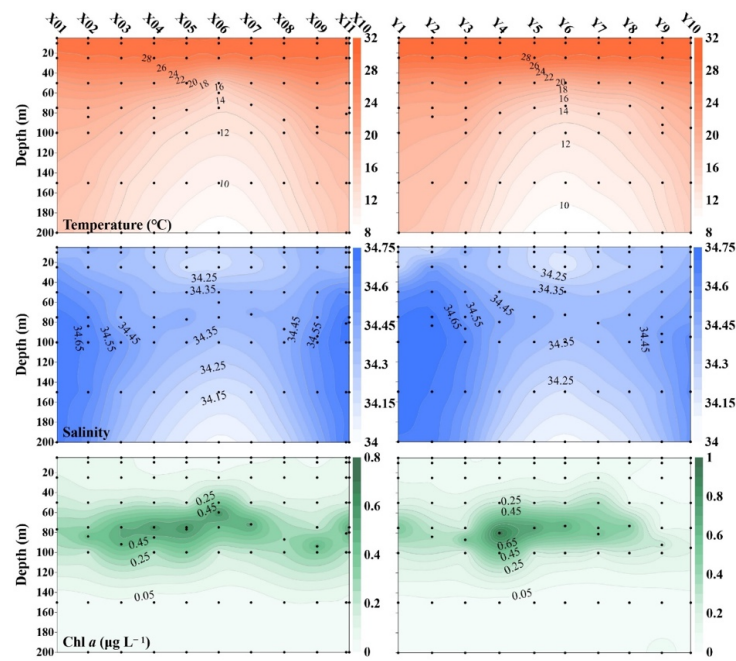


Figure 4 Temperature, salinity, and chlorophyll a distribution along the transects X and Y of the eddy region (0–200 m).

Ciliate communities showed pronounced spatial variability. More than 90 tintinnid species belonging to over 30 genera were identified, with peak abundances generally occurring in the 25–100 m layer. Aloricate ciliates consistently displayed much higher abundances than tintinnids, especially in the eddy core where large accumulations were observed (Figure 5). Importantly, two distinct distribution patterns were detected: (1) groups such as aloricate ciliates concentrated in the eddy center, and (2) subsets of tintinnids reaching their maxima at the eddy peripheries. These contrasting center-dominant and side-dominant patterns, highlighted by tintinnid assemblages (Figure 6), reflect niche differentiation and demonstrate that mesoscale processes exert heterogeneous effects on ciliate communities.

Picophytoplankton and nanoeukaryotes showed marked group-specific patterns. *Synechococcus* (SYN) abundances reached maximum levels in the eddy core, coinciding closely with the chlorophyll maximum. In contrast, *Prochlorococcus* (PRO) declined markedly in the eddy center, forming a complementary pattern to SYN. Picoeukaryotes (PEUK) and nanoeukaryotes (NEUK) occurred at lower overall abundances, but both showed patchy distributions at the eddy margins and in mid-depth layers, suggesting that their dynamics were influenced by intermittent effects of mesoscale processes (Figure 7). These findings indicate that mesoscale processes strongly restructure microbial food webs by altering hydrographic conditions, nutrient supply, and biological interactions.

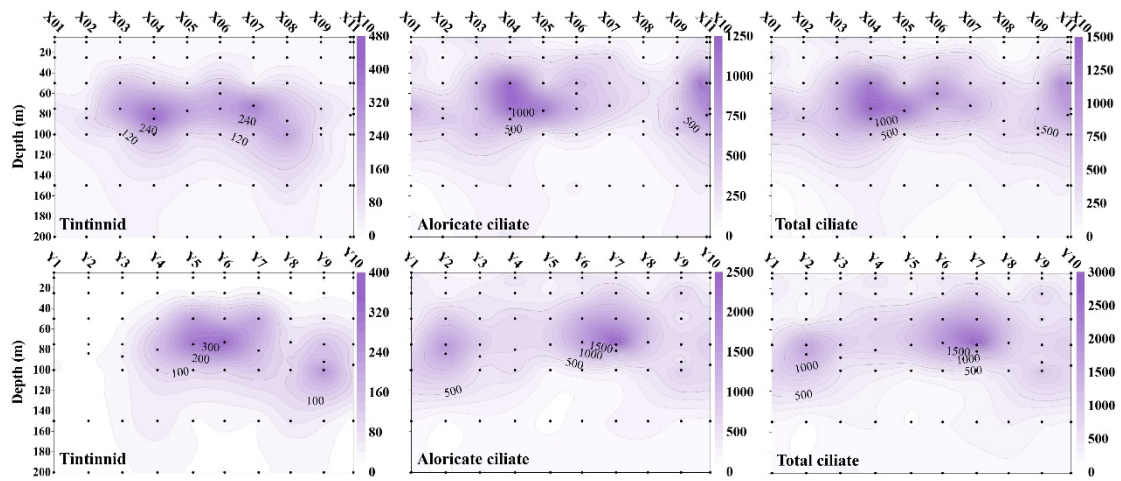


Figure 5 Abundances of ciliates along the transects X and Y of the eddy region (0–200 m, ind./L).
From left to right: tintinnids, aloricate ciliates, and total ciliates.

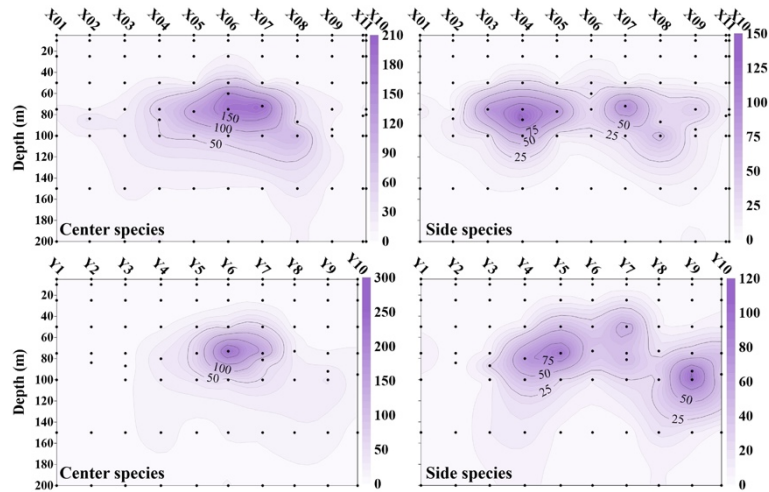


Figure 6 Distribution patterns of tintinnids showing two distinct modes. Left: center-dominant groups with peak abundances in the eddy core; Right: side-dominant groups with peak abundances on both flanks.

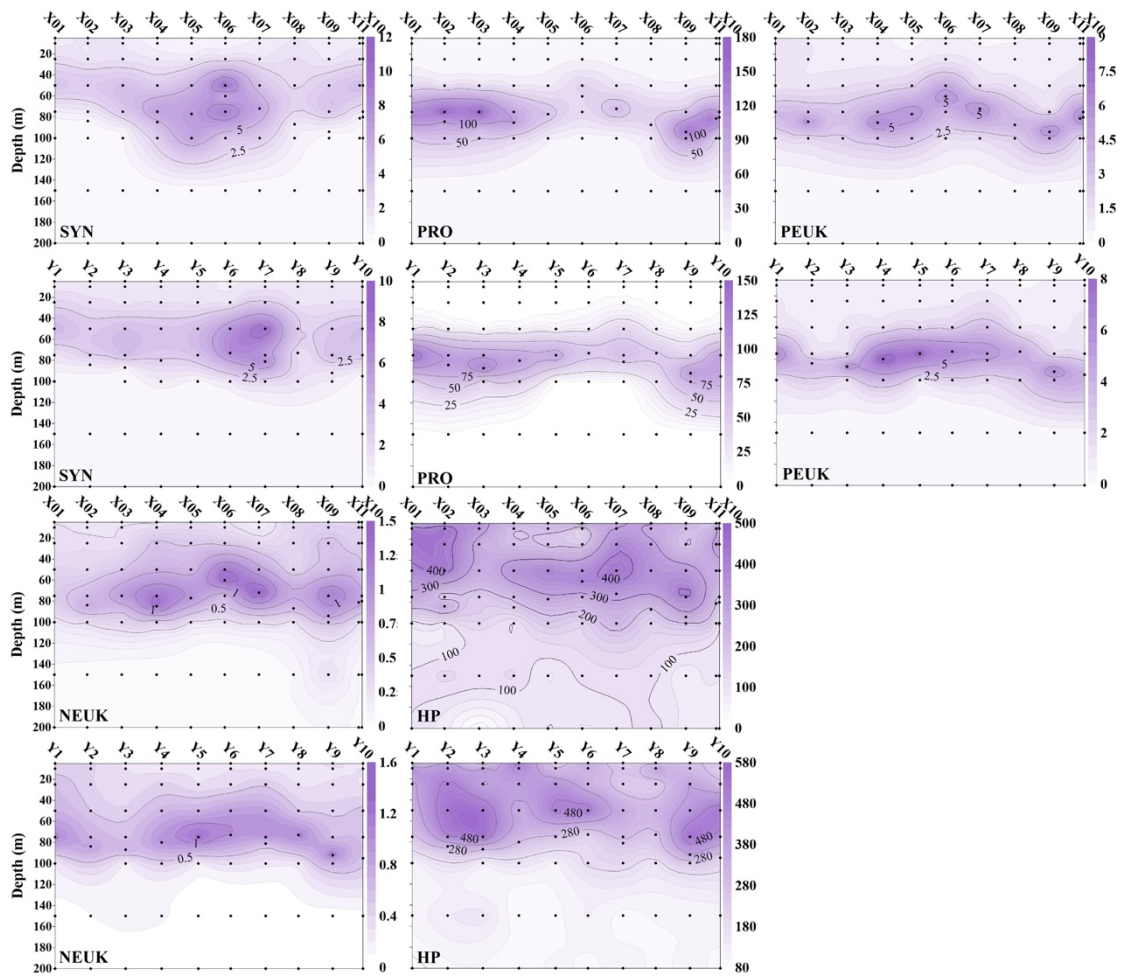


Figure 7 Abundances of picophytoplankton and nano-eukaryotes along the transects X and Y of the eddy region (0–200 m, 10^3 cells/mL).

3) Results from the Transect D

The sampling stations of the Transect D crossed the main axis of the Kuroshio (Figure 8). This design enabled simultaneous collection of samples from both sides of the current, allowing comparisons of microbial food web communities under different water mass conditions. The observations along this transect provided an important opportunity to better understand the influence of the Kuroshio front on the structure of planktonic communities.

Analysis of environmental factors showed that both temperature and salinity profiles along the Transect D exhibited clear uplift, accompanied by chlorophyll-a maxima in the euphotic layer. These features indicate that eddy and frontal processes in this region caused water column disturbances and upwelling, supplying abundant nutrients to

phytoplankton and upper-level consumers (Figure 9).

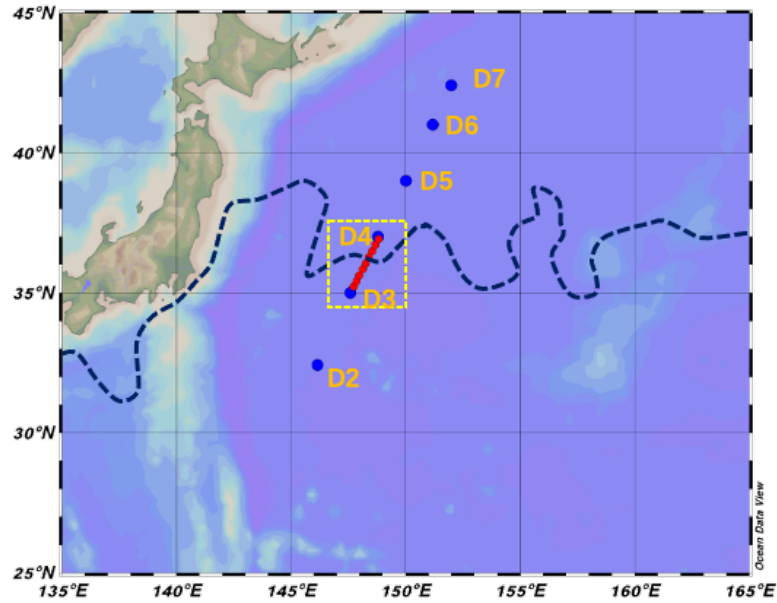


Figure 8 Sampling stations of the Transect D crossing the main axis of the Kuroshio.

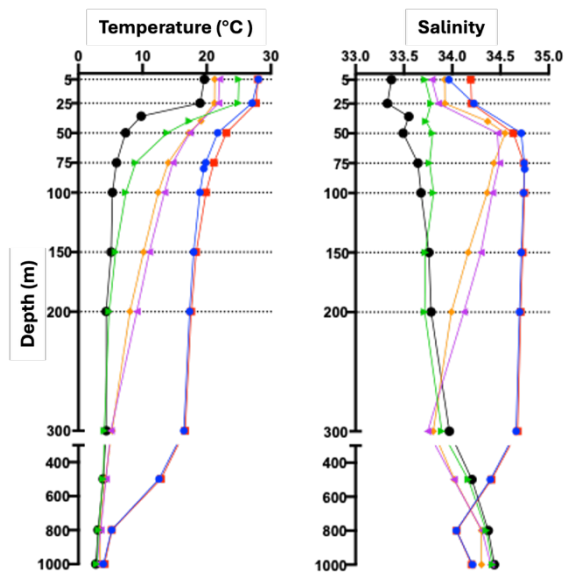


Figure 9 Vertical profiles of temperature and salinity at each station along the Transect D (0–1000 m)

Ciliate communities displayed distribution patterns closely corresponding to these environmental factors. Tintinnids formed abundance maxima between 25–100 m in the euphotic layer, with some groups peaking in the eddy core and others accumulating at the flanks. Aloricate ciliates occurred at higher overall abundances than tintinnids and showed pronounced accumulation in the core. These results revealed two typical

distribution patterns: one type reaching high abundances in the eddy core, and another showing higher abundances on both flanks. This reflects differences in ecological niche utilization among ciliate groups (Figure 10).

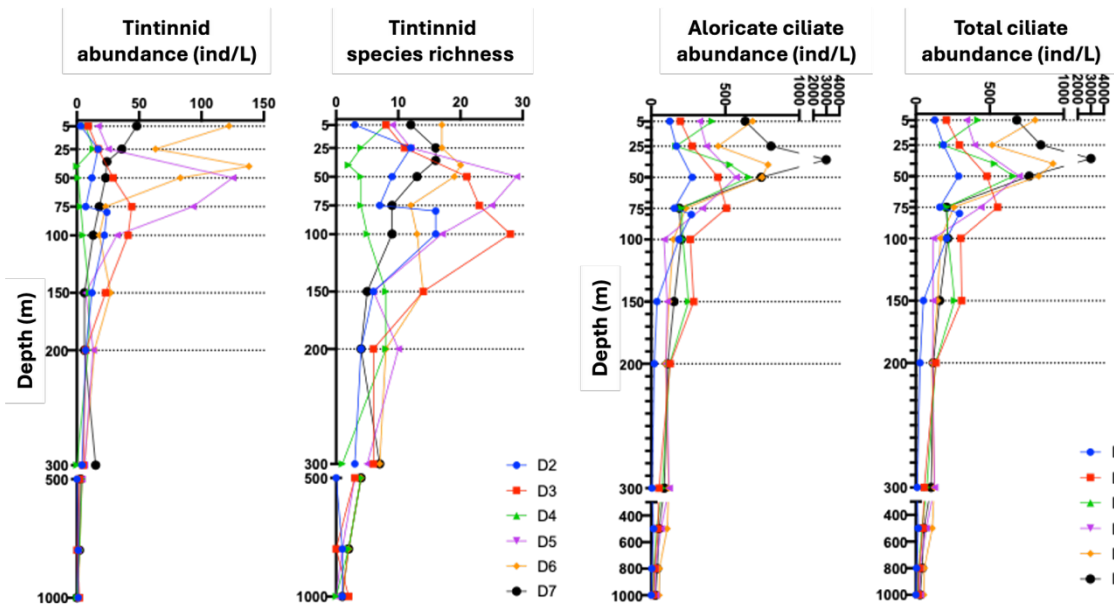


Figure 10 Abundances and species richness of tintinnids and aloricate ciliates along the Transect D.

Picophytoplankton and NEUK showed complementary distribution patterns (Figure 11). SYN reached maximum abundances in the transect core, coinciding with the chlorophyll maximum, indicating a rapid and sensitive response to nutrient upwelling. In contrast, PRO declined significantly in the core, reflecting its adaptation to oligotrophic conditions. PEUK and NEUK occurred at relatively low overall abundances, but exhibited patchy distributions at the transect flanks and in mid-depth waters, suggesting intermittent responses to environmental disturbances. Overall, the observations from the Transect D demonstrate that the coupled effects of frontal and eddy processes exert profound influences on the structure and spatial distribution of microbial food web communities.

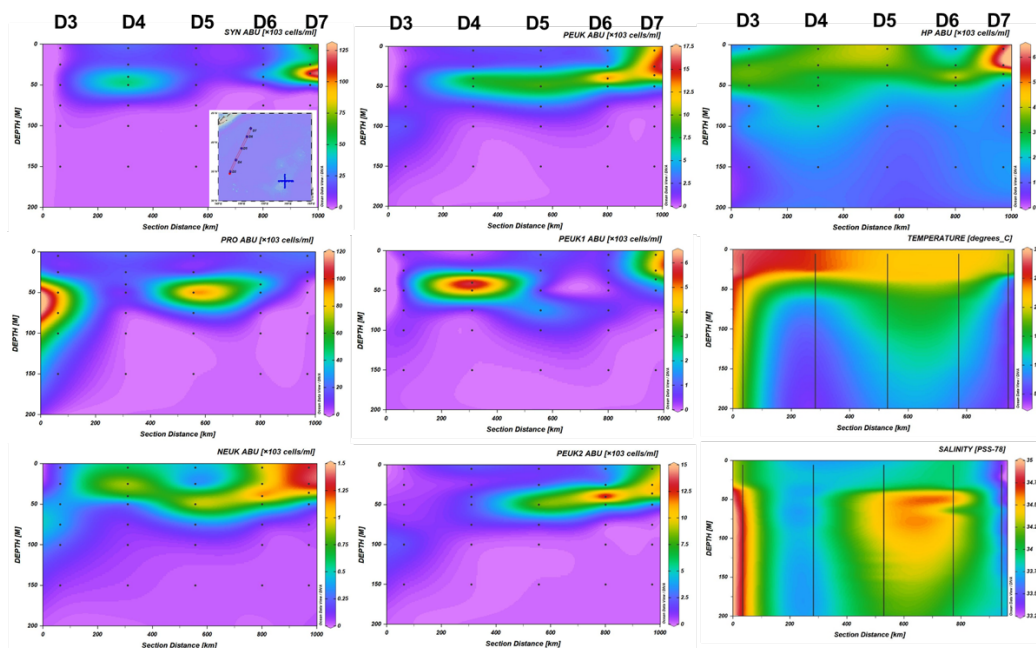


Figure 11 Abundances of picophytoplankton and nanoeukaryotes along the Transect D (0–200 m).

2.2 Microbial Food Webs in Typical Coastal Bays

1) Sampling and observations

In two typical coastal bays, namely Dongshan Bay and Jiaozhou Bay, the project established systematic observation stations and carried out sampling and analyses throughout the year.

In the Zhangjiang Estuary and Dongshan Bay and adjacent waters, seasonal integrated surveys were conducted in 2025, with 13 long-term observation stations designed. Five stations were located in the estuary, and five stations extended from the inner bay channel at DS01 toward the bay mouth at HX-4. On the western and eastern shallow sides of Dongshan Bay, additional stations were set up, including HXH-1 at the intake and outlet of the Zhangzhou Nuclear Power Plant and DS08 near the Gulei Peninsula. Observation parameters included physical, chemical, sedimentary, and biological factors (phytoplankton, zooplankton, benthic organisms, and microorganisms). In addition, hydrographic transects were arranged across the upwelling core near the Dongshan coast and along the main channel of the bay and bay mouth, providing key data on water exchange processes. A station was also set in the thermal discharge area of the nuclear power plant (HXH-2). By 2025, two seasonal cruises had been completed in Dongshan Bay, in February (winter) and May (spring), laying the foundation for systematic studies on the seasonal variation of bay communities.

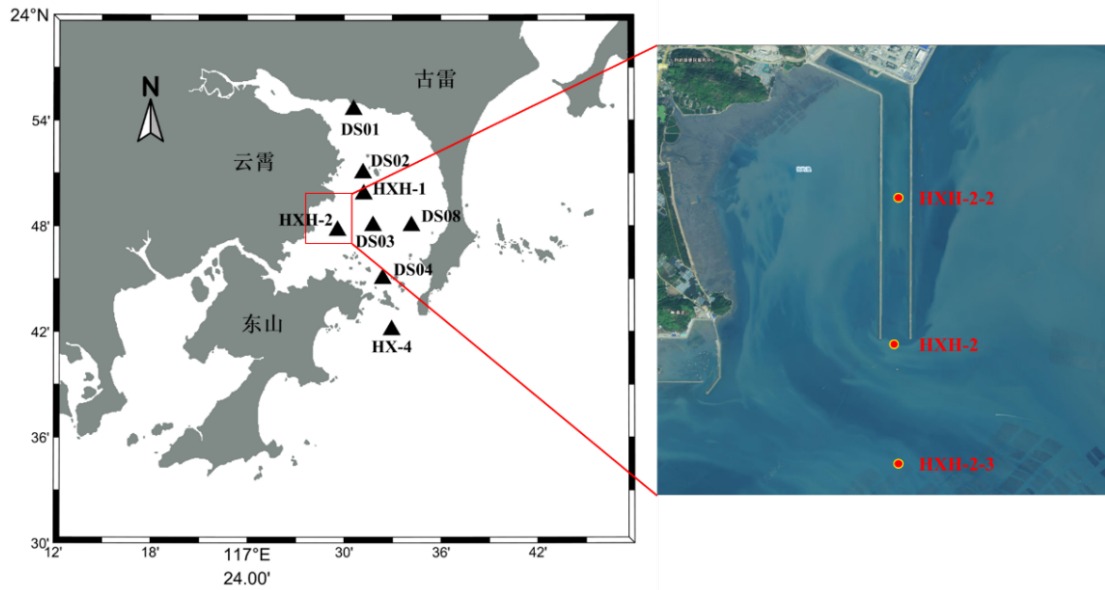


Figure 12 Locations of survey stations in the Zhangjiang Estuary and Dongshan Bay seasonal cruises in 2025.

Table 1 Station information for the Zhangjiang Estuary and Dongshan Bay seasonal cruises in 2025.

Station	Longitude	Latitude	Depth (m)	Sampled Layers	Date of winter cruise	Date of spring cruise
W2	117.41784	23.92676	4.0	0 m	2025.2.26	2025.5.26
W3	117.42505	23.92299	3.5	0 m	2025.2.26	2025.5.26
W4	117.46814	23.91638	2.1	0 m	2025.2.26	2025.5.26
W7	117.43350	23.93191	7.5	0 m, bottom	2025.2.26	2025.5.26
W8	117.42075	23.93674	4.2	0 m	2025.2.26	2025.5.26
DS04	117.54231	23.74713	18.2	0 m, 5 m, 10 m, bottom	2025.2.27	2025.5.27
DS08	117.56859	23.80015	6.6	0 m, bottom	2025.2.27	2025.5.27
DS03	117.53099	23.79871	7.7	0 m, bottom	2025.2.27	2025.5.27
DS02	117.51820	23.84690	10.4	0 m, 5 m, bottom	2025.2.27	2025.5.27
DS01	117.50755	23.91064	2.5	0 m	2025.2.27	2025.5.27
HX-4	117.54720	23.70354	16.3	0 m, 5 m, 10 m, bottom	2025.2.27	2025.5.27
HXH-1	117.52275	23.82613	8.9	0 m, bottom	2025.2.27	2025.5.27
HXH-2-1	117.49381	23.79579	4.4	0 m	2025.2.27	2025.5.27



Figure 13 Field operations of the Zhangjiang Estuary and Dongshan Bay survey cruises in 2025.

In Jiaozhou Bay, monthly sampling was carried out at fixed monitoring stations, covering all 12 months of the year. During sampling, CTD observations and nutrient measurements were combined, resulting in approximately 400 samples of ciliates and picoplankton. In addition, short-term intensive monitoring at intervals of 2–3 days was conducted at selected stations to capture community dynamics on finer temporal scales. The large number of high-resolution biological samples and environmental data provide a solid foundation for revealing the spatiotemporal distribution patterns of microbial food webs in typical coastal bays.

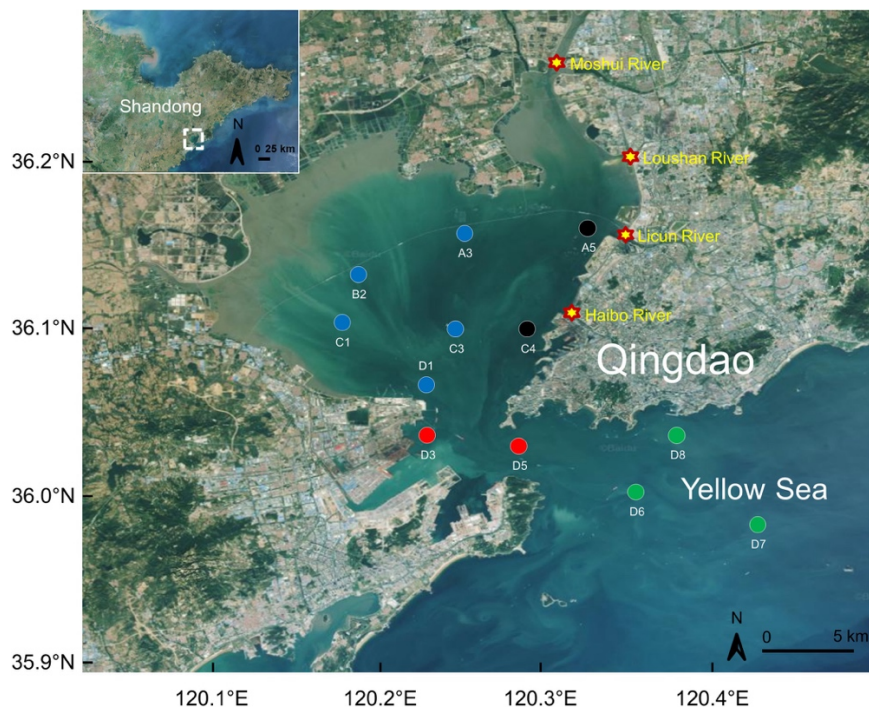


Figure 14 Locations of survey stations in Jiaozhou Bay.



Figure 15 Field operations of the Jiaozhou Bay cruise in June 2025.

Table 2 Station information for the Jiaozhou Bay cruise in 2025.

Station	Longitude	Latitude	Depth (m)
B2	120°11'12"	36°08'00"	3
A3	120°15'00"	36°09'30"	5
A5	120°19'48"	36°09'18"	8
C1	120°10'37"	36°06'16"	6
C3	120°15'00"	36°06'00"	16
C4	120°17'30"	36°06'00"	6
D1	120°14'00"	36°04'00"	15
D3	120°14'00"	36°02'12"	6
D5	120°17'12"	36°01'48"	38
D7	120°25'30"	35°59'00"	18
A1	120°09'24"	36°09'12"	2
D6	120°21'16"	36°00'09"	27
D8	120°22'48"	36°02'01"	17
Y1	120°20'12"	36°11'19"	4

2) Preliminary results of microbial food webs in Dongshan Bay

The preliminary survey results show that in winter 2025, water temperature across the section was generally low, ranging from 14.4 to 15.8 °C. A clear spatial gradient was observed from the bay head to the bay mouth, gradually decreasing seaward. In the vertical direction, stratification of temperature and salinity was not obvious. Salinity ranged from 29 to 31.7, showing a clear horizontal gradient that increased gradually from the bay head to the bay mouth. Vertically, salinity varied only slightly with depth (Figure 16).

During the spring cruise in 2025, water temperatures were significantly higher than in winter, with surface temperatures ranging from 23.5 to 25.5 °C and decreasing gradually from the bay head to the bay mouth. Vertically, slight stratification appeared due to seasonal warming. Salinity was also generally higher than in winter, ranging from 31 to 34, and increased seaward from the bay head to the bay mouth. In seasonal comparison, spring temperatures were about 9–10 °C higher than those in winter, with more pronounced spatial gradients. Freshwater input at the estuary and frontal features at the bay mouth became more evident. Stratification was also more obvious at the bay mouth, with separation between upper and lower layers and the appearance of low-salinity and high-salinity water masses in the lower layer, indicating signals of upwelling (Figure 16).

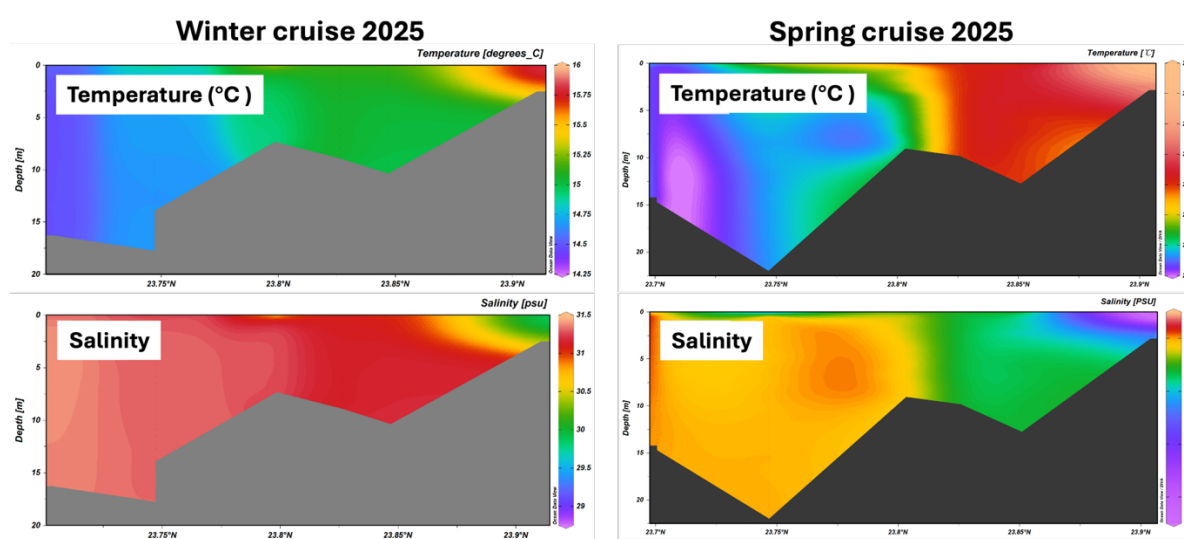


Figure 16 Temperature and salinity along the Dongshan Bay transect during the winter and spring cruises of 2025.

In winter 2025, chlorophyll concentrations were relatively low, ranging from 0.8 to 1.6 $\mu\text{g/L}$. Spatially, the highest values occurred at the bay head and the lowest at the bay mouth, with no clear gradient. Dissolved oxygen concentrations were consistent with chlorophyll distributions, suggesting that oxygen levels were mainly controlled by phytoplankton photosynthesis. In spring, average chlorophyll concentrations remained low, with no significant differences compared with winter, ranging from 1.0 to 1.175 $\mu\text{g/L}$. The spatial distribution was more uniform from the bay head to the bay mouth. Chlorophyll and dissolved oxygen concentrations were lowest at the bay mouth, indicating weak upwelling during spring. Stratification of the surface waters restricted the upward transport of nutrients.

With respect to phytoplankton composition, the Zhangjiang Estuary and Dongshan Bay exhibited clear spatial and seasonal differences. In winter 2025, stations in the

Zhangjiang Estuary were dominated by diatoms, Chlorophyta, prasinophytes, and cryptophytes. Chlorophyll a biomass ranged from 0.9 to 14 $\mu\text{g/L}$, which was significantly higher than in the bay stations. At Dongshan Bay stations, the proportion of diatoms increased, with diatoms, prasinophytes, and cryptophytes as the dominant groups. In spring 2025, stations in the Zhangjiang Estuary were dominated by diatoms, cryptophytes, Chlorophyta, and cyanobacteria, with chlorophyll a biomass ranging from 0.8 to 5.1 $\mu\text{g/L}$, again significantly higher than in the bay stations. At Dongshan Bay stations, diatoms accounted for more than 60%, while other major groups included cryptophytes, prasinophytes, and Chlorophyta.

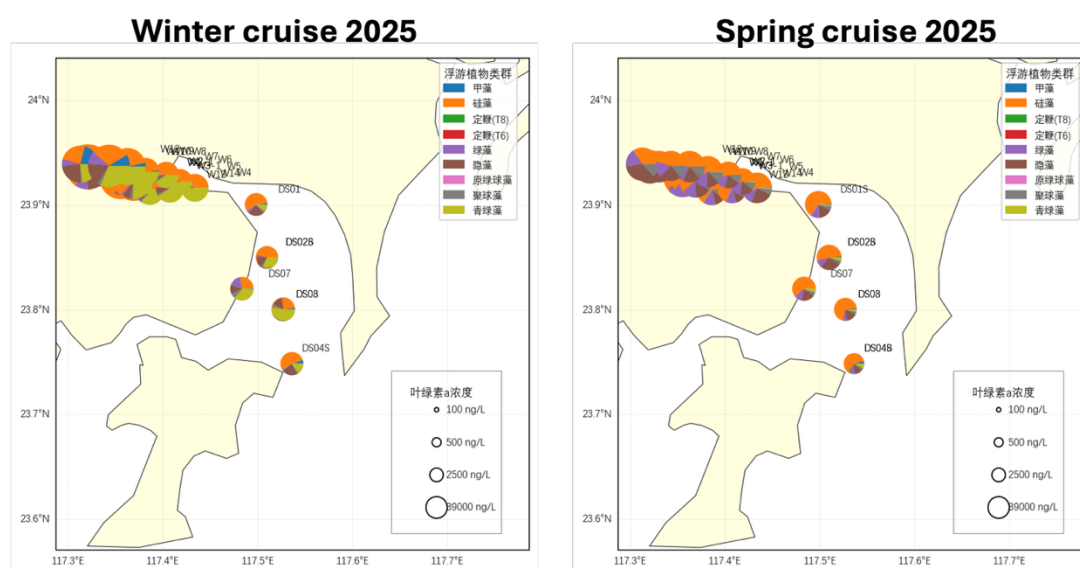


Figure 17 Phytoplankton composition in the surface waters of the Zhangjiang Estuary and Dongshan Bay during the winter and spring cruises of 2025.

3) Microalgal diversity in Jiaozhou Bay

As an illustration, results from the May 2025 survey in Jiaozhou Bay are presented. Twelve sampling stations were established in Jiaozhou Bay. Surface seawater samples were collected and examined microscopically for taxonomic identification and classification, providing a relatively complete dataset on community composition.

Surface water temperatures ranged from 14.43 to 18.89 $^{\circ}\text{C}$, with an average of 16.03 ± 1.41 $^{\circ}\text{C}$. Temperatures were relatively low at the bay mouth and adjacent offshore waters (around 14–15 $^{\circ}\text{C}$), while higher values up to 18.89 $^{\circ}\text{C}$ were recorded in inner bay areas, especially in nearshore zones. This pattern reflects the combined influence of riverine input, heating of shallow waters, and local meteorological conditions. Overall,

temperature increased gradually from the bay mouth toward the inner bay, showing a typical hydrological distribution pattern of coastal bays in spring (Figure 18).

Surface salinity ranged from 27.65 to 30.73, with an average of 30.19 ± 0.90 . Higher values (>30.5) occurred at the bay mouth and outer bay, while lower salinities (about 27.65–28.50) were observed in nearshore and estuarine areas. This indicates significant influence of freshwater input on local salinity distribution. Isohalines showed an increasing trend toward the open sea, reflecting the combined effects of freshwater dilution and exchange with offshore high-salinity waters.

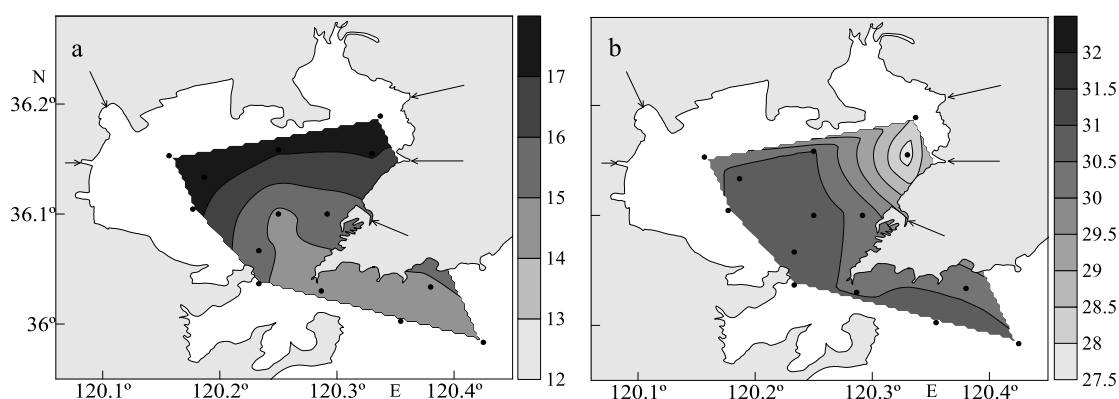


Figure 18 Surface distributions of temperature (a, °C) and salinity (b) in Jiaozhou Bay in May 2025.

Overall, surface water temperatures in Jiaozhou Bay during the survey were controlled by meteorological conditions and water depth, with higher values in the inner bay and lower values at the bay mouth. Salinity distribution was primarily regulated by freshwater discharge and tidal exchange, forming a clear land–sea gradient. These hydrological features provided the environmental background for plankton community distribution and nutrient dynamics, and revealed spatial heterogeneity in water exchange and ecological processes.

Figure 19 shows the spatial distributions of surface dissolved oxygen (DO) and pH during the May survey. Surface DO concentrations ranged from 7.44 to 10.15 mg/L, with an average of 8.50 ± 0.68 mg/L, generally at a high level. Higher values were mainly observed at the bay mouth and outer bay, exceeding 10 mg/L in some areas. This may be associated with exchange with offshore oxygen-rich waters and enhanced phytoplankton photosynthesis in spring. Lower values of about 7.5–8.0 mg/L occurred in some inner bay areas, likely reflecting organic matter decomposition and limited water mixing. In general, DO concentrations decreased gradually from the bay mouth toward the inner bay, indicating spatial differences in water exchange and ecological processes.

Surface pH ranged from 7.97 to 8.27, with an average of 8.13 ± 0.09 , showing weak

alkalinity. Higher values occurred mainly at the bay mouth and in some nearshore waters, reflecting phytoplankton photosynthetic consumption of CO₂ as well as inputs from offshore waters. Lower values (around 7.97–8.05) were recorded in inner bay areas, likely influenced by terrestrial inputs and organic matter respiration and decomposition. The overall distribution of pH was broadly consistent with that of DO, both showing higher values at the bay mouth and lower values in the inner bay.

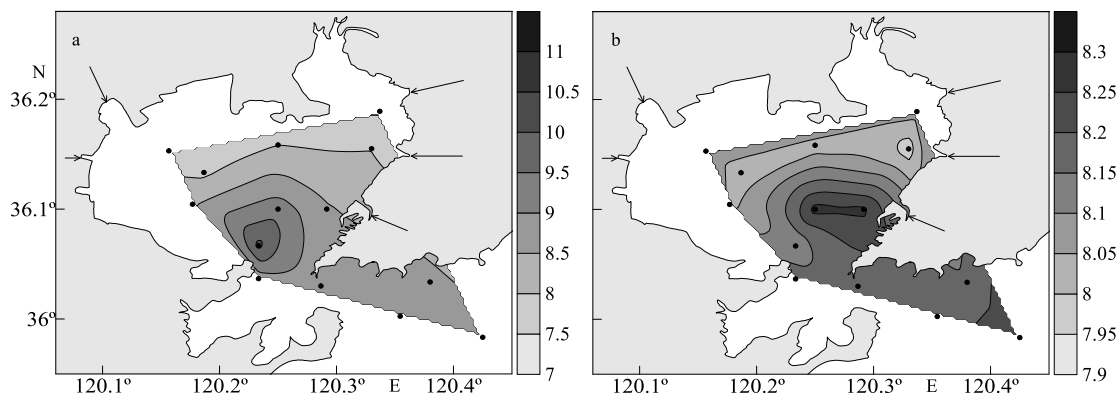


Figure 19 Surface distributions of dissolved oxygen (a, mg/L) and pH (b) in Jiaozhou Bay in May 2025.

The spatial distributions of DO and pH not only reflect the influence of water exchange and terrestrial inputs, but also reveal the regulatory role of phytoplankton metabolic processes on water chemistry. Higher DO and pH values are favorable for maintaining ecological health in surface waters, whereas local low-value areas may indicate potential increases in organic matter load or insufficient hydrodynamic mixing. These findings provide important background for further analysis of plankton distribution and carbon cycling.

Survey results showed that the algal community in Jiaozhou Bay exhibited high species diversity, with the number of eukaryotic algal species ranging from 25 to 38. Community abundances were generally at the level of 10^3 – 10^4 cells/L, with some stations exceeding 1.5×10^4 cells/L. Dominant groups differed significantly among stations. Bloom-forming algae dominated at most stations, accounting for 45%–83% of the total community.

Overall, the number of bloom-forming algal species across the 12 sampling stations ranged from 12 to 23, showing marked spatial differences. Higher proportions of bloom-forming algae were observed in outer bay and near bay mouth stations (e.g., D6, D7, D8) and central bay stations (e.g., D1, C3), while lower proportions occurred in the western bay (A3, B2, C1) and northeastern bay (A5, C4). In terms of dominant species composition, *Chaetoceros* spp. were overwhelmingly dominant at most stations, particularly at the bay mouth and central bay. At D1 (79.90%), D3 (72.10%), D5 (83.60%), D6 (80.10%), D7 (75.30%), D8 (83.70%), and C3 (87.30%), the proportion of *Chaetoceros*

spp. among bloom-forming algae exceeded 70%. This distribution pattern reflects the strong adaptation of *Chaetoceros* spp. to the outer bay and well-exchanged waters. In contrast, *Cryptomonas* sp. showed growth advantages in the western bay (A3, 52.90%; C1, 32.00%) and northeastern bay (C4, 24.00%), likely associated with high water mixing and abundant dissolved organic matter. At A5 in the northwestern bay, *Gonyaulax* sp. showed ecological dominance (46.00%), while station B2 was dominated by *Nitzschia* spp. (60.40%).

These results reveal clear spatial differentiation of microalgal communities in a typical coastal bay, highlighting the significant influence of water mass conditions and nutrient environments on community composition and abundance levels.

III. Scientific Activities

3.1 Participation in the CAS–CNRS Annual Bilateral Strategic Dialogue

On 10 June 2025, project members attended the annual bilateral strategic dialogue between the Chinese Academy of Sciences (CAS) and the French National Centre for Scientific Research (CNRS) in Paris (Figure 20). The meeting was co-chaired by CAS President Hou Jianguo and CNRS President Antoine Petit. Discussions focused on bilateral cooperation in fields such as marine science, renewable energy, and global change, and both sides exchanged views on the strategic direction for joint laboratory development and scientific collaboration.

During the dialogue, G  rald Gr  gori presented recent progress of the Sino–French Joint Laboratory of Marine Microbial Ecology, with emphasis on cooperative achievements in observations of typical bays and the open ocean. This dialogue further strengthened mutual trust and collaboration between China and France in the field of marine ecological processes and observational technologies, laying a solid foundation for future in-depth cooperation.



Figure 20 Wuchang Zhang (first from left) and G  rald Gr  gori (second from right) attending the CAS–CNRS Annual Bilateral Strategic Dialogue.

3.2 Visit of the Chinese team to the Mediterranean Institute of Oceanography (MIO)

From 8 to 17 June 2025, Wuchang Zhang and Yuan Zhao visited the Mediterranean Institute of Oceanography (MIO). During a week-long collaboration, both sides held systematic and in-depth academic discussions on topics including ecological processes of marine microbial communities, the application of flow cytometry in in situ observations, cross-regional ecological data comparison, and the establishment of standardized methods.

The two sides jointly reviewed the research progress achieved during the first phase of the joint laboratory. Building on the complementary strengths of China and France in sampling, data processing, and model construction, they co-designed the framework for the second phase of collaboration, identifying high-frequency ecological observations and cross-latitude comparisons as the core tasks, while expanding research on microbial responses to extreme environments. Multiple exchanges were also conducted with G  rald Gr  gori regarding CNRS’s second-phase funding plan, advancing preparations for a joint proposal and forming an initial research framework.



Figure 21 Wuchang Zhang engaging in academic discussions with the French team at MIO.

On 13 June 2025, Tang Danling's team, together with Zhang Wuchang, Zhao Yuan, G rard Gr gori, and Th o Garcia, held an online meeting to exchange results from the Mediterranean BioSWOT cruise. The meeting also confirmed the collaboration framework for satellite remote sensing analysis of picophytoplankton distributions during the cruise.



Figure 22 Online meeting between Chinese and French project members.

3.3 Project members convening and chairing a session at the EGU General Assembly 2025

On 1 May 2025, Prof. Xiaoxia Sun convened and chaired a session at the European Geosciences Union (EGU) General Assembly in Vienna, entitled "Effects of Anthropogenic Pressure and Climate Change on Coastal and Marine Ecosystems." The session focused on the responses of marine ecosystems to the combined effects of climate change and human activities. Discussions covered integrated observation

system development, carbon and nutrient cycling, extreme events and ecological impacts, ocean acidification, and ecosystem restoration. The session attracted researchers from multiple countries and promoted cross-disciplinary and international collaboration.

At this session, Associate Researcher Shujin Guo delivered a presentation entitled “Long-term variation of phytoplankton community in the southern Yellow Sea (1959–2023).” The report provided a systematic overview of the long-term changes in phytoplankton communities and their driving mechanisms, and stimulated in-depth discussion with scholars from both China and abroad.



Figure 23 Xiaoxia Sun chairing the EGU General Assembly session.

3.4 Survey of Buoy No. 22 at the East China Sea Station

From 11 to 14 January 2025, Project Coordinator Wuchang Zhang conducted a field survey of Buoy No. 22 during its maintenance at the East China Sea Station of the Nearshore Ocean Observation and Research Network of the Chinese Academy of Sciences. The buoy, with a diameter of 15 m and a weight of about 170 tons, is fixed with a three-anchor system. It represents China’s first integrated observation and experimental platform of this scale, with the largest diameter, the most comprehensive set of observational parameters, and the highest degree of automation. The buoy is capable of continuously collecting multi-parameter data on meteorology, hydrology, water quality, and vertical profiles in the northern waters near Shengshan Island, Zhoushan. It provides valuable support for research on long-term changes, fisheries

development, and disaster forecasting (Figure 24).

During the inspection, special attention was given to evaluating the buoy's power supply and internal cabin layout. The results confirmed that the platform is capable of supporting a flow cytometer, which could be used for high-frequency in situ observations lasting two weeks to one month. This deployment would provide an ideal experimental platform for continuous monitoring of microbial food webs and serve as a practical foundation for the long-term application and validation of automated in situ flow cytometry.



Figure 24 Buoy No. 22 at the East China Sea Station and internal cabin layout.

3.5 Exhibition of Female Scientists from China and France

On the occasion of the 60th anniversary of diplomatic relations between China and France, the French National Centre for Scientific Research (CNRS) and the French Association “Women & Science” (F&S) jointly launched the exhibition “*The Power of Women in Science.*” The exhibition was co-organized by the French Embassy in China and the Science Communication Center of the China Association for Science and Technology. It was held at the National Science Communication Center in Beijing from November 2024 to February 2025, and later opened as a touring exhibition at the Talent Park in Shenzhen in April 2025.

The exhibition showcased 20 newly photographed portraits of Chinese female scientists, along with 20 portraits of French female scientists that had already been displayed in six cities across France (Toulouse, Paris, Lyon, Grenoble, Clermont-Ferrand, and Marseille). The exhibition highlighted the talent of women researchers and the importance of Sino–French scientific cooperation.

Two members of the project team, Danling Tang and Yuan Zhao, were selected as part of the exhibition. Their portraits were displayed as representative female scientists engaged in Sino–French collaborative research. This not only demonstrated their significant contributions to marine science, but also underscored the project team’s active role in Sino–French cooperation.



Figure 25 Group photo at the opening ceremony of the Beijing exhibition.



Figure 26 Exhibition panels of Danling Tang and Yuan Zhao

IV. Project Progress and Implementation Status

All project activities during this stage proceeded smoothly according to the established plan. Research tasks and scientific activities were carried out within the expected scope, and the overall progress is consistent with the annual plan. Moving forward, the project will continue to focus on the two main research themes: mesoscale processes and microbial food webs in typical coastal bays. Emphasis will be placed on advancing sample analysis, data integration, international collaboration, and the construction of joint observation platforms, to ensure the achievement of the overall project objectives.



Figure 27 Gantt chart of the project plan as specified in the task document.