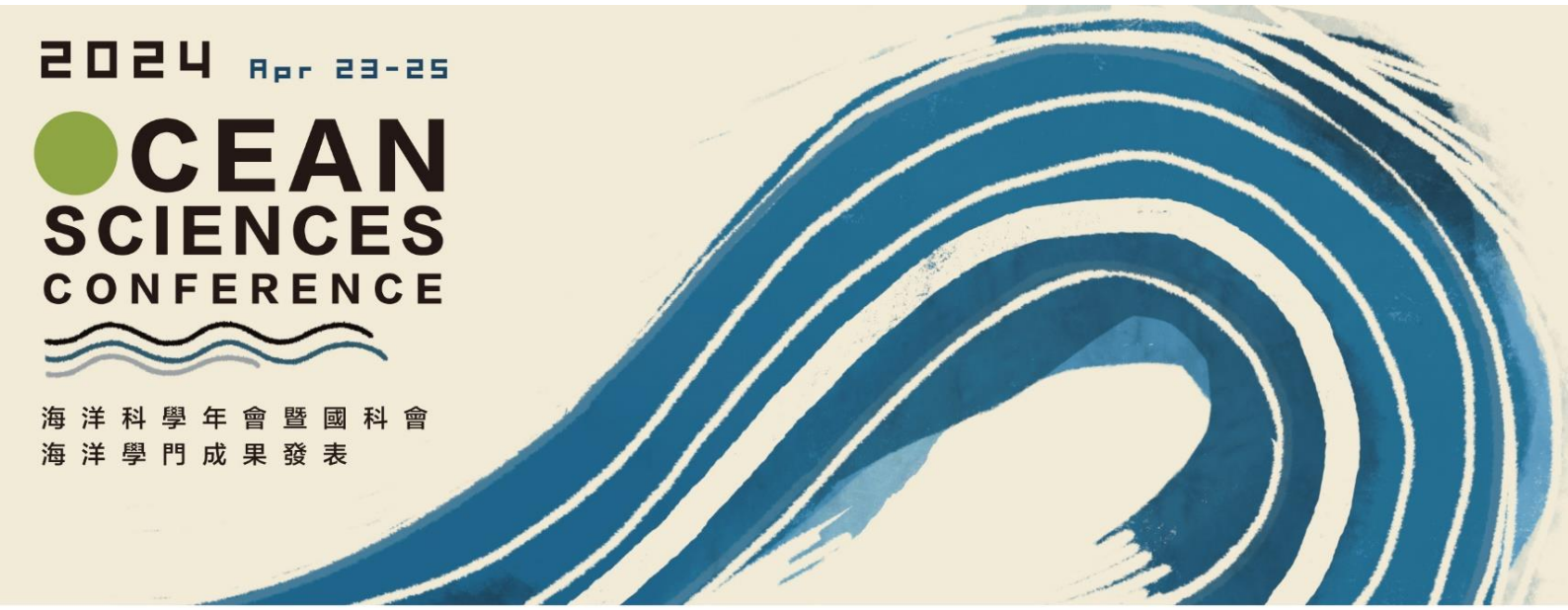
2024 年海洋科學年會暨國科會海洋學門成果發表

2024 Ocean Sciences Conference

摘要議程

| 0423-0425 | 新竹 | 北埔 | 麻布山林 |



共同主辦單位：

國科會地球科學研究推動中心

海洋委員會海洋保育署

財團法人國家實驗研究院台灣海洋科技研究中心

國立臺灣大學海洋研究所

國立臺灣海洋大學海洋科學與資源學院

承辦單位：中華民國海洋學會

目錄

會議宗旨

海洋科學年會為臺灣海洋科學界年度盛會，2024 年 4 月 23 日至 4 月 25 日於新竹北埔麻布山林舉辦。本次年會舉辦方式由海洋學界相關領域老師、研究人員、博士後研究人員、學生及助理於海洋科學年會中報告最新的研究進展與成果。內容涵括除了四大議程：海洋物理、海洋化學、海洋地質/地球物理與海洋生物/漁業，今年新增海洋生物多樣性及保育，以求更廣泛的學術交流。

本次會議內容涵蓋：各議程演講、海報展示及海報競賽；如同以往舉辦青年論壇，評選出優秀學生報告，頒發獎項以茲鼓勵。會議首日將邀請大會演講者(邀請中)與各國家研究船隊及貴儀中心與資料庫進行 15 分鐘成果發表報告。與會者除了可以分享最新的研究成果和進展外，於會議中的交流更有助於學者間相互瞭解與溝通，並提供年輕學子們一個學習分享的平台，也能為推廣海洋科學研究及教育紮下厚實的根基。

會議組織

一、召集人：

楊穎堅：中華民國海洋學會理事長

二、共同主辦單位：

國科會地球科學研究推動中心
海洋委員會海洋保育署
財團法人國家實驗研究院台灣海洋科技研究中心
國立臺灣大學海洋研究所
國立臺灣海洋大學海洋科學與資源學院

三、承辦單位：中華民國海洋學會

議程與召集人

議程	類別	召集人
國家研究船隊事務(含貴儀中心及資料庫)綜合報告 National Fleet of Research Vessels (Marine Instrument Center and ODB)	OC	楊穎堅 中華民國海洋學會理事長
海洋學門基礎領域(含貴儀及資料庫助理/技術員報告)		
海洋物理 Physical Oceanography	OC-P	張明輝 國立臺灣大學教授
海洋化學 Chemical Oceanography and Marine Chemistry	OC-C	周文臣 國立臺灣海洋大學教授
海洋地質/地球物理 Marine Geology & Geophysics	OCGS-MG	陳明德 國立臺灣海洋大學教授
海洋生物/漁業 Biological Oceanography and Marine Biology	OC-B	陳仲吉 國立臺灣師範大學教授
海洋生物多樣性及保育 Marine Biodiversity and Conservation	OC-A	陳韋仁 國立臺灣大學教授

論文編號說明

※海報競賽：PC-M-N

M 代表海報組別；N 代表海報於該組之次序，代號與組別對應如下：

B：海報競賽生物漁業組

如 PC-B-1 為海報競賽生物漁業第一號

B：海報競賽生物組：如 PC-B-1 為海報競賽生物組第一號

C：海報競賽化學組：如 PC-C-1 為海報競賽化學組第一號

G：海報競賽地質地物組：如 PC-G-1 為海報競賽地質地物組第一號

P：海報競賽物理組：如 PC-P-1 為海報競賽化學組第一號

※海報展示：P-M-N

M 代表海報組別；N 代表海報於該組之次序，代號與組別對應如下：

OC：海報展示國家研究船事務(含貴儀中心及資料庫)綜合報告組

如 P-OC-1 為海報展示國家研究船事務(含貴儀中心及資料庫)綜合報告組第一號

OCA：海報展示海洋生物多樣性及保育組

如 P-OCA-1 為海報展示海洋生物多樣性及保育組第一號

OCB：海報展示生物與漁業組

如 P-OCB-1 為海報展示生物與漁業組第一號

OCC：海報展示化學組

如 P-OCC-1 為海報競賽化學組第一號

OCG：海報展示地質/地物組

如 P-OCG-1 為海報競賽地質/地物組第一號

OCP：海報展示物理組

如 P-OCP-1 為海報競賽組物理組第一號

會議議程

4月23日(星期二)

	詠山館三樓M31					
8:00-8:30	簽到 / 報到 (學會服務攤位&廠商攤位：詠山館二樓廊廳)					
8:30-8:40	【開幕式】海洋學理事長致詞/海洋學門召集人致詞					
8:40-9:20	大會演講_黃金維 (含Q&A時間) The SWOT mission: a radar interferometry altimeter advancing the measurements of Earth's surface water and ocean topography SWOT衛星任務：雷達干涉測高技術在地球表面水體及海洋地形測量的突破					
9:20-10:00	大會演講_詹森 (含Q&A時間) 題目：黑潮震盪					
10:00-10:20	休息/茶點時間					
10:20-10:30	貴賓致詞					
10:30-12:00	研究船隊與貴儀合併年度績效報告 (各15分鐘) 10:30-10:45國家研究船隊總計畫 10:45-11:00新海研1號及貴儀中心 11:00-11:15新海研2號及貴儀中心 11:15-11:30新海研3號及貴儀中心 11:30-11:45勵進研究船 11:45-12:00海洋學門資料庫					
12:00-13:00	午餐休息 (加購午餐者請至富森餐廳領取及用餐)					
	詠山館M21	詠山館M22	草堂A	草堂B	詠山館一樓	
13:00-13:15	詹森	康利國★	許介瑋★		海報展示	海報競賽
13:15-13:30	何宗儒	陳仲吉	Shraddha Band			
13:30-13:45	張明輝★	何珮綺	陳松春	洪佳章		
13:45-14:00	鄭宇昕	塗子萱	劉祖乾	洪慶章★		
14:00-14:15	方盈智	鍾至青	蔣正興	陳鎮東		
14:15-14:30	陳世楠	江俊億	潘惠娟	曾筱君★		
14:30-14:45	黃金維	林秀瑾★	張日新★	方天熹		
14:45-15:00	陳佳琳★	呂曉沛	Elena Dominguez Valdes			
15:00-15:15			林慧玲			
15:00-15:30	休息/茶點時間					
15:30-15:45	楊穎堅	林裕薳★		陳建志		
15:45-16:00	吳朝榮	李明安		簡國童★		
16:00-16:15	潘任飛★	Sandipan Mondal		周文臣		
16:15-16:30	曾于恆	吳研綸		施詠嚴		
16:30-16:45	許哲源	鍾明宗★		陳宗岳★		
16:45-17:00	譚子偉★	江偉全				
18:00-21:00	晚宴(富森餐廳)					

★各場次主持人　物理　生物漁業　地質地物　化學

會議議程

4月24日(星期三)

	詠山館M21		詠山館M22		草堂A		草堂B		詠山館M32	詠山館一樓	
8:00-8:15	藍亦汝(青)	**物理組青年論壇評審**							多樣性與保育青年論壇評審	**海報展示**	**海報競賽**
8:15-8:30	江柏勳(青)	1.鄭宇昕(海洋大學) 2.許哲源(臺灣大學) 3.陳佳琳(成功大學) **4.方盈智(中山大學)★**	陳品嶧(青)	**生物漁業組青年論壇評審**	張翠玉				**1.柯佳吟(臺灣大學)★** 2. 陳韋仁(臺灣大學) **3.塗子萱(中山大學)★**		
8:30-8:45	莊采玲(青)		陳薇伊(青)	**1.鍾明宗(臺灣大學)★** 2.呂曉沛(成功大學) **3.林裕嘉(中山大學)★** 4. 托星豪(中山大學)	Fenies Pierrick		Mariche B. Natividad(青)	**化學組青年論壇評審**	**海保署計畫成果報告**		
8:45-9:00	郭仲諒(青)		蕭民煌(青)		Jeroen Groeneveld		Vicente G. Abedneko(青)	1.謝玉德(臺灣大學) 2.陳建志(高科大) **3.黃蔚人(中山大學)★** **4.施詠嚴(海軍官校)★**	陳韋仁★		
9:00-9:15	林伯謙(青)		Irene Lim Chia Ling(青)		吳祚任★		林依宣(青)		王德嫊		
9:15-9:30	楊博元(青)		古佳正(青)		RAUL TAPIA		楊博凱(青)		Lauriane Ribas-Deulofeu		
9:30-9:45	李皓元(青)		梁婷濱(青)		林玉詩		劉亭妏(青)		蔡佳蓉 (青)		
9:45-10:00	游千霈(青)		謝騏遠(青)		賀詩琳		林嘉瀚(青)		10:15-10:30 陳彥妤 (青)		
10:00-10:15	Quoc Hiep, Tong(青)		休息/茶點時間						陳昕 (青)		
10:00-10:30									Rebeca Alvarado(青)		
10:30-10:45	陳冠宇		時繼宇(青)	**1. 鍾明宗(臺灣大學)★** 2. 呂曉沛(成功大學) **3. 林裕嘉(中山大學)★** 4. 托星豪(中山大學)	李佩庭(青)	**地質地物組青年論壇評審**	吳亞臻(青)	**化學組青年論壇評審**	柯佳吟		
10:45-11:00	鄭志文★		李維祐(青)		Akshat Gopalakrishnan(青)	**1.潘惠娟(海洋大學)★** **2.賀詩琳(臺灣大學)★** 3. 張日新(臺灣大學) 4. 許介瑋(高科大)	李俞靜(青)	1.謝玉德(臺灣大學) 2.陳建志(高科大) **3.黃蔚人(中山大學)★** **4.施詠嚴(海軍官校)★**	黃婧雲		
11:00-11:15	許伯駿		袁子倫		董如芸(青)		吳文淮(青)		張貴鈞		
11:15-11:30	黃千芬		Aafaq Nazir		黃逸軒(青)		吳紫菊(青)		童婧惠		
11:30-11:45	曹俊和★		蔡安益★		卓冠宇(青)		邱韋豪(青)		黃玉萱		
11:45-12:00	林幼淳		王怡甄		蔡宏霖(青)		鄭喬方(青)				
12:00-12:15	黃志誠										
12:00-13:00	★各場次主持人				**午餐休息 (加購午餐者請至園區入口旁富森餐廳領取及用餐)**						
13:00-15:00	**海報競賽評分時間(地點：詠山館一樓)** **【物理組評審】林幼淳(海洋大學)/簡嘉德(臺灣大學)/許伯駿(中央大學)/譚子偉(海軍官校)** **【化學組評審】雷漢杰(中山大學)/施詠嚴(海軍官校)/陳建志(高雄科技大學)** **【地質地物組評審】潘惠娟(海洋大學)/張日新(臺灣大學)/許介瑋(高科大)** **【生物漁業組評審】鍾明宗(臺灣大學)/呂曉沛(成功大學)/塗子萱(中山大學)/托星豪(中山大學)**								13:30-15:00 海洋保護區 圓桌會議		
15:00-15:30	休息/茶點時間										
15:30-17:00	**海報競賽評分時間(地點：詠山館一樓)** **【物理組評審】林幼淳(海洋大學)/簡嘉德(臺灣大學)/許伯駿(中央大學)/譚子偉(海軍官校)** **【化學組評審】雷漢杰(中山大學)/施詠嚴(海軍官校)/陳建志(高雄科技大學)** **【地質地物組評審】潘惠娟(海洋大學)/張日新(臺灣大學)/許介瑋(高科大)** **【生物漁業組評審】鍾明宗(臺灣大學)/呂曉沛(成功大學)/塗子萱(中山大學)/托星豪(中山大學)**										

物理	生物漁業	地質地物	化學	多樣性與保育
青年論壇	青年論壇	青年論壇	青年論壇	青年論壇

會議議程

4月25日(星期四)

	詠山館M21	詠山館M22		詠山館M32	詠山館一樓	
8:00-8:15		吳美琳(青)	多樣性與保育青年論壇評審		海報展示	海報競賽
8:15-8:30	許瑞峯★	GRACE PUTRIAYU ANGELICA SITORUS(青)				
8:30-8:45	雷漢杰	劉愷程(青)	1.陳韋仁(臺灣大學)★ 2.陳孟仙(中山大學)★ 3.塗子萱(中山大學)			
8:45-9:00	黃蔚人	李良能(青)				
9:00-9:15	莊佩涓	劉瀚淮(青)		何東垣		
9:15-9:30		Subramani Thirunavukkarasu(青)		任昊佳		
9:30-9:45		樊同雲		謝玉德★		
9:45-10:00		藍國維		廖文軒		
10:00-10:15		詹雅帆★		謝志強		
10:15-10:30		林芸琪		張順恩		
10:30-10:45		陳孟仙		托星豪		
10:45-11:00		何宣慶		簡嘉德		
11:00-11:15		Lorenzo C. Halasan		林卉婷		
11:15-11:30		Crystal McRae		李承軒		
11:30-11:45						
11:45-12:30	閉幕式及頒獎 詠山館M21教室					
12:30-13:00	大會撤場					

★各場次主持人

地質地物	化學	多樣性與保育	GEOTRACES and BioGeoSCAPES
青年論壇	青年論壇	青年論壇	

4 月 23 日星期二上午議程

詠山館三樓 M31		
8:00-8:30		**簽到 / 報到 (學會服務攤位&廠商攤位：詠山館二樓廊廳)**
8:30-8:40		**【開幕式】海洋學理事長致詞/海洋學門召集人致詞**
8:40-10:00		**大會專題演講**
開始	講者	講題
8:40	**黃金維**	The SWOT mission: a radar interferometry altimeter advancing the measurements of Earth's surface water and ocean topography
9:20	**詹森**	黑潮震盪
10:00-10:20		休息/茶點時間
10:20-10:30		貴賓致詞
10:30-12:00		研究船隊與貴儀合併年度績效報告 (各 15 分鐘)
10:30		國家研究船隊總計畫
10:45		新海研 1 號及貴儀中心
11:00		新海研 2 號及貴儀中心
11:15		新海研 3 號及貴儀中心
11:30		勵進研究船
11:45		海洋學門資料庫

4 月 23 日星期二下午議程

詠山館 M21		物理專題演講	
開始	講者	講題	頁數
主持人：張明輝 / 陳佳琳			
13:00	詹森	航向藍海：2023 勵進 2308 帛琉航次觀測之北太平洋中尺度氣旋減弱現象	P39
13:15	何宗儒	台灣東部黑潮截斷事件對北南海渦度的影響	P40
13:30	張明輝	綠島背流處渦漩研究之回顧與進展	P41
13:45	鄭宇昕	Observations of Leeward Vorticity Evolution Induced by Kuroshio Passage Past a Sharp Cape	P42
14:00	方盈智	Water column variability when mesoscale eddiy impinges on the Kuroshio	P43
14:15	陳世楠	Application of a simple diffusivity formulation to examine jet–eddy energy partitioning in quasi- geostrophic turbulence	P44
14:30	黃金維		P45
14:45	陳佳琳	A Divergence and Vorticity View of Nonlinear Oceanic Lee Wave Obtained by A Two-vessel Survey	P46
15:00-15:30		休息/茶點時間	
主持人：**潘任飛 / 譚子偉**			
15:30	楊穎堅	颱風所引起的上層海洋紊流混合	P47
15:45	吳朝榮	Unleashing the Power of the Sun: The Increasing Impact of the Solar Cycle on Off-Season Super Typhoons since the 1990s	P48
16:00	潘任飛	Marine Heatwave: a Supercharger for Typhoons	P49
16:15	曾于恆	Projected Changes of Kuroshio in a Warming Climate	P50
16:30	許哲源	Surface Mixed Layer Restratification Modulated by Diurnal Warm Layer and Internal Waves in South China Sea	P51
16:45	譚子偉	Measurement and inversion of deep-sea current speeds up to 1 m/s at 2500m–3000m water depth utilizing acoustic flow noise and neural network	P52

4 月 23 日星期二下午議程

詠山館 M22		生物漁業專題演講	
開始	講者	講題	頁數
主持人：**康利國 / 林秀瑾**			
13:00	康利國	以高通量定序解析骨藻在藻華過程中感受環境營養鹽變化之調適機制	P60
13:15	陳仲吉	東海南部不同水團對有機碳消耗的影響	P61
13:30	何珮綺	Resource richness controls plankton trophic structure and community predator-prey mass ratio (PPMR) in marine plankton food webs	P62
13:45	塗子萱	The diurnal variation of dissolved oxygen in seawater is influenced by DOC excretion from seagrass and microbes	P63
14:00	鍾至青	副熱帶黑潮湧升流水域超微浮游生物組成之日夜變化	P64
14:15	江俊億	小體型、短壽命遠洋武裝魷(*Abralia multihamata*)的成長、生殖與能量分配	P65
14:30	林秀瑾	Evaluate Northwest Pacific fisheries resources using DNA markers	P66
14:45	呂曉沛	結合 16S-rDNA 和 16S-rRNA 研究東海南部原核浮游生物群聚結構	P67
15:00-15:30		休息/茶點時間	
主持人：**林裕薰 / 鍾明宗**			
15:30	林裕薰	Spatial trends in the essential fish habitats in southwestern Taiwan coast	P68
15:45	李明安	Understanding Feeding Ecology and Habitat of Greater Amberjack influenced by ENSO Events in Taiwanese Waters	P69
16:00	Sandipan Mondal	POTENTIAL UNIDIRECTIONAL IMPAGCT OF CLIMATE CHANGE ON THE WORLD FISHERIES: CASE STUDY FOCUSING TWO MACKEREL SPECIES OF THE NORTH-WESTERN PACIFIC	P70
16:15	吳研綸	解析不同時間尺度下氣候變遷對中上層生態系統族群變動影響	P71
16:30	鍾明宗	頭足類的野外代謝率與溫度相關性	P72
16:45	江偉全	Expansion of oxygen minimum zones may effects on movement behavior of blue marlin (Makaira nigricans) in the northwest Pacific Ocean	P73

4 月 23 日星期二下午議程

草堂 A		地質地物專題演講	
開始	講者	講題	頁數
主持人：許介瑋 / 張日新			
13:00	許介瑋	初探七股潟湖淺層沉積物空間與時序上的變化	P78
13:15	Shraddha Band	Precession influenced nutrient utilization in the east pacific during the Pliocene using foraminifera-bound nitrogen isotopes	P79
13:30	陳松春	離岸風電海域地質調查初步成果	P80
13:45	劉祖乾	Shore-parallel frontal systems along the entire western side of the Taiwan Strait due to the coupling between river plumes and monsoon-driven currents as the major dispersal mechanism for fluvial sediment	P81
14:00	蔣正興	A foreland basin with two distinct modern sediment dispersal systems: An example from Taiwan	P82
14:15	潘惠娟	Utilizing Novel Spectroscopy Methods for Sediment Composition Analysis in the Western Pacific: A Case Study of the Mud Zones in the Matsu Area	P83
14:30	張日新	南海北部大陸邊緣筆架海山之特徵與地體構造意涵	P84
14:45	Elena Dominguez Valdes	Making sense of the tropical surface ocean “cold bias” in Mg/Ca temperature records of the Late Pliocene	P85
15:00	林慧玲	海北坡生物拖網和表層沉積物的現生浮游有孔蟲種屬組合的記錄	P86
15:15-15:30		休息/茶點時間	

4 月 23 日星期二下午議程

草堂 B		化學專題演講	
開始	講者	講題	頁數
主持人：**洪慶章 / 曾筱君**			
13:30	洪佳章	Characteristics of dissolved inorganic and organic nutrients in the oligotrophic Kuroshio Current off eastern Taiwan during warm seasons	P95
13:45	洪慶章	Oceanic Blue Carbon in Seas around Taiwan	P96
14:00	陳鎮東	Far-Field Influences Shadow the Effects of a Nuclear Power Plant’s Discharges in a Semi-Enclosed Bay	P97
14:15	曾筱君	The roles of methane and nitrous oxide in blue carbon seagrass meadow	P98
14:30	方天熹	淡水河河口海域浮游植物對汞元素蓄積研究	P99
15:00-15:30		休息/茶點時間	
主持人：**簡國童 / 陳宗岳**			
15:30	陳建志	沿岸地區底棲新陳代謝的重要性	P100
15:45	簡國童	Cadmium Transport from Taiwan’s Rivers to Coastal Regions	P101
16:00	周文臣	高有機碳含量的珊瑚砂海草床可能是海洋鹼度生成的熱點	P102
16:15	施詠嚴	To revisit primary production in the northern South China Sea	P103
16:30	陳宗岳	臺灣沿海碳匯潛力評估：以卯澳灣為例	P104

4 月 24 日星期三上午議程

詠山館 M21		物理組青年論壇	
開始	講者	講題	頁數
主持人：方盈智		物理組青年論壇評審：鄭宇昕 / 許哲源 / 陳佳琳 / 方盈智	
8:00	藍亦汝(青)	以數值模式探討藻礁海岸流場與底床剪應力	P134
8:15	江柏勳(青)	應用 DrifterTek 浮球探討台灣東部海域中尺度渦漩的流場變化	P135
8:30	莊采玲(青)	非線性背風波狀態下的散度、旋度及位渦度變化之研究	P136
8:45	郭仲諒(青)	Revisiting flow and hydrographic fields in the southern part of the Changyun Rise during summer and winter	P137
9:00	林伯謙(青)	空拍影像技術於殼狀珊瑚藻覆蓋率之研究	P138
9:15	楊博元(青)	2022 年東加火山氣壓波與氣象海嘯之波型探討	P139
9:30	李皓元(青)	臺灣周邊海域內波模擬預報	P140
9:45	游千霈(青)	利用海嘯浮標預警系統觀測南海北部深海海盆之內孤立波	P141
10:00	Quoc Hiep, Tong(青)	Simulation of Internal Waves by Using Reduced Gravity Methods	P142
10:15-10:30		休息/茶點時間	

4 月 24 日星期三上午議程

詠山館 M21		物理專題演講	
開始	講者	講題	頁數
主持人：**鄭志文 / 曹俊和**			
10:30	陳冠宇	溫帶氣旋與熱帶氣旋的波浪與海流特性差異	P53
10:45	鄭志文	Satellite observation of new type of Kuroshio intrusion entering the northern South China Sea	P54
11:00	許伯駿	臺灣鄰近海域的海洋熱浪及海洋寒潮事件	P55
11:15	黃千芬	Ocean Current Mapping Using Time Reversal Method	P56
11:30	曹俊和	The role of physical oceanic and atmospheric variation on a massive phytoplankton bloom in the North Pacific in 2018.	P57
11:45	林幼淳	波浪梯度對大氣邊界層內之風應力影響	P58
12:00	黃志誠	海岸粗糙邊界層紊流與懸浮絮凝沉積物研究 - 桃園藻礁現場觀測	P59

4 月 24 日星期三上午議程

詠山館 M22		生物漁業青年論壇	
開始	講者	講題	頁數
主持人：鍾明宗 / 林裕嘉		生物漁業組青年論壇評審：鍾明宗 / 呂曉沛 / 林裕嘉 / 托星豪	
8:15	陳品嶧(青)	Comparing biotic and abiotic factors on shaping bacterial heterotroph metacommunity in the southern East China Sea	P143
8:30	陳薇伊(青)	Warming experiments produce changes in the bacterial growth and lytic-lysogenic viral infection in coastal Pacific water during winter at different latitudes	P144
8:45	蕭民煌(青)	利用穩定同位素評估頭足類在臺灣淺灘海域的營養特徵及生態角色	P145
9:00	Irene Lim Chia Ling(青)	Modelling of Gillnet Fishing Data Uncertainty and Spatial Distribution around the waters of Taiwan	P146
9:15	古佳正(青)	Migratory ecology of Pacific bluefin tuna (*Thunnus orientalis*) revealed by otolith stable isotope analysis	P147
9:30	梁婷淯(青)	多尺度氣候變異對印度洋中表層頂端掠食者豐度與分布影響變動	P148
9:45	謝騏遠(青)	The lost trait of marine vertebrate in the wild: tracing the field metabolism with the novel isotope proxy	P149
10:00-10:30		休息/茶點時間	
詠山館 M22		**生物漁業青年論壇/專題演講**	
10:30	時繼宇(青)	應用次世代定序深度探討馬祖骨藻基因之時序變化	P150
10:45	李維祐(青)	解析不同波長光源對籠具梭子蟹科捕撈率影響之研究	P151
主持人：**蔡安益**			
11:00	袁子倫	利用漁船航次和市場數據透過線性和非線性統計模型制定豐度指數	P74
11:15	Aafaq Nazir	Stable Isotope Analysis of Otoliths Reveals Habitat and Origin of Barramundi	P75
11:30	蔡安益	Warm eddy driving significant changes in prokaryotic growth and grazing in the tropical Pacific Ocean	P76
11:45	王怡甄	臺灣淺灘暨澎湖西南海域之季節性中小型魚類攝食變動	P77

4 月 24 日星期三上午議程

草堂 A		地質地物專題演講	
開始	講者	講題	頁數
主持人：**吳祚任**			
8:15	張翠玉	海床地震波所造成的深海水壓擾動	P87
8:30	Fenies Pierrick	Reconstructing Kuroshio Current deflection during the Last Glacial Maximum using lipid biomarkers	P88
8:45	Jeroen Groeneveld	The east Pacific Oxygen Minimum Zone during the Pliocene	P89
9:00	吳祚任	發展反映台灣週邊地形效應之全新風暴潮參數化模型	P90
9:15	RAUL TAPIA	Assessing the Habitat depth range of Planktic Foraminifera in the Sumatra-Java Region using Mg/Ca-IFA in Net Samples	P91
9:30	林玉詩	山溪型河川 - 被動大陸邊緣系統(臺灣海峽東北部)的顆粒態有機質源匯分析	P92
9:45	賀詩琳	El Niño-like tropical Pacific Ocean cooling pattern during the Last Glacial Maximum	P93
10:00-10:30		休息/茶點時間	
草堂 A		**地質地物青年論壇**	
主持人：潘惠娟 / 賀詩琳		地質地物組青年論壇評審： 潘惠娟 / 賀詩琳 / 張日新 / 許介瑋	
10:30	李佩庭(青)	Mixed layer thickness drives Mg/Ca-inferred temperature variability of planktic foraminifer Trilobatus sacculifer in the northern South China Sea	P152
10:45	Akshat Gopalakrishnan(青)	Constraining the recording depth of TEX86 at the edge of the Indo-Pacific Warm Pool using multispecies Mg/Ca records spanning the last glacial cycle	P153
11:00	董如芸(青)	Replicability of paleotemperature records in the northern Okinawa Trough and its implications for paleoceanographic reconstructions	P154
11:15	黃逸軒(青)	龜山島崩塌事件之三維數值模擬	P155
11:30	卓冠宇(青)	Ocean Temperature Stratification of the East Pacific During the Pliocene Using Oxygen Isotopes on Different Species of Planktonic Foraminifera	P156
11:45	蔡宏霖(青)	Long-term Observations of GDGTs in Suspended Particulate Matter and Surface Sediments in the Warm Part of the East China Sea	P157

4 月 24 日星期三上午議程

草堂 B		化學專題青年論壇	
開始	講者	講題	頁數
主持人：黃蔚人 / 施詠嚴		化學組青年論壇評審：謝玉德 / 陳建志 / 黃蔚人 / 施詠嚴	
8:30	Mariche B. Natividad(青)	Evaluating the net ecosystem productivity and calcification of restored seagrass meadows	P158
8:45	Vicente G. Abedneko(青)	Effect of OA on spiny lobster (Palunirus Homarus) molting duration and foraging ability under OA stress	P159
9:00	林依宣(青)	台灣周遭海域有色性溶解有機物之初探	P160
9:15	楊博凱(青)	Barium uptake and isotope fractionation in phytoplankton: implications for the marine carbon cycle	P161
9:30	劉亭妏(青)	東亞大氣懸浮微粒中碳水化合物的季節變化及其生地化作用：結合主成分分析與正因子矩陣分析探討其來源	P162
9:45	林嘉瀚(青)	陸域及海域環境中大氣濕沉降提供的額外氮之影響：近五年氮通量之解析	P163
10:00-10:30		休息/茶點時間	
草堂 B		**化學專題青年論壇**	
10:30	吳亞臻(青)	Using barium isotopes to trace underwater mud volcanoes in the Southwest offshore of Taiwan : implications for the marine carbon cycle	P164
10:45	李俞靜(青)	Accumulations and sources of mercury in the Pacific Saury off the western North Pacific Ocean	P165
11:00	吳文淮(青)	海洋塑膠雪花的形成與沉降	P166
11:15	吳紫菊(青)	沉積物再懸浮對墾丁海草床有機顆粒動態之影響	P167
11:30	邱韋豪(青)	臺灣主要河口牡蠣中微塑膠初探	P168
11:45	鄭喬方(青)	Comparing CO2 Partial Pressure Measurement in Shrimp Mariculture: CO2SYS Program vs. Syringe-Headspace Technique	P169

4 月 24 日星期三上午議程

詠山館 M32		多樣性與保育青年論壇/專題演講 海保署計畫成果報告 「110-113 年臺灣海域重要生態系調查及生態服務價值評估」計畫成果發表會	
開始	講者	講題	頁數
主持人：**陳韋仁**			
9:15	陳韋仁	Fish eDNA survey on Taiwanese waters and marine protected areas	P108
9:30	王德媸	Functional trait diversity of the Taiwanese reef fish fauna evaluated by environmental DNA metabarcoding	P109
9:45	Lauriane Ribas-Deulofeu	Advancing reef conservation in the Anthropocene: Taiwan coral ecosystem status and MPAs effectiveness	P110
主持人：柯佳吟 /塗子萱		多樣性與保育青年論壇評審：柯佳吟 / 陳韋仁 / 塗子萱	
10:00	蔡佳蓉 (青)	Reef forensics: Variation in ecological processes in contrasting environmental conditions	P170
10:15	陳彥妤 (青)	Unraveling Regional Variability in the Shallow-Mesophotic Transition through Benthic Composition Similarities	P171
10:30	陳昕 (青)	Benthic macrofauna in shallow-water coral reef ecosystems in Taiwan	P172
10:45	Rebeca Alvarado(青)	Assessing Blue Carbon Management Strategies in the Asia-Pacific Region	P173
11:00	柯佳吟	從沿近岸開始的整體生態調查與保育	P111
11:15	黃靖雲	氣候變遷！？近年海洋環境是否一如往昔？	P112
11:30	張貴鈞	氣候變遷 ing，我們如何了解南方四島的棲地風險	P113
11:45	童靖惠	Visualizing the Underwater Soundscape:Long-term Monitoring Revealing Shift of Bioacoustic Patterns in Taiwan’ s Coral and Algal Reef Ecosystems	P114
12:00	黃玉萱	國科會海洋學門資料庫 - 臺灣周邊海洋生物資料管存與資料展示平台(Hidy Viewer 2.0)	P115

4 月 24 日星期三下午議程 @詠山館 M32

13:30-15:00	海洋保護區圓桌會議

4 月 25 日星期四上午議程

詠山館 M21		化學專題演講	
開始	講者	講題	頁數
主持人：**許瑞峯**			
8:15	許瑞峯	Plastic pollution: from micron-scale to nano-scale	P105
8:30	雷漢杰	Distributions of carbonate chemistry from the Kuroshio to the Ryukyu Current off eastern Taiwan	P106
8:45	黃蔚人	2023 夏季西菲律賓海表層二氧化碳變異	P107
9:00	莊佩涓	巨型硫化細菌對本吉拉湧升流系統中底棲-浮游耦合及反饋的影響	P94

11:45-12:30	閉幕式 & 頒獎

4 月 25 日星期四上午議程

詠山館 M22		多樣性與保育青年論壇/專題演講	
開始	講者	講題	頁數
主持人：陳韋仁 / 陳孟仙		多樣性與保育青年論壇評審：陳韋仁 / 陳孟仙 / 塗子萱	
8:00	吳美琳(青)	The Effects of Experimental Warming on Microbial Community Growth and Mortality During The Cold Season	P174
8:15	GRACE PUTRIAYU ANGELICA SITORUS(青)	How Warm Eddies Affect Microbial Communities in the Tropical Pacific Ocean	P175
8:30	劉愷程(青)	Genetic Diversity and Distribution of Harmful Algae in the Coastal Waters of Kenting, Taiwan	P176
8:45	李良能(青)	夜光蟲生命週期與其生存策略：配子生理以及繁殖	P177
9:00	劉瀚淮(青)	飢餓對於眼斑海葵魚攝入微塑膠風險影響	P178
9:15	Subramani Thirunavukkarasu (青)	Microplastic contaminants of burrowing biota from the highly conserved wetland of Siangshan in Hsinchu, Taiwan	P179
主持人：**詹雅帆**			
9:30	樊同雲	墾丁國家公園海域珊瑚礁受海洋熱浪與颱風的影響及抗氣候變遷珊瑚苗圃的建立	P116
9:45	藍國維	珊瑚養殖縮小化: 利用奈米缸來建立種珊瑚	P117
10:00	詹雅帆	Reciprocal transplant experiment reveals multiple factors influencing changes in coral microbial communities across climate zones	P118
10:15	林芸琪	台灣東北沿岸海域混營真核生物的種類組成與攝食機制	P119
10:30	陳孟仙	熱帶潟湖到水道的魚類群聚	P120
10:45	何宣慶	澎湖周邊海域拖網漁業混獲魚類調查	P121
11:00	Lorenzo C. Halasan	Genetic Structure of the Western Pacific Asymmetron lucayanum (Branchiostomatidae) Clade	P122
11:15	Crystal McRae	Heterotrophy provides a greater benefit to coral performance under lower compared to warmer temperatures in ex-situ aquaculture	P123
11:45-12:30		**閉幕式及頒獎 @詠山館 M21 教室**	

4 月 25 日星期四上午議程

詠山館 M32		GEOTRACES and BioGeoSCAPES	
開始	講者	講題	頁數
主持人：**謝玉德**			
9:00	何東垣	國際計畫介紹:從 GEOTRACES 到 BioGeoSCAPES	P124
9:15	任昊佳	The Physio-Biogeochemical Processes Inferred from the Dual Isotopes of Nitrate in the Seas Surrounding Taiwan	P125
9:30	謝玉德	Barium isotopes in Tamsui River mixing experiments: implications for tracing riverine inputs to the ocean	P126
9:45	廖文軒	The distribution of dissolved trace metal concentrations in the offshore region near southwestern Taiwan	P127
10:00	謝志強	西北太平洋沉降顆粒元素組成與通量特徵	P128
10:15	張順恩	海洋單細胞固氮藍細菌的比較基因體分析	P129
10:30	托星豪	C:N ratio and N-containing macromolecules of surface phytoplankton in the eastern North Pacific	P130
10:45	簡嘉德	Applications of marine biogeochemical models	P131
11:00	林卉婷	The application and limitations of MC-ICPMS measured 236U/238U as an ocean tracer	P132
11:15	李承軒	Method development for analyzing poly- and perfluoroalkyl substances in seawater and marine plankton	P133
11:45-12:30		**閉幕式及頒獎 @詠山館 M21 教室**	

海報競賽 @詠山館一樓

生物 Marine Biology

PC-A-1	王奕鈞	運用環境 DNA 高通量分子條碼研究季風和水團對台灣周遭近海魚類群集的影響	P181
PC-A-2	黃信瑋	利用特化型誘餌式遠端水底攝影系統監測海洋環境	P182
PC-A-3	謝宛蓁	長期暴露微塑膠對眼斑海葵魚社會行為與生長之影響	P183
PC-A-4	李俊廷	夜光蟲之沉降機制及其對沿岸生態系的影響	P184
PC-A-5	楊子瑩	夜光蟲(*Noctiluca scintillans*)在台灣西部沿岸之品系差異	P185
PC-A-6	林妤真	用酸性胞器染劑確定夏季副熱帶沿岸生態系有哪些微小的色素型真核生物會攝食？	P186
PC-A-7	羅一峰	以轉錄組學探討台灣潮間帶魚類環境適應之策略	P187
PC-A-8	許凌瑄	台灣淺灘暨周邊海域夏季仔稚魚群聚結構變動之研究	P188
PC-B-1	王梓亘	海洋酸化和鹽度改變對紫海膽成長的影響	P189
PC-B-2	余奕穎	海水酸化對線紋海馬成長與繁殖之影響	P190
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化學 Chemical Oceanography

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專題演講與青年論壇摘要

海洋學門資料庫成果報告

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計畫名稱：國家新研究船船隊貴重儀器及資料庫使用中心－子計畫: 海洋學門資料庫(3/4)

計畫編號：112-2740-M-002-002

摘要

科會海洋學門資料庫 (簡稱 ODB) 使命是收集、 保存和彙整臺灣海洋研究船和其他海洋調查產出的物理、化學、生物、地質、地球物理等跨領域探測數據。目標以系統性方式整理、分析及展示海洋研究成果，支援海洋相關領域研究需求，提供資料和加值應用產品供外界申請使用。

近年 ODB 已逐步為海底影像、 eDNA 等新型態資料建立資料處理程序， 納入管存與應用範圍。未來會將海底影像匯入處理、 辨識標註的作業流程標準化，提供服務介面、支援學界予以利用; 建構臺灣周邊海洋微生物 eDNA 分析資料庫亦有充足進展，並與國科會中網計畫「 航向藍海-海洋研究平面到立體」 學者合作， 朝向建立西北太平洋總體基因體資料庫努力。此外，ODB 全力支持分散式資料庫架構與開放資料之目標，持續完善資訊技術基礎架構， 並將資料庫服務轉換為開放應用程式介面（ Open Application Programming Interface, Open API）的微服務架構， 以此提供開放海洋資訊服務。 在符合資料釋出法規前提下， 提供臺灣周遭海域海洋資料如 CTD、 SADCP 平均場資料、生物海洋資料庫出現紀錄等，也轉製全球海洋開放資料如海洋熱浪等， 推展海洋研究與科普。

做為 ODB 對外最主要的互動式" 海的" 資料展示平台 Hidy Viewer 2， 改版已進入上線運作並完成大幅功能新增改善。 Hidy Viewer 2 結合了新開發之 Open API 可讓使用者自由疊合 ODB 海洋資料與衛星影像地理圖層。 而 Open API 也同樣應用於新的海洋資訊交流平台，此平台為實現國內相關海洋資料單位對開放資訊服務技術之交流需求。 未來 ODB 仍將持續發展對政府開放資料、環境教育推廣、基礎科學教育與海洋研究等中長期目標所需之資訊技術。 而面對日益龐大複雜的海洋船測資料， 如多音束測深資料， ODB 積極規劃新的資料處理管存技術。同時 ODB 結合 IOT 資訊、研究船即時資訊互動系統（ IRIS）、 研究船網路暨資料儲存架構以及 MIDAS 船測資料下載服務，提供研究船進行海洋探測時實務可靠之軟硬體服務。 ODB 現有多元的海洋資料服務 (包括海流、水深、水文、化學與生物資料等)， 均可於 ODB 官網查詢使用。

航向藍海：2023 勵進 2308 帛琉航次觀測之北太平洋中尺度氣旋減弱現象

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摘要

海洋上層到處有 O(100-300) km 的中尺度氣旋及反氣旋渦，這些渦旋在向西行進時會發生彼此能量交換、小渦旋糾結形成較大的渦旋等，了解這些過程對分析海洋能量的收支及重新分配都非常重要，進而有助我們了解氣候變遷背後的海洋與海氣交互作用動力。為了探索這些過程裡的每個環節，在國科會支持的藍海計畫下，2023 年 6 月勵進研究船 2308 航次鎖定北太平洋臺灣到帛琉中間一個尺度約 200 km 的中尺度氣旋渦進行探測。這個氣旋渦緊接著其西南側一個長軸~330 km (東北－西南向)、短軸~200 km 的橢圓形氣旋渦，連續的衛星海面高度及地轉流資料均顯此較小氣旋在減弱中。研究船現場紊流觀測資料則進一步顯示，渦旋內的紊流動能耗散率 為 $O(10^{-8})$ W kg^{-1}，船載都普勒流剖儀所測的渦旋西南邊緣水平流速與垂直流切皆增強， 上升到 $O(10^{-8}－10^{-7})$ W kg^{-1}，氣旋渦的動能可能在邊緣耗散掉或轉移到較大的渦旋。渦旋彼此交互作用以及小渦旋能量如何傳到大渦旋將透過數值模式來分析。

台灣東部黑潮截斷事件對北南海渦度的影響

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計畫名稱：黑潮到紊流之間的能量交換觀測研究-臺灣東部海洋渦漩對黑潮上游的影響
計畫編號：111-2611-M-019 -017 -MY3

摘要

儘管1998年至2013年全球暖化間歇期的問題仍存在爭論，但在該時期在台灣以東黑潮的表面流速有減少，在呂宋島以東則增加。本研究發現在全球暖化間歇期，台灣東部黑潮主路徑的截斷事件引起了南海北部負渦度的顯著增加，這可能與臺灣以東的黑潮流速減弱、呂宋島以東的黑潮流速增強有關。台灣東部的黑潮受到北太平洋西向中尺度渦漩的影響，黑潮的主路徑有時會被這些中尺度渦漩截斷，導致往北的黑潮積聚在台灣東南外海。黑潮上游被迫西行經呂宋海峽進入南海海域，增加當地的負渦度。應用和成分析，當台灣以東黑潮截斷事件發生時，在全球暖化間歇期呂宋海峽以西的北南海負渦度較其他時期增加了45%。

綠島背流處渦漩研究之回顧與進展

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摘要

水流流經圓柱體於背流處產生之渦漩為流體力學中之經典研究主題，因此現象與生活息息相關，例如建物受風穩定度、橋墩背流處基座的泥沙侵蝕、水中繫纜的拖曳力等問題。若將尺度放大到海洋亦有同等重要性，黑潮猶如實驗水槽中的水流，而黑潮上的島嶼可視為水槽中的圓柱，直徑約為 5-10 公里的綠島位於流幅約 100-150 公里流速約 1-1.5 公尺/秒的黑潮中，是典型案例，也是大自然提供的最佳地球流力實驗場。但由於後者的尺度相較於前者大上不只 1 萬倍，本質上的差異在所難免，包括地球自轉效應、分層效應、潮流效應、演變成紊流必須有一系列中繼過程等。我們的觀測與模式研究發現：

(1) 背流處的渦旋度是為行星渦度(柯氏參數)的 20 倍、在渦旋邊緣的自由剪切層(free shear layer)更可達到 30 倍。流場有強大的垂直向流切，這些流切使得水體克服密度分層的限制，造成切變不穩定，進而演化成紊流，我們估計紊流動能消散率為 O (10^{-7}-10^{-5}) W Kg^{-1} 的遠高於一般海域值。此促使上下層水的混和，使得海表水呈現低溫、高鹽與高葉綠素濃度，這些被湧升的水體會經由渦旋或者黑潮強流平流到達更下游的水域。

(2) 渦流變動包含兩種變化週期，分別 12.42 小時(M2)及 6.21 小時(M4)，推測是因 M2 與 M4 潮的週期接近渦流原生週期(以 *St* 推論的週期)，故形成共振，原生週期消失，卻被潮週期給同步化，此現象與水槽實驗中跨流方向來回擺動的圓柱類似，當圓柱擺動週期接近原生週期，便產生同步效果。

(3) 近期觀測，經由逐流浮標 GPS 點位顯示的軌跡，確實與在實驗水槽與大氣中渦漩串(如冬季的濟州島上空)形成的馮卡門渦街相似。

(4) 進一步的研究歸納出尾渦流場中發生紊流的熱點為在渦旋與背景黑潮主流交界處的自由剪切層，成因可能為剪切層中的渦管傾斜所造成，離心不穩定亦有可能。強烈紊流的發生與隨時間傾斜的自由剪切層亦步亦趨，無論位渦或者理察遜數(*Ri*)均有邊際不穩定的情況。

Observations of Leeward Vorticity Evolution Induced by Kuroshio Passage Past a Sharp Cape

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計畫名稱：黑潮到紊流之間的能量交換觀測研究－子計畫:黑潮流經臺灣東部大陸坡所引起從中至小尺度的海水運動過程(II)
計畫編號：NSTC 112-2611-M-019-022 -

摘要

We conducted ship-based wake vorticity evolution observations in the sea south of Taiwan, where both Kuroshio and tidal currents are present and affected by the sharp cape. Currents flowing over rough topography were slowed by frictional drag and form drag. Twenty-eight shipboard surveys were conducted, including tow-yo VMP and CTD surveys in the vicinity of the headland, completing 8 transects in the course of the tidal cycle (12.42 hours). Wake vorticities may be generated by two lateral and bottom boundary-related processes, i.e. flow separation and shear instability. The inflow angle of the Kuroshio current in the cape upstream may impact how vorticity is generated. In the looping path, form drag was pivotal in generating wake eddies and entrained more South China Sea water to eastern Taiwan. Conversely, in the leaping path, the formation of wake eddies was predominantly driven by the horizontal shear gradient and water type tended to the property of the West Philippines Sea. Despite currents dominated by Kuroshio, the arising period of wake vorticities is modulated by tidal currents. Submesoscale eddies cause temperature decreases and higher Chl-a concentration, presumably by advection and inner turbulent mixing. These features may extend to the surface and can be captured by satellites.

Water column variability when mesoscale eddiy impinges on the Kuroshio

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計畫名稱：黑潮到紊流之間的能量交換觀測研究－子計畫:台灣東部黑潮流域的表面流場研究
計畫編號：NSTC 112-2611-M-110-019

Abstract

This study is based on one glider-derived hydrographic data set collected east of Taiwan during December 2016 – March 2017 and the underway measurements along a round-trip east-west transect from the NOR3-0117 cruise in the area southeast of Taiwan. We studied the Ertel potential vorticity (EPV) and investigated dynamics controlling the EPV. The EPV resulted from the glider data showed that horizontal density gradient was only minorly important in the surface mixed layer (SML). Relative vorticity driven by the ambient eddy field was substantial at deeper depths and can even result in a sign change of the EPV, with an implication for instability and lateral exchange of materials. Instead, the EPV analysis using the NOR3-0117 cruise data showed that relative vorticity can impact the EPV gradient within the SML. This result is a consequence of better horizontal resolution (< 10 km) of the UCTD measurements. Subsurface velocity measurements were made during the impingement (22 – 24 September 2022) of an anticyclonic eddy (AE) on the Kuroshio. An enhanced eastward flow (> 0.5 m s^{-1}) with a spatial extent of ~60 km emerged above 200 m depth in less than 24 hours. It suggests that local evolution of the Kuroshio-eddy impingement has a timescale not resolvable by some state-of-the-art satellite products. The NOR3-0117 cruise also made repeated water column measurements near the center of this AE, including one 4600-m deep CTD measurement. From the measured thermohaline field, the estimated vertical extent of the AE was between 100 – 300 m depth, where the vertical stratification was reduced. Our work underlines that underway measurements aboard a research vessel are important in both scientific and practical manners, especially in waters where eddies colliding with the Kuroshio.

Application of a simple diffusivity formulation to examine jet–eddy energy partitioning in quasi- geostrophic turbulence

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NSTC 112-2611-M-002-015

ABSTRACT

This study uses a simple diffusivity formulation to examine flow regime transition and jet–eddy energy partitioning in two-layer quasi-geostrophic turbulence. Guided by simulations, the formulation is empirically constructed so that the diffusivity is bounded by a f-plane asymptote (D_f) in the limit of vanishing β (termed drag-controlled) while reduced to a drag-independent scaling (D_β) of Lapeyre and Held toward large β (termed β-controlled). Good agreement is found for diffusivities diagnosed from simulations with both quadratic and linear drag and in 2D turbulence. From the formulation, a regime diagram is readily constructed, with $D_f/D_\beta = 1$ separating the drag-controlled and β-controlled regimes. The diagram also sets the parameter range where an eddy velocity scaling is applicable. The quantitative representations of eddy variables then enable a reasonably skillful theory for zonal jet speed to be developed from energy balance. It is shown that, using $D_f/D_\beta \geq 10$, a state where eddy statistics are approximately drag insensitive could be identified and interpreted using wave-damping competitions in slowing an inverse cascade. However, contrary to an existing hypothesis, the energy dissipation in such a state is not dominated by zonal jets. A modest revision for a way to maintain balance while keeping eddies drag insensitive is proposed. In the regime diagram, a subspace of zonostrophic condition, defined as jet dissipation surpassing eddy, is further quantified. It is demonstrated that a rough scaling could help interpret how the relative importance of jet and eddy dissipation varies across the parameter space.

海洋物理專題演講 Physical Oceanography

A Divergence and Vorticity View of Nonlinear Oceanic Lee Wave Obtained by A Two-vessel Survey

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Abstract

The spatial distribution of the flow field by shipboard measurements often suffers a spatial-temporal aliasing effect. This study describes a detailed view of horizontal divergence and relative vorticity by a two-vessel survey to characterize velocity gradients and the resulting transport process in the presence of nonlinear lee waves. This study will investigate the three-dimensional structure of the horizontal velocity gradients and turbulent mixing within a nonlinear internal lee wave behind a shallow seamount. Synchronous two-vessel Acoustic Doppler Current Profilers (ADCPs) provide in-situ measurements of velocity tensors that significantly minimize the spatial and temporal aliasing effect. The magnitude of horizontal divergence and relative vorticity normalized by the planetary vorticity (δ/f, ζ/f ~ O(10)) are one to two orders of magnitude greater than that in the typical submesoscale turbulence field. Our analysis indicates that crestlines of horizontal divergence are associated with recurrent patterns of upwelling velocity on the lee of the pinnacle. Due to the bottom Ekman effect, the deflected Kuroshio currents further generate the streamwise vorticity and across-stream vertical shear, enhancing vertical shear instability and submesoscale instability. In-situ observational surveys conducted over the seamounts further indicates that the peak of the turbulent eddy diffusivity and maximum vertical nitrate gradient are relevant to the isopycnal displacement and the combination of submesocale instability and shear instability that spawn vertical nitrate transport.

颱風所引起的上層海洋紊流混合

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計畫名稱：黑潮到紊流之間的能量交換觀測研究-子計畫:臺灣東部外海中尺度渦漩對當地海洋環境之影響(II)
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摘要

在颱風所經過的海域可能會造成上層海洋溫度下降，進而形成冷尾跡。造成此現象的主要機制包括紊流垂直混合、Ekman pumping 與海氣間的熱通量交換。為了更好地了解此詳細的物理過程，並提高數值模型預測的準確性，需要更多對於紊流垂直混合的觀測與研究。本研究透過 2023 年颱風季節期間在臺灣東南海域佈放的海氣象觀測浮標及都卜勒流速剖面儀錨碇觀測資料，分析颱風期間的紊流垂直混合情形。

實驗期間總共紀錄到四個颱風經過的資料，分別為杜蘇芮(Doksuri)颱風、蘇拉(Saola)颱風、海葵(Haikui)颱風和小犬(Koinu)颱風。本次報告中，我們針對杜蘇芮颱風進行初步的資料分析與討論。浮標站點位於杜蘇芮颱風右側風速 34 節暴風半徑(R_{34})附近，颱風期間最大風速約 18 m/s，最大浪高約 7 公尺。本研究藉由浮標所紀錄的溫度與流速觀測資料，推算出的理查森數(Richardson number, Ri)用以評估紊流混合情形。觀測結果顯示，當浮標位在 R_{34} 暴風半徑以內時，深度 27 公尺以淺，N^2 大約介於 10^{-8}-10^{-5} s^{-2}，S^2 大約維持在 10^{-4} s^{-2}，Ri 主要受 N^2 變化影響，並持續保持小於臨界值 0.25。透過不同深度的 Ri 變化可知，Ri 達到臨界值 0.25 之深度約為 40 公尺，顯示紊流混合所影響的深度約到此處。而水深 40 至 100 公尺的 N^2 大約維持在 10^{-4} s^{-2}，Ri 主要受 S^2 的變化所影響。此外，根據先前研究，颱風右側的 R_{34} 暴風半徑附近，上層海水有向下沉降的現象。在杜蘇芮颱風的案例中，我們也觀察到混合後的海水向下沉降，Ri 等於臨界值 0.25 的所在深度大約可達 70 公尺，混合層深度大約可達 90 公尺，這代表強風所造成的紊流垂直混合最深約可達 70 公尺，而下沉流可將已經混合好的海水往下輸送最深約可達 90 公尺，詳細的結果將在報告中進一步闡述。

Unleashing the Power of the Sun: The Increasing Impact of the Solar Cycle on Off-Season Super Typhoons since the 1990s

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ABSTRCAT

The occurrence of super typhoons outside the normal typhoon season can result in devastating loss of life and property damage. Our research reveals that the 11-year solar cycle can affect the incidence of these off-season typhoons (from November to April) in the western North Pacific by influencing sea surface temperature (SST) through a footprint mechanism. The solar cycle, once amplified by atmospheric and ocean interactions, generates a noticeable SST footprint in the subtropical North Pacific during winter and spring, which eventually intrudes into the tropical central Pacific and affects the atmospheric conditions, resulting in an increase or decrease in the occurrence of super typhoons during active or inactive solar periods. This mechanism has become more effective since the Atlantic Multi-decadal Oscillation (AMO) shifted to a warm phase in the 1990s, intensifying the subtropical Pacific couplings. An example of this type of off-season super typhoon during an active solar period is Typhoon Haiyan in 2013. By incorporating information about the solar cycle, we can anticipate the likelihood of super typhoon occurrences, thus improving decadal disaster preparation and planning.

Marine Heatwave: a Supercharger for Typhoons

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計畫名稱：淺海中的颱風海洋交互作用(II)
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摘要

Due to the cold water temperatures, the East China Sea (ECS) is usually unfavorable for typhoon development. Recently, in a rare event, Typhoon Bavi (2020) reached major typhoon status and became the strongest typhoon in the ECS in the past decade. Based on in situ observations and model simulations, we discover that this typhoon is fueled by a marine heatwave, which creates a very warm ocean condition with sea surface temperature (SST) exceeding 30°C. Also, because of suppressed typhoon-induced SST cooling caused by the shallow water depth (41m) and strong salinity stratification (river runoff) within the ECS, the SST beneath the typhoon remains relatively high and enhances the total heat flux for the typhoon. More interestingly, due to the fair weather ahead of the typhoon, we find that the rapid development of this marine heatwave is likely, in part, attributed to the typhoon itself. As the risks from typhoons and marine heatwaves are heightening under climate change, this study provides important insights into the interaction between typhoons and marine heatwaves.

Projected Changes of Kuroshio in a Warming Climate

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Abstract

The projected changes in the Kuroshio and the associated mechanisms in response to future warming scenarios remain unclear. While some studies propose a negative midlatitude wind stress curl (WSC) tendency could expedite Kuroshio recirculation, others suggest that the isopycnal transport of warmer subtropical mode water (STMW) to the east of the Kuroshio enhances only the velocity in the upper ocean. In the future projections under the Shared Socioeconomic Pathways 5-8.5 (SSP5-8.5) within the Coupled Model Intercomparison Project Phase 6 (CMIP6) model ensemble, a consistent enhancement of the Kuroshio along the Japanese coast (JP-Kuroshio) is observed. Particularly, the response of the JP-Kuroshio to WSC changes is more pronounced in high-resolution (HR) models compared to low-resolution (LR) ones. However, diverse results emerge in the East China Sea (ECS-Kuroshio). While most CMIP6 HR models indicate a reduction of Kuroshio within the upper 1000 m in the ECS-Kuroshio, the ensemble of CMIP6 LR models shows an intensification of Kuroshio within the upper 300 m and a deceleration below, suggesting a consistent baroclinic feature in ECS-Kuroshio. Additional ocean model sensitivity experiments confirm that the WSC influences the Kuroshio throughout the entire water column, particularly below 300 m. Within the upper 300 m, the primary driver of Kuroshio changes is the surface warming, aligning with the STMW mechanism. Moreover, it is suggested that the surface salinity flux may also play an important role in the dynamics of Kuroshio changes.

Surface Mixed Layer Restratification Modulated by Diurnal Warm Layer and Internal Waves in South China Sea

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The upper ocean restratification process is captured by an EM-APEX float deployed in the northern South China Sea (SCS) during the spring in 2022. This process is initiated by a thick diurnal warm layer (DWL) formed under the low wind speed and clear sky during daytime. The sharp temperature gradient of DWL in the upper 20 m can effectively inhibit the convective mixing even after sunset. As a result, the stratification in the subsurface layer is increased by the interior oceanic dynamics in the following days, which can further prevent the destratification from atmospheric forcing. In this context, internal waves are identified as the primary driver of the restratification in the subsurface layer. The strong vertical shear of near-inertial internal waves in the upper thermocline can lead to shear instability, confirmed by the linear stability analysis. The resulting vertical dynamics raise the deepest depth of the nighttime surface mixed layer. The horizontal advection may not significantly affect this restratification process for the entire period. The shallowing of surface mixed layer depth can efficiently trap the heat, yielding the warming of daily-mean sea surface temperature > 1°C within five days. Our observations provide insights into how internal waves and DWL can contribute to the evolution of turbulent mixing in the upper ocean, potentially improving the accuracy of future model predictions related to the springtime restratification of the ocean surface boundary layer in the northern SCS.

Measurement and inversion of deep-sea current speeds up to 1 m/s at 2500m–3000m water depth utilizing acoustic flow noise and neural network

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摘要

The primary objective of this study is to investigate the acoustic characteristics of flow noise within the 20 Hz frequency band induced by deep-sea currents. Inspired by in-situ measurements of robust deep-sea currents (flow noise) reaching up to ~110 cm/s, recorded by an attached tiled current meter (TCM-3) on a Moored Autonomous Noise Recorder (MANR) #1 at a depth of ~2500 m on one of the New England Seamount ridges, our investigation extended to MANR#2. Situated at a horizontal distance of 15.2 km from MANR#1 and at ~3000 m depth on another seamount ridge, MANR#2 lacks a TCM-3 to record currents. Nevertheless, MANR#2 displays strong acoustic intensity in its spectrogram during nearly the same recording periods as MANR#1 from April to June 2023, suggesting the presence of significant flow noise at MANR#2. Consequently, we developed a machine learning-based model using acoustic noise data obtained from MANR#1. This neural network model is specifically tailored and generalized to invert the currents at MANR#2, aiming to bridge the data gap arising from the absence of a TCM-3 device at MANR#2. The analysis establishes a strong correlation between the measured power spectra, centroid frequency, and consistent characteristic peak frequency for flow noise among all MANRs, including MANR#4 at a ~4500 m depth. These observations reveal the presence of previously unreported strong deep-sea currents. Additionally, distinct variations in the acoustic fingerprints attributed to currents among the MANRs, influenced by ocean dynamics and complex bathymetry, are discussed. Specifically, the strong currents recorded at MANR#1 indicate a southward heading direction along with a ~0.1°C temperature rise.

溫帶氣旋與熱帶氣旋的波浪與海流特性差異

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計畫名稱：颱風、渦流與內波對南海北部生物地球化學作用之衝擊-子計畫:中尺度渦旋動力的實測與模擬研究(II)及湧升流、渦漩、島嶼尾流以及台灣海峽冬季流場之變動(II)
計畫編號：NSTC 112-2611-M-110-017 -

摘要

本研究分析了溫帶氣旋與熱帶氣旋的波浪與海流特性差異:溫帶氣旋的風向穩定，吹風距離比較長，造成比較大的波浪示性波高；而熱帶氣旋風向較不穩定，吹風距離較短，造成示性波高比較小。因為海洋的混合層厚度不大，溫和偏弱的風速下，低緯度的流會比較強。對於風速大於26 公尺每秒的強風，低緯度海洋的混合層厚度變大，因此流的速度變小。

Satellite observation of new type of Kuroshio intrusion entering the northern South China Sea

衛星觀測新型態黑潮入侵北南海

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摘 要

In addition to existing theories, this study proposes a new mechanism of Kuroshio Intrusion passing through the Luzon Strait (LSKI) on the basis of the satellite observed sea surface height anomaly from January 1993 to December 2018. First, 11 events of westward propagating cyclonic Eddy Impingement on the Kuroshio on the Eastern side of Taiwan (EIET) were recognized. Statistical results indicate that approximately 82% of EIET led to consequential LSKI. Systematic analysis indicates a reduction in northward inertial advection, which is responsible for connecting EIET to consequential LSKI. Dynamic diagnosis further unveils the detailed physical exchange processes therein. Squeezing of the planetary vorticity and advection of negative relative vorticity in response to the collision of the EIET with downstream Kuroshio current (KC) contribute to LSKI. Although the beta-term is relatively weak, for the left flank of LSKI, where the influences of advection and flow divergence largely reduce, it plays a dominant role in forcing the KC to intrude farther west into the northern SCS. Aforementioned results identify the possibility of the downstream Kuroshio changes might modify the upstream LSKI critically. More interestingly, this mechanism is a backward feedback sourcing from the Kuroshio downstream region (east of Taiwan) to the upstream region (Luzon Strait).

臺灣鄰近海域的海洋熱浪及海洋寒潮事件

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計畫名稱：多衛星資料觀測臺灣鄰近海域的海洋熱浪、寒潮及海洋酸化影響及其動力機制、臺灣北部沿海至東海南部的海洋次中尺度動力過程觀測與機制探討
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摘要

海洋熱浪和海洋寒潮是近年來獲得顯著關注的極端海洋環境事件之一。海洋熱浪的發生對珊瑚礁區域構成了嚴重的威脅，因為過熱的海水加速了珊瑚白化，從而影響了整個相鄰的海洋生態系統。持續上升的海面二氧化碳分壓導致了台灣東北珊瑚棲息地的海洋酸化和海表溫度的增加。自 2016 年以來，該地區一直經歷著強烈的海洋熱浪事件，其累積的熱壓力在 2020 年到 2022 年之間達到高峰。除了日益增加的大氣二氧化碳濃度是一個因素外，黑潮沿台灣東海岸的路徑從 10 月到 4 月有向台灣海岸西移的趨勢。黑潮進入東海大陸棚的西向和北向分量迅速增加。黑潮和東北台灣沿岸反流在珊瑚棲息地附近的相互作用形成了一個逆時針方向的循環，並持續呈現西移趨勢。這導致了更暖的水流入台灣東北方海域。另一方面，2020 年到 2022 年負相位的太平洋十年震盪和反聖嬰型態的氣候條件進一步導致海面溫度的增加，平均海洋熱浪事件累積達到每年 172 天。另外，珊瑚漂白指數即度加熱周，顯示 2020 年是該地區首次經歷超過 8˚C-weeks，達到漂白警戒等級 2，而 2022 年的情況更為嚴重，平均有 12 天達到此級別。近年來東北台灣颱風入侵次數減少，缺乏定期的冷水以緩解熱量，該地區珊瑚棲息地的未來海洋環境引起了重大關注。另一方面，我們也計算了各種事件指標來分析臺灣鄰近海域的海洋熱浪與海洋寒潮事件，指標包含事件數、事件發生數、累積天數、強度類別、強度溫度、事件升溫率與降溫率以及各種類型的海洋熱浪與海洋寒潮事件。基於這些指標我們可以深入分析從沿海次中尺度和開放水域的中尺度事件，並探討其與海洋流場與氣候型態之間的關係。

Ocean Current Mapping Using Time Reversal Method

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計畫名稱：應用時間反轉法遙測海流
計畫編號：MOST 111-2611-M-002-017

Abstract

Real-time coastal currents mapping, using the acoustic tomographic technique, presents challenges due to the conventional requirement of recovering acoustic instruments to obtain reciprocal arrival patterns for differential travel time (DTT) calculation. This research develops and validates a time reversal coastal acoustic tomographic (TR-CAT) system to enable real-time current estimation without instrument recovery. The TR-CAT approach utilizes time reversal to focus acoustic signals and mitigate multipath interference, allowing immediate DTT extraction from time-reversed receptions alone. The theory is illustrated using a Pekeris waveguide featuring a water depth of 60 m. Forward propagation convolves transmitted pulses with the impulse response. Then, time reversal and re-transmission refocus on the source. With currents, the maximum peak in the time-reversed arrival pattern exhibits a time shift, which could be used to estimate flow velocity. Relationships are derived between the times of the maximum peak of the time-reversed arrival pattern and the cross-correlation function of the reciprocal arrival pattern and DTT. Paired regular and TR transceivers implemented sequenced m-sequence and time-reversed waveforms, respectively. Regular systems used a microcontroller generating binary phase shift keyed m-sequences, while TR systems truncated and time-reversed receptions before re-transmission. Tank testing validated TR waveforms and timing correction methods. Field deployment in Bachimen Harbor demonstrated robust performance, with currents decreasing from 0.49 to 0.21 m/s during flood tides. Results validate the TR-CAT technique for real-time coastal current mapping without reciprocal transmissions or instrument recovery. In conclusion, this research successfully demonstrates a practical TR-CAT system using time reversal for real-time ocean acoustic tomographic current mapping. The straightforward approach shows promise for economical, efficient ocean monitoring.

The role of physical oceanic and atmospheric variation on a massive phytoplankton bloom in the North Pacific in 2018.

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計畫名稱：北太平洋副熱帶環流之渦旋造成的中尺度與次中尺度的環境變化(4/4)
計畫編號：NSTC 112-2611-M-019-027 -

Abstract

A huge phytoplankton bloom extending to a million-kilometer square was observed west of the Hawaii Islands in summer 2018, via satellite observation. After the Kīlauea large eruption in May 2018, easterly wind blew the volcanic ash far away toward the open ocean. At the north edge of the volcano ash, the huge bloom grew with the increasing in local rainfall under favorable ocean conditions. Beneath wind forcing, mixed layer depth reached as shallow as 25 m in the bloom region, accompanied by strong eddy-flow stretching and warm sea surface temperature exceeding 25oC. Besides, the bloom resided at where ocean stratification turned weak near subsurface fronts. Comparing to background ocean fields with low chlorophyll concentration, we observed higher saturated oxygen (over 105%) above 50 m and shallower chemocline (with maximum vertical changes in oxygen) within 50 m and 100 m in the bloom region. These findings showed a perfect natural environment to stimulate huge phytoplankton growth in the far nutrient-poor North Pacific, connected to volcanology, meteorology, atmospherology, and oceanography.

波浪梯度對大氣邊界層內之風應力影響

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計畫名稱：深入探討大氣邊界層內波浪梯度與風應力交互作用(1/3)
計畫編號：NSTC 112-2611-M-019-029 -

摘要

Surface winds in the marine atmospheric boundary layer (MABL) are often modified by the roughness of sea surface underneath. The small-scale features of sea surface temperature (SST) gradient were previously shown to have positively feedback to the wind stress divergence and curl by perturbing the turbulences of wind in the MABL throughout the world ocean. The influence of wave to wind is proposed by applying the similar but opposite mechanism to the gradients of significant wave height (Hs). This analysis is conducted using the satellite measured Hs over the North Pacific during the winter seasons from 1993 to 2016. The results show that waves over the western North Pacific are mostly wind driven: the wind stress divergence and curl are positive and linear correlated to the downwind and crosswind Hs gradients, respectively. The small-scale features of wave height gradient in the northeast regions of North Pacific signal a reversed energy transfer from wave to wind, where the wind stresses and Hs gradients are negatively correlated. Those regions are mostly dominated by swell, which transfers energy to the wind under certain circumstances.

海岸粗糙邊界層紊流與懸浮絮凝沉積物研究－桃園藻礁現場觀測

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摘要

我們提出了現場觀測的證據顯示海邊懸浮沉積物在波流底部邊界層流動下受到垂直紊流擴散和絮凝機制的作用。本研究是在桃園海岸的藻礁上進行了現場觀測，以探討流體動力學的垂直結構（波浪、水流和湍流）和懸浮沉積物特性（質量和體積濃度以及顆粒尺寸分佈）。 測量到的摩擦速度與對數律剖面擬合估計的摩擦速度一致，此顯示經典的壁面定律適用於粗糙礁石海底的波流底部邊界層流動。觀測到的懸浮絮凝物的有效密度和沈降速度與絮凝物的平均直徑顯著相關，其碎形維度為2.18，此數值直接證實了礁體上的懸浮沉積物發生了絮凝作用。同時測得的粒徑分佈曲線顯示，上部水體中存在有較大的絮凝物，其體積濃度較高，微尺度的絮凝體範圍內的體積濃度較小，而質量濃度較小，此點顯示絮凝體中微尺寸的礦物質成分減少，而下層水體的絮凝物中礦物成分增加。使用 Stokes 定律估計的沉降速度與使用 Rouse 曲線擬合的沉降速度一致，顯示懸浮絮凝物受到垂直湍流擴散機制的作用。現場觀測結果表明，沉積物在懸浮過程中將遵循紊流擴散和絮凝兩種機制來改變其質量和體積分佈。

以高通量定序解析骨藻在藻華過程中感受環境營養鹽變化之調適機制

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計畫名稱：以高通量定序解析骨藻在藻華過程中感受環境營養鹽變化之調適機制
計畫編號：MOST 109-2628-M-019 -001 -MY4

摘要

在海洋中，矽藻貢獻約 40% 的海洋初級生產力，其中骨藻 (*Skeletonema*) 為沿岸河口及湧升流區經常形成藻華的優勢種，而影響它們生長控制因子經常被認為是受營養鹽的供應所控制。為了能準確地評估浮游植物對營養鹽的反應，在本研究中主要研發骨藻營養鹽相關指標基因的次世代定序平台，藉此同時偵測不同骨藻種類對於環境中營養鹽改變之基因反應，為其在藻華形成及族群群聚改變時提供不同種類調適營養鹽變化之直接證據，並希望將此一平台應用於骨藻藻華經常出現之樣站，包括馬祖觀測站與美國納拉甘西特港灣長期採樣站。彙整在馬祖南竿長期觀測站結果顯示，矽藻經常在每年 3 月及 6 月時較高生物量出現，但細胞數量隨時間的變動大，其中骨藻是主要的優勢種之一，最多可佔浮游植物群聚約七成。目前利用骨藻屬營養鹽相關指標基因的次世代定序平台在 2022 年馬祖野外樣本共發現六種骨藻的序列，其中 *S. dohrnii*/marinoi 及 *S. subsalsum* 為主要的骨藻種類。相對在美國納拉甘西特港灣長期採樣站的採樣中，冬季開始形成骨藻藻華，骨藻相對數量可達到整體矽藻群聚的 95%以上維持將近兩個月，之後逐漸消失直到靠近夏季時才零星有短暫骨藻大量出現情形，以次世代定序平台之定序結果發現，在冬季藻華中則單一骨藻種類 (*S. dohrnii*/marinoi) 為優勢種。目前仍持續分析兩地營養鹽相關指標基因的表現情形，將合併所測得之營養鹽環境參數比較骨藻藻華形成過程的變化情形，以提供我們解釋骨藻藻華形成與環境營養鹽之關係。

東海南部不同水團對有機碳消耗的影響

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摘要

在東海陸棚南部海域，受到高溫、高鹽的黑潮水、台灣暖流，以及低溫且低鹽的中國沿岸流等影響主要影響。此外，陸棚海域也易受到人為活動的影響，因此導致本海域的物理、化學和生物水文因子呈現複雜的季節性和空間性變異。針對上述問題，本研究旨在通過對東海陸棚南部海域的研究調查，探討有機碳消耗（浮游生物群聚呼吸率）的變異情況。浮游生物群聚呼吸率指的是特定水域中所有浮游生物的集體代謝過程，其可能因溫度、營養鹽可用性以及浮游生物群聚本身的組成等因素而變化。了解浮游生物群聚呼吸率對於評估海域生態系統的整體代謝活動和生態動態至關重要。它提供了對碳和營養循環的洞察，以及環境變化（如富營養化或氣候變化）對浮游生物群聚和生態系統健康的潛在影響。在空間變異的探討上，由於本研究設定的測線主要受到大陸沿岸水、台灣海峽水和黑潮水的影響，因此根據鹽度和溫度特性將測線上的測站劃分為受到大陸沿岸水、台灣海峽水和黑潮水影響的三類型，並分別分析這三種水團的浮游生物群聚呼吸率及其相關參數的變異情況，從而探討影響浮游生物群聚呼吸率空間變化的可能因素。

關鍵字: 無機營養鹽、有機碳消耗、浮游生物群聚呼吸率、東海、黑潮、台灣海峽水

Resource richness controls plankton trophic structure and community predator-prey mass ratio (PPMR) in marine plankton food webs

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Abstract

Body size is the key trait regulating predator-prey interactions in marine plankton food webs. The body size ratio between predator and prey, i.e. predator-prey mass ratio (PPMR), is an important parameter to estimate trophic transfer efficiency. However, what environmental factors determine plankton food web structure and PPMR in natural marine systems remains elusive. We applied size-fractioned C and N stable isotope values ($\delta^{13}C$ and $\delta^{15}N$) of marine plankton community to evaluate the trophic diversity and community PPMR. Specifically, the total area (TA), nearest neighbor distance (NND), and standard deviation of nearest neighbor distance (SDNND) of size-fractioned plankton $\delta^{13}C$ and $\delta^{15}N$ are the indicators of community trophic niche space and similarity of trophic ecology of different plankton size groups. Community PPMR is estimated based on the slope of trophic position and $\log_2$(body size) linear regression. We found that TA, and NND increases with surface silicate concentrations. This implies that increase of limiting nutrients leads to higher diversity of prey preference by different zooplankton size groups. Furthermore, we found that community PPMR decreased with phytoplankton biomass. This infers that zooplankton more preferentially consume large prey in resource-rich environment where primary production is high. Our study reveals that siliceous nutrient supply limits the prey size preferences of zooplankton, possibly through the alteration of phytoplankton community diversity. More importantly, zooplankton prey selection on large, high trophic level prey increases with enriched basal resource, and thus increases the length of marine food chains.

The diurnal variation of dissolved oxygen in seawater is influenced by DOC excretion from seagrass and microbes

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計畫名稱：東沙海草床之生地化循環與微生物相之關係及其受全球環境變遷之影響
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Abstract

Tropical seagrass beds exhibit pronounced diel variations in dissolved oxygen (DO) and dissolved organic carbon (DOC), mediated by primary production, respiration, and microbial activities. However, near-future climate change scenarios predict elevated ocean temperatures with more frequent extremes. Tropical seagrass beds already inhabit ecosystems with wide environmental fluctuations and are therefore tolerant of current diel O_2 and temperature extremes. Therefore, we examined two seagrass sites with contrasting hydrodynamics at Dongsha Island to elucidate the mechanisms influencing DO and DOC dynamics. Metabolic rates and DOC fluxes were quantified using in situ benthic chambers. Moreover, active microbial communities were characterized via the amplicon sequencing of 16S rRNA transcripts. During summer, seagrass beds predominantly exhibited net autotrophy, transitioning to a more heterotrophic state in winter. In contrast, unvegetated sediments remained net heterotrophic. Interestingly, DOC fluxes varied, with the sheltered lagoon acting as a net DOC source, whereas the open coast predominantly functioned as a sink. Diverse microbial taxa emerged, varying across locations and seasons and correlating with factors such as carbon, temperature, and DO. A surge in microbial activity over diel cycles likely drove the observed nighttime DO declines. Overall, contrasting trends were observed between the sheltered lagoon and open coast sites. As ocean temperatures continue to rise, the net heterotrophy and sulfidic conditions seen in the lagoon may represent the future for tropical seagrass ecosystems, underscoring the need to maintain coastal water quality and understand microbial community resilience.

副熱帶黑潮湧升流水域超微浮游生物組成之日夜變化

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計劃名稱：以基因體學相關技術解析有機碳在微生物碳幫浦過程中之宿命-II
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摘要

為了解湧升流海域微生物碳幫浦效應之作用機制，於 2023 年 3 月於臺灣北部彭佳嶼海域進行 24 小時晝夜連續採樣與觀測。研究進行期間，並沒有明顯的湧升現象發生，應是此水域難得遇到的現象。以 16S rDNA 多樣性分析細菌組成變化，發現 *Proteobacteria* 是最為優勢的菌群，佔比可達 50%以上，其次則為 *Cyanobacteria*、*Actinobacteria*、以及 *Bacterioidota* 等。在有光層部分，*Cyanobacteria*、*Actinobacteria*、以及 *Bacterioidota* 等在表水的佔比總和可達 50%，而後隨著深度遞減。反之，深水層中除了 *Proteobacteria* 的佔比高達 80%以上，也可以看到 *Chloroflexi* 的出現。古生菌部分以 *Nitrososphaeria* 綱中之 *Nitrosopumilaceae* 屬以及 *Thermoplasmata* 之 Marine_Group-II 為優勢菌種，在表水佔比極低，隨著水深增加，其佔比增加至約 30%。另以 16S rRNA 解析活躍細菌組成，*Cyanobacteria* 是有光層最為活躍的菌群；在底層或是暮光層水體，除了 *Proteobacteria* 外，*Chloroflexi* 的活性也有增加的情形。轉錄體定序結果顯示水深 25 公尺以淺的微生物基因表現日週變化與 50 公尺以深的基因表現動態有明顯的差異，此部分資料仍在深入解析中，對於了解此水域「微生物碳幫浦」的運作機制應有相當的助益。

小體型、短壽命遠洋武裝魷(*Abralia multihamata*)的成長、生殖與能量分配

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計畫名稱：台灣淺灘(Taiwan Bank)湧昇區暨周邊水域生態系動態特性影響之研究-臺灣淺灘周邊海域頭足類動物分布及生態特性變動研究
計畫編號：112-2611-M-019-025

摘要

許多頭足類物種在達到性成熟後仍會持續生長，並在生殖投資上表現出極大的個體差異。多鉤鉤腕魷 *Abralia multihamata* 是區域性經濟漁業的常見物種，但對於其成長、性成熟，以及生殖能量分配等知識幾乎空白。本研究於 2021-2023 年間自臺灣西南海域蝦拖及拖網漁業中採集多鉤鉤腕魷樣本，並假設平衡石具日增長週期用以推估生活史特徵及孵化季節；透過分析體型、生長速度、成熟度及孵化季節之間的函數關係，評估其如何選擇其生殖投資策略。多鉤鉤腕魷平均日齡約 70－80 天，即一季一個世代；外套膜長及日齡呈線性關係，但雌性生長(0.58±0.15 mm/day)明顯快於雄性(0.39±0.09 mm/day)。雌性亦較雄性更早達到性成熟，成熟雌性會將 15-20%的整體重量投入性腺和附屬生殖器官，它們終年產卵並在秋季具有一明顯高峰。生長季節也影響了性別間生殖投資的能量分配。秋季孵化的雌性體質佳、成長快且付出更高的生殖投資，因此秋季產卵高峰有助於維持族群豐度；而秋季雄性同樣有成長方面優勢，但生殖投資無明顯季節差異。本研究結果表明，環境中生物和非生物因子的季節變化在生殖能量分配上扮演重要角色，而對於多鉤鉤腕魷這類小體型、短壽命的頭足類來說，性別間體型與生殖上的能量分配差異應是合乎邏輯的族群策略。

Evaluate Northwest Pacific fisheries resources using DNA markers

以 DNA 標誌評估西北太平洋漁業資源

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Abstract

Two marginal seas of the Northwest Pacific, the East China Sea (ECS) and South China Sea (SCS), represent one of the world's most densely populated regions. These seas have long endured substantial fishing pressures by surrounding nations. Climate change and marine pollution have heightened concerns, contributing to the ecological fragility and continual depletion of marine resources over the past few decades. Taiwan, positioned at the confluence of ECS and SCS, provides a pivotal conduit for fisheries resources and, therefore, is critical for evaluation. DNA markers have been widely applied to evaluate fisheries resources by estimating the genetic diversity, population structure, effective population size, historical population dynamics, migration patterns, etc. For the past few years, our team has used DNA markers to study several fisheries species, including cutlassfishes (*Trichiurus* spp.), squid (*Uroteuthis edulis*), and yellowstripe scad (*Selaroides leptolepis*). We observed a general pattern of a more restricted distribution range and difficulties in species identification based on morphology, which resulted in elusive fishery data.

Keywords: fishery, microsatellite, mitochondrial DNA

結合 16S-rDNA 和 16S-rRNA 研究東海南部原核浮游生物群聚結構

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計畫名稱：副熱帶陸棚浮游生物食物網生態過程研究(Ⅱ)－ 子計畫：運用多源基因體學探究各類群海洋浮游生物的晝夜垂直移動與交互作用(3/3)
計畫編號：NSTC 112-2611-M-006-005 -

摘要

原核浮游生物是海洋生態系統中基本生物地球化學過程的驅動者。然而，不同的分類群可能有不同的分布範圍與活耀程度，而對於生態系統功能具有不一致的貢獻。為了更好地反映生物群聚中常態存在與相對活躍的成員，本研究針對東海南部原核浮游生物群聚的多樣性、組成和活性進行調查，使用高通量定序技術，對單一樣本同時產生 16S-rDNA 和 16S-rRNA 數據進行分析比較，旨在評估由 rDNA、rRNA 和 rRNA:rDNA 所檢測到的群聚生態特徵的異同。本研究結合三個航次樣本共產生了 120 個定序數據集，涵蓋了 rDNA 和 rRNA 兩個分子層次，三個季節變化（春季、秋季和冬季），四個水層差異（表層、葉綠素最大層、中層和底層），以及五個站點（從近岸到遠岸）。結果發現透過 rDNA 和 rRNA 檢測到原核浮游生物的 ASVs（基於序列的分類單元）存在巨大差異，每個樣本中僅有 12%至 52%的 ASVs 可同時被 rDNA 和 rRNA 偵測重疊。基於 rDNA 和 rRNA 數據所偵測到的優勢種類與分類組成比例也不相同，其中 Nitrososphaeria 和 Acidimicrobiia 這兩大類群在 rDNA 中占較高比例，而 Alphaproteobacteria、Gammaproteobacteria 和 Bacteroidia 則在 rRNA 中占較高比例。通過 rRNA:rDNA 比值估計每個分類單元的相對代謝活性，發現 Nitrososphaeria 和 Acidimicrobiia 中大多數 ASVs 的 rRNA:rDNA 比值通常小於 1。相對地，Alphaproteobacteria 和 Bacteroidia 中有某一些 ASVs 的比值相當大（>10），表明它們在亞熱帶沿岸水域中可能具有較高的活性。這項研究表明，同時獲取 16S-rDNA 和 16S-rRNA 數據可以更全面地了解海洋原核浮游生物的多樣性和活性。

Spatial trends in the essential fish habitats in southwestern Taiwan coast

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Abstract

Scientific trawl surveys in the southwestern Taiwan coast were conducted using the research vessel New Ocean Research III to identify the essential fish habitats with higher abundance of commercially important fish. From We collected a total of 10572 fish individuals from 87 families and 266 species from 12 coastal sites in western Taiwan from 2020 to 2023, in which 76 % (66 families) and 70% (185 species) are at least with low economical values. The proportions of commercially important fish were generally higher in mid-western Taiwan from Chang-Yuen Ridge (雲彰隆起) to Taichi (台西), as well as in southern Taiwan from Jiading (茄定) to Lingyuan (林園). If we focused on fish species with medium to high values, sites from mid-Taiwan were generally had higher proportion of high-value fish species than those in sites from southern Taiwan. This mid-south Taiwan contrast was stronger in warm months (May to Octobers) than cold months (December to January). Further studies will be carried out to elucidate proper spatial management about the structure of benthic fish communities in western Taiwan coast.

Understanding Feeding Ecology and Habitat of Greater Amberjack influenced by ENSO Events in Taiwanese Waters

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計畫名稱：台灣淺灘(Taiwan Bank)湧昇區暨周邊水域生態系動態特性影響之研究-總計畫及子計畫:台灣淺灘湧昇區暨周邊水域浮游動物群聚特性與水文環境之研究

計畫編號：NSTC 112-2611-M-019-021

Abstract

The greater amberjack (*Seriola dumerili*) holds significant ecological and economic importance, yet knowledge about its feeding ecology and habitat dynamics remains limited. This study delves into the feeding dynamics of the greater amberjack and its prey species in Taiwanese waters, exploring spatial and temporal variations influenced by environmental factors. Concurrently, it investigates the impact of El Niño–Southern Oscillation (ENSO) events on habitat suitability and catch rates, using a weighted habitat suitability index (HSI) modeling approach and environmental data. Results reveal distinct dietary preferences, seasonal variations, and ontogenetic shifts in feeding patterns of the greater amberjack, highlighting the influence of oceanographic factors on prey availability. Moreover, analysis of ENSO events demonstrates their significant role in shaping habitat suitability and catch rates across seasons, with implications for the management of this commercially important species in the Taiwanese waters.

生物與漁業專題演講 Biology and Fisheries Science

解析不同時間尺度下氣候變遷對中上層生態系統族群變動影響

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計畫名稱：氣候變遷下熱帶性鮪類族群動態與生態系統組成特性同步變動關係研究 (3/3)
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摘要

鮪類具有高經濟性及高洄游之特性且易受到海洋環境變動而改變其時空間分佈，許多研究透過各種方式建置解析氣候變遷對鮪類影響之機制，然方法間仍存差異。因此本研究透過兩個案例，比較不同時間尺度及模式方法建置下鮪類族群變動概況。皮爾森及棲地適合指數分析顯示 1981-2016 年間熱帶大西洋黃鰭鮪與大目鮪受到氣候指數的影響下物種間可能存在競爭關係且其餌料生物豐度有減少的趨勢；而多物種體長模式(Mizer)建置下，大型表層物種(黃鰭鮪及大目鮪)之產量減少 5~20%，中型表層物種(鮪類之餌料生物)則減少 15~50%，並在生態系統中觀察到蜂腰控制(wasp-waist control)的現象。透過彙整上述結果得知，棲地模式建置可對於歷史時期之漁業資源變動作更深入之解析，然物種間之連結大多仰賴統計數據，較不易統整生態系統之控制現象；生態系統模式建置雖然可以解決上述種間連結的問題，但模式本身(以 Mizer 為例)卻存在較小的調整空間，僅能匯入海水溫度作為環境指標，對於環境其氣候指數之考量較缺乏全面性。

頭足類的野外代謝率與溫度相關性

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計畫名稱：海洋同位素空間圖的建立以及後續應用於生物生理生態的調查：以頭足類為例
計畫編號：111-2611-M-002 -028 -MY3

摘要

海洋生物面對日益暖化的海洋，如何調解其生理特徵決定了地理分佈，進而影響人類在漁業資源的使用，調查自然環境中海洋生物的生理特徵及行為面對諸多挑戰，例如無法實際觀測、現有技術的高成本等，因此本計畫使用嶄新的同位素方法，調查台灣漁獲的重要物種__頭足類，其新陳代謝率如何在升溫下變化。相較於魚類以及其他軟體動物，頭足類的生理生態研究較少，但卻是相當重要的漁業資源，然而資源管理缺乏基礎的生理資訊，本研究使用烏賊骨板穩定氧同位素重建個體經歷溫度，以及使用骨板穩定碳同位素作為新陳代謝指標，探討台灣西南海域的虎斑烏賊族群在一年間新陳代謝率和溫度的相關性，研究發現虎斑烏賊偏好 25˚C 至 27˚C 海溫，在此溫度區間內，虎斑烏賊新陳代謝有最大的代謝範圍，可調整能量使用面對環境壓力，高於此溫度，高能量的需求不適合虎斑烏賊的生長，因此海水升溫可能會造成其體型縮小並改變其生活史策略，未來研究會擴大不同年間的比較，調查虎斑烏賊在海水升溫下的代謝調節以及群族動態

Expansion of oxygen minimum zones may effects on movement behavior of blue marlin (Makaira nigricans) in the northwest Pacific Ocean

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Abstract

In the open ocean, temperature, hydrostatic pressure, dissolved oxygen, and prey availability are thought to be dominant features that influence acceptable habitat. Satellite tracking of blue marlin (*Makaira nigricans*) has revealed movement patterns that span months and thousands of kilometers across open ocean. In total, 14 blue marlin were tagged between Feb 2010 to May 2014 and PSATs remain affixed from 27 to 360 days-at-liberty. Linear displacements ranged from 56 to 3,759 km from deployment to pop-up locations. Diving depths ranged from the surface to ~441 m and water temperatures occupied ranged from 32.3°C to 6.8°C, and the distributions of time spent at depth were significantly different between daytime and nighttime. Tagged blue marlin spent the majority of daytime in the surface mixed-layer to ~50 m, and at nighttime they were exclusively confined to the surface. The movements of blue marlin appeared to be restricted during the 2010 La Niña. Blue marlin exhibited residency patterns exclusive to the northwest Pacific Ocean during 2010-2013, when sea surface temperatures across the equatorial Eastern Central Pacific Ocean were higher. During 2014, blue marlin undertook movements across the equator and exhibited residency patterns near coastal areas. As a result of low oxygen and/or temperature conditions closer to the surface, the depth distribution of blue marlin was restricted in those areas. It is postulated the El Niño Southern Oscillation (ENSO) affected movement behaviors over temporal and spatial scales by shaping the available thermal habitat of blue marlin.

利用漁船航次和市場數據透過線性和非線性統計模型制定豐度指數

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摘要

由於台灣沿近海漁業尚未強制漁船繳交漁業日誌，對於近海漁業資源管理較為困難。本研究主要以台灣西南部沿海拖網漁業中的黑口石首魚（Atrobucca nibe）為例，展示了如何建立來自資料有限漁業的相對豐度指數。本研究使用航行數據記錄儀（voyage data recorder；VDR）和市場歷史漁獲來發展單位努力的漁獲量（CPUE），其中使用三種統計模型對 CPUE 進行標準化：一般線性模型（GLM）、一般加法模型（GAM）和向量自迴歸時空模型（VAST），總共設計了 15 種模型，並且採用交叉驗證 R^2 進行模型評估。結果表明在考慮不同影響變數對於模型預測能力時，對於多物種漁業之目標效應因子，建議透過主成分分析（PCA）方法來處理，同時各船隻效應和空間效應也具有影響力。另外，模型的預測性能，由於 PCA 和環境數據屬非線性特徵，這項研究表明 GAM 的表現優於線性的模型；且當 VAST 擴展以納入非線性特徵時，該模型在預測能力上超越其他模型。

Stable Isotope Analysis of Otoliths Reveals Habitat and Origin of Barramundi

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Summary

Barramundi (*Lates calcarifer*) is a euryhaline fish that is widely distributed in the Indo-West Pacific and is a popular food fish extensively farmed in Taiwan. However, there is a lack of information on the origin, habitat use, and migratory behavior of barramundi in Taiwanese waters. This study evaluated the $\delta^{13}C$ and $\delta^{18}O$ values of otolith growth increments in both wild and farmed barramundi and estimated salinity from otolith $\delta^{18}O$ values to determine the habitat use and origin of wild individuals. The study also discriminated between wild and farmed individuals using otolith $\delta^{13}C$ and $\delta^{18}O$ values to investigate whether individuals captured from the Danshui River Estuary have an aquaculture origin due to religious release or stock enhancement programs. The wild individuals from the estuary exhibited a wide range of $\delta^{13}C$ and $\delta^{18}O$ values, while farmed samples showed consistent values within a group. Based on otolith $\delta^{18}O$ values and estimated salinity, most of the wild fish samples were born in the brackish water environment, with varying migration behavior among individuals. The time-series change diagram of salinity for each sample in this study reveals a consistent trend in salinity change. The individuals enter into waters with lower salinity (or even freshwater) after birth and return to waters with a salinity similar to their birthplace when they are approximately one year old. The $\delta^{13}C$ and $\delta^{18}O$ values of individuals of age less than 1 year old were useful to determine that the fish samples captured in freshwater in this study did not originate from aquaculture. The $\delta^{13}C$ and $\delta^{18}O$ values also revealed significant differences among fish groups, with 95% correct classification accuracy using quadratic discriminant analysis. The otolith core values showed that only one sample caught in the Danshui River Estuary might have aquaculture origin. Stable isotope ($\delta^{13}C$ and $\delta^{18}O$) values were successfully utilized to trace the life history of barramundi and distinguish individuals from different origins. The results can be utilized to formulate sustainable management policies for this important fishery resource.

Warm eddy driving significant changes in prokaryotic growth and grazing in the tropical Pacific Ocean

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計畫名稱：副熱帶陸棚浮游生物食物網生態過程研究（Ⅱ)--總計畫及子計畫：picophytoplankton被攝食與被病毒裂解的能量比例(2/2)

計畫編號：112-2611-M-019 -028 -

Throughout the western tropical Pacific Ocean, eddies and currents play an important role in biogeochemical cycling. Many studies have investigated the effects of hydrography on vertical patterns of picophytoplankton and bacterial abundance in mesoscale eddies. There is a lack of field observations to determine what impact dynamic hydrological systems of eddies have on plankton community activity (growth and mortality rates). An objective of this study was to examine how anticyclonic eddies influence picoplankton abundance and activity (growth and mortality rates). To meet this purpose, bacterial and picophytoplankton growth and mortality rates were examined by modified dilution experiments conducted at the surface, deep chlorophyll maximum (DCM), and 200 m depth outside (OE) and inside of warm eddies core (EC) in the west Pacific Ocean. Bacteria and picophytoplankton growth rates were higher in EC samples than in OE samples. A high bacterial grazing rate was also found in the EC region in the present study. Furthermore, the picophytoplankton grazing rate in EC was frequently greater than the grazing rate in OE. Furthermore, the higher grazing rates in the EC region cause a lower proportion of viral lysis to account for bacteria and picophytoplankton mortality. The results of our experiments suggest that downwelling in EC might increase picophytoplankton growth and grazing rates, increasing the carbon sink in the warm eddy and potentially increasing ocean carbon storage.

臺灣淺灘暨澎湖西南海域之季節性中小型魚類攝食變動

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計畫名稱：台灣淺灘(Taiwan Bank)湧昇區暨周邊水域生態系動態特性影響之研究 (II)－子計畫：臺灣淺灘周邊海域之中小型魚類組成多樣性及攝食結構變動特性
計畫編號：NSTC 111-2611-M-019-027-MY2

摘　要

為了解臺灣淺灘暨澎湖西南海域之生物相及生態系的時空間變動特性，本研究於2020年5月及9月間，利用商業性拖網漁船於本研究海域進行海生物樣本採集，並透過所有海生物之種類組成、所攝食之餌料生物與食物網結構、營養位階等結果，建構其魚類物種多樣性及攝食結構，以協助總計畫之海域生態動態模式所需基礎資料。結果顯示，5月之生物相包含有魚類34科61種，而9月則為31科47種，其餘尚包含有蝦類、蝦蛄類、蟹類、頭足類、螺貝類及其他底棲生物，其物種組成有時間上之差異；進一步分析依物種、生態、攝食等方式劃分之魚類功能組之胃內容物結果來看，其食性包含有食魚、食頭足類、食蝦蟹、食其他底棲生物、食浮游生物等；由拖網採集所得之魚類營養位階多介於3-4之間，且9月之平均營養位階略高於5月。多數魚類功能組在時間上之攝食種類並無顯著差異，此可能與各魚種別之體長大小範圍、樣本數不足(空胃率高)或功能組劃分方式有關。

初探七股潟湖淺層沉積物空間與時序上的變化

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計畫名稱：陸源/非陸源物質在高輸砂量之河-海輸運系統中的宿命整合研究 (XV)－子計畫：河口至陸坡沉積物中硫酸鹽還原「速率」與作用對碳埋藏的影響(1/3)
計畫編號：NSTC 112-2611-M-992-002

摘要

七股潟湖，作為全台最大的天然潟湖，連同其周邊濕地，被評估為全台最大的區域碳匯之一。然而，關於這些區域在全球碳循環中的具體作用，尤其是沉積物的碳埋藏機制，目前仍存在顯著的知識缺口。特別是七股潟湖的碳匯估算，這主要依賴於數值模型，而缺乏實際的地球化學數據支持。。

本研究旨在通過對七股潟湖淺層沉積物的地球化學特性進行深入分析，來填補這一項知識缺口。本研究在南北潮口、潟湖中央以及七股溪口等關鍵區域採集沉積物岩心樣本，分析沉積物的粒徑大小、總有機碳、氮含量與其同位素特徵、總硫與還原硫含量；並分析沉積物間隙水中硫化氫、硫酸鹽、總鹼度、營養鹽甲烷濃度；另一方面實際量測沉積速率與硫酸鹽還原速率以評估碳埋藏通量，揭示該區的空間變異性及時序上的差異。

本研究調查七股潟湖表層與淺層沉積物的地球化學特徵之季節性變化，尤其是冬季與夏季之間的差異，透過探索沉積物中有機質的組成、來源、傳輸、沉積機制以及埋藏過程，本研究將提供對該區域碳循環及生物地球化學現象的全面理解。

Precession influenced nutrient utilization in the east pacific during the Pliocene using foraminifera-bound nitrogen isotopes

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The Late Pliocene - early Pleistocene climate variability is predominantly manifested through glacial-interglacial changes with ~ 41 kyr (obliquity) periodicity. The tropical Pacific climate changes during this period are mostly inferred from sea surface temperature (SST) reconstructions which express strong orbital control of obliquity periodicity and are highly correlated with greenhouse gas forcing. However, the role of local insolation in driving biology-mediated tropical climate changes in the upwelling systems of the tropical Pacific remains under expressed.

The Eastern tropical Pacific hosts three major upwelling systems (equatorial upwelling, ETSP and ETNP) transporting subsurface nutrients that support surface productivity thereby modulating the strength of the biological pump in the tropics. The degree of nutrient utilization along the equatorial upwelling region is dependent on the strength of the upwelling. Stronger upwelling brings more nutrients to the surface which are incompletely utilized. This process leaves its imprint on the nitrogen isotope values ($\delta^{15}N_{nitrate}$) of the sinking organic matter, such that lower than subsurface (source of nitrate) $\delta^{15}N_{nitrate}$ is observed during stronger upwelling and vice-a-versa.

To reconstruct the nutrient utilization in the EEP spanning the late Pliocene – early Pleistocene, we constructed a foraminifera-bound $\delta^{15}N$ (FB-$\delta^{15}N$) record of *Trilobatus sacculifer* from IODP Site U1338 (2º30.469'N,117º58.178"W, water depth 4200 m). Our record covers the first three major glacial-interglacial Marine Isotope Stages (MIS-96, 98 and 100) after the onset of Northern Hemisphere Glaciation. Contrary to SST reconstructions from the EEP region, the nutrient utilization was observed to be sensitive to precession-driven local insolation changes rather than changes in obliquity. We propose that the strength of biological pump in the Pacific equatorial upwelling system was modulated by local insolation as opposed to glacial-interglacial changes or the greenhouse gas forcing.

離岸風電海域地質調查初步成果

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計畫名稱：離岸風場海域地質調查及地質環境資訊服務

計畫編號：112-5226904000-02

摘要

離岸風電是我國淨零轉型十二項關鍵戰略之「風電/光電」關鍵戰略之一項，是我國重要的綠能政策之一，離岸風場主要分布於臺灣海峽，部分分布在高屏近岸區，台灣海峽風場從澎湖海域往北至彰濱海域(包含台中)、竹苗、桃園及北部海域等，地質環境關係到風機基礎及維運安全，為瞭解風場海域地質環境狀況，經濟部地質調查及礦業管理中心(簡稱地礦中心，原為「經濟部中央地質調查所」，自 112 年 9 月 26 日起改制)，規劃於 111-114 年逐年完成風場海域區域尺度地質調查，其中彰濱離岸風場是主要的風場，發電容量佔離岸風電整體規劃發電量之 80%以上，因此優先於 111 年完成彰濱風場海域區域尺度地質調查，112 年則已完成澎湖海域、補充彰濱海域及竹苗近岸區地質調查，後續 113~114 年則規劃在竹苗及北部海域進行調查。

在彰濱離岸風場海域地質調查結果，經評估分析可能影響風機基礎地質安全控因，計有淺層斷層(淺於 120 公尺)、沙波飄移(海床基準面變動)及流體煙囪等，而淺層不均勻分布的玄武岩堅硬地層(淺於 100 公尺)可能會影響基礎施工。未來風場開發商可針對風場區域高影響潛勢之地質安全因子，進行詳細調查，從基礎鄰避或採取適當之設計方式來因應，以確保風機基礎地質安全。

為因應離岸風場第三階段區塊開發，112 年調查區往北延展至竹苗近岸區，調查發現有活動背斜及斷層，可能和陸上之青草湖背斜、陸上活動斷層(ex.新竹斷層)有關，由於竹苗近岸區目前風機林立，活動背斜及斷層可能會影響風機基礎安全，將進一步分析地質構造分布情形。

地礦中心完成的風場海域地質調查資料，全部公開於「離岸風電地質與環境感知系統」 (網址：https://windpower.geologycloud.tw/map)，包含查詢及協作平臺的功能，其中協作功能可套疊風場規劃位置及相關環境敏感或限制區位，作為風場規劃及決策評估參考。另為落實政府「友善產業環境」政策，風場開發商可依據「離岸風電地質與環境感知系統服務平臺資料提供及使用作業要點」(112 年 4 月 25 日公布實施)申請地質調查資料使用，作為廠商工程尺度調查之基礎地質資料，相關調查資料也可提供學研界使用，最大化資料使用效益。

Shore-parallel frontal systems along the entire western side of the Taiwan Strait due to the coupling between river plumes and monsoon-driven currents as the major dispersal mechanism for fluvial sediment

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計畫名稱: 總計畫-高輸砂量之河-海輸運系統中顆粒動力作用及沈積的綜合研究(XV)

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摘要

The Taiwan Strait (TS) linking the East China Sea and South China Sea, is the major conduit for the exchange of water masses and terrestrial and marine-sourced sediments between the two major Asian marginal seas. Two world major rivers, the Changjiang (Yangtze) and Zhujiang (Pearl) Rivers are located at the north and south openings of the TS, respectively as distal fluvial sediment sources. Along the west coast of the TS there are a few small rivers as proximal sediment sources. Despite the seasonal changes of the monsoon climate, the river effluent discharged by these rivers jointly form shore-parallel frontal systems throughout the TS and throughout a year. Therefore, river plumes coupled with monsoon-driven winds and ocean currents, form the major dispersal systems of riverine sediments on the western side of the TS. These fronts mark the boundary between water masses carried in the coastal currents on the western side of the TS and those carried by ocean currents in the interior of the TS.

A foreland basin with two distinct modern sediment dispersal systems: An example from Taiwan

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計畫名稱：台灣東部海域連接海岸的海底峽谷控制成因調查研究

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摘要

The western Taiwan Foreland basin (WTFB) is a classical peripheral foreland basin longitudinally bounded by the East China Sea to the north and the South China Sea to the south and spill longitudinally into the nearby marginal sea basins. Due to oblique collision in Taiwan region the WTFB has evolved into two subbasins: a mature basin dominated by fluvial sediments in central-north Taiwan and an immature one dominated by deep marine facies in southern Taiwan, accompanied by two distinct sediment routing systems, respectively. In the north, the Choushui River drainage, narrow seaway of the Taiwan Strait shelf, Huapingshu Channel, Mienhua Canyon and the southern Okinawa Trough (SOT) are integrated into a united sediment dispersal system, allowing sediments sourced by the mature basin to be laterally over-spilled to the East China Sea and finally deposited at SOT. In southern Taiwan, the Kaoping River drainage, Kaoping Canyon, Penghu Canyon, deep-sea Penghu Channel and northern Manila Trench (NMT) are inter-connected to form a longitudinal sediment dispersal system, allowing sediments mainly derived from the southern Taiwan orogen longitudinally transported to the South China Sea basin and the NMT

Utilizing Novel Spectroscopy Methods for Sediment Composition Analysis in the Western Pacific: A Case Study of the Mud Zones in the Matsu Area

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計畫名稱：創新沉積物礦物代用指標之西太平洋古海洋研究（Ⅱ）
計畫編號：112-2611-M-019-015-

Abstract

The Taiwan Strait is a vital connection between the East China Sea and the South China Sea, with sediment origin and distribution influenced by regional dynamics like strong winds, rainfall, ocean currents, and typhoons. The strong winds and heavy precipitation affecting the lands near the Strait transport a significant amount of terrigenous sediments into the Taiwan Strait, making the characteristics of sediments in the East China Sea mud zones indicators (e.g., grain size, mineral composition) of ancient typhoon and flood intensities and frequencies. This study utilized visible to near-infrared reflectance spectroscopy (ASD LabSpec Pro FR UV/VIS/NIR), radiocarbon dating, and chronological comparison to analyze cores from the Matsu area, documenting extreme climate changes over nearly 1300 years. Techniques such as Target Peak Search (TPS) and Principal Component Regression (PCR) identified variations in clay minerals (illite, kaolinite, smectite) and heavy minerals (epidote) content. Additionally, handheld X-ray fluorescence (XRF) spectroscopy and particle size analysis revealed changes in elemental content (titanium, zirconium, rubidium) and particle distribution. These analyses suggest shifts in terrigenous material output and provide insights into the intensity and frequency of historical typhoons and precipitation. The data indicates a warmer, wetter climate during the Medieval Climate Anomaly (A.D. 1200-950), leading to increased flood or rain intensity and more terrigenous sediments in the Strait. Between A.D. 1350 and 1500, a drier climate is suggested by lower particle size and elemental ratios. These results highlight the sedimentary records from the Matsu area as indicators of extreme climatic events over the past 1300 years, enhancing our understanding of East Asia's paleoclimatic patterns and aiding future climate risk assessments.

南海北部大陸邊緣筆架海山之特徵與地體構造意涵

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計畫名稱：東沙隆起晚中新世以來的震測地層學與地質事件研究
計畫編號：MOST 110-2611-M-002-008-MY3

被動大陸邊緣係指大陸地殼張裂、並並於海底擴張發生了新的海洋之後，介於大陸地殼與海洋地殼間，常具有非常過渡性特徵的地殼。近年來由於油氣探勘資料的利用，被動大陸邊緣之研究有非常長足的發展，除了富岩漿與貧岩漿兩種主要類型之外，新的模型將過渡型的大陸地殼分做數區，從近陸側的近端段(proximal domain)與頸端段(necking domain)，到遠陸側的遠端段(distal domain)與外端段(outer domain)。其中遠端段常因地殼高度拉張而常似海洋地殼，但仍有許多大陸地殼特徵例如向海傾底脫的斷層與斷塊。南海北部大陸邊緣的遠端段之特徵即為近年來非常多研究的重點，例如 IODP367 與 368 的調查航次，然而該調查僅著重珠江口接鄰的南海西北次海盆處，對於其北側大陸邊緣之下部陸坡、即筆架海山群處討論較少，因此我們希望能藉由既有資料的重新處理來了解筆架海山群在大陸邊緣發展的意義。水深資料顯示了筆架海山群的形貌，震測資料則除了顯示被動陸緣的層序之外，亦顯示海傾斷層的存在，或為滑脫構造面，則我們認為筆架海山群是被動大陸邊緣遠端段的表徵、而筆架海山則處於遠端段與海洋地殼的交界。另一方面，我們也注意筆架海山在更晚近的地層層序內有正斷層的出現，說明在後張裂層序發生之後，有一區域性張裂作用的發生，此現象過往係以馬尼拉海溝之隱沒作用造成海溝外緣撓曲而形成的外隆升有關，雖過往亦有報導撓曲或發生在東沙隆起處。整合上述，我們提出筆架海山在被動大陸邊緣時期為一外斷塊高區，而進入活動大陸時期時則成為隱沒系統最外緣的外隆升。

地質地物專題演講 Geological Oceanography

海北坡生物拖網和表層沉積物的現生浮游有孔蟲種屬組合的記錄

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計畫名稱：陸源/非陸源物質在高輸砂量之河-海輸運系統中的宿命整合研究(XIV)—
子計畫：現生有孔蟲在水體的及沈積物的分布-人類活動印記 (Ⅱ)
計畫編號：NSTC 111-2611-M-110-010

摘要

本報告係根據於 2018 年、2020 年和 2022 年沿著珠江沖淡水的擴散路徑，從河口到台灣海峽南部所取得的表層沉積物與生物拖網標本的分析結果，並參照航次期間 NASA's Earth Observing System Data and Information System (EOSDIS)衛星遙測的水文資料綜整的初步結果。整體而言，以孟加拉玫瑰紅染色處理的表層沉積物所取得的新鮮有孔蟲殼體的濃度隨著採樣點遠離珠江口而增加；而當採樣點接近台灣淺灘，有孔蟲殼的數量顯著減少。比較特別的是 2018 年和 2020 年五個重複位置的表層沉積物標本所取得的新鮮浮游有孔蟲經過鑑定計數後，兩者所呈現的種屬組成非常相似，顛覆一般將沿岸地區視為動態沉積環境的刻板印象，並且支持表層沉積物的確可以反映水體在短時間尺度 (週間) 的生物活動狀況。然而染色表層沉積物中的種屬組合與同時進行的生物拖網收集到的有孔蟲族群卻有顯著的差異，來自表層沉積物的種屬群落顯示出比水體拖網的組合有更豐富的偏好冷水的種屬，可能反映了 2020 年 7 月研究航次前該海域普遍存在的水文環境。此外，在台灣淺灘附近也觀察到了類似的“表層沉積物和浮游生物拖網所顯示的湧升流印記之間的明顯差異”-台灣淺灘的表層沉積物並沒有如拖網所出現大量的偏好冷水的種屬。浮游生物拖網和表層沉積物之間有孔蟲組合的不對應性顯示水體中生物顆粒和底床沉積物所表現出的訊號之間的不一致性質。對於這種脫鉤現像有兩種可能的解釋：第一種是水體沉降的顆粒與海底沉積物之間樣本所代表的時間尺度不同所造成的差異；第二個可能則是反映特定水團 (湧升) 與水層整體平均情況之間的不同。

海床地震波所造成的深海水壓擾動

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計畫名稱：探索西菲律賓海床的垂直運動 II:加瓜海脊東側的海床測斜儀觀測
計畫編號：112-2611-M-002-018-

摘要

Significant seismic events produce discernible ground motions that are recorded by global seismic networks, influencing the ocean floors and disrupting water masses in the deep sea. This study analyzes ocean bottom pressure data acquired from two tsunami monitoring stations deployed by the Central Weather Administration (CWA, Taiwan) in Taiwan's eastern and southwestern offshore regions. The purpose is to unveil the correlation between seismic seafloor motions and ambient water perturbation. A comprehensive statistical analysis was conducted on the waveforms of the bottom-pressure time series spanning from 2018 to 2021. Given the negligible impact of water layer compressibility on low-frequency seafloor oscillations, the seafloor pressure induced by low-frequency seismic waves is directly proportional to seafloor acceleration. Notably, the minimal response of bottom pressure at a frequency of approximately 60 mHz (17s period), beyond the tsunami frequency band, prompted an investigation into the transition of water fluctuation in response to seismic Rayleigh waves. Power spectral analysis revealed that the proportionality coefficient of ground motions and water pressure perturbations equates to the mass of the water column at the observatory's installation or, approximately, the product of water density and ocean depth. However, the potential impact of sediment layer resonances introduces uncertainty in the pressure/acceleration transition in seafloor water pressures. This study addresses the practical concern of whether the threshold value in the PMEL tsunami monitoring system (Deep-Ocean Assessment and Reporting of Tsunami, DART) applies to regional earthquakes capable of generating hazardous trans-Pacific tsunamis. Additionally, it contributes to exploring the physical mechanisms involved in transforming energy from the solid earth to the ocean water layer.

Reconstructing Kuroshio Current deflection during the Last Glacial Maximum using lipid biomarkers

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The Kuroshio Current (KC) is a North Pacific western boundary current that transports heat and moisture from the Indo-Pacific Warm Pool to the east coast of Asia, influencing the intensity of the East Asian monsoon and the path of typhoons. This current originates east of the Philippines and flows up the east coast of Taiwan before entering the Okinawa Trough and the East China Sea. It enters the Okinawa Trough via the Yonaguni Depression, an incision in the platform of the Ryukyu Arc (sill depth 775 m). Below 600 m, the intermediate waters carried by the KC collide with the Ryukyu Arc and deviate eastwards along its eastern edge to form the Ryukyu Current.

Despite numerous previous studies, the trajectory of the KC during the Last Glacial Maximum due to the drop in sea level remains uncertain. To do this, measurements of terrestrial lipid biomarkers (n-alkanes, n-alkanols and PAHs) were carried out on core MD18-3532, collected during the EAGER campaign in an intra-slope basin of the accretionary prism of the Ryukyu Arc, east off Taiwan. This intra-slope basin is currently disconnected from the KC but should be on its trajectory in the event of a deviation during lowstand. It is also isolated from terrigenous inputs from Taiwan by turbidity currents by the presence of a 1200 m shoal separating it from the fore-arc basins of the Ryukyu Arc.

From measurements of terrigenous lipid biomarkers (n-alkanes) on core MD18-3532, it was possible to demonstrate an intensification of the transport of continental organic carbon to the study site during the period of low sea level from the Last Glacial Maximum to the Bølling-Allerød (14 ka). Using the Carbon Preference Index and Average Chain Length, it was shown that the source of these biomarkers was Taiwan. The changes in their abundance show a greater transfer of terrigenous material to the study site during periods of low sea level, with a gradual decrease from the Bølling-Allerød and as sea level rises. Given the geographical isolation of the intra-slope basin, this pattern can only be explained by the intensification of the eastward defleciton of intermediate waters due to the drop in sea level, leading to an intensification of the subsurface Ryukyu Current, which would drag the surface waters and leads to the formation of an eastern branch of the KC. These results thus support the previous work by Fenies et al. (2023) on the existence of a secondary branch of the KC during the Last Glacial Maximum up to the Bølling-Allerød. After 14 ka, the rise in sea level allowed the KC to enter the Okinawa Trough fully, causing the secondary branch to collapse.

The east Pacific Oxygen Minimum Zone during the Pliocene

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Abstract

Global climate during the Pliocene (5.33-2.58 Ma) was similar or even warmer than today's climate such that this period provides a potential analog on how future global climate change may look like. Although the Pliocene has been studied extensively, major gaps in our knowledge are still existing, specifically in the east Pacific. During the early Pliocene the east Pacific was likely warmer than today, the equatorial cold tongue did not exist yet and the Oxygen Minimum Zones may have been less intense or even absent. This overview attempts to look at the history of the OMZ in the east Pacific both on a long-term timescale, i.e. from the early Pliocene to after the onset of Northern Hemisphere Glaciation, and on a shorter, glacial-interglacial timescale. We reconstruct variability potentially related to the OMZ from several (I)ODP sites (Site U1338, Site 1236, Site 1241) using different foraminifera-based proxies. Changes in the stratification of the water column, related to upwelling intensity and possibly el Padre, are mainly reconstructed by temperature (Mg/Ca) and relative salinity ($\delta^{18}O_{sw}$) analysed on different species of foraminifera representing different waterdepths (*Trilobatus sacculifer, Neogloboquadrina dutertrei, Globorotalia crassaformis*). Nutrient utilization in the water column related to the upwelling of nutrients is reconstructed by nitrogen isotopes determined on the shells of *T. sacculifer* and may be related to changes in the OMZ. Specific changes in the OMZ are reconstructed by the abundance of the planktic foraminifera *Globorotaloides hexagonus*, which shows a strong affinity with the OMZ. Additionally, this species will be used to perform pore morphology analyses on that are related to the concentration of oxygen in the water column.

Keywords: Oxygen Minimum Zone, Pliocene, trace metals, stable isotopes,
planktic foraminifera, paleo-reconstruction, East Equatorial Pacific

地質地物専題演講 Geological Oceanography

Assessing the Habitat depth range of Planktic Foraminifera in the Sumatra-Java Region using Mg/Ca-IFA in Net Samples

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The habitat depth of planktic foraminifera is commonly inferred from their population counts at various levels in the water column, obtained via plankton nets. This approach can be subject to bias due to the use of total or living foraminifera in the counts, and the criteria for determining "living" specimens. Another approach is to match the foraminifera Mg/Ca-based temperature of surface sediments with the temperature of the overlying water column. However, this approach yields only a single depth estimate. To investigate the range of foraminiferal habitat depth, here we examine the Mg/Ca-based temperature recorded by individual foraminifera (IF) specimens of four species, namely the surface dwellers *Globigerinoides ruber* and *Trilobatus trilobus* and the deeper dwellers *Neogloboquadrina dutertrei* and *Globorotalia menardii*. The samples were collected using depth-stratified plankton net deployments in the Indo-Pacific Warm Pool offshore Indonesia.

Our IF-Mg/Ca data of all species show a wide range of temperatures (13 to 35 ºC), occasionally exceeding the actual in situ measurements. These overestimates persist regardless of the calibration choice and hydrographic settings, suggesting that they may arise from the loss of foraminiferal shell fragments during cleaning, as the magnesium content within the shell is not uniform. As the spread of the IF-Mg/Ca temperature distribution is likely exaggerated, we consider the possible range of habitat depth of foraminifera as the 90% confidence interval of the IF-Mg/Ca data distribution, rather than the full range (i.e., maximum-minimum). The data distribution points to regional habitat depth variations: from the surface to ~90 m for *G. ruber* and ~50 to ~80 m for *T. trilobus* off Sumatra, whereas off Java the habitat of both species is confined to the top ~20 m of the water column. *G. menardii* off Java and *N. dutertrei* off Sumatra occur just below the Mixed Layer Depth (MLD), with the latter species residing closer to the top of the thermocline, overlapping with the lower end of the habitat depth range of *G. ruber* and *T. trilobus* off Java. Interestingly, the IF-Mg/Ca-inferred spatial pattern in the habitat depths for *G. ruber* and *T. trilobus* differs from that derived from total census counts assessment and sedimentary geochemical inferences. Our findings thus emphasize the need to integrate various sampling types to improve our understanding of the habitat depth range of planktonic foraminifera, which will consequently enhance the robustness of paleoceanographic interpretation based on foraminifera.

(1) Keynote speech : OCGS-MG_海洋地質/地球物理

山溪型河川－被動大陸邊緣系統(臺灣海峽東北部)的顆粒態有機質源匯分析

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計畫名稱：陸源/非陸源物質在高輸砂量之河-海輸運系統中的宿命整合研究 (XIII)－子計畫：河流主導陸棚沉積物的生地化過程與碳埋藏
計畫編號：NSTC 112-2611-M-110-028

摘要

臺灣以山溪型河川聞名於全球河川水文與輸沙研究。關於山溪型河川入海後陸源有機質的宿命，前人研究多以主動大陸邊緣 (如沖繩海槽或高屏外海) 為研究標的，但其在被動大陸邊緣 (臺灣海峽) 的傳輸、生地化轉變以及埋藏，則較少研究探討。本研究以臺灣海峽東北段為研究區，探討該區陸源顆粒態有機質 (懸浮顆粒或沉積物) 的傳輸與轉變。在夏季海水懸浮顆粒部分，木質素體積濃度雖然在近岸地區有高值，但與濁度相關性高於鹽度，暗示再懸浮過程主控其空間分布；重量濃度資料則暗示木質素從河流入海後，在水層歷經相當程度的降解作用，並有富含木質素的顆粒遠程穿輸至該區域。在沉積物部分，木質素與岩石源有機質展現差異性的空間分布，前者富集於沿岸泥質帶，推測其傳輸受風、浪等動力過程主導，並透過再懸浮影響水層木質素分布；後者則集中於跨陸棚泥質帶，推測其傳輸受重力過程主導。研究結果更進一步顯示岩石源有機質的比例對沉積物的氧氣消耗速率有負面影響，反映了陸源有機質輸運對海床地化過程的宏觀控制。

- The fates of terrestrial organic matter in a passive continental margin (NE Taiwan Strait) sustained by small mountainous rivers were investigated.
- The particulate lignin content in the seawater was enriched in coastal waters but exhibited stronger correlation with turbidity than with salinity.
- Sedimentary lignin and petrogenic organic carbon showed distinct spatial distribution, reflecting varying transport pathways.
- The proportion of petrogenic organic carbon had a negative effect on the total oxygen consumption rate of the benthic community.

El Niño-like tropical Pacific Ocean cooling pattern during the Last Glacial Maximum

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Given the importance of the tropical Pacific Ocean in the global climate system, much effort has been focussed on predicting the spatial pattern of the surface warming here under rising greenhouse gas concentrations. However, the inability of state-of-the-art climate models to faithfully reproduce the observed 20th century tropical Pacific surface warming pattern casts doubt on the robustness of future projections. To investigate how greenhouse forcing affects tropical Pacific upper ocean patterns, we reconstructed upper ocean conditions here using a proxy compilation and a multi-model ensemble for the Last Glacial Maximum and Holocene, two past climate periods marked by differing greenhouse gas concentrations. We show that under the low-CO_2 conditions of the Last Glacial Maximum, the western tropical Pacific cooled more than the eastern tropical Pacific, leading to an El Niño-like cooling pattern. This proxy-based pattern contrasts with the zonally uniform cooling observed in the LGM model simulations, highlighting the need to examine the issue of models overestimating eastern tropical Pacific sea surface temperature sensitivity to greenhouse forcing. Our proxy-based findings also imply that the western Pacific may warm more than the eastern Pacific in response to future climate change, resulting in a La Niña-like surface warming pattern.

(1) **專題演講**: *OCGS-MG_海洋地質/地球物理*

巨型硫化細菌對本吉拉湧升流系統中底棲-浮游耦合及反饋的影響

Impact of Giant Sulfur Bacteria on Benthic-Pelagic Coupling and Feedbacks in the Benguela Upwelling Systems

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摘要

The availability of major nutrients, nitrogen (N) and phosphorus (P), largely controls primary in eastern boundary upwelling systems. The oxygen minimum zone (OMZ) on the Namibian shelf is characterized by high productivity and extraordinarily high particulate organic carbon (POC) contents (up to 12 % dry weight) in the surface sediments. The anaerobic degradation of POC by bacterial sulfate reduction leads to the production of hydrogen sulfide (H_2S) that supports extensive communities of large sulfur bacteria *Thiomargarita namibiensis* in surface shelf sediments. These bacteria oxidize sulfide by reducing nitrate (NO_3^-) to either ammonium (NH_4^+) or dinitrogen (N_2). *Thiomargarita* also affect phosphorus cycling by intracellular incorporation of polyphosphates and extracellular formation of hydroxyapatites. In order to understand and quantify the complexity of the coupled benthic cycles of C, N, P, S, Fe in the Benguela Upwelling System, a reaction-transport model (RTM) was used to simulate sediment biogeochemical data collected from the RV Meteor cruise (M157, August 4th -September 16th 2019) off Namibia. At the two stations where LSB were observed, produced hydrogen sulfide was almost completely oxidized by LSB using nitrate as the electron acceptor. Modeled rates of nitrate reduction to N_2 by LSB were over two times higher than nitrate reduction to ammonium. This points toward a potentialnegative feedback by LSB on primary production. Our modeling suggests a significant control of LSB on benthic N and P fluxes to the water column. Given the extensive coverage of LSB on the shelf (>30,000 km^2), more accurate forecasts of nutrient cycling and primary production in the BUS necessitate a closer inspection of benthic P sources and sinks in the mud belt and a clearer understanding of the controls on the end product of nitrate reduction by LSB.

Characteristics of dissolved inorganic and organic nutrients in the oligotrophic Kuroshio Current off eastern Taiwan during warm seasons

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計畫名稱：海洋暖化對生物碳幫浦之影響:SEATS 測站綜整研究

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Abstract

This study conducted sensitive and precise analyses of dissolved organic and inorganic nutrients to investigate the distributions and controls of N+N, SRP, DON, and DOP in the oligotrophic Kuroshio Current (KC) area off eastern Taiwan during warm seasons. The water in the studied area was classified into four major types: typical Kuroshio water (KW), KW influenced by the East China Sea water, KC influenced by the South China Sea (SCS) water, and KW influenced by the SCS water and river plumes, which is confined to the coastal zone. Nutrient distributions in KC revealed very low N+N (0.002–0.40 μM) and SRP (0.015–0.125 μM) concentrations but high DON (<8 μM) and DOP (<0.3 μM) concentrations above the nutricline depth, which accounted for >80% of TDN and TDP, respectively; theses concentrations can primarily be attributed to strong, permanent surface stratification. Among the water types, KW had the lowest N+N, SRP, DON, and DOP concentrations but greatest chlorophyll maximum depth and nutricline depth, except for in locations influenced by island-induced upwelling. The concentrations of all nutrients increased by various degrees in the other water types, which was attributed to the exchange and mixing of different water masses and coastal uplift of subsurface waters. KW was not only highly oligotrophic but also N+N-limited reflected from very low [N+N]/[SRP] ratio (0.02–0.15) in the mixed layer (ML). Overall, the N+N limitation and high nitrate anomaly value (N*: 2.47 ± 0.16 μM) above the nutricline depth strongly indicate prevailing N_2 fixation at the surface of KW. Persistent coastal injection of subsurface water occurs everywhere over the shore-side region of the KC, resulting in increasing surface concentrations of nutrients and chlorophyll *a*. Overall, the aforementioned hysical and biogeochemical processes determined the upper-ocean distributions of nutrient species in warm seasons.

Oceanic Blue Carbon in Seas around Taiwan

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ABSTRACT

In order to mitigate the impacts of climate change, achieving carbon neutrality has become paramount. Previously, the estimation of negative carbon emissions was primarily focused on green carbon and yellow carbon. However, the oceans constitute one of the major global carbon pools, absorbing approximately 25-30% of the carbon dioxide from the atmosphere. Taiwan is committed to achieving net-zero carbon emissions by 2050, and the contribution of carbon absorption by the surrounding water cannot be overlooked. Therefore, this study aims to comprehensively review research on oceanic blue carbon (carbon sequestration or particulate organic carbon (POC) flux entering the bottom of the euphotic zone) sinks in Taiwan's territorial waters and exclusive economic zone. The results indicated that the carbon sequestration within Taiwan's territorial waters was 4.0±0.7 Mt-CO_2 yr^{-1}. Within the exclusive economic zone (EEZ), the carbon sequestration in the East China Sea, the northern South China Sea, and the western North Pacific Ocean were 49.3±14.9, 19.9±4.5, and 26.4±7.8 Mt-CO_2 yr^{-1}, respectively. In other words, carbon sequestration by deep-sea blue carbon can account for about 33.5% of annual carbon emissions in Taiwan, suggesting that deep-sea blue carbon cannot be ignored in order to achieve net-zero carbon emissions. Estimation uncertainty of oceanic blue carbon in seas around Taiwan can be affected by overlapping EEZs, lateral carbon transport, typhoons, mesoscale eddies, and internal waves, but detailed spatio-temporal investigations in seas around Taiwan are still needed.

Keywords: Biological carbon pump, Particulate organic carbon, Net zero carbon emissions, POC flux, Carbon neutrality, East China Sea, South China Sea, Pacific.

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Far-Field Influences Shadow the Effects of a Nuclear Power Plant's Discharges in a Semi-Enclosed Bay

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Abstract

The sustainable development of society depends on the reliable supply of electricity while keeping impacts on the environment to a minimum. A 951 MWe nuclear power plant in the semi-enclosed Nanwan Bay at the southern tip of Taiwan began operating in May 1984. Part of the bay is in Kenting National Park, which is known for its coral reefs and abundant marine life; thus, thermal pollution from the cooling water discharge is a great concern. Fortunately, the bay opens south to face the Luzon Strait, where the world's strongest internal tides are generated. Because the bay is deep enough, internal waves bring up cold deep water and reduce the surface temperature by as much as 10 °C for a few hours every day. These internal waves and topographically generated upwelling also bring nutrients to the euphotic layer from the depths, but the upwelled waters quickly leave the bay along with the cooling water. As a result, a thermal plume with a temperature of 1 °C or higher than the ambient temperature only covers 1 km. By way of comparison, El Niño—Southern Oscillation- or Pacific Decadal Oscillation-related interannual variations in temperature are as high as 5 °C. The rapid turnover of the upwelled waters also helps to prevent heat released by the power plant from accumulating and diminishes the thermal stress, thus sustaining corals and other marine life forms. Typhoons, even hundreds of kilometers away, could also induce the upwelling of cold subsurface water. Consecutive typhoons have been observed to reduce the water surface temperature by up to 10 °C for two weeks or longer. Furthermore, the currents are such that the thermal plume flows out of the bay most of the time. All of these factors make the surface waters in the bay about 0.5 °C cooler than the waters outside of the bay, despite the operation of a nearby nuclear power plant.

The roles of methane and nitrous oxide in blue carbon seagrass meadow

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計畫名稱：台灣近海水團環境因子與沿岸藍碳生態系統甲烷濃度變化之研究

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摘要

Seagrasses stand as pivotal ecosystems on a global scale, offering a significant benefit in the battle against climate change through their ability to capture and store carbon. This carbon sequestration process is crucial in our efforts to mitigate the adverse effects of climate change. However, the overall impact of seagrass meadows on the climate is also influenced by the emissions of methane (CH_4) and nitrous oxide (N_2O), potent greenhouse gases. The lack of comprehensive accounting for CH_4 and N_2O fluxes in these environments means that we might either overestimate or underestimate the actual carbon sequestration capabilities of seagrass ecosystems. Despite their importance, there is a scarcity of data regarding the CH_4 and N_2O emissions from seagrass meadows. In an effort to fill this knowledge gap, we conducted a detailed study to quantify the fluxes of CH_4 and N_2O across the sediment-water interface in seagrass meadows and adjacent areas devoid of vegetation during different seasons—spring, summer, and autumn. Additionally, we evaluated the system-wide exchanges of CH_4 and N_2O between the sea and the atmosphere. Our findings revealed that the fluxes of CH_4 and N_2O varied significantly with the seasons, showing a peak during the autumn, followed by summer, and then spring. This seasonal variation highlights the dynamic nature of seagrass ecosystems and underscores the need for a more nuanced understanding of their role in global carbon cycling and their impact on the climate.

海洋化學專題演講 Chemical Oceanography

沿岸地區底棲新陳代謝的重要性

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計畫名稱：國科會計畫-人為活動對河流、近岸系統與大洋之氮循環研究
計畫編號：NSTC 112-2611-M-992-001-

摘要

近幾年陸續有研究指出，沿岸地區生態系統除了具有較高的生物多樣性以及提供生態系統多元的服務以外，其底部的沉積物在生地化循環上也扮演著相當重要的角色。不同地區所受到的人為活動影響皆不同，使得周遭水體環境之生地化反應之表現也有所差異，沉積物的生地化反應也會受此影響。然而，目前國內有關近岸地區不同人為影響下之水體與沉積物間交互作用以及生地化反應較少人探討。為了進一步釐清此過程，本研究於國科會計畫支持下建立並設置了一套水體與沉積物培養系統，用以量測沉積物之生地化循環。本研究於 2023 年 12 月於墾丁海口地區與 2024 年 1 月於台南七股地區採取各 9 管沉積物回實驗室進行培養，測量其新陳代謝作用與各項生地化反應所需參數。實驗結果顯示，墾丁海口沉積物的 Gross productivity 為 2633±1100 μM mole m^{-2} h^{-1}，Respiration 為 1345±628 μM mole m^{-2} h^{-1}，autotrophic/heterotrophic ratio 指標為 1±0.2；七股地區沉積物的 Gross productivity 為 2513±281 μM mole m^{-2} h^{-1}，Respiration 為 1678±403 μM mole m^{-2} h^{-1}，autotrophic/heterotrophic ratio 指標為 0.8±0.1。此結果反應，墾丁海口沉積物與七股沉積物之新陳代謝有明顯的差異，墾丁海口沉積物之新陳代謝主要是以自營性代謝為主，而七股沉積物主要是以異營性代謝為主。推測兩地區之底部新陳代謝會有如此差異，主要是因為墾丁海口地區人為活動較少且有海草生長，七股地區人為活動影響相對較大且無底棲植被生長。總體來說本研究初步顯示，不同地區沉積物新陳代謝有顯著差異，同樣也反應著沉積物生地化循環可能有所不同，因此有關近岸地區沉積物之生地化循環是不可忽視且須要進一步探討。

Cadmium Transport from Taiwan's Rivers to Coastal Regions

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Abstract

Globally, Cd has a net dissolved flux greater than its gross flux, indicating a particulate source. Cd behavior in aquatic environments is unique compared with other trace elements such as Cu, Ni etc. Cd exhibits distinctively different features from freshwater to coastal environment. Cd is found in the Earth's crust at ~0.15 mg/kg, which can be transported by weathered particulate matter toward the ocean. Cd has strong adsorption affinity with Mn oxide and complexing capacity with sulfide, forming solid complexes, in the aquatic environments. Upon reaching estuarine/coastal region to be in contact with saline water, Cd can form Cl-complexes. Therefore, unless forming sulfide complexes, desorption from oxides and weathered particulate matter is expected in saline waters.

Taiwan, with a Central Range present, has many rivers of mountainous characteristics. Many rivers may have very limited, some even none, segments of estuarine zone with salinity (thus chloride) gradient. Therefore, river characteristics can play a role in transport of material to coastal regions. Comparison of dissolved and particulate Cd concentrations in rivers and coastal waters, along with information of suspended particulate matter and sediments from different regions of Taiwan suggests that the flux of particulate matter transported to the coast can be a major factor affecting dissolved Cd concentrations in coastal waters. Variability of dissolved Cd concentration in coastal waters may be influenced by river characteristics and consequent particulate fluxes delivered from rivers to the seas.

高有機碳含量的珊瑚砂海草床可能是海洋鹼度生成的熱點

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2. 112-2611-M-019 -005 -

摘要

海草床作為一種潛在的自然氣候解決方案受到了越來越多的關注。這種關注主要源自於海草床高的基礎生產力以及沉積物中有機碳高的埋藏率。然而，近年來有越來越多的研究發現，除了傳統的有機碳儲存之外，海草床在鹼度所驅動的二氧化碳移除方面（無機碳儲存）亦具有巨大的潛力，此一潛力是過去沿岸藍碳研究中被忽視的一部分。有鑑於此，本研究選擇了兩個沉積物特性截然不同的海草床進行比較與研究：一個生長於有機碳含量豐富（大於 10%）的海源性碳酸鹽沉積物上，即東沙；另一個生長於有機碳貧乏的（小於 1%）陸源性矽酸鹽沉積物上，即墾丁海口。結果表明，與生長在有機碳貧乏的矽酸鹽沉積物上的海草床相比，生長在機碳含量豐富碳酸鹽沉積物上的海草床底棲鹼度釋放通量高出了兩個數量級（2426±1325 *vs.* 40.2±37.3 μmol cm^{-2} $year^{-1}$），且上覆水體中的二氧化碳分壓顯著較低。此一發現表明，生長在有機碳含量高碳酸鹽沉積物上的海草床，由於有機碳有氧及無氧代謝過程所驅動的碳酸鈣溶解作用，可釋放大量的鹼度，使其成為海洋鹼度生成的熱點，進而增強了海草床水體無機碳的儲存能力。因此，加強對於此類海草床的保護和復育，並將其納入相關的政策和計劃中，可望實現更佳的沿岸藍碳氣候變化緩解效益。

To revisit primary production in the northern South China Sea

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Project: 颱風、渦流與內波對南海北部生物地球化學作用之衝擊－子計畫:颱風、渦流與內波對南海北部基礎生產力之衝擊及不同碳同位素量測基礎生產力之潛在差異(Ⅱ)
Grant number: NSTC 112-2611-M-012-001

Abstract

Examining the primary production (PP) of marine phytoplankton is one of the substantial ways to better understand an entry point of CO_2 from the atmosphere to ocean in the blue carbon. Using the ^{13}C as a bio-tracer for *in situ* incubation of marine PP has been widely employed in recent years. Since the ^{13}C tracer has fewer limitations compared to ^{14}C tracer for *in situ* incubated PP, it has been confirmed as a reliable alternative method for PP incubation. The algorithm and assessment of global marine PP model via satellite-derived water color images relies mainly on ^{14}C-spiked PP experiments as a calibration. However, the discrepancy between the two-tracer incubation methods is still unclear. We used two tracers to examine *in situ* PP in the northern South China Sea (NSCS) from 2020 to 2023. In our preliminary findings, the integrated ^{13}C-PP and ^{14}C-PP (^{13}C-IPP and ^{14}C-IPP) ranged from 169 to 846 and 156 to 356 mg-C m^{-2} d^{-1}, respectively. A significant linear relationship between ^{13}C- and ^{14}C-incubation PP has been observed. The ^{14}C-PP is approximately underestimated by ~40% compared with the ^{13}C-PP suggesting that previous PP values could be underestimated in the NSCS. It implies that the ^{13}C-IPP is a reliable option for satellite-based IPP calibration. It however requires further investigation for verification.

臺灣沿海碳匯潛力評估：以卯澳灣為例

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計畫名稱：副熱帶陸棚浮游生物食物網生態過程研究 (Ⅱ)--子計畫：東海微生物的有機碳通量研究 (Ⅱ)
計畫編號：111-2611-M-019-013-

摘要

臺灣四面環海，擁有漫長的海岸線與豐富的沿岸生態系，這些生態系都是重要的海洋碳庫。為達成政府 2050 淨零碳排的國家目標，評估臺灣各種自然碳匯的潛力是刻不容緩。本研究即是以卯澳灣為例，透過調查一年四季植物性浮游生物與底棲大型藻的基礎生產力，藉以評估此區域的碳匯潛力。結果顯示，卯澳灣光合生物一年四季的碳排放係數 (負值代表吸收) 介於 -0.2290 至 -0.7705 $gCO_{2e}\ m^{-2}\ d^{-1}$ 之間，平均值為 $-0.4437 \pm 0.2421\ gCO_{2e}\ m^{-2}\ d^{-1}$。在季節性的變化上，呈現冬季高於其他三個季節的現象，可能是冬季時海水混合較佳，提供較多的無機營養鹽所造成的。此外，當底棲大型藻的覆蓋率提高時，對海洋碳匯就會有較高的貢獻度。

Plastic pollution: from micron-scale to nano-scale

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計畫名稱：以微、奈米角度探討「海洋污染物幫浦」與其潛在之生態風險
計畫編號：MOST110-2628-M-019-001-M4

摘要

Plastic pollution are increasingly recognized as ubiquitous contaminants in the Earth, and pose an ecological risk to both ecosystems and humans. Fresh plastics and debris enter natural systems and undergo various degradation processes, to gradually break down this material into micro-plastics (MPs) and nano-plastics (NPs). As plastic materials degrade (i.e. NPs), their ecological and toxic impacts become more complex. Therefore, the NP analysis and quantification is considered a critical step for further ecological assessments. Here, we successfully quantified mass concentrations of both MPs and NPs from cigarette butts (CGB) by leaching in aquatic environment, with pyrolysis gas chromatography mass spectrometry (Py-GC/MS). Our data indicates that the release of micro and nanoscale plastics (MPs and NPs) of smoked and non-smoked CGB significantly increased with time, and smoked exhibited higher release speed and number of MPs and NPs. Notably, the NP release amount from smoked CGB was 2.5-fold higher than unsmoked CGB due to smoked CGB with heat-aged fibers (reducing force displacement) causing more fragmented NP fiber production. Collectively, the study provided first quantified data that CGB can leach MPs and NPs in aquatic environments and suggest a needed attention and consideration of new global contaminants.

Distributions of carbonate chemistry from the Kuroshio to the Ryukyu Current off eastern Taiwan

台灣東部從黑潮到琉球海流的碳化學分布

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計畫名稱：南海與西菲律賓海不同深度海水交換對彼此水化學以及生地化之影響
計畫編號：112-2611-M-110 -012 -

摘要

Kuroshio and Ryukyu Current (RC) are two strong boundary currents in the western North Pacific Ocean. As a counter-current, the RC originates from the eastward branch of the northward Kuroshio broken by the Yilan Ridge at around 600m depth off eastern Taiwan. Previous studies mainly focused on the physical properties of the RC; however, limited knowledge is available regarding its seawater composition and chemical properties. This study aims to investigate the distributions of carbonate chemistry across the Kuroshio and the RC off eastern Taiwan. A survey was conducted using the New Ocean Researcher 2 (NOR2, cruise no: NOR2-0075) in 19－24, July, 2022, along 23.5°N from eastern Taiwan to 125°E.

Our results show that the Kuroshio Intermediate Water (KIW) contributes significantly to the composition of the RC between 500 and 2250m, having a decreasing proportion eastward to 124.5°E. Meanwhile, carbonate chemistry changes correspondingly. At 125°E, the influence of the KIW declines rapidly, indicating that the RC starts to flow northeastward and move away from the 23.5°N. This study provides a pathway of how the KIW transports further east in the WPS and to higher latitudes via the RC.

2023 夏季西菲律賓海表層二氧化碳變異

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計畫名稱：西北太平洋海洋藍碳整合研究－西北太平洋海洋藍碳整合研究(2/4)

計畫編號：NSTC 112-2119-M-019-008

摘要

西北太平洋的西菲律賓海域面積廣大，但常常在全球碳循環中受到忽視，也缺乏足夠的現場量測的碳酸鹽資料。這個海域在 2023 年夏季反聖嬰現象即將結束時，同時也有有三個颱風經過，我們透過研究船在該海域淺於 500 公尺處採集總鹼度（Total Alkalinity）和溶解無機碳（Dissolved Inorganic Carbon）水樣，並使用表水走航系統測量約 5 公尺水深的二氧化碳分壓（pCO_2）。將 TA 和 DIC 標準化至鹽度 35 以後，各自以 nTA 和 nDIC 呈現。結果顯示，nTA 介於 2290 至 2340 μmol kg^{-1} 之間，nDIC 介於 1963-2258 μmol kg^{-1} 之間。透過比較飽和 DIC 與 nTA 與 nDIC 之間的關係，我們認為表水 DIC 和 TA 受到了強烈的混合作用以及生物吸收的影響，而淺於 500 公尺的次表層則釋放 DIC。上述結果與研究期間的表面 pCO_2 大多為未飽和(under-saturation)一致。本研究顯示除了溫度變化以外，蒸發降雨造成的混合作用在夏季颱風季節會造成額外的影響，未來應該重視這個受到極端天氣和氣候變化影響的研究區域。

Fish eDNA survey on Taiwanese waters and marine protected areas

臺灣海域及海洋保護區魚類環境 DNA 調查

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計畫名稱：112-113 年臺灣海域重要生態系調查及生態服務價值評估
計畫編號：112-P-40

摘要

In the project in cooperation with the Taiwanese Ocean Conservation Administration, the eDNA meta-barcoding and other ecological surveys were carried out to set up baseline data for perspective work on conservation in Taiwan. The investigated areas include the representatives of diverse marine ecosystems and protected areas around Taiwan. Both vessel- and diving-based investigations were performed. The fish diversity at different spatial scales was assessed by eDNA. Additionally, basic environmental and habitat data were collected to address specific research inquiries. As to the ship-based surveys, data from a total of 179 eDNA samples from various stations/seasons over the past three years have been gathered. This effort resulted in the recording of 1343 marine fish and 24 marine mammal species in the Taiwanese waters, which account for about 42% and 75% of the total fish and cetacean species been recorded in Taiwan, respectively. On the other hand, 104 eDNA samples were collected by divers across 101 reef sites in Taiwan and its outlying islands. Analyses of these samples revealed the detection of 854 marine fish species, with the most common species found from the Labridae (89 species) and Pomacentridae (48 species). Spatial disparities in diversity presentation were observed to be more pronounced than temporal variations, displaying a pattern of distance decay of similarity in fish assemblages. Sites characterized by favorable environmental conditions and/or high protection intensity, such as the South Penghu Marine National Park, exhibited high species diversity. This suggests that eDNA could serve as an efficient tool for monitoring environmental stress and assessing the effectiveness of Marine Protected Areas.

Functional trait diversity of the Taiwanese reef fish fauna evaluated by environmental DNA metabarcoding

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計畫名稱：112-113 年臺灣海域重要生態系調查及生態服務價值評估
計畫編號：112-P-40

摘要

Changes of coral habitats under climate change and habitat degradations have led to the alterations of coral reef fish assemblages. One of the potential consequences is the decline in functional trait diversity (FD) among fish communities, which could compromise the resilience of coral reef ecosystems and related ecosystem services. Therefore, long-term field monitoring of FD is essential for prioritizing conservation efforts. The environmental DNA (eDNA) metabarcoding has been proven to be an effective approach for capturing the FD of reef fish assemblages. In this study, it was utilized to provide the first field investigation of the Taiwanese coral reef fish fauna. A total of 104 seawater samples from 101 sites spanning the North, West (Penghu), South and East regions of Taiwan were collected. Our analyses revealed a total of 271 unique trait combinations (FEs) of six functional traits identified from 602 detected species. Among regions, the South exhibits the highest FEs and range of unique trait combinations (FRic), while the East has the lowest. The high number of FEs supported by only one species (FV, 58–75% per region) indicates most of them being vulnerable. Continued monitoring of FD may uncover further losses in ecological functioning.

Advancing reef conservation in the Anthropocene: Taiwan coral ecosystem status and MPAs effectiveness

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計畫名稱：臺灣海域重要生態系調查及生態服務價值評估

計畫編號：110-P-38, 111-P-40, 112-P-40

Global and local stressors profoundly impact coral-associated ecosystems. Marine Protected Areas (MPAs) were shown to help reduce local drivers of degradation and increase ecosystem resilience. However, long-term conservation efforts need to account for climate change pervasiveness. To minimize global challenges' consequences, the portfolio-based conservation strategy proposed to protect both "good" and "bad" coral communities to preserve their rich biodiversity alongside their most resistant populations. Taiwan constitutes an ideal study area as it harbors both tropical reefs and subtropical coral communities along a gradient of human disturbances. Additionally, its geographical position could serve as an essential transitional stepping-stone for future coral-associated ecosystems. However, the complex MPA governance in Taiwan makes their effectiveness unclear. Therefore, we aim to provide (1) a nationwide assessment of Taiwan coral-associated ecosystems; (2) identify the natural and anthropogenic drivers; (3) extract regional baselines to define appropriate conservation objectives and targeted locations. Our results confirmed differences in the benthic composition among regions. Environmental parameters were essential drivers of the differentiation. Yet, anthropogenic markers highlighted evident negative impacts and a smoothening of regional specificities. Management status rarely explained coral-associated ecosystems' conditions, highlighting the one-size-fits-all approach inadequacy to evaluate MPAs. Finally, our approach enables portfolio-based conservation strategies that acknowledges regional specificities for the sustainable management of coral-associated ecosystems.

從沿近岸開始的整體生態調查與保育

Ecological survey and conservation starting from coastal areas

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計畫名稱：112-113 年臺灣海域重要生態系調查及生態服務價值評估
計畫編號：112-P-40

摘要

現今全球生物多樣性與生態保育以生態系統為基礎的管理(ecosystem-based management)和基於自然的解決方案(natural-based solutions)為重要趨勢，希冀能夠透過可持續管理和利用自然來應對環境變化與保育的挑戰，本研究透過在臺灣周邊海域固定測站之生態與環境基礎資料調查，希冀剖析(1)近年海域環境變化與過去異同，(2)仔稚魚組成季節性變化與海域環境關係，此外微塑膠為本世紀另一新興國際關注的海洋環境問題，因此，本研究同時透過不同水層間水樣收集，希冀進一步瞭解(1)微塑膠在臺灣周邊海域分布情形，(2)微塑膠與仔稚魚空間分布重疊性。本研究結果發現，臺灣周邊海域水文特性與歷年相仿，2021-2023 年調查則觀察到持續升高的水溫，當臺灣周邊海域依水文特性區分為北部、西部、東部時，營養鹽與葉綠素濃度在各海域的各季節間具有不同變化；仔稚魚種豐度季節間多皆以北部宜蘭外海、西部澎湖周圍海域、東部臺東外海為較高，考慮數量之仔稚魚群聚則各海域與各季節間趨勢相近；微塑膠分布各季節間以西部海域有較高之濃度，定性分析結果則顯示，多數微粒為纖維素，其中又以微晶纖維素(Microcrystalline cellulose)佔多數，微塑膠則以聚對苯二甲酸乙二酯(PET)為最多，約佔 1/3，其次為聚乙烯(PE)、聚氧化亞甲基(POM)、聚氯乙烯樹酯(PVC)，而其他種塑膠僅有零星紀錄；仔稚魚與人造物/微塑膠的空間分布則各季節間關係不一致，仍待持續觀察。本研究結果雖未能釐清一致性整體變化，綜合海域環境、仔稚魚、微塑膠空間分布情形，確實能提供對於臺灣周邊海域基礎資訊，以及自然與人為活動之影響，並提供未來海洋保育與管理重要參考依據。

氣候變遷！？近年海洋環境是否一如往昔？

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計畫編號：112-P-40

摘要

臺灣周邊海域主要水團的季節性變化主要受柯氏力、季風和海底地形的影響，東部海域可見西菲律賓海水和南中國海水在不同季節間的消長與混合；西部海域夏季時表層有北上流入的南中國海水，冬季則有沿著中國海岸南下的低溫沿岸流進入，而春季和秋季時由黑潮支流佔據；北部海域的水團主要混合黑潮與東海陸棚海水，冬季時也可在北部海域觀測到中國沿岸流。本研究 2021-2023 年的探測支持過去已知趨勢，此外，三年間水溫略微升高，影響無機營養鹽溶解度與浮游藻類生長。研究顯示，東部海域營養鹽濃度不論季節皆低，西部海域以冬季時最高，春季其次，夏季和秋季時較低，而北部海域也在冬季時最高，春季和秋季其次，夏季時較低。臺灣周邊海域的氮磷比不論水深、區域、季節，皆低於全球亞熱帶海域平均值 20；在水深淺於 25 米海域，氮磷比數值範圍在 1-16 之間，在水深 26-100 米間，氮磷比略高於 25 米以淺海域；相關性分析發現，在 25 米以淺海域，水溫與葉綠素α濃度呈現負相關，與硝酸、亞硝酸、磷酸鹽濃度呈現正相關，在 26-100 米區間海域則正好相反。進一步探討葉綠素α濃度變化，發現冬季、春季、秋季時葉綠素α濃度在水溫 22-24℃最高，夏季時則在水溫 27~28℃最高，冬季還有另一個葉綠素α濃度較高的峰值出現在水溫 17~18℃。本研究階段性成果可見不同水團來源形塑臺灣周邊海洋環境的季節性變化，同時顯示不同水溫及營養鹽組成下的基礎生產力差異。

氣候變遷 ing，我們如何了解南方四島的棲地風險
Management mitigates habitat risks increased by climate change

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計畫名稱:臺灣海域重要生態系調查與生態服務價值評估
計畫編號:111-P-40

摘要

氣候變遷和人類活動可能對環境造成深遠影響，兩者交互作用之下可能更為強烈，而生態系統服務也會深受影響。生態系統服務(Ecosystem Services)代表在生態系中，人類直接或間接謀取的所有福利，例如提供食物、自然材料、空氣與水資源等，當中包含生物棲息地，其代表孕育生態系的基底，因此探索氣候變遷和人類活動對生態系統服務的影響時，若能關注生物棲息地受到的風險，將能夠規劃管理措施與進行保護行動。本研究目的將透過量化棲息地風險，以確定更容易受到威脅並需要加強保護的區域或棲息地類型，並評估如果全球暖化持續下去，區域性的保護管理措施是否可以減輕棲息地風險。本研究針對臺灣澎湖南方四島國家公園為案例，進行現況棲地風險評估以及三種情境分析，包含有保護管理情境、全球暖化情境和暖化下的保護情境。研究結果表明，當前澎湖南方四島棲地主要受到各式商業漁業(譬如延繩釣、曳繩釣等)所造成的棲地風險，並且棲地風險會隨全球暖化的影響使得風險上升，不過如果採取較嚴謹的保護管理措施下，澎湖南方四島的棲地風險將有明顯的下降。整體而言，加強對現有人類活動（特別是漁業活動）的管理，可以明顯降低該地區的棲地風險，風險下降程度甚至有機會更高於全球暖化所帶來的壓力，而將能使得澎湖南方四島生物棲地能在氣候變遷下減輕所受的威脅。

Visualizing the Underwater Soundscape: Long-term Monitoring Revealing Shift of Bioacoustic Patterns in Taiwan's Coral and Algal Reef Ecosystems

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Abstract

The diversity and composition of marine sound communities play a crucial role in soundscape ecology nowadays. Passive Acoustic Monitoring (PAM) offers invaluable insights into the long-term dynamics between biophony, geophony, and anthrophony. Understanding bioacoustic behaviors especially requires prolonged recordings and automated analyses to identify spatial-temporal patterns. Since 2021, we have conducted the PAM experiments in two protected areas—the coral reefs in Keelung and the algal reefs in Taoyuan. At each site, we systematically collect soundscape data across different seasons, aiming for at least three collections per year. This consistent effort enables us to monitor the underwater acoustic environment continuously. Spectrogram visualization of underwater soundscapes distinguishes bioacoustic behaviors between coral and algal reef ecosystems. We employed two approaches to evaluate biodiversity: one approach separates various sound sources to calculate the Shannon sound diversity index, and the other calculates the snapping shrimp's snap rate within a one-minute timeframe. Our findings confirm previous research, indicating consistent diurnal and seasonal patterns of biological diversity in both ecosystems, with nighttime and summer identified as peak periods for biological vocal activities. Additionally, we observed that the seasonal variations in the sound diversity index are consistent with those in the snap rate at both sites. During summer, the snap rates in Keelung (about 10,000 snaps per minute) and Taoyuan (about 4,000 snaps per minute) are significantly higher than those in subtropical regions of coral reefs. These insights highlight the success of conservation efforts in Taiwan but also reveal a concerning decline in both the sound diversity index and snap rate, particularly after pandemic restrictions were relaxed. Furthermore, anthropogenic noise pollution in the Taiwan Strait presents a significant risk to the health of the marine ecosystem.

國科會海洋學門資料庫–臺灣周邊海洋生物資料管存與資料展示平台(Hidy Viewer 2.0)

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計畫名稱：國家新研究船船隊貴重儀器及資料庫使用中心-子計畫：海洋學門資料庫(3/4)
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摘要

國科會海洋學門資料庫(Ocean Data Bank，下稱ODB)自2009年起彙整台灣周遭海域拖網研究建置生物海洋資料庫，累積超過13萬筆以仔稚魚和浮游動物為主的豐度資料。為了能管存拖網以外的海洋生物資料，ODB改以達爾文核心集標準(Darwin Core Standard)為基礎設計欄位建置新版生物海洋資料庫。同時，ODB透過與海洋保育署和臺大海洋所的合作計畫，取得上萬筆、多種調查主題的資料，並將之整理入庫，現累積有153,312筆生物出現紀錄，涵蓋浮游動物、仔稚魚、底拖魚類、魚類環境DNA和大型底棲動物五大主題。為進一步實現資料加值應用與開放，我們將生物出現紀錄資料介接至ODB資料展示平台－Hidy Viewer 2 (下稱Hidy2，https://odbview.oc.ntu.edu.tw/hidy/)，Hidy2具簡潔、易懂的介面設計，功能包含：查詢物種地理分布、單點調查物種名錄、區域資料組成…等，另外也能將出現紀錄查詢結果與Hidy2中的豐富海洋圖資套疊(如：水深、海溫、海流…等)。如果想要直接取得出現紀錄資料，可以透過我們的開放應用程式介面－Eco API介接(說明文檔：https://api.odb.ntu.edu.tw/ecoapi/doc)。

墾丁國家公園海域珊瑚礁受海洋熱浪與颱風的影響及抗氣候變遷珊瑚苗圃的建立

Impacts of marine heatwaves and typhoons on coral reefs and the establishment of climate change-resistant coral nurseries in Kenting National Park

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計畫名稱：經由優化培育和復育技術增強珊瑚的熱表現(2/3)

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摘要

海洋熱浪和颱風是威脅全球淺海珊瑚礁生存的主要氣候變遷因素。2020 和 2022 年，整個台灣沿海地區及其鄰近島嶼經歷有史以來最強的兩次海洋熱浪，並引發最廣泛和最嚴重的珊瑚大白化事件。2023 年，台灣在連續 4 年沒有颱風登陸後，受到 4 個颱風的直接侵襲，並對珊瑚礁造成破壞。利用這些獨特的高干擾年份，我們於 2020 至 2023 年研究海洋熱浪和颱風對台灣南部墾丁國家公園海域裙礁 5 個地點珊瑚群聚動態的影響。後壁湖礁區硬珊瑚覆蓋率從 36.5%大幅下降至 8.5%，是所有地點中減少最多的，並且此生態系統可能正在崩潰中，原因包括長期過漁、人為污染、海洋熱浪和颱風的影響，保育作為應盡快做好污水處理、沿海水土保持和建立有效的海洋保護區。另一方面，合界、進水口外側和內側礁區的硬珊瑚覆蓋率在 2023 年分別為 31.8、33.9 和 32.7%，其經歷了先增加然後下降的變化，主要是由於海洋熱浪和/或颱風的影響，並且優勢珊瑚種類發生改變。出水口礁區的硬珊瑚覆蓋率在 2020 年因海洋熱浪由 55.7%下降至 34.4%，但隨後增加，並在 2021 至 2023 年期間保持在較高且穩定的狀態（51.1-47.9%），其地形屏障而受颱風影響小，受益於間歇性湧升流而緩衝海洋熱浪和鄰近核電廠溫排水的影響，海水溫度高且多變而使珊瑚群聚具有耐熱性；2023 年移植銳枝鹿角珊瑚 220 個碎片到消波塊上，一年後的存活率為 65%；2024 年已移植了分枝形、團塊形和表覆形珊瑚共 12 種、378 個碎片到消波塊上，目的是建立耐熱珊瑚苗圃，研發以自然為基礎的氣候變遷解決方案和使人工海岸生態化。

海洋生物多樣性及保育專題演講 Marine Biodiversity& Conservation

Reciprocal transplant experiment reveals multiple factors influencing changes in coral microbial communities across climate zones

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Previous studies have demonstrated the influence of external factors (environmental factors and the coral host factors) on the community structure of coral-associated bacteria. However, the internal factors, e.g. the interaction within the bacterial community or bacteria itself, have often been overlooked in studies of the coral microbiome. Hence, we performed a reciprocal transplant of corals between two different climate zones to examine the resultant alterations in coral-associated bacterial communities. The findings highlight the significance of environmental factors, host selection, and highly resilient bacteria in shaping the coral microbial composition. The results support that coral species consistently harbor specific predominant bacterial groups influenced by host selection, while locations display unique bacterial taxa due to environmental variations. The transplantation of corals into new environments leads to a gradual shift in the bacterial community, from initially resembling that of the native location to eventually resembling that of the transplanted location, emphasizing the crucial role of bacterial community composition for coral survival under changing ambient conditions. Furthermore, highly resilient bacteria that persisted throughout the reciprocal transplant experiment demonstrated their adaptability to environmental and host changes, suggesting the presence of robust adaptation or resistance mechanisms in bacterial communities.

台灣東北沿岸海域混營真核生物的種類組成與攝食機制

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摘要

先前研究指出台灣東北沿岸海域的小型混營真核生物是細菌的主要攝食者。本研究為了探討這些嗜菌性真核生物的種類組成，利用酸性胞器性染劑來區分本海域中的嗜菌者。本研究的採樣地點為台灣東北角近岸海域，採樣時間為 2023 年的七月與八月。樣本透過 Lysotracker 染色後利用流式細胞儀篩選出來有 Lysotracker 訊號的細胞，來進行 18S rRNA 擴增子定序，分選樣本時區分為無色素的異營性生物與有色素的混營性生物。研究結果顯示本海域的混營生物主要包含 *Chrysochromulina* sp.、*Florenciellales* sp.、*Mamiella gilva*、*Tetraselmis* sp.與 *Teleaulax* sp.等。而異營性生物包括 MAST-1D、-4B、-4C、-4D、-4E、-7D、-10 與 MOCH-4 等。此外，為了瞭解綠藻的嗜菌機制，我們在不同光照（高光、低光、無光）和不同營養鹽條件（高營養鹽、低營養鹽）下進行單一物種攝食實驗。結果顯示高光照和高營養鹽條件下的攝食率較高，這個結果表示在較佳的生理狀態下，攝食較強。這一發現與過去認為混營生物的攝食主要為補充光合作用能量不足的觀點不同。未來，我們會針對更多種類的混營生物進行攝食機制探討，以深入了解它們在不同環境條件下的生態角色。

熱帶潟湖到水道的魚類群聚

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計畫名稱：台江國家公園之永續發展-台江國家公園之永續發展(總計畫)
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摘要

本研究利用台江國家公園內具有的獨特海洋生態系，包含潟湖、沿岸及海溝等海洋生態環境，探討園區內七股潟湖、七股沿海及澎湖水道的魚類群聚多樣性、生態功能群的差異性，及其優勢魚種的棲地利用。本研究採用 2021 年 9 月至 2022 年 12 月間以待袋網收集七股潟湖共 31 網次的漁獲，以及 2016 年 4 月至 2023 年 7 月間以海研三號和新海研三號的桁桿式底拖網在七股沿海及澎湖水道共 7 個測點進行 72 個網次的底拖調查資料進行比較。在七股潟湖、七股沿海和澎湖水道，分別記錄到 55 科 145 種(155 taxa), 40 科 101 種(106 taxa)和 44 科 85 種(98 taxa)的魚種。此三個海洋生態系的魚類群聚呈現高度歧異，同時出現在三個生態系的魚種，只有 4 種(檸檬斑鮅、卵鰨、彎角鰯和格氏舌鰨)，而潟湖至沿海以及沿海至水道海域共有的魚種，各有 23 種和 30 種。此外，三個海洋生態系的前五優勢魚種亦皆不相同，七股潟湖的前五優勢魚種依序為黑邊布氏鰗(15.0%)、短棘鰗(11.1%)、大鱗鮻(8.5%)、環球海鰶(7.0%)和銀雞魚(6.9%)，七股沿海為高體大鱗鮅(19.9%)、寬條鸚天竺鯛(15.2%)、黑斑圓鱗鰨(11.5%)、準大頭狗母魚(10.8%)和扁鰯(8.1%)，而澎湖水道則為腔吻鱈屬 sp.(15.3%)、斯氏鱷齒魚(12.1%)、鱗鰭叫姑魚(11.7%)、小口鮠(5.6%)和六帶擬鱸(3.9%)。七股潟湖的魚類群聚有明顯的季節變化，七股沿海和澎湖水道則因水深、溫度、鹽度和底質粒徑等環境因子影響其空間分布。從定棲型及棲地依賴型魚種功能群來看，七股潟湖(32 種)、七股沿海(12 種)及澎湖水道(9 種)分別都是不同種海水魚類的重要生殖和育幼場所。

澎湖周邊海域拖網漁業混獲魚類調查

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摘要

本研究自 2021 年起,在澎湖馬公第三漁港及赤崁地區採集底拖漁業混獲魚類樣本進行分類研究,共計鑑定超過 200 個物種，其中包含絲鰭鱚屬(*Trichonotus*)及細鋤蛇鰻屬(*Yirrkala*)之未發表新種；台灣新紀錄種眼斑絲鰭鱚(*Trichonotus polyophthalmus*)及大鱗短額鮜(*Engyprosopon macrolepis*)；多個澎湖新紀錄種，如:島鱵(*Hemiramphus archipelagicus*)、黑錐體糯鰻(*Ariosoma emmae*)、橘斑無鰭蛇鰻(*Apterichtus hatookai*)、異棘海緋鯉(*Upeneus heterospinus*)、紫身短體蛇鰻(*Brachysomophis porphyreus*)、黑麗蛇鰻(*Callechelys kuro*)、東方狗母魚(*Synodus orientalis*)。另有數個尚未確認物種仍須進一步進行研究比對，如:短體蛇鰻(*Brachysomophis* sp.)、短額鮜(*Engyprosopon* sp.)及橫口鰯(*Plagiotremus* sp.)。另外我們也發現赤崁地區應為多種經濟性物種之育幼場。

Genetic Structure of the Western Pacific *Asymmetron lucayanum* (Branchiostomatidae) Clade

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Abstract

Lancelets, also known as amphioxi, are primitive marine chordates and the closest known relative of vertebrates. Owing to their simple morphology which is retained throughout millions of years and a relatively small genome size (~0.5 Gb), lancelets become compelling model organisms in the study of chordates and vertebrate evolution. Numerous *evo-devo*-related studies on lancelets have been published in the past years, but rarely on their genetic diversity, population structuring, and demographic history. Herein, we investigate the genetic structure of a commonly occurring lancelet in the Western Pacific – *Asymmetron lucayanum* Clade B. This study incorporated the combinatory use of the mtCOI gene and RADseq-derived SNP markers. MtCOI showed the probable presence of four subpopulations within *A. lucayanum* Clade B (B1-4), with B1 as the most widespread and considered as the ancestral origin. The Haplotype network additionally showed the deep divergence of Clade B against the rest of the *A. lucayanum* clades (A, C, and D). Mismatch distribution suggested an expansion time of around 7.55 million years ago (MYA), whereas Bayesian skyline analysis presented a more recent timeline at around ~1 MYA. On-going RADseq-derived genomic data on 92 subsampled individuals yielded more than 1.2 million loci and a usable 40,911 SNPs size. Additional calculations are currently underway to infer higher resolution within the genetic relationships. With the additional genomic data, we can deduce potential mechanisms leading to their differentiations and historical adaptations.

Keywords: lancelet, amphioxus, COI, SNPs, RADseq

Heterotrophy provides a greater benefit to coral performance under lower compared to warmer temperatures in *ex-situ* aquaculture

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Abstract

The degradation of coral reefs globally has prompted a renewed interest in the applicability of *ex-situ* aquaculture to support research and restoration. To maximize benefits and cost efficiency of coral aquaculture, however, it is imperative to identify conditions that optimize *ex-situ* performance. We examined the influence of two cultivation factors – feeding and temperature – on coral health, reproduction, and recruitment. Colonies of the reef-building coral, *Pocillopora acuta*, were fragmented into four pieces with one piece from each colony being allocated to each treatment (fed 26°C, unfed 26°C, fed 29°C, unfed 29°C) for one year. Offspring produced by these colonies were settled and cultured at 26°C and 29°C; all offspring were fed. After 5 months of culture, feeding differentially influenced coral performance between the two temperatures. Whereby, at 26°C fed and unfed colonies differed in colour (fed darker than unfed), reproductive output (fed higher than unfed), larval size (fed larger than unfed), and physiology (chlorophyll a, symbiont density, and host protein concentration higher in fed than unfed). Interestingly the same trends were not found at 29°C, with colour, reproductive output, larval size, and physiological parameters being similar between fed and unfed colonies. Settlement, as well as recruit survival and size, was higher at 29°C than 26°C regardless of parent treatment. These preliminary results suggest that optimal culture conditions differ based on life stage, whereby culturing adult colonies at 26°C with food provision is preferential, and cultivation of offspring at 29°C can lead to higher recruitment and growth. Molecular (lipidomics and transcriptomics) investigations will be undertaken to provide a more comprehensive assessment to complement the ecological metrics examined. Clear determination of species-specific *ex-situ* culture requirements can help (1) establish stable broodstock populations, (2) produce corals for outplanting onto degraded reefs, and (3) test the capacity for thermal tolerance enhancement based on temperature conditioning.

國際計畫介紹:從 GEOTRACES 到 BioGeoSCAPES

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計畫名稱：西北太平洋氣膠鐵生物地球化學循環(II):相態轉換及野外驗證
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摘要

GEOTRACES(https://www.geotraces.org/)，是過去 20 年來海洋生物地球化學暨海洋地球化學領域最具成就的國際聯合計畫，共達 35 個國家參與，透過此計畫的整合及努力，學界對全球各大洋水體中微量元素及其同位素的大尺度分佈和相關生物地球化學循環過程有跳躍性的重大進展與認識! 多年來臺灣學界部分成員積極參與 GEOTRACES 計畫，並持續於科學指導委員會中擔任國家代表,目前新任代表為台大海研所謝玉德教授;但一方面 GEOTRACES 已執行近 20 年,另一方面該計畫側重化學層面,環境物理化學因子和生物間更複雜多變的交互作用機制非常需要生物及化學海洋專長的連結，也因而產生了海洋生物地球化學領域的新興計畫，BioGeoSCAPES (https://biogeoscapes.org/)，該計畫旨在探索地球快速變動環境下海洋巨觀或微觀「新陳代謝(metabolism)」和營養物質循環(nutrient cycling)間的交互作用，該計畫已啟動正式籌辦，本人和中研院植微所顧鈃教授分別擔任資深科學指導委員會成員和台灣聯絡代表。位居環西北太平洋中心位置的台灣具有極其多元的大氣、海洋物理地質過程及各式人為干擾，如季風、颱風、黑潮、內波、中尺度渦流、海地熱液、地震、河川地下水 PM2.5 輸入等，造就各式物理和化學條件在各時間尺度重大變異,例如各海域所供應的營養鹽及微量金屬的條件和變動將在各式不同時間尺度決定各式不同生態區位的浮游植物族群的動態，如固氮細菌和非固氮細菌間的演替、微生物圈的動態變化。本報告將說明相關計畫現況並討論潛在議題，歡迎有興趣的老師和同學參與及指教。

The Physio-Biogeochemical Processes Inferred from the Dual Isotopes of Nitrate in the Seas Surrounding Taiwan

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計畫名稱：西北太平洋副熱帶環流區氮循環在現代和過去的變化
計畫編號：MOST 111-2116-M-002-032-MY3
計畫名稱：建立海洋人工表層藻床增匯方法學
計畫編號：112B 科 005-V

摘要

The physical structure of the ocean defines the regimes of biological activities. Biological processes modulate the chemical changes of the environment t hrough production and recycling, and eventually determines the chemical characteristics of each physical domain. In turn, we could use the biogeochemical features to constrain physical processes. The seas surrounding Taiwan represent a dynamical region with great spatial and t emporal changes in the physi o-biogeochemical processes that remain to be explored with new tools.

The dual isotopes of nitrate in the ocean have been dev eloped in recent years to constrain these processes. Nitrogen, mostly in the form of nitrate, is the prim ary limi ting nutrient for phytoplankton growth in the ocean. The present marine N cycle is dominated by biological processes thus provide a critical link between bi ology and environment. Among the processes, nitrate uptake and denit rification fractionate $\delta^{15}N$ and $\delta^{18}O$ with equal rates, whereas deviations from a constant ratio in $\delta^{15}N$ and $\delta^{18}O$ can result from biological N_2 fixation when newly formed N is adde d to the nitrate pool, or from nitrification when recycled ammonium i s oxidized to nitrate. In this talk, I will show dual isotope data from cruise s conducted between 2018 and 2023 with great spatial and seasonal coverage s of the seas surrounding Taiwan. These data reveal strong spatial difference in the upper ocean N cycling. The Kuroshio and Western P hilippine Sea are dominated by newly fixed N from biological N_2 fixation coupled with recycling of the N within the euphotic layer and below. The marginal seas including the northern South China Sea and the Taiwan Strait are strongly influenced by partial nitrate assimilation coupled with nitrification below the euphotic zone. Changes in the dual isotope si gnatures of the nitrate on different monsoon seasons in turn are significa ntly influenced by exchanges of water masses. Under the influence of winter monsoons, nitrate originating from the Changjiang diluted water is carried across the Taiwan Strait by the Mixed China Coastal Water , encouraging nitrate assimilation and nitri fication. In the northern South China Sea, intensified Kurosh io intrusions through the Luzon Strait during winter monsoons are shown to modify the thermocline nitrate isotope signatures.

Barium isotopes in Tamsui River mixing experiments: implications for tracing riverine inputs to the ocean

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計畫名稱：研究海洋鋇同位素之源與匯的變化：示蹤海洋鋇與碳的循環(2/3)
計畫編號：112-2611-M-002-004-

Abstract

GEOTRACES is an international programme aimed at enhancing our understanding of trace element cycling in the ocean. Continental runoff has long been considered as a major source delivering nutrients and trace elements to the ocean, yet precisely estimating their inputs is challenging due to non-conservative mixing behaviours for some elements. For instance, barium (Ba) serves as a common tracer for tracking riverine inputs into the ocean, despite its non-conservative mixing behaviour posing challenges for reliability. Recent studies highlight non-conservative mixing of Ba isotopes in estuaries, but understanding of the controls on estuarine Ba isotopic compositions remains limited. To investigate the impact of suspended particulate matter (SPM) on Ba isotopes, we conducted a series of river and seawater mixing experiments using samples collected from the Tamsui River, Taiwan. The results indicate maximum Ba desorption in the low salinity mixing zone, with isotopically light Ba released during desorption, strongly correlated with freshwater SPM concentrations. This relationship offers insights into estuarine Ba non-conservative mixing, providing a novel approach to understanding past weathering and climate changes through improved estimates of river water and SPM discharges.

The distribution of dissolved trace metal concentrations in the offshore region near southwestern Taiwan

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計畫名稱：利用實驗及野外觀測研究重要且被低估的海洋沈積物微量金屬輸入
計畫編號：112WFA0911871

Abstract

Trace metals are essential minor nutrients to limit or stimulate the growth of phytoplankton in the ocean, where receives these metals at different depths of water column from different sources, such as aerosol deposition, hydrothermal inputs, and continental discharges. The offshore region in southwestern Taiwan, near Gaoping submarine canyon, receive a large amount of materials from the discharge of Gaoping River with a significant seasonal variation. In that region, obvious benthic nepheloid layer is also observed with a wide range around 200 m above the seafloor. Due to the difficulty of sampling above the seafloor, study of trace metal cycling in benthic nepheloid layer remains limited globally. Thus, the offshore region in southwestern Taiwan can be an ideal platform for advancing our understanding of trace metal cycling in benthic nepheloid layer. Taking advantage of cruises, NOR1-0054 and T030, we collected seawater samples near Gaoping canyon with a newly established trace metal clean sampling system (particularly for T030). From T-S diagram, we observed different extent of freshwater inputs at different stations along the slope, implying that freshwater brings some additional trace metal inputs from Taiwan island margin. We also found that dissolved Fe, Mn, and Co concentrations are highly correlated to transmission data, indicating marginal inputs play a critical role in providing these metals to the region. In comparison, dissolved Ni, Cu, Zn, and Cd concentrations demonstrate a typical nutrient-type distribution with insignificant marginal inputs, which were probably masked by relatively high concentrations of nutrient-type metals in deep waters. Systematic studies along the Gaoping canyon system will be carried out for better understanding of trace metal cycling in the benthic nepheloid layer soon.

西北太平洋沉降顆粒元素組成與通量特徵
Characterization of the elemental composition and fluxes of sinking particles in the Northwestern Pacific Ocean

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摘要

海洋沉降顆粒，主要包括有機物、生物殼體、岩石性顆粒及自生源礦物等，其沉降通量為海洋表層到深海物質循環提供最基本且關鍵訊息。本研究和日本研究團隊合作，分析於西北太平洋50°N高營養鹽低葉綠素海域 (50°N, 165°E)和 40°N 較低營養鹽黑潮延伸海域(40°N, 165°E) 之1000米及5000米沉降顆粒，探索大氣及海洋物理及化學條件對微量金屬沉降通量與元素組成關係。研究結果發現微量金屬於50°N的1000米有顯著較高的通量，推測此區有較高的營養鹽及生產力，同時提升金屬沉降通量；同一測站中，鐵和銅於5000米都有較高的沉降通量和金屬對磷的比值，從鐵對鈦的富集因子接近於1推估與陸棚沉積物的側向傳輸有關，而銅的富集因子於5000米都大於20，推測有其他顆粒銅的來源。其他金屬如鎘，1000米顯著都高於5000米，因為鎘在陸源顆粒上的含量極低(0.1ppm)，1000米所收到的顆粒鎘應源自生物顆粒，高鎘鈦富集因子和鎘磷比支持此推論。於鎘通量高峰的季節時，鎳則在1000米則有高於5000米的通量現象，推測此時生物體鎳有較多較顯著的通量貢獻。而非生物所需的元素鉛，兩種不同的深度有相近的通量變動範圍。金屬沉降牽涉因素很廣，不同金屬來源和循環機制可做為大氣和海洋生地化過程的追蹤指標，相關分析工作仍持續進行中。

海洋單細胞固氮藍細菌的比較基因體分析

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計畫名稱：海洋固氮生物在氣候變化中的動態變化與生態功能(1/3)
計畫編號：112-2611-M-019-009

摘要

固氮藍細菌是海洋中固氮作用主要的貢獻者。在傳統的觀念中，多細胞的束毛藻以及與矽藻共生的藍細菌(因較大容易被觀測到)，被認為是海洋中主要的固氮生物。近年來，由於分子生物技術在海洋科學中的發展與應用，大量單細胞的固氮藍細菌被陸續發現了。在本研究中，我們透過比較基因體分析與分子鐘分析，揭現了主要單細胞固氮藍細菌類群的演化史與生理特徵。本研究成果為了解海洋中主要單細胞固氮藍細菌在環境變遷中的生存策略與響應提供重要的資訊。

C:N ratio and N-containing macromolecules of surface phytoplankton in the eastern North Pacific

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計畫名稱：Simons Collaboration on Ocean Processes and Ecology-Gradients
計畫編號：Grant 723789 (to Z.V.F.)

Abstract

The transition zone between the oligotrophic North Pacific Subtropical Gyre (NPSG) and neighboring eutrophic equatorial region exhibits precipitous changes in environmental conditions which are associated with changes in the microbial ecosystem. As participants in the Simons Collaboration on Ocean Processes and Ecology (SCOPE)-Gradients project, we had attended the 4th Gradients cruise in late 2021 to investigate total particulate C and N (TPC, TPN) and N-containing macromolecules of surface phytoplankton along the V-shaped San Diego-Equator-Honolulu transects across the transition zone between the NPSG and the equator. Both TPC and TPN showed an increasing trend from the oligotrophic to the eutrophic region, as the C:N ratio showed the opposite trend. The N-containing macromolecules, including chlorophyll *a* (Chl*a*), total protein, RNA, and DNA, showed similar trends with TPN. On the other hand, the mass ratios of protein:Chl*a*, protein:RNA, and protein:DNA showed similar trends with the C:N ratio. Total protein contributed most of nitrogen in the TPN (~30%) and presented a decreasing trend from the NPSG to the equator. Such gradients of elements and macromolecules might reflect the changes on nutrient supply in the eastern North Pacific Ocean.

海洋生物地球化學模式的應用

Applications of marine biogeochemical models

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摘要

海洋生物地球化學模式是強大的工具，他們主要應用於理解和預測在多樣氣侯環境條件下海洋生物地球化學的動態。這些模式整合了生物、化學、地質和物理過程，以模擬海洋中發生的相互作用和回饋機制。我將介紹這些模式的一些關鍵應用。這些應用可以增進我們對海洋中如碳、氮、磷和氧等關鍵元素的生物地球化學循環的理解，幫助重建古氣候，並預測海洋在全球氣候變化中的角色及影響。

Marine biogeochemical models are powerful tools designed to understand and predict the dynamics of marine biogeochemistry across diverse environmental conditions. These models integrate biological, chemical, geological, and physical processes to simulate the interactions and feedback mechanisms that occur in the ocean. I will introduce some key applications of these models. They offer insights into the biogeochemical cycles of crucial elements such as carbon, nitrogen, phosphorus, and oxygen in the ocean, aid in reconstructing paleoclimate, and project the ocean's role in global climate change.

The application and limitations of MC-ICPMS measured $^{236}U/^{238}U$ as an ocean tracer

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計畫名稱：人造核種鈾 236、碳 14、與持久性有機汙染物在熱帶與副熱帶西太平洋水域中之分布
計畫編號：MOST 111-2611-M-002-014

摘要

Since the development of using multi-collector inductively-coupled-plasma mass spectrometry (MC-ICPMS) to quantify $^{236}U/^{238}U$ ratios in natural samples in 2021, we have quantified some coral cores and seawater samples from the Pacific Ocean. We successfully obtained the highest temporal resolution (bi-monthly) $^{236}U/^{238}U$ record using a fast-growing (2cm/year) coral retrieved from southern Taiwan. We also reconstructed five depth profiles of seawater collected from the northeast, central tropical, and western tropical Pacific Ocean and the offshore of southwestern Taiwan. From the coral and seawater records, we learned that $^{236}U/^{238}U$ are sensitive nuclear reaction tracers and that 236U penetration depths reached 600 m in the tropical Pacific Ocean. However, from the process, we also learned the limitations of our method. First, small coral core subsampling is challenging, and we encounter challenges in obtaining meaningful replicated measurements of high temporal resolutions. Second, our detection limit was at about $^{236}U/^{238}U$ 4×10^{-10}, and thus, we collaborated with the accelerator mass spectrometry lab for seawater samples collected from deeper than 600 m. Third, we are still learning the inconsistent performance of our secondary electron multiplier for detecting low ^{236}U. Despite some challenges, the MC-ICPMS technique is still very promising in detecting natural samples influenced by anthropogenic ^{236}U input with small samples.

Method development for analyzing poly- and perfluoroalkyl substances in seawater and marine plankton

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計畫名稱：全氟/多氟烷基物質在海洋浮游生物中的生物累積作用
計畫編號：111-2611-M-001 -012 -MY3

摘要

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic organofluorine compounds widely used in industrial and commercial applications. Public concerns about their environmental persistence, bioaccumulation, biomagnification, and ecotoxicity have been rising in the last decade. However, our knowledge about PFAS cycling and fate in the marine environment is still very limited. While detecting PFAS in samples with a complicated matrix (e.g., seawater) is challenging, we have developed methods for analyzing up to 40 target PFAS compounds in seawater and plankton samples by a liquid chromatography-tandem mass spectrometer (LC-QQQ). Solid-phase extraction (SPE) by weak-anion exchange (WAX) resins was optimized for preconcentration and sample clean-up, and the isotope dilution (31 isotopically labeled compounds) method was applied to ensure the recovery yield within 70-130%. Our optimized methods were verified by limited reference materials, and the limit of detection can achieve 1-10 pg/L (aqueous) and 10-100 pg/g (solid). Moreover, we have also developed methods for non-target screening using a high-resolution mass spectrometer (LC-IMS-qTOF), which allows us to identify unknown PFAS (PFAS without available analytical standards) in samples.

以數值模式探討藻礁海岸流場與底床剪應力

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摘要

Currents in coastal zones under multiple mechanisms in terms of tides, waves, wind, and high roughness are difficult to model; bed shear stresses under wave-current flows are particularly challenging yet not being well studied. Few studies reported the modeling and validation of the bed shear stress in reef environments. In this paper, we present the first direct assessment of numerical modeling on depth-averaged currents and bed shear stresses over an algal reef using a coupled wave-current model (Delft-3D). The modeled results were validated and compared to the field observed data. The model considers hydrodynamic forcing in terms of tides, waves, wind stresses, and bed friction. Results show that the model generally reproduces the depth-averaged currents and bed shear stresses when considering all the mechanisms. Two models were chosen to study the nonlinear enhancement of bed shear stress by waves. We found a significant difference between the two models in predicting the bed shear stresses compared to the observed data. Nonlinear contribution from wave enhances the magnitude of bed shear stresses, which reduces the model error. The results highlight the nonlinear interaction between waves and currents is meaningful in predicting the bed shear stresses during high-wave-orbital motions; improvement of the present wave-current nonlinear interaction model for predicting the bed shear stresses may be needed.

應用 DrifterTek 浮球探討台灣東部海域中尺度渦漩的流場變化

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計畫名稱：黑潮到紊流之間的能量交換觀測研究-子計畫:海洋邊緣紊流混合與能量轉換之研究(II)
計畫編號：NSTC 112-2611-M-006-004

摘要

在本研究利用 DrifterTek(流浪者)浮球來收集浮球的資料，本次研究著重在軌跡與速度的部分，並在浮球下方加裝自行研發的托傘，除了可以確保流向不會被表面的浪還有波去影響，也可以增加浮力，減少浮球翻覆的機率。DrifterTek 浮球、MicroStar 浮球和 SAFE 浮球於台灣東側的 A 渦漩東側下放時，三者軌跡受到渦漩外圍軌跡影響，均由西北向東南移動，以 Day1 為例: 三者跟 ADCP 船測所獲得的流速相似，約為 0.5551m/s，衛星海表面高程推算得流速在渦旋 A 的東側僅有 0.4557m/s。DrifterTek 浮球和 MicroStar 浮球的 NRMSE 約為 13%, 顯示 DrifterTek 與自製拖傘可合理量測渦漩的速度。根據衛星海表面高程推算得的動能變化(KE)顯示，Day4 過後渦漩 A 與黑潮交會後東側流場能量有減弱的趨勢，且渦漩 A 東側有一散度較大的區域，致使 DrifterTek 浮球 MicroStar 浮球皆離開順鐘向的渦漩 A，並呈現 12-14 小時為周期的往復性擺盪。

非線性背風波狀態下的散度、旋度及位渦度變化之研究

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計畫名稱：黑潮到紊流之間的能量交換觀測研究-子計畫:海洋邊緣紊流混合與能量轉換之研究(II)
計畫編號：NSTC 112-2611-M-006-004

摘要

與北大西洋的墨西哥灣流相似，黑潮將溫暖的熱帶水和具有商業價值的海洋生物從菲律賓海向北輸送到日本南部以及邊緣陸棚和內海區域。許多先前的研究發現，在海底山脈或地形山脊處，會產生不穩定尾流、紊流和密度混合的現象，且地形特徵引起的混合現象和相關的物理過程，對黑潮中水體特性和營養鹽分布的下游演變相當重要。ROMS(Regional Ocean Modeling System)是一個基於自由液面和地形追蹤座標的三維中尺度海洋模擬系統，目前已廣泛被應用於河口及開放海域等相關研究，對模擬海洋環境、氣候和生態系統有很大的貢獻。因此，本研究利用數值模式 ROMS 來模擬綠島周圍海域的海底山脊，試圖了解山脊地形後紊流混合和剪切不穩定等物理現象，並進一步討論在空間上的分布情形。

先前的研究發現，當墨西哥灣流和加利福尼亞暗流與地形山脊相互作用時，負位渦度的位置通常有較強的能量耗散。本研究模擬的位渦度反映了不同入流條件下的亞中尺度過程以及對應的內背風波強度，當地形福祿數隨著入流速度增加時，海底山脊後的等密度線下降 $\partial_y\rho>0$ 也會更加明顯，這是因為在非線性狀態下垂直相對渦度 $\zeta_z = \partial_x v - \partial_y u$ 的負值較大，因此造成負位渦度以及較強的能量耗散。

Revisiting flow and hydrographic fields in the southern part of the Changyun Rise during summer and winter

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Abstract

The Changyun Rise (CYR) is a submarine shoal with an average depth of 30-40 meters in the southeastern portion of the Taiwan Strait. The large-scale background flow through the Penghu Channel is relatively well-known and is guided by the local bathymetry. However, the flow field and stratification structure around the CYR have not been investigated in detail due to sparse wintertime in situ observations. This study revisits velocity measurements derived from a bottom-mounted ADCP (bm-ADCP) mooring on the southern side of the CYR during the TSNOW project in the summer and winter of 1999. The flow field was predominated by the strong barotropic tides of $O(100)$ cm s^{-1}. The baroclinic tides were largely semidiurnal with a relatively weaker magnitude of 30 - 50 cm s^{-1} and exhibited seasonal variability. The non-tidal component of the flow also showed a clear seasonal difference. The vertical structure of the barotropic flow indicated a tidal bottom boundary layer (BBL), with an estimated thickness of ~30 - 40 m (local water depth is 70 m). Observed tidal BBLs also showed seasonality due to variations in stratification between summer and winter. Non-tidal component of the flow unveiled a near-bottom eastward flow lasting ~3 - 5 days under northeasterly winds in winter, possibly a bottom Ekman transport. Two ~13-hour fixed-point shipborne CTD/LADCP observations in April and September 2022 were used in this study. Calculated Richardson numbers, a metric used to assess mixing in the water column, were found mostly < 0.25 in the lower half of the water column. This suggests favorable conditions for shear-driven instability and mixing resulted from tidal BBLs. Performance of most global tidal models is usually reduced in the region where bathymetry is complicated. Our harmonic analysis using in situ data showed that the TPXO global tidal model is fairly reliable. We tentatively evaluated the CMEMS GLORYS12V1 reanalysis product using the TSNOW bm-ADCP data and concluded that GLORYS12V1 can roughly reproduce non-tidal currents at a synoptic time scale.

空拍影像技術於殼狀珊瑚藻覆蓋率之研究

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摘要

台灣桃園海岸擁有獨特的藻礁地形，桃園藻礁主要是由殼狀珊瑚藻(crustose coralline algae, CCA)所組成。本研究提出一種利用可見光無人機影像搭配自動化影像辨識的方法，用來提升殼狀珊瑚藻覆蓋率調查的範圍及效率。本研究透過監督式分析進行自動化辨識，首先將影像進行分類，分為殼狀珊瑚藻、黑洞及殘留物。之後測試不同的指標，找出最佳化的閾值的設定。目前透過 ExG（Excess Green Index）作為閾值進行設定，可以達到最佳的辨識結果，但因為各區殼狀藻影像特性不同，導致各區的閾值皆不同。由自動化分析成果可知，大部分區域(白玉、大潭)已有良好的自動辨識成果，平均 Kappa 值分別為 0.46 及 0.44。而觀新藻礁區，因殼狀藻影像特性與殘留物過於相似，造成自動辨識誤判，導致辨識成果不好，平均 Kappa 值為 0.22。目前較難透過監督式分析及可見光影像，提高該區的自動化辨識成果。未來建議可以使用 AI 人工智慧等工具進行更深入的影像辨識，以改善自動化辨識的成果。

2022 年東加火山氣壓波與氣象海嘯之波型探討

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摘要

2022 年 1 月 15 日位於東加首都 Nuku'alofa 西北方約 70 公里之 Hunga Tonga-Hunga Ha’apai 火山（以下簡稱東加火山）發生大規模噴發，產生跨洋型態之海嘯。此事件不單僅是傳統之火山海嘯，其成因主要為兩種物理機制，其一為火山爆發之氣壓衝擊波引起的氣象海嘯，其二為火山爆發本身引起的火山型海嘯。

前者之氣象海嘯為非典型壓力型海嘯，為透過與大氣波的相位耦合產生之海嘯。爆發所產生之大氣衝擊波以接近音速之速度向外傳播，並於平流層中以似同心圓方式圍繞地球。此衝擊波複合蘭姆波、聲波、重力波，其中又以蘭姆波為振幅中最大者。蘭姆波為一種長波，是此事件中壓力誘發海嘯波之產生的主要原因。

東加火山海嘯事件後，許多針對此事件之海嘯模擬研究隨即展開。Gusman 等(2022)根據紐西蘭附近之觀測站數據，提出穩定波速之大氣衝擊波模型公式。Dogan 等(2023)觀察到波速隨時間並非一致，因此提出另一種模型公式。

本研究目的為修改前人研究提出之公式，使用 COMCOT（COrnell Multi-grid Coupled Tsunami Model）海嘯模式作模擬，並與 DART 以及中央氣象署浮標資料之去潮觀測數據做比對，探討氣壓波與海水波動之關係，提出與觀測資料吻合之新公式。

臺灣周邊海域內波模擬預報

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摘要

台灣周邊海域為我國海軍演訓任務之主要地區，因此為了準確掌握台灣周邊海域海流、波浪與溫鹽之變化，亟待建立一套自動化、作業化海洋數值預報模式。本研究以 sbPOM 數值模式為基礎，從頭建立完整執行流程，其內容包含系統套件安裝與模式編譯、資料前後處理，並完成美國東部海岸範例測試。為完成台灣與南中國海海域的模擬，本研究先由海床地形、水溫、鹽度和水流速度等關鍵邊界條件進行了多重測試和調整，以美國東岸範例為基礎，修改不同輸入參數，以確保模擬的精確性和可信。完成美國東部海岸之範例測試後，我們針對計算區域進行多項邊界條件調整，包括改變模擬範圍、修改海底地形、修改流速邊界數值模式。透過建構並驗證適合臺灣海域之內波數值模式，用以了解臺灣周邊海域內波之發生機制與行為。

關鍵字：sb-POM(Stony Brook Parallel Ocean Model)，混合坐標大洋環流模式(HYCOM)，內波

利用海嘯浮標預警系統觀測南海北部深海海盆之內孤立波

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內波（Internal Wave）是海洋中普遍存在的現象；然而，獨特的水下地形可能會使內波成為內孤立波（Internal Solitary Wave, ISW），其特徵是巨大的波幅、水平方向之海流有強烈垂直剪切、等密度線與等溫線的垂直位移以及能造成海底的壓力變化，其中於南海的巨大內波之振幅可達 200 公尺。一直以來有非常多針對 ISW 的研究，觀測方法多為使用都普勒流剖儀、水下溫度計串等。儘管南海的巨大內波盛行，但此處的長期觀測資料卻是鮮有。

本研究主要使用海嘯浮標預警系統收集之長期觀測結果進行分析。該系統配有高精密度、高採樣頻率之海底壓力計（Bottom Pressure Recorder）記錄海水高度變化所產生的海底壓力變化，海面則有用於下達指令、與衛星溝通及搭載 GPS 收發器之浮標。此系統部署在距離巴士海峽以西約 110 公里、深度約 2800 公尺的南海北部深海海盆，提供接近五年的連續觀測資料。

本研究將 BPR 記錄的壓力變化資料進行連續小波轉換（Continuous Wavelet Transform, CWT）和希爾伯特-黃變換（Hilbert-Huang Transform, HHT）。首先，CWT 顯示出在一小時週期區間有特殊訊號出現，且出現時序與潮汐相關。運用 HHT 方法可分離出潮汐及其他低頻波段訊號。濾除潮汐與低頻波段訊號後的變化與 CWT 之一小時週期區間訊號相同，而且這些訊號發生的時間與大、小潮變化相關。將此結果與先前研究成果做比對，發現一小時週期區間之訊號的出現時間與在此地的 ISW 相同，也就是在大潮的前後四天產生，因此可以初步確定這些訊號是 ISW 所造成。為進一步了解 ISW 的性質，如相速度、垂直速度、所造成之壓力變化等，運用 Dubreil-Jacotin-Long Equation（DJL）模式搭配背景水文資料進行模擬，結果顯示 DJL 模式所估算的海底壓力變化與觀測資料相近，而且 DJL 所估計之相速度也接近向日葵 9 號衛星（Himawari 9）高解析度影像所估算的相速度。上述結果顯示 DJL 搭配背景水文資料可準確估算 ISW 的性質。

綜上所述，此研究發現 ISW 所造成的壓力變化是可以在深海處被觀測到的。其次， DJL 模式搭配背景水文資料，可以估算 ISW 的各項性質。最後，透過分析長期觀測資料以及 DJL 方法的輔助，可以獲得此海域的 ISW 波候資訊。

Simulation of Internal Waves by Using Reduced Gravity Methods

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Abstract

Internal waves are waves occurring in stratified fluids, which consist of layers of different densities, recognizable through temperature, salinity, and current fluctuations or via phenomena. Despite their recognition since the early 1900s, capturing internal waves in both spatial and temporal dimensions remains a significant challenge. Numerical modeling has been a crucial tool in simulating the intricate characteristics of internal waves. However, such simulations are often hindered by the inherent complexity of internal wave dynamics, making them both difficult and time-consuming. To address this, the study focused on utilizing the reduced gravity method to simulate internal waves in stratified fluids to achieve both speed and accuracy in simulation forecasting. This study employed an internal dam break case for calibration and internal solitary waves for validation, utilizing Truchas and COMCOT as numerical modeling tools. The internal dam break case investigated the similarity using the reduced gravity method and non-using reduced gravity methods. In validation, internal solitary waves have been used to compare with analytical results for both used and on-used methods. All simulations were evaluated using the Root-Mean-Square Error (RMSE) to compare between simulations. In the dam break simulation, it was observed that the interface oscillations were nearly identical between the two-layer simulation and the reduced gravity simulation with one layer. Similarly, there was a remarkable agreement between the analytical and numerical results for the internal solitary wave simulation, with a low RMSE value of 0.000185. These findings confirm the efficacy of the reduced gravity method in successfully simulating internal waves, facilitating a transition from a two-layer model to a more simplified one-layer model. By employing this method, the research concerning internal waves can be streamlined through expedited simulation. Therefore, this study highlights the potential of the reduced gravity method as a valuable tool for the study of internal wave dynamics

Comparing biotic and abiotic factors on shaping bacterial heterotroph metacommunity in the southern East China Sea

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Abstract

Spatial and temporal community dynamics of heterotrophic bacteria play an essential role in regulating elemental cycles in the ocean; yet, how various factors influence community variation (i.e., metacommunity) is not fully understood. In the past decade, multiple processes have been proposed to determine marine bacterioplankton metacommunities; however, a substantial portion of community variation remains unexplained. Here, we propose a new analytical framework that allows to compare the strength of biotic filtering, relative to abiotic filtering and dispersal limitation in shaping marine bacteria metacommunity. To account for biotic filtering, we considered communities of phototrophic, heterotrophic and parasitic eukaryotes, which possibly interact with heterotrophic bacteria. Using a variation partitioning analysis model (VPA), we expect those eukaryotic community variations can explain better the heterotroph metacommunities.

Our samples were collected from 7 research cruises (2014-2017) from the highly hydrologically dynamical southern East China Sea, in an east-west transect across 280 km. The results of VPA show that at high fluoresce levels, biotic factors (interactions among functional groups) explained more variation of bacterial heterotroph metacommunities than abiotic factors. The high contribution of biotic factors under those conditions might be due to top-down regulation on heterotrophic bacteria from heterotrophic eukaryotes. Conversely, at lower fluoresce levels, abiotic factors could cause a bottom-up effect on heterotrophic bacteria.

Warming experiments produce changes in the bacterial growth and lytic-lysogenic viral infection in coastal Pacific water during winter at different latitudes

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Abstract

Ocean surface waters are expected to warm by 2–6°C over the course of this century as a result of climatic change. We aim to assess the viral abundance and dynamics of viral lytic-lysogenic replication strategies in coastal waters in Taiwan and Japan during the winter of 2023. In particular, to examine changes in lytic and lysogenic viral production as a function of warming. In this study, *in situ* temperature treatments with mitomycin C induced lower bacterial growth rates of 0.003 to 0.033 h^{-1} than control treatments of 0.031 to 0.064 h^{-1}. Furthermore, bacterial growth rate without mitomycin C under warmed condition increased between 0.040 to 0.093 h^{-1}. There was a wide range of inducible prophage detected, ranging from undetectable to 14.2%. There was a higher rate of lysogenic infection under warmed conditions at all stations, ranging from 14.6 to 41.8%. Based on the observations that lysogeny occurs at warm treatments and increases with increased bacterial production, we suggest that there is a decrease in the amount of carbon entering the dissolved phase through viral shunts (lysed bacteria), favoring the microbial loop (grazing on bacteria).

利用穩定同位素評估頭足類在臺灣淺灘海域的營養特徵及生態角色

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摘要

臺灣淺灘(Taiwan Bank)為臺灣西南海域之重要漁場，其中頭足類是常見的經濟性物種，扮演著傳遞浮游生物與中表層掠食者能量的關鍵角色。然而，目前對於該海域的頭足類之營養特徵尚無完整瞭解。本研究於 2020 年間自商業底拖網採集臺灣淺灘周邊海域之頭足類及魚蝦類樣本，分析 9 種優勢頭足類物種之肌肉碳氮穩定同位素 ($\delta^{13}C$, $\delta^{15}N$)值，用以估算營養區位(trophic position)與營養生態位寬度(trophic niche width)及種間重疊(trophic overlap)。以臺灣淺灘海域採集之中大型浮游動物碳氮同位素值(中型 $\delta^{13}C$:-18.85±1.6；$\delta^{15}N$: 6.25±1.0；大型 $\delta^{13}C$:-18.72±1.6；$\delta^{15}N$: 7.84±1.2)作為基準，所估算頭足類營養區位約為2.9－3.4(貝瑞氏四盤耳烏賊 *Euprymna berryi*: 2.92±0.24；中國槍魷 *Uroteuthis chinensis*: 3.3±0.29)。貝葉斯混合模型結果顯示，頭足類和共存魚蝦類呈現不同程度的營養生態位重疊。營養特徵與生態習性和棲地有關，頭足類營養區位接近，可能與淺灘的深度有關，在相近的水深範圍，使得生物在這海域中，有機率攝食到相同的餌料生物。最後，我們觀察到同位素值並不總是隨體型增加而上升，暗示僅部分頭足類物種會隨成長改變其攝食組成。本研究有助於更加了解臺灣淺灘周邊海域頭足類之營養特徵，並強調從整體生態角度進行漁業管理的重要性

關鍵字：碳氮穩定同位素、浮游動物基準值、營養區位、營養生態位寬度。

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Modelling of Gillnet Fishing Data Uncertainty and Spatial Distribution around the waters of Taiwan

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Abstract

Gillnet fishing, a passive fishing gears that are deployed as a vertical wall in movement path of the target fish, has historically been prevalent in Taiwan's small-scale fishing sector, contributing to environmental challenges such as overfishing and ghost net pollution. This study examines gillnet fishery data collected from port observers and vessel voyage data recorders (VDR) between 2017 and 2021. This study employed two models to classify fish species into gillnet types and fishing operation layers. The first model utilized prior research to determine, while the second model relied on species behavior and biological characteristics to classify gillnet types (Drift Gillnet (GND), Set Gillnet (GNS) or Encircling Gillnet (GNC)) and operation layers, considering factors like fishing boat (CT) and fishing location. The study identified grey mullet (*Mugil cephalus*) as the most frequently caught species, comprising 26.89% of the overall data, followed by spanish mackerel (*Scomberomorus commerson*) at 5.81%. Additionally, the data revealed 8.92% of catch species were classified as very imprecise, with 0.49% categorized as undefined. Furthermore, behavioral and habitat analyses aid in the classification of gillnet operation layers, addressing the challenge of imprecise and undefined species. Spatial distribution analysis of 712 fishing vessels revealed clear operational trends. CT3 vessels (20 to 50 tons) were widely distributed across various depths, particularly focusing on the midwater to bottom water column. In contrast, CT4 vessels (50 to 100 tons) were concentrated mainly in the Taiwan Strait. Additionally, CTR and CT1 vessels (5 to 10 tons) were predominantly found operating in reef-associated areas. This comprehensive approach sheds light on gillnet fishing dynamics and their ecological impacts, providing valuable insights for sustainable management practices within Taiwan's fishing sector.

Keywords: Gillnet, VDR, modelling, habitats, fish behavior, biological characteristic
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Migratory ecology of Pacific bluefin tuna (*Thunnus orientalis*) revealed by otolith stable isotope analysis

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Pacific bluefin tuna (*Thunnus orientalis*, PBF) is a highly migratory species traveling long distances across the Pacific Ocean, making fishery management challenging. PBF is managed as a single stock although it has two known spawning grounds in the Western North Pacific Ocean between the Philippine Sea and the East China Sea (WNP), and the Sea of Japan (SoJ). During the juvenile stage, some PBFs undertake transoceanic migration to the California Current Large Marine Ecosystem (CCLME) in the eastern Pacific Ocean. Investigating these migratory patterns is crucial because PBF is fished by several countries throughout their life stages. However, knowledge about PBF movement between spawning grounds and their transoceanic migrations remains limited. To evaluate migratory patterns and natal origins, we analyzed otolith $\delta^{13}C_{oto}$ and $\delta^{18}O_{oto}$ stable isotope ratios of 93 PBFs caught in WNP spawning grounds and 29 fish from the CCLME. The $\delta^{13}C_{oto}$ analysis revealed a migratory life history as the predominant strategy within the population. The migration pattern to the CCLME highlights the importance of these eastern feeding grounds, likely due to upwelling providing abundant food sources. Besides, $\delta^{18}O_{oto}$ analysis indicated site fidelity and a higher contribution from the WNP spawning grounds. Interestingly, fish in the CCLME were also determined to originate from the WNP, suggesting a greater contribution from the WNP than the SoJ spawning grounds. These findings emphasize the importance of conservation efforts in the WNP spawning ground. By combining data from western and eastern fish, this study suggests that the WNP spawning ground is highly productive and contributes more migratory fish to the CCLME.

多尺度氣候變異對印度洋中表層頂端掠食者豐度與分布影響變動

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摘要

印度洋中表層頂端掠食者包含鮪類、旗魚類及鯊魚類，其豐度與分佈變動可能會受到海洋環境變動所影響，導致中表層頂端掠食者之間會因棲地相似進而存在競爭現象，且過去研究中多探討生態系統中單一物種間之垂直關係，多種頂端掠食者間相互影響關係之研究則較少著墨。因此本研究將針對印度洋中表層頂端掠食者漁獲資料先利用零膨脹與 delta 模型對其進行標準化，並探討在多尺度氣候變異的影響下印度洋中表層頂端掠食者其豐度與分佈變動影響為何。初步空間分佈結果顯示，黃鰭鮪、大目鮪、劍旗魚、黑皮旗魚與條紋四鰭旗魚高釣獲區域主要分佈於印度洋中部及北部海域，而長鰭鮪、劍旗魚以及正鰹則主要棲息於南部海域。另透過典型相關分析探討中表層頂端掠食者與氣候變異因子之間相關性，結果顯示，Root 1 中黃鰭鮪與條紋四鰭旗魚與 DMI 間存在較高相關性，而 Root 2 中則是大目鮪、南方黑鮪以及雨傘旗魚與 DMI 以及 PDO 具有較高相關性。後續分析擬探討頂端掠食者與氣候變異因子週期相關性以及其分佈變動之趨勢。

關鍵字: 典型相關分析、頂端掠食物種、氣候變遷

The lost trait of marine vertebrate in the wild: tracing the field metabolism with the novel isotope proxy

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摘要

The physiological traits of marine organisms are shaped by environmental conditions and anthropogenic pressure. Thus, it is crucial to understand the physiological responses to environmental variations. However, physiological performance has been often evaluated in lab control experiments rather than in the wild because of technological limitations. To have a better understanding of physiological performance in the wild environment, previous studies pointed out that stable carbon isotope value ($\delta^{13}C$) recorded in fish otoliths can be used as a metabolic proxy reflecting the field metabolism, but it is only applicable to bony fishes. We try to expand the application to as many marine organisms as possible and thus developed $\delta^{13}C$ metabolic proxy in the structural carbonate of vertebrae. Our study (1) provides the first experimental validation showing the relationship between vertebra $\delta^{13}C$ metabolic proxy and metabolic rate (oxygen consumption) through culturing black porgy (Acanthopagrus schlegelii); (2) expands the investigation of $\delta^{13}C$ metabolic proxy among marine fishes (more than 25 species) and the comparison between two calcified structures: otoliths and vertebrae. The results show that the $\delta^{13}C$ value recorded in vertebrae can also be used as a potential metabolic proxy. With the newly developed $\delta^{13}C$ metabolic proxy, we can investigate the field metabolic rate of not only bony fishes but also other marine vertebrates in the changing environment in the future.

應用次世代定序深度探討馬祖骨藻基因之時序變化

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計畫名稱：以高通量定序解析骨藻在藻華過程中感受環境營養鹽變化之調適機制

計畫編號：112-2811-M-019-002

摘　要

次世代定序 (Next generation sequencing, NGS) 問世以來，各種應用的方式使得此技術成為研究生物與環境交互作用的利器，例如直接取得環境中所有遺傳物質的多源基因體學 (metagenomic) 與多源轉錄體學 (metatranscriptomic) 研究，但若想研究環境中的特定物種，則這些技術常會受到目標生物在環境中的生物量 (biomass) 或基因表達量 (gene expression) 限制，若要提高解析程度，則必需增加定序的深度與資料量，此舉又會造成分析運算上的算力浪費與資料複雜度。因此本研究利用馬祖南竿介壽澳口採樣進行了長期觀察，以導向定序 (targeted sequencing) 及多重目標增殖 (Multiplexing amplicon sequencing) 方法，將 illumina 次世代定序平台的高通量輸出集中鎖定在特定矽藻—骨藻 (*Skeletonema)* 屬的管家基因、硝酸鹽運輸蛋白基因與磷酸鹽運輸蛋白基因，藉由這些基因的讀序數 (read counts) 變化情形觀察不同骨藻屬隨時間的族群消漲變化與營養鹽利用型式變化。

解析不同波長光源對籠具梭子蟹科捕撈率影響之研究

The effect of different wavelength LED lights in cages on the fishing effort of Portunidae

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摘要

蟹類對於光具有高敏感度，而梭子蟹科因具高經濟價值，為籠具漁業重要捕撈物種，因此如能提高籠具的捕獲量將有效協助增加漁民收入，同時進行有效管理政策。本研究在 2023 年分別至馬來西亞登佳樓與泰國北大年府海域進行海上試驗，分析不同波長 LED 光源對於梭子蟹科捕獲率之影響。分析結果顯示，放置 360 個籠具中捕撈 14 種梭子蟹共 417 隻，兩海域中補撈的物種與漁獲量皆具差異，在海上試驗結果中梭子蟹捕撈量以藍光組捕獲率為最佳平均 0.833 隻/籠，其次為綠光組平均 0.673 隻/籠、控制組平均 0.62 隻/籠，而紅光組平均 0.6 隻/籠效率最低，經卡方檢定結果顯示藍光組與其他組別具有顯著差異($P<0.05$)。

進一步比較受光照後梭子蟹之眼球組織切片，以了解光照對眼球細胞之影響機制，分析結果顯示藍色 LED 光源的眼球切片，顯現出較多橫紋肌與完整視錐細胞反映顯示眼球對藍光更為敏感，海上試驗與生理切片結果皆表示藍光對眼球刺激更具效果。

關鍵字：梭子蟹、LED、籠具、CPUE

Mixed layer thickness drives Mg/Ca-inferred temperature variability of planktic foraminifer *Trilobatus sacculifer* in the northern South China Sea

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Mg/Ca ratio of foraminiferal tests varies as a function of ambient seawater temperature. Foraminiferal Mg/Ca records are commonly utilized in paleoclimate reconstruction, e.g., to infer upper water column stratification using paired Mg/Ca records based on foraminifera dwelling in the mixed layer and thermocline assuming a fixed habitat depth through time. This assumption, however, contradicts modern observations that indicate habitat depth shifts in response to seasonal hydrographic changes. To improve our understanding of the temporal variability and depth origin of foraminiferal Mg/Ca signal, we analyzed the Mg/Ca ratio of individual tests (IFA-Mg/Ca) of the mixed layer-dwelling species *Trilobatus sacculifer* from sediment trap samples deployed at two water depths (2000 m and 3500 m) in the northern South China Sea (nSCS) during the period 2017–2019. In the absence of a Mg/Ca-temperature calibration based on single-specimen measurements, our single-specimen Mg/Ca ratios were converted to temperatures using a calibration developed for multi-specimen measurements. This choice was justified as our newly developed cleaning protocol yields comparable Mg/Ca data for both single-specimen and the conventional multi-specimen measurements. Our Mg/Ca-inferred temperature time series exhibit a good agreement with the satellite sea surface temperature (SST) during cold seasons but indicate temperatures approximately 3 ºC lower during warm seasons, resulting in dampened seasonal cycles. Winter (Dec-Feb) temperatures derived from IFA-Mg/Ca data also show interannual differences due to ENSO variability, with temperatures similar to satellite SST recorded during the La Niña phase when the mixed layer was deeper. Notably, the distribution of *T. sacculifer* IFA-Mg/Ca temperatures is generally unimodal in winter but bimodal in summer, indicating that *T. sacculifer* alters its habitat depth range seasonally. The bimodal distribution in summer months is probably a result of mixed layer-dwelling *T. sacculifer* thriving also at the deep chlorophyll maximum, which tends to form when the mixed layer is shallower in summer. Consequently, the *T. sacculifer* IFA-Mg/Ca temperature variability (spread in sample distribution) demonstrates a strong negative correlation with the mixed layer thickness. However, some IFA-Mg/Ca temperature data fall outside of the aforementioned relationship, potentially due to lateral transport. Our findings demonstrate that the temperature variability recorded by individual *T. sacculifer* test is indicative of variations in its habitat depth in response to hydrographic changes induced by seasonal monsoons and ENSO events in the nSCS. Therefore, IFA-Mg/Ca temperature variability is a promising indicator for the reconstruction of past changes in the upper water column thermal structure.

Key words: sediment trap, individual foraminifera analysis, Mg/Ca, mixed layer thickness

Constraining the recording depth of TEX_{86} at the edge of the Indo-Pacific Warm Pool using multispecies Mg/Ca records spanning the last glacial cycle

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Abstract

The Indo-Pacific Warm Pool (IPWP) holds the warmest surface ocean waters on earth and is a major source of heat and moisture to the global climate. Thus, past changes in the upper ocean temperature here are of high interest to the palaeoceanographic community. In this regard, one of the highly debated issues is the diverging temperature reconstructions during the Pliocene based on TEX_{86} and Mg/Ca of foraminifera. This discrepancy has been attributed to secular changes in seawater Mg/Ca or TEX_{86} recording a combined surface and subsurface signal. To further shed light on the Mg/Ca-TEX_{86} discrepancy in the IPWP and depth origin of TEX_{86} signal, we reconstruct surface and subsurface temperatures at the edge of the IPWP using $U^{K'}_{37}$, TEX_{86}, and multi-species foraminiferal Mg/Ca. We focus on the past 25 kyr, which allows us to rule out the effect of long term variations in seawater composition as a driver of the proxy discrepancy. Our multiproxy surface and subsurface temperatures dataset shows cooler LGM and warmer Holocene. $U^{K'}_{37}$ and surface-dwelling *G. ruber* temperatures agree well, exhibiting ~2°C warming in the surface ocean since the LGM. *G. ruber* displays peak warming during Early Holocene followed by cooling towards Late Holocene, whereas $U^{K'}_{37}$ approaches the saturation limit and thus does not exhibit the same trend. The Holocene cooling trend for *G. ruber* at our location appears to be linked to the austral winter insolation, which differs from the trends observed at other sites in the warm pool. When interpreted as sea surface temperature (SST), commonly applied SST calibrations yield TEX_{86} temperatures that were considerably higher than modern SST and temperatures derived from $U^{K'}_{37}$ and *G. ruber* Mg/Ca at our site. Relatively high GDGT 2/3 ratios (7-12) throughout the record suggests that the TEX_{86} likely registers subsurface temperature signal at our site. Indeed, when interpreted as subsurface temperature using three different calibrations, TEX_{86} record shows a good agreement with the Mg/Ca records of thermocline dwelling *P. obliquiloculata* , *N. dutertrei* and *G. tumida* . These results imply that TEX_{86} likely reflects temperature at the thermocline close to the habitat depth of these thermocline dwelling foraminifera in the range of ~ 100 - 200 m water depth. The subsurface warming trend across the last glacial cycle recorded by foraminifera and GDGTs at our site is consistent with the observations at other sites in the IPWP region, indicating a coherent regional glacial-interglacial climate shift. Our study highlights the potential of utilizing a multiproxy approach to constrain proxy interpretation and improve the robustness of the paleoclimate reconstruction.

Keywords : IPWP, LGM, Multiproxy, Mg/Ca, Foraminifera, TEX_{86}.

Replicability of paleotemperature records in the northern Okinawa Trough and its implications for paleoceanographic reconstructions

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Abstract

Geochemical proxies are frequently utilized in the reconstruction of past ocean temperatures. Due to resource constraints, these reconstructions typically rely on a single sediment core, raising questions about the local and regional representativeness of paleotemperature records. To address this, we analyzed four sediment cores located within a 10 km radius in the northern Okinawa Trough, which share the same climatic forcing and thus should reflect similar climate variations. We compiled published data and generated new paleotemperature estimates based on three widely used geochemical proxies (foraminiferal Mg/Ca, $U^{K'}_{37}$, TEX_{86}). Analysis of the mean absolute deviations for nearby records based on the same proxy revealed that $U^{K'}_{37}$ has the highest reproducibility, followed by Mg/Ca and TEX_{86}. However, inconsistencies in inter-proxy offsets among nearby sites suggest the presence of noise in the proxy records, likely stemming from instrumental errors and sediment heterogeneity. Furthermore, the Mg/Ca and $U^{K'}_{37}$ records agree within uncertainty when accounting for inter-site variability and calibration errors, challenging previous interpretations of temperature signals from different seasons. All proxies indicate similar glacial-interglacial trends, albeit with varying magnitudes of blacial cooling. Both Mg/Ca and $U^{K'}_{37}$ records suggest a glacial cooling of ~3°C, whereas TEX_{86} sea surface temperature (SST) data indicate a stronger cooling of approximately ~6-8°C. Modern observations indicate a subsurface TEX_{86} recording depth of 50–100 m, coinciding with the thermocline. However, the TEX_{86} subsurface temperature (subT) record doesn't resemble the Mg/Ca records of thermocline-dwelling foraminifera but aligns better with benthic foraminiferal Mg/Ca records of *Uvigerina* spp. (~700 m) and the intermediate temperature record derived from radiolarian assemblages (~500 m), indicating a deeper recording depth than the thermocline. In summary, our findings show that proxy noise can impact inter-proxy comparisons of paleotemperature records, but not the direction of glacial-interglacial shifts. Future research should prioritize constraining the recording depth of paleotemperature proxies and reducing calibration uncertainty for more precise and reliable quantitative paleotemperature reconstruction.

Keywords: Okinawa Trough, Mg/Ca, $U^{K'}_{37}$, TEX_{86}

龜山島崩塌事件之三維數值模擬

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摘要

過去，對於火山崩塌引發的海嘯特性的估算常依賴於對總海嘯體積的近似或使用經驗公式來估算初始波高。然而，在這項研究中，我們以台灣東部外海的龜山島為例，採用了不連續雙黏性流模型（Discontinuous Bi-viscous Model，簡稱 DBM），並結合了三維不可壓縮流碎波模型 Splash3D，以描繪岩屑型山崩引起的地滑動態過程，以及其進入海洋後所引發的山崩型海嘯行為。

在 Huang（2018）的研究中，利用了多波束測深數據、底質剖面、底拖側掃聲納、火花放電波源的震測剖面以及遠程操作載具（ROV）潛水數據等資料，對龜山島北方海域的地滑特徵進行了深入研究。該研究指出，該區域的地滑堆積物可分為三個質量運移沉積（MTD）單元（MTD1、MTD2 和 MTD3），其中主要的火山碎屑崩塌堆積物被識別為 MTD3，並提出了一個模型以解釋側翼崩塌及其後續的海底山崩事件。

透過 Huang（2018）對 MTD3 的測量數據，本研究得以校準 DBM 所使用的參數，進而重建龜山島周邊古代海嘯事件。這不僅有助於更深入了解地滑事件發生期間的動態過程，同時為未來該地區潛在海嘯危害的防災參考和制定策略提供了理想的基礎。

Ocean Temperature Stratification of the East Pacific During the Pliocene Using Oxygen Isotopes on Different Species of Planktonic Foraminifera

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Abstract

The East Pacific plays a vital role in controlling the global climate. Today, it is characterized by relatively cold and nutrient-rich water masses that upwell along the coast of South America and at the equator. An essential feature of interannual timescales is El Niño-Southern Oscillation (ENSO) variations. During El Niño, the easterly winds along the equator weaken, allowing warm water from the western Pacific Warm Pool to move eastwards, warming the east Pacific. It has been suggested that this might have been the standard situation during the Pliocene, a climate state sometimes referred to as "El Padre".

The transition from glacial Marine Isotope Stage M2 of the late Pliocene (~3.25 Ma) to the interglacial MIS KM5c during the mid-Piacenzian warm period (MPWP) may be similar to today, so a warming and increase in CO2 during this transition may, therefore be used as an analog for future global climate change.

Data coverage in the East Pacific, specifically on the structure of the water column, is still scarce. Thus, in this study, we are working on IODP Site U1338 (2°30.469′N, 117°58.178′W; 4200m water depth) from the equatorial Eastern Pacific, using oxygen isotopes and magnesium calcium ratio on foraminifera including *T. sacculifer*, *N. dutertrei*, *G. crassaformis*, and *D. altispira*, to reconstruct how the structure of the water column changed through the late Pliocene. The age model is based on the benthic isotope record (Lyle et al., 2019) of Site U1338 compared with the LR04 stack (Lisiecki & Raymo, 2005).

The data was compared with different sites to reconstruct the Pliocene and the stratification of the water column. According to the changes in the water column stratification before and after the NHG, we are attending to see El Padre by comparing it to the magnesium-calcium ratio and nitrogen isotope data.

Long-term Observations of GDGTs in Suspended Particulate Matter and Surface Sediments in the Warm Part of the East China Sea

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Abstract

The TetraEther indeX of 86 carbons (TEX$_{86}$) is a newly developed marine proxy for sea surface temperature (SST). TEX$_{86}$ is a group of resistant molecules of glycerol dialkyl glycerol tetraethers (GDGT), which is believed to be derived from the planktic archaea. Archaea are distributed in all the seawater columns and can live in extreme environments. The worldwide distribution of archaea provides a vast potential that can be a powerful tool for reconstructing past SSTs. However, our understanding of modern distributions of archaea in seawater and surface sediments must be moved with time to ensure the proxy estimates of SSTs are highly reliable. Collecting the suspended particle matter (SPM) in the ocean and surface sediment helps us better understand the distribution and possible control factors of the archaea in the modern setting. This study collected the SPM seasonally (February, April, August, and November) from 2016 to 2018, with box coring surface sediments from the Southern Okinawa Trough (SOT), in the annually warm part of the East China Sea (ECS). The sediment trap studies (ig. Chung et al., 2003; Hsu et al., 2004) suggest an advection effect on the particle sedimentation in the SOT. To test any seasonality or advection fingerprints on the downward transfer of GDGTs in the SOT, we designed a long-term experiment in which we adopted two global TEX$_{86}$ SST and subsurface temperature (subT, 0-200 m) calibration methods, the global empirical equations (Kim et al., 2010; Kim et al., 2012a), and a regionally-varied BAYSPAR statistical technique (Tierney and Tingley, 2014), to estimate SST and subT for the collected SPM and surface sediment samples. Comparing the situ historical water temperature, including WOA09 (Levitus et al., 2010) and ODB (Ocean Data Bank, National Science and Technology Council, https://www.odb.ntu.edu.tw/) to our surface sediment TEX$_{86}$-driven temperature, both methods perform well in estimating SSTs of annual mean, though the global equation is slightly overestimated. Both methods successfully estimate subT from our surface sediments with the errors of the calibration uncertainties. Particularly noticed is that our estimated TEX$_{86}$ and GDGT concentrations based on the collected SPM from the water profiles do not show large seasonal changes. Moreover, the SPM GDGT concentrations increase from the surface with depth to maxima level at approximately 100-150 m depth and decrease persistently to 1000m. The depth distribution pattern and similar TEX$_{86}$ values measured from our SPMs and surface sediments suggest a tight coupling or dominant vertical transfer from the water column to the sediments of the GDGTs. Our studies suggest that the GDGT aggregation into fecal pellets in the downward transfer of particle flux affects more than advection at our sites. While focusing our SPM data from the mixed layer (0 -200 m), we found that the global SST equation was overestimated but captured the subT more successfully within the uncertainties of the equation. We note that the regionally-varied BAYSPAR technique successfully captures both SST and subT and produces estimations much closer to the in situ temperature. Overall, we demonstrate that the GDGTs are less seasonal-biased paleotemperature proxies. The GDGT distribution with depth is consistent with the limited studies (ig. Nakanishi et al., 2012; Dong et al., 2019) in the western Pacific. We conclude that the BAYSPAR technique is preferred in proxy estimation for temperature in the ECS.

Evaluating the net ecosystem productivity and calcification of restored seagrass meadows

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Summary

Seagrass meadows play a vital role as carbon sinks, yet their ecological function is threatened by rapid decline. Restoration efforts have gained attention as a nature-based approach to enhance coastal recovery and remove carbon dioxide. However, the metabolic dynamics and carbon sequestration potential of restored seagrass meadows remain underexplored. Our study aims to investigate whether restoration enhances metabolic rates, specifically gross primary productivity (GPP), community respiration (CR), net ecosystem productivity (NEP), and net ecosystem calcification (NEC). Using ex-situ core incubation, we compare these metabolic parameters between seagrass beds (SG), bare sediment (BS), and the water column (WC). Seagrass beds exhibited significantly higher GPP (14.36 ± 1.98 mmol O_2 m^{-2} h^{-1}) and NEP (4.15 ± 0.73 mmol O_2 m^{-2} d^{-1}) compared to BS (GPP: 2.13 ± 1.26 mmol O_2 m^{-2} h^{-1}; NEP: 0.18 mmol O_2 m^{-2} d^{-1}) and WC (GPP: 1.14 ± 2.14 mmol O_2 m^{-2} h^{-1}; NEP: 0.36 mmol O_2 m^{-2} d^{-1}), indicating their ability to shift benthic ecosystem metabolism towards a net autotrophic state and act as carbon sinks. Seagrass and bare sediment exhibited negative NEC at night (SG: -0.02 ± 0.01 $CaCO_3$ mmol m^{-2} h^{-1}; BS: -0.03 ± 0.01 $CaCO_3$ mmol m^{-2} h^{-1}) and positive NEC during the day (SG: 0.05 ± 0.02 $CaCO_3$ mmol m^{-2} h^{-1}; BS: 0.01 ± 0.02 $CaCO_3$ mmol m^{-2} h^{-1}). This indicates a transition from net dissolving to net calcifying conditions. Meanwhile, the water column remained consistently net calcifying (night: 0.001 $CaCO_3$ mmol m^{-2} h^{-1}; day: 0.03 $CaCO_3$ mmol m^{-2} h^{-1}). Despite the positive daily NEC observed in seagrass beds, indicating net calcification, the overall carbon budget suggests net carbon uptake, primarily driven by increased photosynthetic activity. Our findings highlight the ecological importance of seagrass restoration in mitigating climate change through carbon sequestration. This study is the first to quantify the metabolic performance of restored seagrass meadows in Taiwan using ex-situ core incubation. While this innovative approach enhances feasibility, in-situ assessments are also necessary to validate the results and ensure a comprehensive understanding of seagrass ecosystem dynamics.

台灣周遭海域有色性溶解有機物之初探
A Preliminary Study of Chromophoric Dissolved Organic Matter in the Surrounding Seas of Taiwan

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摘要

自工業革命以來，大氣中二氧化碳濃度急遽上升，而大洋可利用藻類光合作用吸收二氧化碳，產生溶解性有機物（Dissolved Organic Matter， DOM），達到碳吸收及儲存。在藍碳生態系統中海草床面積雖然僅占全球海床面積 0.1 %，但其儲碳量卻占海洋 18 %。溶解性有機物質中有色性溶解有機物（Chromophoric Dissolved Organic Matter, CDOM）占了大多數。然而，有關台灣周遭海域不同系統間所產生的 CDOM 尚未釐清，特別是在近岸海草床的研究相當少。

本研究利用新海洋研究船二號於 2023 年 7 月在西北太平洋採集大洋水體樣本，另外，於 2022 年 9 月至 2023 年 5 月之間於台灣南部墾丁海草床採集沉積物孔隙水，同時於 2023 年 6 月及 2023 年 12 月在墾丁海口村海草床採集水體樣品，該區域人為活動程度較低，預期能充分反應水體海草新陳代謝後的 DOM。本實驗希望藉由比較大洋開放水體與具有海草床區域水體之間 CDOM 組成訊號。

本實驗使用方法有，分光光譜法及螢光光譜法，並利用三維螢光激發發射矩陣 Fluorescence Excitation-Emission（F-EEM）以及平行因子分析法（PARAFAC），進行有 CDOM 之比較，其中 F-EEM 為主要的分析方式，對具有相似螢光強度特性進行分類，主要可分腐植酸或黃腐植酸之腐植質及由胺基酸組成之類蛋白質，而 PARAFAC 分析利用 MATLAB 統計模擬方式，藉此將不同波段之激發（Excitation）光與發射（Emission）光進一步分類成不同 DOM 之訊號來源。

FEEM 結果顯示：1. 在無嚴重人為汙染之環境下，具有海草床的區域有明顯類蛋白質訊號（占 65%），且此類訊號推測為海草所釋放出之物質。2. 沉積物孔隙水中有海草床及無海草床對照後，主要組成的訊號以腐植質為主，分別占 69%及 75%，但具有海草床區域仍有些許類蛋白訊號（占 31%），印證了海草床之溶解性有機物會對沉積物產生影響。3. 海草床區域夏季有明顯海草活動類蛋白質訊號（占 65%），而冬季此類訊號較低（占 30%），主要因素除了採樣當日氣候變化外，亦與海草生長習性有很大之相關性。

關鍵字：溶解性有機物質、有色性溶解有機物、近岸藍碳生態系統
Keywords: Dissolved Organic Matter, Chromophoric Dissolved Organic Matter, Coastal Blue Carbon Ecosystems

Barium uptake and isotope fractionation in phytoplankton: implications for the marine carbon cycle

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計畫名稱：研究海洋鋇同位素之源與匯的變化：示蹤海洋鋇與碳的循環(2/3)
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Abstract

Barium (Ba) is considered a useful proxy for marine productivity. Although Ba is not a biologically essential element in marine phytoplankton, it is involved in its uptake and barite formation, closely linked to the carbon cycle in the ocean. Recent developments in Ba stable isotopes show great potential in studying marine productivity. However, the input and out of Ba budget in the ocean is imbalanced based on available isotope data. The isotope fractionation factor in barites obtained from laboratory studies is significantly different from field observations in marine water columns and sediments. The isotope fractionation by phytoplankton uptake thus becomes critical to understanding its isotopic budget and the offset.

To address this issue, we conducted a series of plankton culture experiments to understand Ba uptake by phytoplankton and its isotope fractionation. We found that Ba uptake rate in model diatom, *Thalassiosira weissflogii*, exhibits a positive correlation with Ba concentrations in seawater. Its isotope compositions are lighter than two model coccolithophores, *Emiliania huxleyi* and *Gephyrocapsa oceanica*. Moreover, Ba to organic carbon ratios in the model species were significantly lower than the values observed in sediment trap samples obtained in the field. This observation indicates a varying Ba to organic carbon ratio with depth and implies the underestimation of primary productivity while using a fixed Ba to organic carbon ratio. Our study provides the first constraint on Ba isotope fractionation by marine phytoplankton before barite formation, and new insights on using Ba elemental and isotopic ratios as productivity proxy in the ocean.

東亞大氣懸浮微粒中碳水化合物的季節變化及其生地化作用：結合主成分分析與正因子矩陣分析探討其來源

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計畫名稱:大氣供應的外部水溶性與非水溶性氮和磷物種對海洋生地畫之影響
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摘要

碳水化合物為生物體中主要的營養素，在細胞中分解成葡萄糖等單醣分子，進行呼吸作用產生能量，大氣沉降中碳水化合物的來源包含：植物花粉、真菌孢子、土壤以及生質能燃燒。進入大氣的主要途徑是沉降，它是水溶性有機碳（WSOC）的主要類別，可做為有機物追蹤劑，進而探討二次氣溶膠（Secondary Origin Aerosol；SOA)之來源。

本研究將採樣點設立於東海南端且鄰近閩江出海口的馬祖，從 2019 年 4 月至 2020 年 9 月期間，一共採集了 108 個樣本。採樣期間總質量濃度為 40.03μg m^{-3}，水溶性總醣類濃度為 0.15nmol m^{-3}，並分析營養鹽及主要離子，作為來源分析變數。主要視為交通運輸排放的 NO_2^-與 NO_3^-的平均濃度分別為 0.11 與 10.82 nmol m^{-3}；通常被視為工業排放、化石燃料燃燒的 NH_4^+及 SO_4^{2-}的平均濃度為 13.64 和 9.09nmol m^{-3}。而海洋來源的 Na^+跟 Cl^-的濃度為 24.53 和 16.29nmol m^{-3}；K^+、Ca^{2+}與無機磷則可被當作土壤塵埃或其餘混合來源，平均濃度分別是 1.19、1.43、0.06nmol m^{-3}。

其中，單醣濃度為 0.08nmol m^{-3}，主要分布於粒徑大小<0.95μm 的濾紙上，而雙醣主要分布於>3μm 的濾紙上，平均濃度為 0.07 nmol m^{-3}，說明主要附著於 $PM_{2.5}$ 上的碳水化合物為顆粒較小的單醣，而單醣在總醣類中佔比接近 50%，代表該地單醣對於生物有更多可利用性。透過主成分分析及正矩陣分析模式分析個物種之來源，其結果顯示，數據集中的情況下，PCA 與 PMF 兩種數值模擬模式的結果相互呼應，可發現當地氣膠輸入主要分為四種來源，分別為：生質能燃燒、人為排放、海洋及地殼，說明分析的各物種特徵明顯，可顯著代表當地氣膠來源。而碳水化合物主要來源為生質能燃燒，有著季節趨勢，在生質能燃燒旺盛的春季，可提供微生物所需碳源，促進養分循環及植物生長，對生地化造成多方面的影響。

陸域及海域環境中大氣濕沉降提供的額外氮之影響：近五年氮通量之解析

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計畫名稱：大氣供應的外部水溶性與非水溶性氮和磷物種對海洋生地化之影響
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摘要

在濕沉降中，有機氮在大氣活性氮排放中很重要的一個成分，尤其在人為影響較小的偏遠地區更為明顯。在近年來中國能源政策的影響，人為活動排放逐漸減少，濕沉降活性氮逐漸穩定並緩慢減少。為了了解能源政策與 COVID-19 疫情爆發期間大氣氮濕沉降對沿岸地區(人為影響較大)及海域地區(人為影響較小)的影響，本研究收集 2020 年 4 月至 2024 年 4 月馬祖地區(中國沿岸地區 n = 99)及彭佳嶼地區(海域地區 n = 97)的雨水樣本進行離子成分組成並結合氣團回歸模型(HYSPLIT)、主成分分析(Principle Component Analysis；PCA)及正因子矩陣分析(Positive Matrix Factorization；PMF)來了解兩區域的濕沉降氮來源。結果顯示在兩區域溶解性總氮(Total Dissolved Nitrogen；TDN)與溶解性無機氮(Dissolved Inorganic Nitrogen；DIN)皆呈現夏低冬高的趨勢。透過離子分析結果可以發現兩地區 Cl^-/Na^+ 比率皆低於海水(1.17)，顯示兩地區皆有氯虧損現象。而透過兩地區 NH_4^+與非海鹽性硫酸根($nss\text{-}SO_4^{2-}$)比率進行比較，沿岸地區 $NH_4^+/nss\text{-}SO_4^{2-}$為 1.07，海域地區為 0.85。此結果顯示沿岸地區主要以 $(NH_4)_2SO_4$ 及 NH_4HSO_4 混和的方式存在於大氣中，因此推測為人為與海洋的混和性來源；海域地區主要以 NH_4HSO_4 方式存在於大氣中，因此推測該地區受海洋來源影響。DON/TDN 比率研究可以發現沿岸地區 DON/TDN 占比為(1.69%～34.0%)而海域地區為(0.12%～60.1%)，根據此結果可以了解 DON 在人為影響小的地區中扮演很重要的角色。透過 PCA 與 PMF 分析結果顯示沿岸與海域地區溶解性無機氮(DIN)皆為人為排放(工業排放及汽機車排放)為主；溶解性有機氮(DON)較可能來源於植被排放揮發性有機物，且海域地區以陸源為主。在通量方面，沿岸地區的 DIN 通量(30.9 mmol m^{-2} yr^{-1})相較於海域地區 DIN 通量(17.8 mmol m^{-2} yr^{-1})高出近 2 倍之多，而 DON 通量兩地區差異不大(0.47, 0.34 mmol m^{-2} yr^{-1})。而根據本研究近年沿岸地區 DIN 趨勢(-7.1 mmol m^{-2} yr^{-1})及海域地區 DIN 趨勢(-4.2 mmol m^{-2} yr^{-1})結果中可以得知，在 COVID-19 疫情前後期間，人為排放有明顯減少的趨勢且逐漸趨於穩定並緩慢下降的現象。

Using barium isotopes to trace underwater mud volcanoes in the Southwest offshore of Taiwan : implications for the marine carbon cycle

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計畫名稱：研究海洋鋇同位素之源與匯的變化：示蹤海洋鋇與碳的循環(2/3)

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Abstract

Submarine mud volcanoes and cold seeps along continental margins have long been considered significant sources of methane emissions to the ocean, potentially triggering climate events in the past. However, directly evaluating their contributions to the ocean is challenging due to complex mixing processes. The marine barium cycle is also potentially influenced by methane emissions, given the tight link between Ba and sulfate reduction during the sulfate methane transition zone in marine sediments. Despite the potentially crucial roles that submarine mud volcanoes and cold seeps may play in the marine Ba cycle, their Ba isotope compositions and fractionations remain unknown. In this study, we collected seawater, sediment, and porewater samples from areas where methane is actively venting: a submarine mud volcano (MV4) and a cold seep site (FWCR) in the southwestern offshore region of Taiwan. Additionally, we conducted the first measurements of Ba concentrations and isotopes in this region. The results indicate that seawater Ba above the methane vent sites exhibits isotopic enrichment compared to the global average seawater barium isotopic compositions at similar barium concentrations. These enriched Ba isotope signals likely result from barite precipitation during the mixing of high-Ba (CH_4) pore fluids and seawater. Ba isotopes show great potential as a new tracer for evaluating methane emission inputs to the ocean.

Accumulations and sources of mercury in the Pacific Saury off the western North Pacific Ocean

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Abstract

This study investigates mercury (Hg) dynamics in Pacific saury (*Cololabis saira*) across the North Pacific Ocean, specifically off East Japan in 2018. Saury traits vary with total mercury (THg) concentrations in muscle tissues ranging from 0.017 to 0.082 μg g^{-1} w.w., averaging of 0.042 (n=46). A positive correlation between THg and saury length (Knl, 270 to 319 mm) emphasizes increased Hg accumulation with growth. Stable isotopic tracers highlight pacific Euphausiids (Krill) as a significant contributor to the saury diet (>70% of total). A significant correlation between logarithm THg concentration (ln THg) and $\delta^{15}N$ (‰) (R^2 = 0.73) further offers insight into Hg trophic biomagnification. Comparative analysis between the eastern (ENPO) and western North Pacific Ocean (WNPO) indicates differences, with WNPO saury exhibiting lower $\delta^{15}N$ values and higher THg levels than ENPO saury. This suggests that the WNPO, located near East Asia, the world's largest Hg emitter, experiences elevated Hg levels in seawater due to anthropogenic release. Overall, this study advances understanding of Pacific saury's ecological interactions and Hg bioaccumulations, emphasizing the importance of species-specific behaviors and regional influences in ecological studies.

Keywords: Mercury, Pacific saury (*Cololabis saira*), bioaccumulation, stable isotopes, western North Pacific Ocean (WNPO)

海洋塑膠雪花的形成與沉降

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計畫名稱：海洋大氣學門重點計畫-西北太平洋海洋基礎生產力宿命與海洋生物幫浦長期觀測與研究（Ⅱ)(Ⅰ)
計畫編號：MOST111-2611-M019-008

摘要

自塑膠問世已來，塑膠的產量隨工業發展不斷提高，海中的塑膠廢棄物也隨之增加。據研究指出，海洋沉積物也存在不同密度的微塑膠(MP)，其中浮力聚合物佔 60%。事實上， MP 與微藻的聚集已被認為是 MP 垂直傳輸的主要驅動力。當 MP 被微藻黏附聚集成的有機顆粒便被稱為海洋塑膠雪花。而本研究為探討 PET(1.38 g/cm^3)與 PE(0.9 g/cm^3)不同密度微型塑膠對海洋雪花的行形成數量、聚合情形、尺寸、沉降速度以及海洋雪花對微型塑膠的移除率，分別以實驗室模擬及現場採集臺灣東北部的表水(SW)及葉綠素最大值(DCM)之水體添加 PET 與 PE 之微型塑膠進行培養。結果呈現，上述兩項實驗均有 80%以上的海洋雪花內含微型塑膠。模擬實驗與現場實證均以添加 PET 的組別較容易形成海洋雪花，而在現場發現 SW 中含 PET 的海洋雪花數量上遠大於 DCM，推測係由於 SW 較 DCM 含有更多的有機物質提供海洋雪花聚合導致。此外，海洋塑膠雪花沉降速度受包裹之塑膠材質及顆粒數量有明顯變化，如模擬實驗中含 PET 的海洋雪花沉降速度快於無添加組與 PE 組，而造成 PET 塑膠雪花沉降較快之原因，可能是 PET 高密度之特性使得顆粒具壓載效應，而 PE 密度小於海水使海洋雪花更具浮力。本研究結合實驗室模擬及現場實驗證實海洋塑膠雪花的形成和沉降受不同特性之塑膠調控，影響微型塑膠在海中的垂直傳輸與宿命。

沉積物再懸浮對墾丁海草床有機顆粒動態之影響

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摘要

有機顆粒的轉化和傳輸已被認為是海洋及沿岸碳封存及其最終儲量的關鍵。然而目前研究對於海草床生態系的有機顆粒特性及其動態傳輸甚為缺乏。有鑑於此，為了瞭解海草床的有機顆粒之組成、濃度及傳輸情形，以利於推測海草床藍碳系統對有機碳的埋存能力。本研究於 2022 年 5、9 月及 2023 年 6 月於墾丁海口海草床(Seagrass Water，後稱 SW)及海草床外開放水體(Outside Water，後稱 OW)進行水體連續採樣及一次海草床沉積物孔隙水採樣。分析溶解態有機碳(Dissolved organic carbon, DOC)、顆粒性有機碳 (Particulate organic carbon, POC)、透明外聚合物顆粒(Transparent exopolymer particles, TEP)及考馬斯染色之蛋白質顆粒(Coomassie stainable particles, CSP)等參數，以瞭解海草床的有機顆粒之組成、濃度及傳輸情形。結果顯示，水體未受擾動時 SW 與 OW 水體中的 POC、TEP、CSP 濃度相似，然而在環境擾動(如降雨、海況、海浪和潮汐)過後，有機碳化學參數與膠體濃度皆大幅度升高，可能是底質受再懸浮作用影響。為證實此一推測，本研究取樣不同深度之海草床底質孔隙水，結果顯示底質孔隙水中 DOC、POC、TEP 與 CSP 濃度皆遠高於 SW，指出海草床底質系統具備良好的碳儲存能力，但當底質受大量擾動時可能會將這些物質呈現再懸浮狀態，致使顆粒態有機碳再釋出。

臺灣主要河口牡蠣中微塑膠初探

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計畫名稱：以微、奈米角度探討「海洋污染物幫浦」與其潛在之生態風險

計畫編號：MOST110-2628-M-019-001-M4

摘要

微型塑膠(Microplastics, MPs)是廣泛存在於海洋環境中的新興汙染物之一，由於其體積小且表面積大，於水體環境中容易被水生生物攝入，進而使人體因攝食受 MPs 汙染之水產品而危害健康。本研究藉由七個河口處所採集的牡蠣作為生物指標，瞭解河川中的 MPs 汙染情形，並使用解剖顯微鏡及顯微傅立葉轉換紅外光譜儀(Microscope Fourier-Transform Infrared Spectrometer, μ-FTIR)分析 MPs 之形態特徵及濃度。初步結果顯示，七個測站的牡蠣體內 MPs 豐度介於 0.05~0.70 items/g w.w.(濕重)，其中淡水河 MPs 豐度最高，為 0.70 items/g w.w.，潛在的汙染來源可能包括附近人類活動、工業區設立等因素，檢測到的 MPs 的粒徑範圍在 54 μm~2.29 mm，主要的 MPs 形態為碎片(fragment)及纖維(fiber)，其中由聚丙烯(Polypropylene, PP)為最多。此外，本研究也計算牡蠣健康狀態指數(Condition Index, CI)，發現牡蠣的 CI 與 MPs 豐度呈現負相關。此研究結果會將進一步跟其他文獻做比較，有助於更全面的瞭解 MPs 在臺灣河川中的分佈及影響。期望未來本研究可以做為臺灣的環境保護的參考指標。

Comparing CO_2 Partial Pressure Measurement in Shrimp Mariculture: CO2SYS Program vs. Syringe-Headspace Technique

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Abstract

Currently, various methods exist for measuring dissolved CO_2 across different aquatic environments. Previous studies have shown that the CO2SYS program tends to significantly overestimate the Partial Pressure of CO_2 (pCO_2) in environments characterized by high acidity and organic-rich freshwater, suggesting that direct measurement of pCO_2 is preferable in such contexts. However, there has been limited research on direct pCO_2 measurements in mariculture water. This study explores the potential biases and the suitability of measuring pCO_2 in shrimp mariculture water utilizing both the CO2SYS program and the syringe-headspace technique with a LI-COR CO_2 gas analyzer. Data comprising 229 points were collected from indoor, semi-indoor, and earthen ponds within shrimp mariculture settings between 2022 and 2023. We monitored hydrological parameters and analyzed Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), and Dissolved Organic Carbon (DOC). Additionally, we assessed the pCO_2 using both the CO2SYS-calculated method and the direct measurement method via the syringe-headspace technique with a LI-COR CO_2 gas analyzer. Organizing the data by pH revealed that samples with a pH ≤ 7.5, which constitute 39% of the dataset, showed the most significant overestimation by CO2SYS-calculated pCO_2 when compared to LI-COR-measured pCO_2, with a difference of approximately 115.1 ± 2455.1 µatm. In conclusion, for accurate pCO_2 measurements in shrimp farms, the direct syringe-headspace technique is recommended, even though it is predominantly used in freshwater ecology. Furthermore, adjusting the pH as part of standard mariculture management practices could help reduce CO_2 emissions.

Reef forensics: Variation in ecological processes in contrasting environmental conditions

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計畫名稱：臺灣海域重要生態系調查與生態服務價值評估(海保署)、
從個體表現到生態系的穩定性: 珊瑚礁視角(國科會)
計畫編號：112-P-40、111-2628-M-002-007-MY3

Abstract

Biotic composition and environmental factors impact reef functioning. It influences key ecological processes that are important for the resilience of these ecosystems. Here, our goal is to characterize how seven key ecological processes vary with the environment to gain insight into reef states. Rates and/or proxies of calcification, bioerosion, herbivory, primary production, secondary production, nutrient uptake and release were examined in contrasting reef habitats of Taiwan: shallow (-5 m) and upper mesophotic (-30 m) waters in three regions (North, Ludao, and Xiaoliqiu). According to our preliminary results, the calcification rate was the highest in Ludao. Rates were also higher in shallow waters than in mesophotic depths, with the notable exception of Xiaoliqiu. The secondary production rate was highest in the North and in Ludao. It was also higher in the shallow waters than in the mesophotic waters of Xiaoliuqiu. Although not significant, Ludao had the highest primary production rate. These rates in three regions tended to be higher in the shallow waters than those in the mesophotic waters. Our work on ecological processes revealed important regional and depth differences that allow us to categorize the state of the reefs under various environmental conditions. To our knowledge, this work is the first to provide an estimate of key ecological processes in Taiwan. Future research endeavors will integrate information on key missing processes and lead to a comprehensive assessment of reef functionality changes at a biogeographic transition zone.

Unraveling Regional Variability in the Shallow-Mesophotic Transition through Benthic Composition Similarities

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Project Title: 臺灣海域重要生態系調查與生態服務價值評估、從個體表現到生態系的穩定性:珊瑚礁視角
Project Number: 112-P-40、111-2628-M-002-007-MY3

Abstract

Depth influences the composition of the benthic community, as light intensity and quality affect the distribution of benthic organisms. However, these changes continue to be overlooked in coral reefs, while most research focuses on shallow-water reef degradation. In this study, we investigated the benthic communities at three depths (5, 15, and 30 m) in three regions (Northern Taiwan, Green Island, and Xiaoliuqiu) in Taiwan. At each site, three to five 20 m long phototransects were established and characterized by measuring photosynthetic active radiation at the time of the dive. Benthic images from 117 benthic transects were manually annotated for organism composition, and the identifications were integrated into an existing benthic dataset to automate this task. Preliminary results show differences in benthic community composition in different regions and depths. In Xiaoliuqiu, the benthic community composition is most similar among depths compared to other regions. The shallow communities are mainly dominated by algae in North Taiwan and Xiaoliuqiu, while in Green Island is dominated by hard coral, followed by algae. In the deeper benthic communities across the three regions, algae persist as the dominant component. Nevertheless, North Taiwan exhibits notable quantities of gorgonian and black coral, whereas Green Island showcases a substantial presence of soft coral. Overall, this study provides exciting insights into the change in β-diversity between reefs exposed to different environmental conditions (shallow vs. deep, tropical vs. subtropical) and under contrasting human impacts. These results are important for managers to think "deeper" about the current extent of coral reef conservation and the overlooked diversity hosted by deeper ecosystems in Taiwan.

Benthic macrofauna in shallow-water coral reef ecosystems in Taiwan

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計畫名稱：112-113 年臺灣海域重要生態系調查及生態服務價值評估
計畫編號：112-P-40

摘要

Sediment benthic macrofauna are foundation of marine food web and play critical roles in sediment reworking and biogeochemical cycling. Owing to their sensitivity to disturbance, infaunal community structures have been considered reliable ecological indicators in environmental monitoring; however, they are rarely investigated in coastal ecosystems in Taiwan, and no ecological study has been conducted on the sediments of highly productive coral reefs. To provide the first ecological information about the coral reef infauna, we systematically surveyed and quantitatively analyzed macrobenthos (body length > 0.5mm), sessile communities (i.e., hard corals), and environmental conditions in shallow-water (depth ≒ 5m) coral reef sediment from 92 sites from Taiwan's main island (44 sites), Penghu (22), Liuqiu Island (9), Green Island (10) and Orchid Island (7). We focus on two research questions: (1) Do infaunal density and taxonomic composition differ geographically? (2) What are the important environmental factors shaping the infaunal communities?

Our results indicate that the infaunal density differed significantly among regions. The average infaunal density is 40,856 individuals per m^2, with the highest density occurring in Green Island at 199,345 individuals per m^2. However, the infauna taxonomic compositions were not different among the regions. Multivariate environmental variables explain 27.2% of the total variation in the taxonomic composition, with the hard coral coverage being the best explanatory variable. The results from this study suggest that Taiwan's coral reef sediments harbor an extraordinary abundance and diversity of macrobenthic infauna, likely supporting the reef food web through their secondary production. Furthermore, this study provides an ecological baseline of shallow-water coral reef ecosystems against future impacts from anthropogenic activities and climate changes.

The Effects of Experimental Warming on Microbial Community Growth and Mortality During The Cold Season

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Abstract

We conducted three in situ microcosms in Taiwan and Japan during the winter of 2023 to investigate the response of microbial plankton communities to warming in coastal waters of the Pacific. Monitoring and analyzing microbial communities, including viruses, bacteria, and picophytoplankton (*Synechococcus* spp., *Prochlorococcus* spp., and picoeukaryotes), were performed by flow cytometry for consecutive seven days. While the control microcosms had the same natural water temperature as coastal waters, the others were treated with warming treatments of + 2-3°C. The growth and grazing of picoplankton (bacteria and picophytoplankton) as well as viral lysis rates on days two and five of the study were also estimated using the modified dilution method. As a result of the time-series incubations, we found that warming did not have a significant positive effect on bacterial abundance in winter at any of the stations. In our time series experiments, viral abundance increased significantly following a temperature increase, indicating that viral impact might have a significant top-down effect on bacteria. The increase in viral abundance at some stations was also correlated with the increase in picophytoplankton abundance. It is important to note that viral lysis will have a greater impact on the mortality of the total prokaryotic community as temperatures rise, removing 51% of the picoplankton population. The combination of viral lysis and nanoflagellate grazing removed up to 66% of averaged bacterial production, suggesting that a more active shunt mechanism during colder seasons might increase the efficiency of carbon and energy retention within the microbial loop.

How Warm Eddies Affect Microbial Communities in the Tropical Pacific Ocean

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ABSTRACT

Mesoscale eddies exhibit unique properties, compared with surrounding water, due to their unique physical processes. There is uncertainty over the physical and biological coupling of warm-core eddies. Our goal was to reveal how warm eddies affect microbial communities (nanoflagellates, bacteria, picophytoplankton, and viruses) during the propagation of anticyclonic warm eddies in the Pacific Ocean. Furthermore, top-down and bottom-up control factors affecting these communities were examined. A difference in the grazing pressure between inside and outside warm eddy affects microbial interactions, as hypothesized here. To explain how grazers affect microbial communities, successive seven-day microcosm experiments were conducted in the eddy core (EC) and outside the eddy (OE). Our findings show that at surface waters, *Synechococcus* spp. was the most abundant picophytoplankton in EC samples. *Synechococcus* spp. abundances in OE samples were higher than in EC samples at other depths, with maximum values at 60 m above the deep chlorophyll maximum (DCM). Furthermore, *Prochlorococcus* spp. dominated in EC samples from the surface to 100 m, with the highest abundance at 100 m. Furthermore, the vertical variation in nanoflagellate, bacterial, and viral abundances also showed that EC surface water samples had significantly higher abundances than OE samples. The results of OE microcosm experiments indicate that regenerated nutrients and carbon availability regulate bacteria and picophytoplankton growth. Furthermore, the convergence effect may drive zooplankton and nanoflagellates toward the core of EC regions, resulting in increased bacterial and picophytoplankton grazing rates.

Keywords: warm eddies, nanoflagellates, bacteria, picophytoplankton, viruses

Genetic Diversity and Distribution of Harmful Algae in the Coastal Waters of Kenting, Taiwan

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Project: Will seagrass beds increase the growth of toxic algae under global warming scenarios?
Project Code: NSTC 111-2611-M-110-028

Abstract

Harmful algal blooms (HABs) have had devastating ecological and economic consequences since the 17th century, resulting in mass marine animal mortality and toxin contamination of seafood. The escalating occurrence of HABs in recent years poses a growing concern for global marine ecosystems and human health. However, comprehensive data on HABs in Taiwanese waters are currently unavailable, making it difficult to predict and prevent future HAB outbreaks. This study conducted two sets of experiments. In Experiment I, benthic microalgae and seawater samples collected from the coastal waters of Kenting, Taiwan, underwent metabarcoding to identify their HA species. Additionally, HA diversity, temporal and spatial changes in different locations (Marine Protected Area and non -Marine Protected Area) and on distinct seagrass beds (*Thalassia hemprichii* and *Halodule uninervis*) were investigated as a reference f or future HAB prediction. Metabarcodes targeted the V1-V3 regions of the 18S rDNA gene. In Experiment II, fluorescence in situ hybridization (FISH) was employed to determine *Gambierdiscus* composition and abundance in the area. *Gambierdiscus* spp. are capable of producing ciguatoxin (CTX) which will accumulate in coral reef fish and invertebrates, subsequently causing ciguatera poisoning (CP) upon human consumption. Nevertheless, due to the indistinguishability of most *Gambierdiscus* spp. under light microscopy, FISH emerged as a newly -developed alternative approach for determining community composition and abundance of the genus in field samples. Our results demonstrated positive binding of FISH probes to their specific *Gambierdiscus* spp., suggesting that FISH has the potential to facilitate real -time and species-specific monitoring of harmful algae in the

夜光蟲生命週期與其生存策略：配子生理以及繁殖

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Noctiluca scintillans，俗稱夜光蟲，是一種直徑 400 -1000μm 的大型雙鞭毛蟲，被歸類為 HAB（赤潮）的物種。繁殖方式包括有性生殖和無性生殖，無性生殖是以二分裂來繁殖，而有性生殖是以配子生成(Gametogenesis)的進行。過去的認知夜光蟲在有性生殖時，會轉換成配子母細胞並釋放細胞膜表面上的配子到水體中，配子再結合形成合子並發育成蟲。配子離開配子母細胞之後，無繁殖或攝食現象，只有游泳能力。然而我們在進行培養夜光蟲時，發現被隔離的配子有疑似無性生殖的現象，在封閉的容器裡配子濃度上升。因此本研究通過培養以及攝食實驗，觀察夜光蟲配子是否有攝食或繁殖能力，以及探討食性和最適培養條件為何。由於夜光蟲有性生殖自然生率較低(~1%)，且配子大小介於 10 -15μm 與成蟲大小相差許多。本研究使用先前發現促進配子母細胞產出的培養辦法，提供足夠的配子作為實驗樣本。並用 Lugol'染劑固定，運用倒立式顯微鏡計數配子濃度以及用流式細胞儀計算水體中細菌含量。我們觀察到夜光蟲配子確定有繁殖現象，並且不會行光合作用。證實夜光蟲有性生殖產出的配子，其實夜光蟲的世代交替行為，是另一種生存形式。後續有測試配子的攝食行為，發現配子濃度與水體中細菌濃度呈現相同趨勢變化，推論配子會攝食小於 2 μm 的餌料。測試配子細菌攝食行為的組別中，只有使用弧菌餵養有穩定的繁殖現象，並且可以培養超過 72hr。依照以上結果推論，夜光蟲有性生殖產出的配子，有不同於成蟲的攝食習性以及繁殖行為，並且是夜光蟲的世代交替下的產物，為一種在遭遇環境壓力時的生存手段。

飢餓對於眼斑海葵魚攝入微塑膠風險影響
Effect of hunger on the risk of microplastic ingestion in false clown anemonefish (*Amphiprion ocellaris*)

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飢餓是影響魚類攝食行為的一個重要因素，並可能影響其攝入微塑膠的風險。本研究探討飢餓的眼斑海葵魚在遇見微塑膠這種新興汙染物時，是否會因飢餓而影響攝食行為及增加攝入微塑膠的數量。本研究共分為 2 個部份，第一部份旨在探討眼斑海葵魚在飢餓情況下是否會增加微塑膠攝入數量，本實驗將飢餓（禁食 48 小時)及飽食的眼斑海葵魚(禁食 4 小時)，暴露於含有微塑膠及飼料的環境中(重量比例 1:1)，並比較兩組之攝食行為及微塑膠攝入數量是否有差異。第二部份旨在探討飢餓及食物中微塑膠汙染狀況對眼斑海葵魚的攝食選擇及攝入微塑膠數量的影響。本實驗採用雙因子設計，分別為飢餓因子及汙染條件因子，飢餓因子包括飢餓及飽食，汙染條件因子包括微塑膠暴露區有添加飼料及不添加飼料，我們同時於實驗缸兩端各提供一個攝食區供眼斑海葵魚選擇，其中一個固定為乾淨無受汙染飼料，另一端則提供純微塑膠或微塑膠加飼料(重量比例 1:1)。在第一個實驗中可以觀測到，不論魚隻飢餓與否，活動行為並無顯著差異，但兩組別皆有觀測到微塑膠攝入之情形，唯飢餓的眼斑海葵魚有攝入較多微塑膠的趨勢。在第二個實驗中，飢餓因子及汙染條件因子對眼斑海葵魚的行為表現沒有顯著影響，但飢餓的眼斑海葵魚在面對混合攝食區時的微塑膠攝入量最高。本研究結果顯示，飢餓會增加眼斑海葵魚攝入微塑膠的風險。

Youth Forum

Microplastic contaminants of burrowing biota from the highly conserved wetland of Siangshan in Hsinchu, Taiwan

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Abstract

Mangrove ecosystems are among the most unique and productive sites in marine ecosystems, providing distinctive biodiversity. They became endangered due to anthropogenic impacts, like pollution by microplastics. We documented the abundances and presence of MP polymers in the water and sediments from 10 different locations, and the burrowing wetland biota of four crab species (*Tubuca arcuata, Macrophthalmus banzai, Parasesarma bidens,* and *Varuna litterata*) from 5 of these locations in the Siangshan Wetland in Hsinchu, Taiwan. Crab species were collected from locations, revealing MP accumulation at a rate of 70.12%. The abundance of MPs revealed 3.00 ± 0.89 to 9.62 ± 1.34 items/individual in the gill and 4.33±0.51 to 13.34±3.38 items/individual in the gut, respectively. The abundance of size ranges recorded was 6.00±4.73 µm to 28.66±13.57 µm in gill and 61.33±29.52µm to 391.34±52.01µm in gut, and the maximum MPs recorded with decreasing sizes were mostly beads, fibers, and fragments. Most of the MPs were found in the gut compared to the gills, with the maximum occupied percentage of black, red, and green colored beads and fragments. The FTIR and Raman spectroscopies revealing the presence of polyethylene, polypropylene, polystyrene, and carbon being likely contaminants from the nearest roadside. Therefore, conservation strategies are severely needed to reduce MP pollution at the nationalized conserved site of Siangshan Wetland in Hsinchu, Taiwan.

Keywords: Mangrove; Wetland; Microplastics; Bioaccumulation; Taiwan.

海報競賽摘要

海報競賽 PC-A-1

Utilizing eDNA metabarcoding to reveal the spatio-seasonal variations of offshore fish communities around Taiwan

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摘要

Marine fish communities provide a wide range of ecosystem services that directly or indirectly benefit human societies. To mitigate the anthropogenic threats imposed on these communities, it is crucial for conservation strategies to account for variations in species composition across spatial and temporal scales. Revealed by previous studies, the complex oceanography around Taiwan, influenced primarily by three water masses (Kuroshio tropical water, South China Sea tropical water, and China coastal water) and two monsoon patterns, has led to spatial and seasonal fluctuations in the compositions of zooplankton communities. However, a comprehensive assessment of spatio-temporal variations of large predators that sit at the top of marine food chain, including marine fish communities around Taiwan, particularly offshore, is still lacking partially due to the limitations of conventional sampling/monitoring methods. To overcome these challenges, environmental DNA (eDNA) metabarcoding stands as a powerful tool to detect a diverse array of fish species and address sampling inefficiencies. In this study, I employed eDNA metabarcoding to assess the compositions of fish communities across space and time by sampling 24 offshore sites around Taiwan during four seasons in 2023. The results demonstrated that marine fish biodiversity varies at both spatial and seasonal scales. In terms of alpha diversity, the richness of fish taxa per site peaked in the northern region and around Penghu Island, whereas the overall richness was the lowest during autumn. Regarding the spatial and temporal beta diversity, the values of Jaccard dissimilarity were generally high (0.8), with the turnover component, or the replacement of taxa, explaining most of the dissimilarity. Moving forward, this study will focus on identifying the other hidden environmental factors that may drive such spatial and seasonal variations.

海報競賽 PC-A-2

利用特化型誘餌式遠端水底攝影系統監測海洋環境
The application of baited remote underwater video system (BRUVs) in turbid marine environment.

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摘要

隨著海洋生態研究的進步，越來越多的採樣類型投入使用，而誘餌式遠端水底攝影系統(BRUVs)於近年更被大量使用，該採樣方法雖具備輕盈、便宜等優點，但在混濁水域中的使用依然受到限制。在2019年，由 Jones 等人將用於底質調查的 Clear liquid optical chamber BRUVs (CLOC-BRUVs)進行改良後應用於混濁水域的魚類採樣，雖證明其可用性，但卻因其過於沉重的架構與昂貴的客製零件而難以普及使用。因此，本研究旨在提升 CLOC-BRUVs 在混濁水域中的可用性，同時針對 CLOC 的原理做進行更進一步的研究改良，以簡化、輕化後的裝置投入野外使用，並透過與傳統漁法的數據來對比 CLOC-BRUVs 的實用性。期待此裝置可彌補傳統漁法的採樣缺陷，針對混濁水域生態的監測與評估盡一份心力。

關鍵字:採樣方法、混濁水域、生態監測、BRUV、CLOC

海報競賽 PC-A-3

長期暴露微塑膠對眼斑海葵魚行為和生長的影響

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計畫名稱：以行為學及實驗生物學方法探討影響社會性珊瑚礁魚類攝入微塑膠之因子

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摘要

隨著全球人口的迅速增長和經濟的發展，野生動物面臨著日益嚴重的環境壓力，其中海洋環境的塑膠污染已成為一個引起關注的問題。珊瑚礁魚類的棲地靠近人類活動範圍，特別容易受到人為污染影響，而目前關於微塑膠對社會性珊瑚礁魚類影響的研究甚少，所以本研究選擇使用具有獨特社會行為的眼斑海葵魚(*Amphiprion ocellaris*)作為實驗物種，探討微塑膠對社會性珊瑚礁魚類行為和生長的影響。實驗分為控制組（餵食 100%商業飼料）和微塑膠組（餵食 50%商業飼料+50%微塑膠），每組 10 重複，每重複為 3 隻不同社會階級的眼班海葵魚所組成的群體。實驗為期 90 天，並於實驗第 1、30、60、90 天進行動物行為影像錄製，以及收取不同社會階級眼斑海葵魚的排遺並計數微塑膠攝入量，並測量魚隻的體重體長以分析其生長率。動物行為部分則會分析攝食、游泳和社會行為等參數。我們的假說包括：(1)與控制組相較，微塑膠組食物整體品質較差，造成較低階的個體生長會更加受到抑制，並進而影響其社會行為。(2)眼斑海葵魚的微塑膠攝入量會因為學習而隨著時間減少。本研究將增進我們關於微塑膠對社會性珊瑚礁魚類行為和生長影響的了解，並幫助我們預測微塑膠汙染對珊瑚礁生態系長期的影響。

關鍵字：微塑膠、眼斑海葵魚、社會行為、生長

海報競賽 PC-A-4

The settling mechanism of *Noctiluca scintillans* and its implications for actual coastal ecosystem

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Abstract

Noctiluca scintillans, a heterotrophic dinoflagellate, is believed to adjust its ammonium concentration by enlarging its food vacuoles through predation, allowing it to descend to deeper water layers and access various feeding opportunities. To explore if food vacuole size primarily affects *N. scintillans* sinking behavior during predation, we conducted feeding experiments using natural concentrations of tintinnid ciliates and varying prey concentrations of *Tetraselmis choi*. We measured food vacuole sizes while grazing on *T. choi* and observed sinking levels. Results indicate that *N. scintillans* consistently sinks when preying on tintinnid ciliates, irrespective of prey abundance. Conversely, although predation on high *T. choi* concentrations induces sinking, such high prey concentrations are not found in natural environments. Additionally, *Pseudo-nitzchia* in the Matsu region, known for Harmful Algal Blooms (HAB), show that *N. scintillans* does not sink due to grazing on this diatom. It makes sense that how come the appearance of *N. scintillans* accompany the disappearance of tintinnid ciliates in the Matsu archipelago in the field study, vice versa. This finding highlights rather the significant role of tintinnid ciliates than the overestimate of the effect of food vacuole size in the sinking mechanism of *N. scintillans*.

海報競賽 PC-A-5

夜光蟲(*Noctiluca scintillans*)在台灣西部沿岸之品系差異

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摘要

夜光蟲(*Noctiluca scintillans*)是一種異營渦鞭毛藻，通常在春末夏初的沿岸環境發生藻華現象。在過去研究中都認為夜光蟲僅一個種類，但近年來研究中卻發現到在不同地區的夜光蟲也會有品系上的差異，因此本研究以 2020 年至 2022 年馬祖介壽澳採集到的夜光蟲樣本和 2023 年間陸續在臺灣西部沿海採集到的夜光蟲樣本，利用聚合酶連鎖反應(Polymerase chain reaction)取得夜光蟲 SSU 之基因序列作為品系分析之依據。結果顯示 2023 年在工學院(25° 9' 6.1" N, 121° 46' 45.5" E)所採集到的夜光蟲並非同一個系群；也發現馬祖 2020 年 12 月 29 採集的夜光蟲與高雄採集到的夜光蟲親緣關係較為相近，而在馬祖 2021 年間 4 月 4 日以及 12 月 5 日採集到的夜光蟲則與加拿大的親緣關係較近。最後藉由不同時間及地點的夜光蟲品系間彼此親緣關係遠近之數據，推測夜光蟲在臺灣沿海及馬祖地區年(內)間並非來自同一系群，而是受洋流影響，分布到各地。

海報競賽 PC-A-6

用酸性胞器染劑確定夏季副熱帶沿岸生態系有哪些微小的色素型真核生物會攝食？

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摘要

混營生物是指一個單細胞生物可行光合作用又能攝食細菌。全球暖化導致表層海水增溫，使營養鹽缺乏狀態更趨顯著，這可能會使表層混營生物的攝食能力提升，混營生物可能成為寡營養鹽海域的優勢種。近幾年的研究發現混營在表層海洋生態系中，不僅扮演初級基礎生產者角色，也是細菌的主要攝食者。但由於海洋中的色素型真核生物體型太小，很難觀察到攝食行為，而傳統攝食實驗相當耗時且複雜，導致混營真核生物在海洋生態系中的數量與比例一直缺乏可靠數據。本研究透過使用酸性胞器染劑快速判別色素型真核生物的攝食能力，採用此方法來檢視台灣東北沿岸海域色素型真核生物有多少比率具有攝食能力。台灣東北沿岸水域夏季染色實驗結果顯示，有 55%的色素型真核生物可能具有攝食能力。同時發現本海域主要的細菌攝食者為 MAST (MArine STramenopiles)、綠藻、雙鞭毛蟲門(Dinoflagellata)和網鞭蟲門(Telonemia)。由此可知相當數量色素型真核生物具有攝食能力。

海報競賽 PC-A-7

以轉錄組學探討台灣潮間帶魚類環境適應之策略

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摘要

潮間帶生物如何適應多變的環境長久以來一直受到關注。該區域常見的鰕虎魚和鰯魚，因其能忍耐極端環境，經常被選作為實驗對象。日益遽增的極端氣候及頻繁的人為擾動，使得潮間帶生物正面臨巨大的挑戰。然而，對於這些生物在面臨環境波動時的分子調控機制的研究卻相對缺乏。據我們現有的生活史資料，棲息於台灣北部沿岸的褐深鰕虎（*Bathygobius fuscus*）的幼魚，相較於南部族群具有較高的生長率，我們推測這可能是明顯的季節變化或食物的獲取量而導致差異。本研究在夏、冬兩季至台灣南、北部潮間帶潮池中進行採集，目標包括三種鰕虎魚（*B. fuscus*、*B. cococensis*、*B. coalitus*）和兩種鰯魚（*Istiblennius edentulus*、*I. lineatus*）。並針對主要的代謝器官肝臟進行轉錄組的高通量次世代定序（next-generation sequencing，NGS）分析，同時聚焦在代謝及成長相關基因的調控模式。本研究將揭示潮間帶底棲魚類如何透過基因調控適應不同環境壓力，結果將有助於瞭解潮間帶生態系統如何回應全球暖化及氣候變遷。

海報競賽 PC-A-8

台灣淺灘暨周邊海域夏季仔稚魚群聚結構變動之研究

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摘要

本研究利用新海研 3 號研究船 2023 年 7 月 2-6 日(NOR3-0165)航次，於台灣淺灘周邊海域採集水文資料及浮游生物樣本，探討該海域的仔稚魚群聚組成與水文環境之間的關係。本研究共採集到 1983 隻仔稚魚，以 DNA 條碼搭配傳統形態鑑定方式，鑑定出仔稚魚 55 科 75 屬 95 種，以玉筋魚科(Ammodytidae)、鰕虎科(Gobiidae)、鯷科(Engraulidae)、鯵科(Carangidae)、乳鯖科(Lactariidae)及沙鮻科(Sillaginidae)為前六大優勢科，佔總豐度的 47.92%。研究結果發現，測站 B5、B11 及 B15 有一低溫高鹽的水團向上發展，證明該處具湧升現象，且該測站及鄰近測站具有較高的仔稚魚豐度與物種數，證明了湧升區確實能成為良好的漁場。利用 DISTLM 線性模型探討仔稚魚群聚與水文環境之間的關聯性，發現了深度、鹽度及浮游動物豐度影響了台灣淺灘周邊海域仔稚魚之群聚結構分布。依仔稚魚分群的結果顯示，湧升區及北邊測站與採樣區域南邊(測站 B7、B12、B16 及 B17)的仔稚魚組成明顯不同，湧升區及北邊測站的仔稚魚以台灣玉筋魚(*Embolichthys mitsukurii*)、鰕虎科(Gobiidae gen. spp.)、突粒眶棘牛尾魚(*Sorsogona tuberculate*)及多鱗短額鮜(*Engyprosopon multisquama*)為優勢，佔總貢獻度的 41.14%；而在南邊測站的仔稚魚以智利串光魚(*Vinciguerria nimbaria*)、燈籠魚科(*Diaplus* slender type)及近蒼圓帆魚(*Cyclothone pseudopallida*)佔優勢，佔總貢獻度的 48.87%。湧升區及北邊測站的仔稚魚以底棲性魚類為主，南邊測站以中深水層魚類為主，推測底棲性魚類可能更容易在湧升區中找到適合的生存條件和食物資源。

海報競賽 PC-B-1

海洋酸化和鹽度改變對紫海膽成長的影響

Effects of ocean acidification and salinity variations on the growth rate of sea urchin *Anthocidaris crassispina*

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Abstract

Human activities have led to numerous threats against global water ecosystems, with climate change, pollution, and habitat destruction at the forefront. The recent surge in extreme climate events has particularly impacted productive coastal ecosystems, adversely affecting slow-moving marine species such as the Taiwanese native sea urchin, Anthocidaris crassispina. It is vital to comprehend how these extreme climate phenomena, including heavy rainfall and acidification, affect species like sea urchins. This study aims to examine the growth and mortality rates of juvenile Anthocidaris crassispina under varied environmental conditions: low salinity (pH 8.2 and 20 psu), low pH (pH 7.8 and 33 psu), and controlled conditions (pH 8.2 and 33 psu). Our findings indicate that sea urchins in the controlled group exhibited the highest growth rate at 0.14 mm d^{-1}, significantly surpassing those in the low pH (0.12 mm d^{-1}) and low salinity (0.10 mm d^{-1}) groups. Additionally, the specific growth rate (SGR), measured by total wet weight, was greatest in the control group at 9.29% d^{-1}, followed by the low pH group at 6.95% d^{-1} and the low salinity group at 5.37% d^{-1}. And for the mortality experiment, there were four different salinities, namely (30psu, 25psu, 20psu and 15psu). The results showed that after 72 hours of observation, the mortality rate of 15psu sea urchins was as high as 90% (34 individuals), and in more than half (22 individuals) died within 48 hours. Future research will investigate the effects of these environmental stressors on gonadal development and osmotic pressure alterations, particularly focusing on the impacts of short-term salinity fluctuations caused by heavy rainfall.

海報競賽 PC-B-2

海水酸化對線紋海馬成長與繁殖之影響

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摘要

自工業化以來，二氧化碳的排放量逐年增加，導致全球暖化以及海水酸化。其中沿海的酸化速度比大洋快得多。近幾年的研究顯示海水酸化會對魚類的感覺系統、耳石生長、生理代謝造成負面影響。然而海馬的棲息地包含海草床、紅樹林、珊瑚礁與海藻混生區的淺灘，這些棲息地亦受不同程度酸化影響。海馬自古以來就是珍稀的中藥材，更是觀賞魚類的主角之一，然而近年來被大量捕抓，全球野外的海馬數量大為減少，加上海水酸化，對含多骨骼的海馬可能是一大威脅。本研究將成年的線紋海馬，讓其養殖於正常海水(pH=8.14)及低 pH(pH=7.54)的海水中 28 天，觀察其成長、存活以及生育作為指標，以了解酸化對線紋海馬之影響。經過 28 天的養殖實驗後，顯示飼養於正常 pH 與低 pH 海馬之最終重量分別為 4.61±1.03 及 4.61±1.44 克，存活率為 73±0.12 及 73±0.12%，生育數為 33±14 及 6±1 隻。結果顯示，低 pH 環境不會顯著衝擊線紋海馬之生長和生存，但會顯著抑制海馬之生育能力，可能使生存於低 pH 環境之海馬子代族群數量衰退。然而，本研究僅觀察至第一子代之數量，其子代於酸化環境中之存活率及其他生理反應需持續進行觀察及研究。

海報競賽 PC-B-3

None-target DOM effects on marine bacteria chemotaxis

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摘要

Studies have indicated that a high proportion of marine heterotrophic prokaryotes are chemotactic. In pelagic ecosystems, heterotrophic prokaryotes keep tracing the particulate organic matter (POM)— foraging the dissolved organic matter (DOM) nearby or colonizing on it as a new patch. POMs distribute in patch; since microbes living in pelagic ecosystems face such patchiness niche structure, chemotactic ability thus highly affects how a bacterium disperses from one particle to another, therefore playing a crucial role in affecting marine microbe's population dynamics. However, previous studies have found that chemotactic ability can be interfered with or inhibited by metabolites in the seawater. It raises a hypothesis that the chemotaxis behaviors of marine bacteria might be affected by none-target DOM (i.e., the environmental organic compounds not from the target POM itself). In this study, a natural marine bacteria assemblage was inoculated into natural seawaters under different DOM concentrations. In each condition, synthesized chitin particles were included as POM. During incubation, inoculated bacteria performed chemotaxis and attached to the chitin POM. Meanwhile, none-target DOM interferes with bacteria on chemotaxis and reduced chance that bacteria attached to the chitin POM. As such, the chemotactic bacterium with less none-target DOM interference should lead to more colonization events. Thus, the ratio between bacteria density in the suspension versus colonization after incubation serves as an indicator for chemotaxis strength. Our results show that the chemotaxis strength of natural marine bacteria negatively correlates with none-target DOM concentration. Our findings indicate that bacteria chemotaxis strength could be affected by none-target DOM, suggesting that dispersal limitation caused by none-target DOM could shape the community dynamics of marine heterotrophic bacteria.

海報競賽 PC-B-4

MIHAYU: Environmentally Friendly Longline Fishing Puller Innovation to Increase the Productivity of Fishermen's Catches in The Republic of Indonesia-The Democratic Republic of Timor-Leste Border Area

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Abstract

The natural resource potential of Indonesia's border regions is rich in marine and fisheries resources. In general, fishermen use their hands to pull longline fishing lines to catch fish, causing injuries to body parts. The large amount of wood waste from furniture craftsmen in the Indonesia-Timor Leste border area, especially Belu Regency, is an opportunity to innovate environmentally friendly fishing gear and reduce the issue of work accidents in fishing. The aim of making this tool is to reduce the issue of work accidents experienced by fishermen. This research method uses a case study method and tries the tool directly at Atapupu Beach, Belu Regency, East Nusa Tenggara, Indonesia. The design of this tool is made from wood waste. MIHAYU (Mini Hauler Kayu) has been proven to be able to reduce work accidents in catching fish such as cuts on the hands and feet. MIHAYU is equipped with two pulleys, namely the right side and the left side. There are two pulleys to get relatively more catches without stopping. The fish caught are three times more than manually pulled because one rotation can pull one meter of line per two seconds. The use of wood-based materials can also reduce the negative impact of ghost fishing (fish trapped in fishing gear waste). This MIHAYU (longline fishing tool) also has the advantage that it can be used on various types of fishing boats, making it easier to use. MIHAYU is an environmentally friendly fishing gear innovation that can increase fishermen's catches. There needs to be collaboration with relevant stakeholders so that this tool can be widely used, generally among lower middle-class fishermen.

Keywords : *Wood Waste, MIHAYU, and Ghost Fishing*

海報競賽 PC-B-5

The effects of ENSO on spatial-temporal distribution and growth rate of three cryptic mullet species in Taiwan

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Abstract

Mugil cephalus, a globally distributed species, coexist in the estuaries of Taiwan with three cryptic mullet species in the northwestern Pacific (NWP1-3). Previous studies have shown that shifts in catches and fishing grounds of mullet due to impacts on climate change. Therefore, this study investigates the impact of ENSO on the species composition and growth rate during early-life history among three cryptic mullet species. The results found that NWP2 was the most abundant species, dominating several months and estuaries. NWP1 had lower abundance than NWP2, but its proportion was relatively higher in La Niña and rarer in El Niño. NWP3 exhibited the lowest abundance, but expanded spatially during El Niño. Variations in species composition are likely influenced by inter-specific reproductive patterns and sea surface temperature (SST).

Interestingly, only the growth rate of NWP2 showed significant differences among years, being lower during El Niño year. To further explore this trend, a Generalized additive model (GAM) was employed to examine the correlation between growth and environmental factors. The GAM analysis revealed that the growth of mullet fry was influenced by multiple factors, especially SST and drifting growth rate (DGR). The results indicated variations in the optimal SST range for growth among various mullet fry species. Specifically, considering the optimal SST range for NWP2, it is speculated that NWP2 fry entering estuaries may experience higher water temperatures and be limited due to poor swimming ability. Consequently, the SST surpasses the optimal growth temperature, resulting in a decline in growth rate. In summary, lower SST during La Niña year benefited the abundance of NWP1, while higher SST during El Niño year benefited NWP3 but impeded the growth of NWP2.

海報競賽 PC-C-1

不同光照對大型藻海木耳生長的影響

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摘　要

隨著科技的日益發展，我們所排放的碳越來越大量，大氣中的二氧化碳從工業革命前的 280 ppm 到如今的 415 ppm 有明顯成長，如何降低碳排及減少大氣中二氧化碳是我們面臨的重要課題，而大型藻類被視為重要海洋碳匯之一，將無機碳轉化成有機碳，並以顆粒有機碳(particulate organic carbon, POC)和溶解有機碳(dissolved organic carbon, DOC)形式將碳封存於深海或海底沉積物。在台灣，一般對海木耳(*Sarcodia suae*)的養殖條件認知是，海木耳適合在低溫與弱光的環境下生長，因此到了春末至秋天之際，海木耳便不再適合生長，儘管我們得知海木耳喜愛的生長環境，但還尚未清楚最適合海木耳生長的光照強度。本研究以不同光照強度對海木耳進行重複多週期之固碳培養實驗(每一週期為 5 天)。結果顯示海木耳在遮光 20%時成長率最高(3.55 ± 0.94 % d^{-1})，換算之固碳率為 66.6 ± 19.4 ton-CO_2 ha^{-1} y^{-1}，海木耳在遮光率 95%時成長率最低 (0.49 ± 1.32 % d^{-1})，固碳率為 10.2 ± 22.2 ton-CO_2 ha^{-1} y^{-1}。上述的實驗結果顯現出不同光照強度對於海木耳生長的影響，同時海木耳的色澤也會隨著不同光照強度而改變，光照越強海木耳顏色越淺，反之，顏色越深。由上述結果可知光照強度對於海木耳的生長、固碳速率及其形態有著至關重要的影響。

海報競賽 PC-C-2

eDNA analysis of marine macrophytes in coastal habitats in Northern China Sea (NSCS), Taiwan

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計畫名稱:[1]颱風、渦流與內波對南海北生物地球化學作用之衝擊-子計畫:南海北部海域海藻藍碳:環境 DNA 檢測沉積物大型海藻及大型海洋植物以估算藍碳貢獻及海洋魚類對南海北部碳匯的貢獻之研究-以養殖魚類為例

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計畫編號:[1]NSTC 112-2611-M-110-022、[2]NSTC 112-2119-M-019-008

Abstract

Coastal macrophytes serve as a promising reservoir of blue carbon (BC) sequestered within the deep sea of Palau and the Northern South China Sea (NSCS). Utilizing 18S rDNA-based environmental DNA (eDNA) metabarcoding, sediment traps were deployed at 500-meter depth in the open sea southeast of Taiwan (NSCS-N) and northeast of Dongsha Island (NSCS-M).

In the NSCS, marine macrophytes, including macroalgae and seagrass, prevailed in the open waters. Seagrasses were particularly abundant in the NSCS-M middle site, comprising up to 89% of macrophytes. Conversely, the northeastern boundary of NSCS near southwestern Taiwan exhibited a distinct pattern rich in macroalgae, with Rhodophytes accounting for 57% of NSCS-N macroalgae, dominated by calcified crustose *Peyssonnelia* sp. (47% of macrophytes).

The eDNA analysis of sunken macrophytes revealed a correlation with coastal vegetation assemblage structures, with NSCS-M seagrass species aligning with those in Dongsha Island, and NSCS-N *Peyssonnelia* sp. being abundant in southern Taiwan coastal habitats. Stable carbon isotope (^{13}C) values in NSCS-M and NSCS-N, around 14% and 21% respectively, reflected the carbon signatures of seagrass and macroalgae, contributing to carbon sequestration in the deep sea offshore in NSCS. This highlights the role of Dongsha and southwestern Taiwan coast macrophytes in BC sequestration on the Northern South China Sea ocean shelf and deep sea, showcasing the lateral transport of coastal macrophytes to deep waters for BC contribution in deep sea environments.

Key words: Coastal macrophytes, Blue carbon (BC), Environmental DNA (eDNA), Sediment traps, Northern South China Sea (NSCS), Seaweed, Seagrass, Dongsha Island, Habitat vegetation, Lateral export, Deep sea, Carbon sequestration, Stable carbon isotopes

海報競賽 PC-C-3

東海南部及南海北部衛星遙測及現場實測視深度之差異

黃彥鈞、姚俏君、成宗儒、沈雅庭
海軍軍官學校應用科學系

計畫名稱：建立臺灣周邊海域海水透明度預測模式研究
計畫編號：國防部112年「國防先進科技研究計畫」(突破式國防科技研發計畫)

摘要

海水視深度或稱海水透明度，無論是對於了解海洋生地化現象，或將其應用在軍事及民間用途上，都扮演著重要的角色，但若要獲得大範圍且沒有時間限制的海水視深度，透過衛星遙測的技術是目前最佳的方法之一，而現場實測資料則是驗證遙測資料準確性的最重要依據。初步研究成果顯示，衛星遙測與實測的海水透明度，在東海南部及南海北部約有−20~30 %的誤差，表示衛星遙測的視深度仍無法完全與實測海水透明度吻合。進一步分析認為，遙測與實測視深度的差異可能為水中葉綠素含量(即浮游植物生物量)所造成，當葉綠素含量越少視深度越深。本研究後續希望有更多實測及遙測視深度的比對，並針對其他參數對視深度的影響進行，以更深入釐清衛星跟實測視深度的差異。

海報競賽 PC-C-4

The impact of strong winter storms on low-latitude marine biogeochemistry in the northern South China Sea

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Project Title:
1. 颱風、渦流與內波對南海北部生物地球化學作用之衝擊－子計畫：颱風、渦流與內波對南海北部基礎生產力之衝擊及不同碳同位素量測基礎生產力之潛在差異（Ⅱ）
2. 強烈冬季冷氣團對南海北部低緯度海洋生地化的衝擊
Project Number:
1. NSTC 112-2611-M-012-001
2. NSTC 112-2813-C-012-004-M

Abstract

In recent years, the climate change has made an increasing trend of frequency and intensity in extreme weather events (EWEs). A negative phase of the Arctic Oscillation (AO), one of the indexes to examine EWEs in winter, represents a strong southward intrusion of cold air to lower latitudes when combined with the northeast monsoon. Due to the rough sea, it is difficult and seldom reported that the influence of negative AO on the low-latitude marine biogeochemistry. This study utilized 6 cruises conducted during winters from 2018 to 2023, to investigate the impact of winter EWEs, the lower phase of negative AO, on biogeochemistry in the northern South China Sea (NSCS). The phytoplankton assemblage in significant negative AO phase was analogous with a typical vertical distribution of phytoplankton observed in high-latitude waters, i.e. a high chlorophyll *a* (Chl *a*) occurring at the surface and decreasing with depth. Additionally, the integrated Chl *a* (50 mg m^{-2}), particulate organic carbon flux (POC flux, 91 ± 50 mg-C m^{-2} d^{-1}), integrated primary production (I-PP, 356 ± 18 mg-C m^{-2} d^{-1}) and carbon export ratio (e-ratio, POC flux / I-PP, 0.25) were higher compared to winters in other AO phases with less significances (I-Chl *a*: 35 mg m^{-2}; POC flux: 53 ± 23 mg-C $m^{-2}d^{-1}$; I-PP: 263 ± 30; e-ratio: 0.20). A considerable reason was attributed to the intense cold air stimulated the phytoplankton growth and enhanced the efficiency of marine biological carbon pump. The retention time of POC was then shortened in the euphotic zone, and consequently increased the oceanic carbon sequestration. These *in situ* surveys demonstrate that noticeable negative AO can have a prominent influence on deep sea biological carbon pump in low-latitude seas of NSCS.

海報競賽 PC-C-5

Seasonal Variations of Partial Pressure of Carbon Dioxide in Chiku Lagoon

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計畫名稱：陸源/非陸源物質在高輸砂量之河-海輸運系統中的宿命整合研究(XIV)-子計畫：亞熱帶潟湖中碳酸鹽系統之時空變化(Ⅱ)(1/2)
計畫編號：MOST 111-2611-M-110-023-

Abstract

Lagoons can act as a source of atmospheric carbon dioxide (CO_2), providing key information on the carbon cycle and “Net-Zero Emissions” in 2050. However, obtaining high-resolution spatiotemporal pCO_2 data remains challenging due to the limitations of traditional discrete sampling methods. At Chiku, Taiwan, we deployed at least five autonomous buoys (Autonomous Buoy for inland Tidal Carbon dioxide, ABiTC) to cover the upper (near inland channels), middle, and lower (near the seawater inlet) lagoons. The changes in water temperature, salinity and pCO_2 changes were monitored during four sampling periods: August 2020 (late summer, wet season), September 2021 (early fall, wet season), January 2022 (mid-winter, dry season), and April 2023 (spring, dry season). Each monitoring period lasted more than 36 hours. The results in the wet season showed that low salinities in the range of 7.2 to 35.1 reflected the freshwater input from heavy rainfall (more than 150 mm per day). The spatial distribution of pCO_2 in the wet seasons showed higher levels of pCO_2 (759-4434 µatm) in the upper lagoon compared to those (332-1271 µatm) in the lower lagoon. In contrast, high salinities in dry seasons, ranging from 25.0 to 36.0, indicated lagoon water with less freshwater input and strong net evaporation. In dry seasons, pCO_2 in the upper lagoon displayed higher levels (443-1365 µatm) than those in the lower lagoon (421-784 µatm). In addition, the spatial pCO_2 distribution in wet seasons displayed a similar distribution but wider pCO_2 ranges than those in dry seasons. Overall, Chiku Lagoon acted as a source of atmospheric CO_2 in both wet and dry seasons, with stronger sources in wet seasons and weaker sources in dry seasons. Finally, a large difference in air-water CO_2 flux between the upper and lower lagoons highlighting the importance of high spatial resolution monitoring in air-water CO_2 flux estimates.

海報競賽 PC-C-6

探討油汙衍生汙染物對珊瑚共生藻之反應受海洋懸浮顆粒之影響

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計畫名稱：探討珊瑚對油汙衍生物有機汙染物質之生物有效利用性受海洋懸浮顆粒之影響
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摘要

海洋懸浮顆粒(Marine suspended particles,MSPs)是指在海洋中攪動或流動呈懸浮狀態之有機或無機性顆粒，相對較大的表面積使容易吸附水中非極性物質，形成海洋環境中汙染物的載體。石油汙染是海洋環境中一直存在的嚴重污染問題之一，其中石油衍生物-多環芳香烃(PAHs)為疏水性持久性有機汙染物，對於其吸附在 MSPs 上，影響海洋生物的生物累積及生物效應，目前相關研究十分缺乏。本計畫研究以擬腎形真葉珊瑚(*Euphyllia paradivisa*)為題材進行，模擬暴露於油汙之實驗，比較添加 MSPs 後暴露於油汙衍生物 PAHs 下，受 MSPs 之影響情形。初步比較珊瑚的共生藻密度及葉綠素 a 濃度，結果顯示增加 MSPs 後其影響不具有顯著差異，然而在有油汙的環境下，其共生藻密度及葉綠素 a 均較控制組少。在有油汙及 MSPs 的環境下，發現 MSPs 會吸附油汙，使共生藻密度與未添加油汙的實驗組沒有差異。同時，經過暴露後水中分析到的油汙 PAHs 濃度確實低於原始濃度，其消失的原因可能為 1. 被水中 MSPs 吸附 2. 被珊瑚累積在體內 3. 揮發至空氣中。至於 PAHs 在生物累積的分布及濃度現在仍然在實驗分析當中。

關鍵詞: 海洋懸浮顆粒、擬腎形真葉珊瑚、共生藻、油汙染、PAHs

海報競賽 PC-C-7

微塑膠的傳輸：大氣與海洋的角力

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計畫名稱：以微、奈米角度探討「海洋污染物幫浦」與其潛在之生態風險畫
計畫編號：MOST110-2628-M-019-001-M4

摘要

海洋中的微塑膠(MP)透過氣泡破裂被轉移到大氣中，已被視為是海洋中 MP 的新傳輸途徑。然而，MP 在海洋與大氣間的傳輸及與周遭物質間複雜的相互作用機制仍然未知。本研究將更全面地探討，天然膠體、海洋中有機及無機顆粒對 MP 轉移至大氣之影響。本次研究顯示，微塑膠可以與水層中的有機聚合物透過天然膠體結合形成海洋塑膠雪花(Marine Plastic Snow)，並且可以進一步通過氣泡破裂從海洋被噴發到大氣中。值得注意的是當水體中存在其它有機(矽藻)或無機(高嶺土)顆粒時，則會降低塑膠微粒轉移至大氣的能力。該研究初步證實塑膠微粒海氣交換的控制因子，會受到天然膠體及顆粒同時調控，同時也為海洋中微塑膠的傳輸宿命提供了全新的見解。

海報競賽 PC-C-8

全球汞海氣交換通量：邊緣海之重要性

Global Mercury Air-Sea Exchange Flux: The Significance of Marginal Seas

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摘要

本研究利用氣體交換模型對全球汞逸散通量進行了估計，發現邊緣海在全球汞逸散中具有重要作用。通過分析汞在不同水體類型中的分佈和傳輸特徵，我們發現邊緣海受到陸地排放、大氣沉降和海氣交換作用影響，對於汞的累積和生物放大起著關鍵作用。研究發現不同緯度和季節的變化也影響了海洋中溶解態元素汞（Dissolved Elemental Mercury, DEM）的濃度。我們進一步分析了邊緣海 DEM 濃度隨季節的變化，發現夏季的 DEM 濃度較高，且與溫度變化相關。此外，溶解態元素汞和溶解態總汞（Dissolved Total Mercury, DTM）濃度之間呈顯著正相關，證實此兩個物種可能來自共同來源，或者 DTM 是 DEM 形成的底物。綜合全球數據，我們估計全球汞逸散通量約為 11.5 Mmole/yr，並發現受河川主導影響的邊緣海的逸散通量與面積存在著不成比例的關係。

關鍵詞：汞、溶解態元素汞、海氣交換通量、氣體交換模型

海報競賽 PC-C-9

澎湖水道及鄰近海域碳酸鹽系統之時空分布初探

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計畫名稱：陸源/非陸源物質在高輸砂量之河-海輸運系統中的宿命整合研究 (XII)－子計畫：邊緣海中二氧化碳以及氧氣動力學(Ⅰ)

計畫編號：109-2611-M-110-011-

摘要

澎湖水道位於南海北端，受黑潮支流入侵之影響，且潮汐在此處有明顯的作用，擁有較複雜的生地化作用機制，使得澎湖水道的碳酸鹽系統動力學尚未完全明瞭。我們透過位於澎湖水道及鄰近海域之三個航次(2018 年 9 月高屏溪口、2022 年 7 月西南海域以及 2020 年 4 月濁水溪口)，每次至少進行一次至少 24 小時的定點採集並量測水中溫度、鹽度、總鹼度(Total Alkalinity)、溶解無機碳(Dissolved Inorganic Carbon)。透過各別航次的時序分析，在這三個航次中由南往北皆發現數據隨時間的規律性變化。以 DIC 來說，在高潮位時 DIC 較高的水體受潮汐影響上抬，而低潮位時則下降，顯現出潮汐在澎湖水道佔有控制參數變化的主導地位。此外，在空間分布上，我們在西南海域澎湖南方海域觀察到在表層有一區 DIC 較低 pH 值較高的水，透過鹽度及標準化總鹼度(NTA)等參數推測為沖淡水之訊號。綜合以上結果，本研究提供了澎湖水道及鄰近海域碳酸鹽系統時空分布的初步了解，揭示了潮汐對該區域碳酸鹽系統動力學的重要影響，為未來的研究提供了參考。

海報競賽 PC-C-10

東海人為影響的百年記錄：來自沉積化合物（有機磷酸酯塑化阻燃劑，OPEs）的證據

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摘要

在過去的數十年間，有機磷酸酯塑化阻燃劑（OPEs）作為新興污染物的產量和使用量快速增加。同時，大量研究也證實了它們對生物群和人類的負面影響，因此它們在環境生態的分佈及其對健康造成的風險在國際間日益受到關注。然而，人們對 OPEs 的相關研究大部分只針對水體中的濃度進行調查，對於海洋沉積物及岩心之研究調查相對較少。在本研究中，對東海區域四個沈積岩芯中的 OPEs 進行調查及分析，沉積物岩心數據表明，該區域自 1960 年代以來，OPEs 就一直存在，並於 2020 年後有濃度高值，約為 13 ng/g。該數據將近一步計算其污染物沉積通量，相信有助於釐清過去百年該區域人類發展及污染的歷史。

海報競賽 PC-C-11

Seaweed as blue carbon: Tracking vertical distribution of seaweeds and other marine macrophytes in Palau deep sea POC

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[2]颱風、渦流與內波對南海北部生物地球化學作用之衝擊-子計畫：南海北部海域大型海藻藍碳：環境 DNA 檢測沉積物大型海藻及大型海洋植物以估算藍碳貢獻及海洋魚類對南海北部碳匯的貢獻之研究-以養殖魚類為例

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Abstract

Palau, an archipelago situated in the western Pacific Ocean approximately 800 kilometers east of the Philippines, forming the westernmost part of the Caroline Islands chain. The deep sea surrounding Palau features underwater canyons, trenches, and abyssal plains that serve as substantial carbon sinks within the global carbon cycle.

In the summer of 2023 (July-August), a research expedition from Taiwan to Palau aimed to investigate the presence of blue carbon in open waters near Palau. The study examined whether marine macrophytes exist in the deep sea off northeastern Palau and explored the fate of these macrophytes after lateral export and drifting from Palau island into the open ocean, where they sink into the deep sea as burial carbon. Sediment samples collected using floating collectors were analyzed for environmental DNA, specifically 18S V9 rDNA metabarcoding, and organic carbon (POC) content. The vertical distribution of macrophytes at different depths (150, 500, and 1000 m) was assessed in PN sampling site. Seaweeds are predominant, followed by seagrass and other macrophytes. There were notable vertical variations observed in the distribution of seaweeds and other macrophytes that terrestrial plants were most prevalent at 500 m depth, while seaweeds dominated at 500 and 1000 m.

Moreover, the overall abundance of macrophytes was higher at 500 meters compared to 150 meters and the deeper waters at 1000 meters. The study highlighted significant lateral export of macrophytes, particularly seaweeds, along with the sinking of seaweeds at deeper depths and/or substantial degradation of seagrass in the waters surrounding Palau.

Keywords: Macrophyte, Palau, Sediment, eDNA, Climate change

海報競賽 PC-C-12

海水中不同粒徑顆粒組成性質:採水瓶及現場過濾幫浦比較

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摘要

顆粒作為控制海水中物質傳輸及循環的重要介質，依組成性質分為礦物性及生物性顆粒並影響顆粒在海水中的反應性，不同顆粒來源上也有所不同，通過不同粒徑之顆粒性質組成可以反映本質或來源。在顆粒的蒐集上本研究以採水瓶搭配多層次孔徑過濾器(貓網)過濾，現場過濾幫浦(三層過濾之Large Volume Water Transfer System)來蒐集顆粒，通過比對兩種採樣儀器蒐集之不同粒徑顆粒(0.4-10 μm、10-60 μm、>60 μm)來了解兩種採樣儀器蒐集到的顆粒本質特徵。總顆粒濃度(SPM)用於了解在不同水體中蒐集到的顆粒量差異，鋁在礦物性顆粒之濃度與生物性顆粒差異約為 3~4 數量級，故為本研究中礦物性顆粒之指標性元素，用以判斷顆粒中礦物性顆粒百分比。從顆粒濃度上採水瓶搭配貓網和現場過濾幫浦蒐集到的顆粒皆以小顆粒為主，隨粒徑增加蒐集到之樣品減少，隨著離陸地距離增加受到陸源輸入減少顆粒濃度也隨之下降，在礦物性顆粒兩者共同趨勢為隨離陸地越遠陸源輸入越少礦物性顆粒百分比越低，但在不同粒徑顆粒之貢獻有所差異，採水瓶為 0.4-10 μm 顆粒中的礦物性顆粒比例最高，反之幫浦在>60 μm 顆路中的礦物性顆粒比例最高，在 10-60μm 顆粒差異則是不明顯，濁流層中所有粒徑顆粒高礦物性顆粒百分比反映濁流顆粒主要是礦物性顆粒，且相較於近岸站點濁流層的顆粒組成在不同粒徑上兩種採樣儀器差異不大，推測若為組成單一的水體使用那種採樣方法對蒐集到的顆粒組成不會有太大的影響，但若在來源較為複雜的近岸環境中就需要考慮兩種儀器蒐集到之顆粒組成不同所導致的結果差異。

海報競賽 PC-G-1

Ventilation Changes in the Northwestern Pacific During the Glacial Period: Preliminary Results of the Core MR23-05 Leg 2 SMK3-PC

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ABSTRACT

The global circulation of deep water plays a crucial role in regulating the long-term carbon storage in both the ocean and the atmosphere. Traditionally, deep-water downwelling in polar regions has been recognized as a significant contributor to carbon dioxide sequestration. Although the present North Pacific lacks deep-water downwelling, studies suggest that during the Last Glacial Maximum (LGM), the North Pacific experienced enhanced ventilation above approximately 2000 meters, leading to the formation of a watermass known as glacial North Pacific intermediate water (GNPIW). Moreover, it is proposed that potential deep-water formation and sinking occurred to depths exceeding 3000 meters during two cold periods of deglaciation, namely Heinrich event 1 and the Younger Dryas. Consequently, the circulation patterns of deep water in the glacial and deglacial Pacific significantly differed from those observed during interglacial periods.

In the summer of 2023, three piston cores, namely MR23-05 Leg2 SMK1-PC, SMK2-PC, and SMK3-PC, were collected off the coast of Shimokita during the R/V Mirai cruise MR23-05 Leg 2. The core MR23-05 Leg2 SMK3-PC, located at a water depth of 1356 meters near the center of the GNPIW, has the potential to provide valuable insights into the ventilation mechanisms in the Northwestern Pacific. In this report, we present the Multi-Sensor Core Logger (MSCL) and color reflection data obtained onboard, as well as water content, content of coarse fraction (> 63 μm) in the sediment, and X-ray fluorescence (XRF) data processed by Itrax for the core MR23-05 Leg2 SMK3-PC. Most of the data suggest heightened variability in the upper three sections of the core, possibly corresponding to the last deglaciation period; however, further investigation with an age model is necessary to validate this interpretation.

海報競賽 PC-G-2

Spatial and temporal distribution of terrestrial-marine source particles and sediments in Qigu Lagoon

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Abstract

The dynamics sedimentation are quite complicated in Qigu Lagoon system. After terrestrial-sourced particles, delivered by rivers or groundwater to lagoon environment, they will be transported and accumulated in lagoon under the influence of tides. marine-sourced particles enter the lagoon through tidal inlets and overwash, and they mix with terrestrial-sourced particles. There exists a tendency that size of Qigu Lagoon is shrinking and becoming shallower, it impacted fishermen who rely on the oyster farming for survival, and thus changed the original local ecological structure. In order to observe the correlation between the terrestrial-marine suspend particles and the surface sediment changes in Qigu Lagoon, this study collected suspended particles whthin the time scale of Qigu Lagoon. We used particle bulk density, particulate organic carbon, and particulate organic nitrogen analysis to define the particle origin and characteristics. In addition, spatial hydrological parameter and surface sediment were also collected to observe the distribution of water masses and sediment transport in Qigu Lagoon. The time series datas show that at low tide, the low-salinity terrestrial-sourced freshwater signal is strong, bulk density, POC, and PN have a significant upward trend. When the tide turned from low to high, bulk density increased (higher than average 1.1 g/cm^3), this means the detrital particles were brought in to lagoon during the flood tide. They cemented with the particles in the lagoon to form floc particles, and then they were brought out of the lagoon during the ebb tide. There was a huge different in salinity between surface salinity and bottom salinity of Qigu lagoon, salinity mixed well near the two tidal inlets and the river mouth, but the salinity stratification phenomenon became more and more obvious toward the middle of the lagoon. As for the water temperature, since the specific heat of the sea is greater than that of the land, the terrestrial side part was influenced by the high temperature fresh water from Qigu river, so the water temperature inside was higher than outside. As for the sediment, there existed three direction sediment transport trends and they converged in the center of the lagoon, where the salinity stratification phenomenon was most obvious. From our results that the lagoon system is the transitioned environment between land and sea.

keywords: lagoon system, tide, suspend particles, bulk sensity, POC, PN, surface sediment, stratification phenomenon, sediment transport trend.

海報競賽 PC-G-3

台灣灘是否具有作為台灣海峽南部各種沉積物傳輸通道之轉運站功能的初探

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摘　要

台灣灘位於台灣海峽南部之地形高處，為南海暖流、中國沿岸流、黑潮支流等海流交會處，同時也是台灣源沉積物、大陸源沉積物、來自長江及珠江沉積物等南北沉積物輸運之樞紐區域，造成此區域的沉積物組成更為複雜。因此，本研究使用「宿命」團隊在台灣灘附近海域採集之表層沉積物樣本及岩心樣本，並收集文獻中已發表的粒徑數據，透過粒徑分佈中平均粒徑、淘選度、歪斜度等參數，結合傳輸趨勢分析方法，期望能綜合判斷台灣灘區域的沉積物分布、特性以及傳輸模式。

本研究累積的粒徑分析結果顯示，台灣灘中心區域平均粒徑分布較集中且較粗，代表其為粗砂，淘選度好。而台灣灘外圍區域則平均粒徑則較細、屬極細砂至中砂，淘選度較差。歪斜度方面結果顯示，台灣灘及周遭區域的整體粒徑趨勢整體偏向粗的粒徑群組。而接近大陸近岸處則為偏向細的粒徑群組，因此，推測是台灣灘區域受到現代水動力作用，使細顆粒沉積物不易沉積，以過去末代冰期時的粗砂質殘餘沉積物為主，而近岸可能受到較多現代細粒沉積物影響，因此現代細粒沉積物與殘餘沉積物混雜，而粒徑不一。Mclaren-Bowls 傳輸趨勢分析結果顯示，台灣灘上的沉積物傳輸趨勢整體由西南往東北方向傳輸，且在中國大陸海岸線及靠近南海海槽側呈現高能量傳輸趨勢，穿越台灣灘中心則是低能量傳輸趨勢。Gao-Collins 傳輸趨勢分析結果則顯示台灣灘上的沉積物傳輸可分為兩階段：南海區域往台灣灘方向的傳輸及台灣灘北區往台灣海峽中部的傳輸。在 NOR1-0061 航次取得的三根岩心結果顯示，台灣灘外側的未膠結沉積物多於台灣灘內側，此未膠結沉積物可能為前次冰河時期的殘餘沉積，推測在台灣灘內側，因受到現代水動力影響較大，導致其未膠結沉積物較少。

總和以上結果，來自南海北方湧升至台灣灘的現代細粒沉積物單方向往東北方向傳輸，並受到台灣灘地形限制的阻擋後，僅有少部分現代沉積物傳輸至台灣海峽中部。而來自於台灣河川及台灣海峽中部的沉積物則並未發現向西南方傳輸的趨勢。因此可得知台灣灘為台灣海峽南部向東北傳輸沉積物的中繼站而非南北沉積物交會之轉運站。

關鍵字：台灣灘、沉積物、粒徑分佈、沉積物傳輸趨勢分析

海報競賽 PC-G-4

Subantarctic Pacific Foraminiferal Records During the Plio-Pleistocene Climate Transition

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Abstract

The Northern Hemisphere Glaciation (NHG) has intensified around 2.7 million years ago (Ma). Previous research shows synchronous cooling records in the Southern Hemisphere that are consistent with the intensification of the NHG. Southern Oceans are connected by the Antarctic Circumpolar Current (ACC). There are few paleoceanography records from its pathway and is especially lacking the foraminiferal records in the Subantarctic Pacific regions. Since foraminiferal faunal assemblage is considered a relatively reliable physical oceanography reconstruction in the Southern Ocean, we provide foraminiferal faunal assemblage results covering the time interval of 3-2.4 Ma from the sediment cores of International Ocean Discovery Program (IODP) site U1541 (54˚12.756'S, 125˚25.540'W; water depth: 3604 m), which lies in the pathway of the ACC, near the mean position of the Subantarctic Front. Besides, we also provide results of elemental analyses, ice-rafted debris (IRD), and planktonic foraminiferal fragmentation index.

We have defined our research time interval into three periods: oNHG (onset of the NHG) interval (3-2.8 Ma), transition interval (2.8-2.5 Ma), and Subantarctic-dominant interval (2.5-2.4 Ma). Three main species/groups (>5%) are identified in our research, that is, *Neogloboquadrina pachyderma*, *Globoconella* spp. (including *G. puncticulata* and *G. inflata* in this study), and *Globigerina bulloides*. During the oNHG interval, the planktonic foraminiferal composition is quite stable. *Globoconella* spp. is the dominant group in this interval. In the early stage of the transition interval, the relative abundance of *G. bulloides* has grown from 12% to 35%; the abundance of *Globoconella* spp. has dropped from 85% to 50%. In the later stage of the transition interval, the abundance of three major species/groups varies in the glacial-interglacial time scale. In the Subantarctic-dominant interval, the abundance of *N. pachyderma* increases dramatically from 12% to 85%; the abundance of *Globoconella* spp. drops from 50% to 4%. The abundance of *G. bulloides* does not show a significant trend during the Subantarctic-dominant interval. Both planktonic and benthic foraminiferal mass accumulation rate (MAR) records vary significantly in the glacial-interglacial time scale when it comes to the transition interval.

Apart from the assemblage results, during the whole research time interval (3-2.4 Ma), the total organic carbon content shows an increasing trend (0.5-1.7%); the total inorganic carbon and $CaCO_3$ content of the sediment shows a decreasing trend (10-1% and 95-20%). The fragmentation index and IRD MAR are mostly higher in the glacial periods and there are no obvious trends during 3-2.4 Ma. In conclusion, planktonic foraminiferal faunal assemblages in the Subantarctic Pacific have reflected the Plio-Pleistocene climate transition synchronously. The variations of the foraminiferal composition might reflect the seawater stratification or the migration of the Subantarctic Front.

海報競賽 PC-G-5

Impact of liquid CO_2 on sedimentary organic matter: case study from the Southern Okinawa Trough

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Abstract

As part of the back-arc basin of the Ryukyu subduction system, the Southern Okinawa Trough is recognized as a significant repository for sediment and the associated organic matter from the nearby lands. Geochemical anomalies in the sedimentary porewaters of the Geolin Mound (GLM) and Mien-Hua Volcano (MHV) hydrothermal fields indicate the presence of liquid CO_2 impregnation. This study examines the effect of liquid CO_2 impregnation on sedimentary organic matter, with a specific focus on terrestrial organic matter. Compared to the reference sites, the CO_2-rich sediment of both fields exhibited exceptionally high dissolved organic carbon (up to 11 mM), indicating the mobilization of organic matter by liquid CO_2. However, only the CO_2-rich sediment of the MHV had lowered total inorganic and organic carbon. The dissolution of carbonate minerals causes a decrease in total inorganic carbon levels. The downcore decreasing pattern in the stable carbon isotopic values of total organic carbon implies selective preservation or alteration of organic compounds. At both fields, the CO_2-rich sediment showed a downward decreasing trend in lignin concentration. The diagenetic alteration proxy of lignin ((Ad/Al)v) displayed a constant downcore value in GLM but a gentle decreasing trend in MHV. Our results suggest that sedimentary organic matter undergoes extensive alteration or degradation processes under the influence of liquid CO_2 impregnation.

海報競賽 PC-G-6

Reconstructing the OMZ in the east Pacific during the Pliocene using *G. hexagonus*

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Abstract

Exploring the development of Oxygen Minimum Zones (OMZs) during the Pliocene (5.3-2.6 Ma) can provide valuable insights into the effects of ongoing climate change. Previous studies suggest that the planktic foraminifer *Globorotaloides hexagonus* thrives in oxygen-deficient waters, indicating its potential as an indicator for OMZ studies. However, because *G. hexagonus* has not been used very often in paleo-reconstructions, the biogeochemical relationship between *G. hexagonus* and OMZs has not yet been fully explored. In this study, we quantified the abundance of *G. hexagonus* at Ocean Drilling Program (ODP) Site 1241 in the East Equatorial Pacific to determine if a relationship exists between *G. hexagonus* abundance and oxygen concentrations during glacial-interglacial cycles in the Pliocene. Preliminary results show significant variations in *G. hexagonus* abundance, suggesting changes in OMZs. Although the results only cover ~2.55-2.4 Ma, there appears to be a correlation between the trend in *G. hexagonus* abundance and glacial-interglacial (obliquity) cycles. Further work will quantify the abundance of *G. hexagonus* across a wider age range throughout the Pliocene (back to 3.3 Ma) to determine the primary driver of the observed variations. Additionally, we will investigate the pore morphology of *G. hexagonus* tests under different dissolved oxygen conditions and conduct geochemical analyses to determine relative dissolved oxygen levels using the Mn/Ca ratio.

Keywords: Oxygen Minimum Zone (OMZ), Pliocene, *Globorotaloides hexagonus*, Planktic Foraminifer, Paleo reconstruction, East Equatorial Pacific

海報競賽 PC-G-7

Contrasting Sediment Characteristics of Modern and Relict Sediments in the Taiwan Strait

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Abstract

In this study, we investigate the differences in sediment texture and composition between modern and relict sediments in the Taiwan Strait using a multi-proxy approach. This includes analyzing clay mineral assemblage, granulometry, magnetic susceptibility (MS), and carbon data of surface sediment samples.

Long-term sediment transport patterns from the Gao and Collins Model led to a more precise delimitation of the modern sediment deposition centers, where $^{210}Pb_{ex}$ Linear Sedimentation Rates are between 0.6 and 1.2 cm/yr. In the eastern TS, there is a polymodal silt enriched in Chlorite-Illite from Taiwan. The Zhe-Min-TS mud belt is also covered by polymodal silt, enriched in Kaolinite.

On the other hand, the Guanyin Depression is covered by palimpsest bimodal fine sand enriched in Smectite-Chlorite from the distal Changjiang river plume. It also exhibits low $\delta^{13}C$ values, indicating a terrestrial contribution of organic matter. In contrast, Taiwan Banks is covered by palimpsest-to-relict well-sorted bioclastic coarse sand with a high content of Quartz and Illite, along with distinctive high $\delta^{13}C$ values and a low C/N ratio, which implies that the organic matter is predominantly derived from marine sources.

Our future work will focus on using EOF to analyze the co-variability of these parameters. The future analysis will aim to understand the interaction between modern and relict sediments in the Taiwan Strait and their implications for sediment dynamics and environmental changes in the region.

海報競賽 PC-G-8

利用 H/V 頻譜分析方法解析日本熊野弧前盆地淺層地層構造

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探索西菲律賓海床的垂直運動 II:加瓜海脊東側的海床測斜儀觀測
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摘要

本研究應用地震噪訊 H/V 頻譜比分析（Horizontal-to-Vertical Spectral Ratio analysis, HVSR）解析海床淺層構造。當地震波在地層傳播時，剪力波相對壓縮波有更大的波速阻抗反應，並會根據速度阻抗層的深度有似共振的頻率響應，因此將水平頻譜除以垂直頻譜的比值峰值，為震波能量在地層中傳播時共振和重複反射的共振頻率，因此可藉由 HVSR 方法估算沉積層厚度與平均剪力波速。在應用上，HVSR 方法可以使用構造地震事件的能量，或者環境噪訊來討論地層的速度阻抗分佈面，本研究採用後者為訊號分析來源。

本研究使用布放在日本紀伊半島外海的海底地震儀（Ocean-Bottom Seismometer, OBS）陣列，涵蓋熊野盆地及相鄰的南海海槽隱沒帶區域。南海海槽是菲律賓海板塊和歐亞板塊的聚合邊界海溝，熊野盆地為該隱沒系統的弧前盆地，其形成於早更新世，主要沉積物來源為紀伊半島和本州東部的砂質沉積物。一共設置五個測線布放儀器陣列，其中四條測線垂直於南海海槽走向，另外一條則平行布置。根據 HVSR 的曲線峰值，本研究在熊野盆地解析出一到兩個強速度阻抗面，且層厚向岸邊呈增厚趨勢。另一方面，在南海海槽南側的菲律賓海板塊海盆區域解析出三個強速度阻抗面，這現象在鄰近平行測線接近海溝處，都能觀察到相似的層厚變化。在增積岩體的外部斜坡區，測站之間的阻抗沒有單一峰值，呈現複合層的能量反應，可能對應構造發育較密集的地層。

本研究透過 HVSR 分析，配合前人使用地球物理方法和地質鑽探的研究結果，對海床淺層構造進行成像解釋，在熊野盆地區域和過去資料有相似的空間變化趨勢；資料在空間上的變化於深海海床較為連續，增積岩體外部及近陸的斜坡區域則相反。這個結果可能反映出在板塊前緣的構造運動造成的變形，或是斜坡上的沉積物崩移作用。本研究將為隱沒帶淺層地層結構提供從深海海盆到弧前盆地一系列的解析、觀察。

海報競賽 PC-P-1

The physical mechanism associated with the recent AMOC recovery after 2010

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Abstract

Atlantic meridional overturning circulation (AMOC) plays an important role in the meridional heat transport within the Earth's climate system. Recent AMOC recovery after 2010 cannot be well simulated by many OMIP2 models (Tsujino et al, 2020), motivating us to investigate the primary mechanism driving this recovery and interannual variability of AMOC. Some previous studies suggest that the North Atlantic Oscillation (NAO) plays a role in setting surface flux anomalies in deep water formation (DWF) sites. Other studies have found that the AMOC can be significantly affected by reduced vertical mixing at high latitudes, when reducing background diffusivity at high latitudes, the volume transport of the AMOC in the upper 3000 m is increasing accordingly.

We conduct sensitivity experiments using two ocean-sea ice coupled models based on OMIP2 experiments, forced by the JRA55-do dataset (Tsujino et al., 2018), which covers a period from 1958–2018. Based on the sensitivity experiments of TIMCOM and POP2 ocean models, this study suggests that the recent AMOC recovery can be well simulated by reducing the vertical mixing coefficient (VDC) of salinity near the surface. Our research will be divided into two parts, focusing on interannual and mean-state variations of AMOC. For interannual variations, we suggest the enhanced AMOC is explained by the recent cooling event over the North Atlantic, which thermally increased the surface density flux. Our analysis shows that there is a peak when the NAO^+ phase leads AMOC for about 2 years as in surface density flux, which subsequently affects the upper ocean. We also suggest a driving role for the changes in the model' DWF site in the Labrador Sea (LS) region, as positive density anomalies result in deeper Mixed Layer Depths (MLDs). Additionally, we found that both upper ocean density and MLD lead AMOC for 1 year, and both above 95% confidence levels. As for mean-state variations, we zonally average from 60W to 20E and select 27.95 kg/m^3 as the isopycnal surface, finding that reducing VDC makes waters denser north of 45N, especially in the Arctic Ocean. The denser water is transported into the Nordic Seas, pushing up the isopycnal surfaces. It shows the AMOC is enhanced by overflows of the denser water crossing the Denmark Strait, particularly evident in the past decade.

海報競賽 PC-P-2

Statistical features and interpretations of surface mixed layer depths around Taiwan

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計畫名稱：黑潮到紊流之間的能量交換觀測研究－子計畫:台灣東部黑潮流域的表面流場研究
計畫編號：NSTC 112-2611-M-110-019

Abstract

Ocean surface mixed layer is commonly defined as a water layer from the surface to a certain depth range where nearly homogeneous water properties exist. This layer significantly influences heat exchange between the ocean and atmosphere, as well as primary biological productivity. Utilizing data of historical shipborne conductivity-temperature-depth (CTD) profiles from the Ocean Data Bank, we have investigated spatiotemporal variations of mixed layer depths (MLDs) around Taiwan, revealing a pronounced seasonal cycle but with geographical differences. Typically, overall averaged MLDs are about 10 – 55 m depth and deeper MLDs are found in winter. However, sparse observations in winter and uneven data distribution may result in potential biases to properly interpret the long-term trend of MLDs. Our ongoing work examines higher order statistical moments, skewness and kurtosis, to better differentiate patterns that may be hidden using simple averaging. Seasonal and regional comparisons manifest higher kurtosis and skewness during summer than winter. The distribution of summer MLDs shows a clear peak, with a pronounced tail toward the right-hand side, likely due to extreme events causing deeper MLDs. Long-term timeseries of the MLDs reveal a marginal declining trend, suggesting a shoaling MLD with time. However, the obtained statistics is not definitive enough to conclude a meaningful trend nor its implications for climate change. This study aims to provide a large-scale perspective of temporal evolutions and regional differences of MLDs to our research community. We hope to gain more fundamental insights into the intricate dynamics of the ocean surface mixed layer.

海報競賽 PC-P-3

南海內波之調和預報模式應用與實測驗證

Applications of harmonic forecasting of internal waves in the South China Sea and its observational validation

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摘要

內孤立波(Internal Solitary Waves, ISWs)是全球邊緣海常見的海洋物理現象，其中南海(South China Sea)的內孤立波因振幅可達到 100 公尺以上而受到矚目。過去眾多的研究均指出，南海的內孤立波起源於呂宋海峽，正壓潮流與當地的海脊交互作用而生成有潮汐頻率的內波，也就是內潮，因潮流有漲退潮兩相位，故內潮在不同相位時期分別往南海及西太平洋行進，其中往南海行進的內潮進一步因非線性效應演變成內孤立波，一路向西抵達東沙環礁海域。既然內孤立波與規律的正壓潮有關，本研究試圖探討其可預報性，使用由衛星高度計資料經由多元反演(Multivariate Inversion)推算的內潮海表高度(通常小於 10 公分)調和參數，來獲取內潮的時空變化預報，進而推算內孤立波位置，並與 2019 年 5 月由海研三號於東沙環礁海域的航次偵測到內波位置比較。分析發現，航次中觀測到的內孤立波抵達時間有 57%的案例是對應到內潮海表高度由正轉負的時間點附近，此發現有利於未來應用以預測南海內孤立波的發生時間。此對應的可能解釋是，由於內潮的海表面高度與水面下內潮的理論相位差為 90 度，因此內孤波抵達時間對應到的是水下內潮的波峰，由於非線性效應內孤立波的行進速度較內潮快，因此原本應形成於內潮波谷的內孤立波被帶至內潮波峰附近的位置，但此推論需進一步觀察。

海報競賽 PC-P-4

2012-2023 年間黑潮觀測流量變化

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摘要

黑潮自北赤道流的尾端分岐開始生成，沿著菲律賓東岸經過呂宋海峽、臺灣並沿東海大陸棚一路向北直到日本的西南岸最後形成黑潮延伸流。黑潮將熱、水團以及鹽分自低緯度輸送至高緯度海域，對於其流域的氣候、生態甚至環境都有顯著的影響。黑潮也經常受中尺度渦旋影響，近二十年的研究顯示臺灣東側及呂宋海峽黑潮容易受到中尺度渦旋的影響而產生交互作用，造成黑潮流量變化，1996-1998 年間宜蘭海脊南方 PCM-1 測線上的溫度和流速資料對應衛星高度計資料分析，得到黑潮的流量受渦旋作用產生約為 100 天的變化。渦旋中心挾帶的水團會影響黑潮的水團特性，進而影響黑潮的斜壓性，透過改變黑潮的密度面坡度來改變黑潮的流量。黑潮流量改變也受雙渦旋之間輻合向黑潮/輻散離黑潮流的影響，造成黑潮流量增加或減少在。此研究使用於臺灣東部海域所進行的黑潮流量觀測整合計畫 KTV1 測線(由花蓮至 123°E)所得到的 32 個航次船測水文與流速資料作為基準，首先使用渦旋偵測系統協助辨別觀測資料下的黑潮是否受渦旋的影響，再將其流場的動力模態分解，來探討渦旋對於黑潮流速剖面的影響及 2012 至 2023 的十年之間黑潮產生的變動。水文資料透過使用熱力風方程式，並以實測資料水深 850 公尺之流速為參考流速來計算，結果顯示黑潮流量值在 13.09-35.21 Sv (1 Sv = 10^6 m^3 s^{-1})之間，平均流量則為 20.62 Sv。氣旋渦(反氣旋渦)的影響下黑潮東側等密度線有著+10(-10)公尺的垂直位移，此斜壓性改變造成的平均流量改變約為 3.83(-2.97) Sv。

海報競賽 PC-P-5

台灣西南海域反氣旋式渦旋之研究

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摘要

過去的研究顯示，當黑潮流經呂宋海峽時常進入南海而形成套流(loop current)，該套流可能脫離黑潮，進一步於臺灣西南海域發展成反氣旋式中尺度渦旋(anticyclonic mesoscale eddy)。為了解此渦旋之性質與特性，本研究使用衛星高度計資料，首先以形成於 2022 年 11 月的渦旋進行個案分析，我們發現此渦旋呈現頗為對稱的圓形，直徑約 200 公里，表面流速約 0.5 m s^{-1}，其相對渦度（relative vorticity, ζ）約為 0.3 倍的行星渦度（planetary vorticity, f），自形成之始，幾乎呈現停滯狀態，以 119°E, 21.5°N 為其中心位置，停留約 1 個月後才向南海西南方向移動，並於隔年 3 月潰散，生命週期 4 個月。在進一步統合分析 2000 年 1 月至 2024 年 1 月，24 年間的資料發現，渦旋的強度與冬季時東北季風於臺灣西南外海因地形造成的風應力旋度（Wind stress curl, WSC）有關，且此渦旋的強度具有明顯的年際變化，且此年際變化與聖嬰現象(El Niño–Southern Oscillation, ENSO)有相對應的關係。

海報競賽 PC-P-6

EM-APEX Float 上測量海表面波
(Surface Wave Measurement at EM-APEX Floats)

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摘要

EM-APEX float(Electromagnetic Autonomous Profiling Explorer，電磁自主剖面探測器)為一種自主化水下觀測載具，可利用海水的導電性，透過兩對互相垂直的電極(electrodes)量測海水運動造成的變化，並以電壓的形式儲存。機體上掛載的溫鹽深儀(CTD)、加速度儀、磁力計，可協助分析海水運動在三維空間上的變化。此研究利用 2 支 EM-APEX float，量測 2023 年 6 月位於西北太平洋的渦漩東方的海氣交互作用動力過程。根據臺大海研所許哲源教授在 2021 年提出的研究方法，我們可利用 EM-APEX float 量測到的電壓資料得到海水水平運動的流速。其中的高頻訊號可用來推估海表面性質。同時，儀器上所搭載的加速度儀可量測海表面波造成的垂直加速度。換言之，綜合 EM-APEX float 上量測的資料，可以得出海表面波的一維頻譜。研究結果顯示在相對的平靜的海面上(示性波高<2 公尺)，利用 EM-APEX float 水平流速資料分析出的頻譜結果與垂直加速度計資料分析出的頻譜結果差異甚大。未來將嘗試修正加速度資料，以得到較精確的觀測結果。

海報競賽 PC-P-7

The physical mechanism associated with the recent AMOC recovery after 2010

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Abstract

Atlantic meridional overturning circulation (AMOC) plays an important role in the meridional heat transport within the Earth's climate system. Recent AMOC recovery after 2010 cannot be well simulated by many OMIP2 models (Tsujino et al, 2020), motivating us to investigate the primary mechanism driving this recovery and interannual variability of AMOC. Some previous studies suggest that the North Atlantic Oscillation (NAO) plays a role in setting surface flux anomalies in deep water formation (DWF) sites. Other studies have found that the AMOC can be significantly affected by reduced vertical mixing at high latitudes, when reducing background diffusivity at high latitudes, the volume transport of the AMOC in the upper 3000 m is increasing accordingly.

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海報競賽 PC-P-8

從 EM-APEX Float 運動觀測內孤立波造成的劇烈垂直速度

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摘要

內孤立波為內潮經一系列非線性作用而演生的產物，其中內部遠超其他海洋現象的高垂直流速為其一鮮明的特徵，本研究透過 EM-APEX Float 儀器在海水中垂直運動速度(dP/dt)的劇烈變化來分析出內孤立波的訊號。本研究以南海海盆區域為研究場域，資料來源為 EM-APEX Float 在 2022 年 3 月 12 日至 29 日為期 18 天漂流觀測所蒐集的水文資料。EM-APEX Float 在海水中垂直方向上的移動會透過調整自身相對周遭海水的浮力，而產生不同於背景海流的垂直移動，並且此過程會造成儀器的旋轉，也就是如果儀器在水中運動的過程中遇到如內孤立波等高垂直流速並且發生頻率低的海洋現象，則儀器會出現有高垂直運動速度但低旋轉速度的較為異常的訊號。換言之，假設海水週期性運動的訊號(如全日潮)在長時間資料的平均下可以被移除，我們可以迴歸統計旋轉速度與儀器在水中相對背景海流的垂直移動速度。本研究會根據上述兩者之間關係的統計結果，來找出發生異常垂直運動速度的資料段，在去除掉訊號來源較複雜的混和層內部和儀器自行大幅調整浮力的深度範圍後，我們有機會判斷是否為內孤立波經過的訊號。未來工作將會再進一步進階分析該處的各水文結構，來驗證此方法之可行性。

海報競賽 PC-P-9

透過古生物歪型海膽於大滅絕存活之案例 探討結構物外形對流場之影響

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摘要

古生物歪型海膽在面臨造成大滅絕之洪水時，因其特殊外型，相較於一般形狀之正型海膽有更高之存活率。本文旨在透過模擬與分析歪型海膽的特殊外型對流場的影響，以及其減緩周圍海砂局部沖刷的機制，以借鑑於現今海事與橋梁工程之基礎局部沖刷問題。

鑑於歪型海膽周圍之三維流場與局部沖刷時產生之強烈紊流，本文於數值模式方面選擇 Splash3D 模式。該模式求解三維 Navier Stokes 方程式，並以 LES (Large Eddy Simulation)大渦模擬閉合紊流模型，此外，本模式還利用 VOF (Volume of Fluid Method) 流體體積法追蹤各流體之介面，以及考慮到海膽有潛沙之特性，使用了 DBM (Discontinuous Bi-viscous model) 非連續雙黏性流模型以此描述底床泥沙之流變行為。

本研究採用潰壩方式模擬海膽所受之強烈水流，並僅專注於海膽的外形對流場的影響。考慮到歪型海膽的形狀不對稱，海膽面向水流和背部面向水流所受到的影響不盡相同，以及海膽埋沙深度和角度亦會影響周遭流場變化，因此本研究將海膽固定在同一位置，只探討其外形所帶來的影響。模擬結果顯示，當歪型海膽背部面向水流時，對流場及局部沖刷的干擾較少。相對於正型海膽，歪型海膽在流場中對於流場及底床的干擾較小，其下游處所產生的局部沖刷坑也較小，這使得歪型海膽更不易受到水流沖走。

透過定床沖刷模擬分析海膽周圍的流場及壓力變化，與動床沖刷模擬相互對應，分析了泥沙受流場影響之沖刷機制。本研究結果顯示，歪型海膽的特殊外型確實使其於面臨水流沖擊時具有較好的優勢，並可藉由此特殊外型機制，減緩海事或橋梁工程所面臨的局部問題。

海報展示摘要

海報展示 PC-OC-1

臺灣長期社會生態核心觀測—西南海岸站

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計畫名稱：臺灣西南海岸長期社會生態核心觀測站
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摘要

長期社會生態核心觀測（Long-Term Social-Ecoloigcal Research; LTSER）之西南海岸站成立，主要是臺灣西南海岸為沿近海養殖漁業的要地，因時代變遷快速，近半世紀漁民主要生計-養殖漁業面臨重大變革與衝擊，漁民生活場域（Lebens Field）受到政策、資本主義及氣候變遷等三大引力的驅動牽扯，必須連結社會及自然科學的方法，跨領域的長期監測當地的社會經濟結構，以及漁業資源和生態系統服務的健康。調查地點以七股地區為主，環境生態項目有七股潟湖之水質、底質及漁撈生物，還有海岸變遷的遙測資料，社會科學的方法為透過利害關係人訪談及問卷調查，並槓桿漁業經濟及人口組成等外部資料，以瞭解七股地區潟湖生態系統與漁村社區發展的健康情形，預期目標是為當地社區提供科學依據的基線資料，對漁業資源、環境變化、土地利用及社會結構進行全面性的監測及分析，評估人類活動對生態系統的影響，以及氣候變遷對生態和社會的影響，以期提出有效的方案來促進漁村社區發展及漁業資源生態的永續共榮之道。並且建置資料庫及資料網站將監測資料共享，讓公民團體參與關注，吸引國家單位及學術研究資源投入，還有國內外LTSER各站間的橫向分析及合作，產生出集體共識，找出永續發展的政策方針。

海報展示 PC-OC-2

新海研二號貴重儀器中心海洋溫室氣體領域發展現況

Current development status of marine greenhouse gases field in precious instrument center of new ocean research vessel No. 2

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摘要

新海研二號貴重儀器中心是以支援海洋生地化領域研究導向為主的研究中心，其支援項目包括海洋水文生物化學分析、海洋有機物分析、海洋溫室氣體分析、海洋浮游生物分析等四項。在海洋溫室氣體分析領域中，現階段已建立酸鹼度自動分析儀、總檢度/無機碳自動分析儀、走航式水下二氧化碳分壓自動偵測儀、碳化學錨錠探針、錨錠式水質自動監測儀及氣相層析儀等關鍵設備的日常性維運與操作。可攜式溫室氣體自動偵測儀及水下螢光反應探針兩項設備尚在測試中，並委請廠商增添部件。在關鍵技術能量之研發，現階段以建立海洋溫室氣體所需之關鍵技術為重點。目前已完成建立碳化學自動分析所需之光學法、滴定法及庫倫計算法、溫室氣體分析之氣項層析法，及現場水質及碳化學自動監測技術之電極法、螢光法及氣相層析法。特別是現場水質及碳化學自動監測系統之關鍵技術研發，為國內海洋界首度建立支援沿岸地區長時間監測海洋環境變動之關鍵設施與技術，回傳數據可即時反應當地海水酸化特徵及海洋碳匯現況，進行預防性處置。未來將逐步建立現場溫室氣體自動監測及現場水下螢光偵測技術等所需之關鍵技術，以提升現場即時數據取得的量能。在服務成效方面，112 年度計畫至今平均每月協助 368 個海洋溫室氣體樣品的分析。

海報展示 PC-OC-3

新海研二號貴重儀器中心海洋浮游生物領域發展現況~全尺寸海洋浮游生物觀測技術

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摘要

本中心於建置 112 年 10 月與 11 月分別添購由 YOKOGAWA 公司生產型號 FlowCam-8400 之流式細胞攝錄儀、以及 HYDROPTIC 公司生產 Zooscan 浮游動物掃描儀。透過國科會海洋學門公告各界後，於 113 年 1 月 25 日完成對外公開的教育訓練。配合中心已經建置的流式細胞儀(Beckman Coulter 公司生產型號: CytoFLEX-S)，三台儀器配合下，檢測目標大小可以由海洋病毒橫跨至大型浮游動物、仔稚魚，達成全尺寸海洋微生物的數量、種類組成與多樣性的半自動化觀測，減少人工顯微鏡觀測時間。對於近年來全球關注的海洋微生物碳通量傳遞，提供準確快速的技術分析。過往能量傳遞通常針對一兩層大小階層不同的餌料與攝食者之間數量變化計算碳傳遞，現在可以計算全尺寸的微生物碳通量，了解微生物食物網的交互影響關係，放眼國內外海洋界，擁有分析全尺寸浮游生物技術者，極其少有。三台機器在檢測完成設定檢測標準流程後，已經開始提供檢測服務。除開發海洋生物觀測技術外，同時也將技術延伸至分析海洋有機顆粒。包括生物膠體、海洋雪花、塑膠微粒等顆粒，進行數量與體積大小的計算，並提供清楚的顆粒照片，以利後續服務海洋有機顆粒及碎屑等相關研究。

海報展示 PC-OC-4

新海研 2 號貴重儀器中心海洋有機物領域發展現況

Current development status of marine emerging containment analysis in Precious Instrument Center of New Ocean Research Vessel No. 2

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計畫名稱：國家新研究船船隊貴重儀器及資料庫使用中心計畫-新海研 2 號研究船貴重儀器使用中心補助計畫
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摘要

新海研 2 號貴重儀器中心海洋有機物領域目前運行儀器，分別為總有機碳分析儀(TOC)、元素分析儀(EA)、熱裂解氣相層析質譜儀(Py-GC-MS/MS)與微奈米顆粒篩選儀(AF4)，提供海洋學界有機物的總量、元素組成、各類有機物鑑定與定量、微奈米有機物粒徑篩選之樣品分析服務。在技術研發方面，現階段以建立海洋新興污染物分析平台所需之關鍵技術為重點。目前已建立微米及奈米塑膠定量分析方法(一次質譜法，GC-MS)和有機磷酸酯(organophosphate esters，OPEs)阻燃劑定量分析方法(串連質譜法，GC-MS/MS)。OPEs 分析技術已實際運用淡水流域至河口海域分布現況的研究，結果顯示 OPEs 總濃度以溶解相最高，濃度介於 1.9-160.9 ng/L，為主要貢獻來源，顆粒相濃度為 0.2-13.9 ng/L，表層沈積物 OPEs 濃度則介於 0.1-3.1 ng/g 之間。海域的 OPEs 主要來源為淡水河輸入，此外，八里污水廠放流管附近海域水體較高的 OPEs 濃度，顯示污水場可能為另一個 OPEs 的來源。此外，本中心除了發展海洋有機物及新興污染物分析技術外，其他學界關切之有機物分析技術，如藻類或微生物之胞內及胞外分泌及代謝體等，亦能依需求合作發展。

海報展示 PC-OC-5

勵進研究船支援臺灣海洋研究，航向帛琉推動科學外交
TORI's R/V LEGEND Holds Open Day in Palau, Enriching Science Diplomacy

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摘要

臺灣四面環海，國家科學及技術委員會(簡稱國科會)大力支持海洋研究，並積極推動海洋科技外交，委由國家實驗研究院台灣海洋科技研究中心(TORI，簡稱國研院海洋中心)支援「航向藍海」計畫、「西北太平洋海洋藍碳整合研究」計畫和「黑潮與紊流能量交換整合計畫」等，與國立臺灣海洋大學、國立臺灣大學、國立臺灣師範大學、國立成功大學、中華民國海軍軍官學校、國立中山大學與帛琉國際珊瑚礁中心等跨國、跨校及跨單位所組成的跨領域團隊，一同航向帛琉。

2023 年 6 月 23 日自台南安平港啟航，為期 43 天的聯合探測航次，順利完成三個海洋科學探測航次作業，包含執行海面波浪海底地形衛星遙測任務、中尺度海洋渦旋研究與海洋藍碳研究所需相關水文資訊量測等，期間安排靠泊邦交國帛琉之馬拉卡爾港(Port of Malakal, Palau)兩次，進行航次任務整備與生活物資補給等，並於 7 月 21 日舉辦「勵進」研究船開放參觀活動，讓帛琉政府官員與民眾能近距離了解臺灣頂尖海洋研究船之探測量能及成就。該航次創下臺灣籍研究船(勵進)首次航抵邦交國帛琉並推動科學外交之紀錄，更象徵「勵進」支援臺灣海洋科學研究邁向全球海洋，實現航向藍海的一大步；睽違 8 個月，2024 年 2 月 25 日「勵進」再度航向緯度 5 度執行水文探測任務，在這為期 29 天的航期，順利完成沉積物收集器的 24 小時佈放作業與稀釋培養實驗、基礎生產力的現地與甲板培養，同步進行溫鹽深儀(CTD)採水、拖網、重力岩心採樣器等採樣作業。

「勵進」研究船連續兩年航向帛琉，成功開啟臺、帛雙方的海洋科學對話，亦展現出「勵進」在臺灣參與國際海洋科學合作中所扮演的重要角色，為「勵進」邁向國際研究續寫新篇章，這也意味著 TORI 與各方合作夥伴在期間付出了相當之努力與心血。期望能藉此促進臺灣和帛琉在海洋科學研究上持續合作，激發更多海洋科研人員的熱情參與。TORI 將繼續與國內外科學團隊並肩合作，共同探索藍海的奧秘，並為兼顧環境保護與海洋資源發展做出積極貢獻。

謝謝科學團隊邀請 TORI 參與計畫，謝謝駐帛琉大使館與帛琉政府的全力支持，也深深感謝所有參與帛琉航次、幕前幕後優秀的 TORI 與各方合作夥伴們，更加期待下一個階段的任務。

關鍵字：「勵進」研究船、科學外交、二訪帛琉、航向藍海、海洋藍碳。

海報展示 PC-OC-6

勵進研究船溫鹽深儀及採水系統專屬佈放回收系統簡介
The CTD Launch and Recovery System (LARS) on R/V Legend

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摘要

為有效降低 CTD 作業於海上的探測風險、提升採樣品質與效率，台灣海洋科技研究中心於 109 年度提出 CTD 及採水系統專屬佈放回收系統（以下稱 CTD LARS 系統）建置計畫，以「主甲板 CTD 功能改裝技術服務」與「主甲板 CTD 功能改裝」兩案方式進行，盼在專業技師輔助下，依中心科儀團隊之實務經驗完成最適合勵進研究船使用的 CTD LARS 系統；並於 111 年 5 月完成實海測試；今年 1 月正式於航次任務中服務學界。此 CTD 佈放回收設備亦是國內首先建置的 LARS 系統。

過往勵進研究船使用多工能絞機配合後 A 架或側 A 架進行 CTD 及採水作業，佈放及回收過程中，需要使用回收勾及人力帶纜以確保 CTD 安全進出甲板，在海況稍差時偶見驚險狀況。CTD LARS 系統使用專屬絞機及吊臂配合泊頭（Docking Head）固定，進行佈放與回收 CTD，減少人力施作比例，可避免海況或風浪不佳時科儀人員因作業造成之安全危害。

海報展示 P-OCA-1

Critical transitions in empirical dynamic modelling

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Abstract

Real-world systems often exhibit complexity and dynamics, characterized by nonlinearity, posing challenges for comprehension through linear statistical methods. Nonlinear statistical approaches, such as empirical dynamic modelling (EDM), employ techniques like state space reconstruction—embedding time series data into lagged coordinates—to grasp system dynamics without presupposing governing equations. EDM, exemplified by methods like S-map (sequential locally weighted global linear map), facilitates the elucidation of interactions within intricate dynamical systems by reconstructing high-dimensional, time-varying interaction networks without explicit equations.

Moreover, a consensus emerges regarding real-world systems featuring critical thresholds, known as tipping points, where sudden shifts to distinct states occur. Given the abrupt and elusive nature of critical transitions, predicting their onset becomes paramount. Herein lies the challenge: identifying early warning signals within EDM frameworks.

One potent early warning signal, the dynamical eigenvalue (DEV), rooted in bifurcation theory, estimates the system's dominant eigenvalue. DEV derives from local systems Jacobians, estimated via state space reconstruction (SSR), without necessitating equilibrium value calculations. Illustrating DEV's efficacy, I present its behaviour and prediction capabilities concerning calcium carbonate ($CaCO_3$) abundance at the conclusion of the greenhouse Earth era. This indicator's applicability extends to diverse real-world multivariate datasets, facilitating critical transition prediction.

海報展示 P-OCA-2

Embryonic developmental stages of hydrothermal vent crab *Xenograpsus testudinatus* from Turtle Island, Taiwan

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Abstract

The present observation was made with the aim of studying the pre-embryonic development of a highly unique hydrothermal vent crab species, *Xenograpsus testudinatus*, to reveal their hidden secret of developmental stages. Therefore, we are currently observing that the newly brood and spawned eggs were dark gray before embryos appeared, and after embryos developed inside the egg, they had a round and golden yellowish-colored pattern. During their development stages, the yolk granules became denser and gathered into the center of the egg. After that, the gastrulation was depleted with the remaining small yolk droplets located in the cephalothorax. The eyes with an oval shape were completely differentiated and fully pigmented, and the number of chromatophores increased and the color intensity was higher. Then, the embryos moved violently, and occasionally twitching was observed, along with morphological changes in size and the abdomen of zoeal stages. Later, the appearance of brown pigments on the dorsal side of the embryo's abdomen and the spine was clearly observed. The diameter of the freshly laid egg was 33.31±2.01 µm. Interestingly, we noted multicellular differentiation with rounded shapes and deep golden yellow, brownish yellow, and orange in color. During day 5, the inner developing embryos were visible, with expanded values of sizes around 41.02±1.21 µm. During this stage, the yolk granules became transparent, and the appearance of segmentation was clearly exposed. The appearance of dense and clear formations of eye spots was noted. After that, on day 6, the appearance of appendages and the formation of dorsal spines were noted, along with the development of mallipeds I, II, pleopods, telson, lateral knob, etc. During this period, vigorous swimming movements were noted. The histological observations of pre-embryonic developmental stages are under process, and significant changes in their development stages are under process.

Keywords: *Xenograpsus testudinatus*, Embryo, development, Turtle Island, Taiwan

海報展示 P-OCA-3

An initial exploration of the influence of submarine groundwater discharge on the microbial communities of the intertidal zone

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Abstract

The submarine groundwater discharge (SGD) refers to the phenomenon where fresh water from the land flows underground towards the ocean. Groundwater typically has low salinity, high nutrients, and slightly acidic water quality. The SGD often affects the activity of organisms and marine ecosystems, and may even alter the stability of ecological systems. The Liuqiu island, located in the southwest of Taiwan Island, is the only coral reef island in Taiwan. The coral reefs on the island have slightly different environments from east to west, with slightly higher coverage on the eastern side and abundant algal communities. In past surveys, numerous SGD points were found around the island, where dense algal growth was observed.

We collected 12 sediment samples from potential SGD sites in the intertidal zone surrounding the Liuqiu island and conducted 16S rRNA fragment sequencing, along with measuring relevant environmental parameters of water samples. Using NMDS and RDA analyses, we explored the relationship between microbial composition at each sampling site and environmental parameters. The results revealed that samples Duo_fws and Duo_P separated from other sites, with phosphate, silicate, and nitrate + nitrite being the main factors causing this grouping. Furthermore, comparing the results of PCA clustering with environmental parameters, we found that the SGD at Duziping influenced the distribution of environmental parameters and microbial composition. However, the microbial composition at the other three sites with SGD was closer to those without groundwater seepage. Through preliminary experimental results, it was found that SGD in the intertidal zone of the Liuqiu island affects microbial composition. Further investigation is needed to understand the extent, mechanism, and conditions of SGD influence.

海報展示 P-OCA-4

Genetic structure and diversity of the red big eye *Priacanthus macracanthus* in Northwest Pacific

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Abstract:

Understanding the genetic diversity and structure is an important component of management for the fisheries resources. Our study examined the population genetic structure, diversity, and demography of the red big eye *Priacanthus macracanthus*, one of the most important commercial species in West Pacific, using the sequences of mitochondrial DNA cytochrome b gene (1,141bp). In all, 206 samples were collected from nine locations, and 101 haplotypes were obtained. All haplotypes were divided into two sympatric haplogroups (A and B), but haplogroup B displayed a higher proportion in each population, excluding the population in South Sea. The results imply that these two haplogroups are not only genetically distinct, but also ecologically distinct populations. Our study suggests that sea level fluctuations, and changes in environmental factors affected diversification. Compared with the results from different analyses of demographic history, our study proposed that the population declined greatly in haplogroup B and the population size of haplogroup A was constant. These results offer important resources for management and further study.

Keywords: *Priacanthus macracanthus*, Phylogeography, Mitochondrial cyt*b*, Demography

海報展示 P-OCA-5

海水表層水溫對抹香鯨出沒之影響

Effects of sea surface temperature on sperm whales occurrences

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摘要

抹香鯨(*Physeter macrocephalus*)為全球分布的大型齒鯨，在 18-20 世紀捕鯨年代因為鯨油而成為主要獵捕物種，造成族群數量急遽下降，至今在 IUCN 保育名錄等級仍列為易危(VU)。臺灣東部海域從 1998 年開展的海上鯨豚調查偶有抹香鯨出沒的紀錄，但僅為夏季偶而少見的目擊種類，而近年來抹香鯨的目擊頻度增加，在 2020-21 花東海域的穿越線調查中，抹香鯨的發現率可達每百公里 0.45-0.74 群次。賞鯨活動中抹香鯨的目擊也達 2- 5.4%的鯨豚群次目擊比例。抹香鯨出現頻度增加的可能原因包含: 數量增加更為常見，環境改變而更為近岸，有特別的生活史需求而近岸。由於北太平洋抹香鯨數量的估算並未有證據顯示數量增加，因此主要測試環境因子是否有變化，討論與抹香鯨出沒的關聯。

使用花蓮海域賞鯨航程中記錄的目擊資料，分析 1998-2022 年抹香鯨出沒的頻度，早期從 1998-2015 年平均每 100 航次可目擊 2.5 群次，而 2016-2022 年為 6.3 群次。配合 MODIS 衛星資料分析海面溫度(SST)，目擊率較高的年份與海面溫度較高有關。水溫變化的影響可能是對於抹香鯨主食的魷魚較有影響，觀察抹香鯨時也有排便的紀錄，顯示抹香鯨於此區有進食的證據。花東海域夏季出沒的南魷(*Sthenoteuthis oualaniensis*)的分布受到海面溫度為主要變因之一，但是否受到其他基礎生產力升降的影響仍需要進一步的分析。

海報展示 P-OCA-6

運用 eDNA 元條形碼探究海洋保育區內外的魚類群落變遷

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摘要

魚類群落是評估海洋生態系健康的關鍵，但傳統以潛水觀察或捕撈作業進行評估的作法不只耗時耗力，也可能會對生態造成干擾。eDNA 元條形碼技術是一種從環境樣本中取得生物 DNA，再透過高通量定序獲得序列資料，用以偵測物種的新興技術。為了瞭解 eDNA 元條形碼技術是否能夠有效監測魚類群落的時空變遷，本研究在基隆市望海巷潮境海灣水產動植物繁殖保育區、大坪海岸與長潭里漁港三地收集海水樣本，利用 MiFish 通用引子針對 12S rRNA 基因片段進行序列擴增，並使用 MiFish pipeline 平台進行分析。結果顯示長潭里漁港的群落以鯛科、鯖科、鯵科等高經濟價值魚類為主，但在潮境保育區與大坪海岸則以雀鯛科、鸚科、三鰭鸚科等礁岩性魚類為主。進一步比較潮境保育區與大坪海岸的差異，保育區內偵測到較多的隆頭魚科和鰯科。此外，本研究也觀察到各調查地點內的魚類群落變化。相較於大坪海岸，潮境保育區內的物種組成季節性變化較大，可能與保育區較豐富的生態功能有關。在長潭里漁港，群落組成隨月份而變，反映漁撈行為對水體 eDNA 造成的影響。綜合而言，即使在數公里內的空間尺度下， eDNA 仍能夠有效揭露棲地與季節之間的魚類群落變遷，深入了解海洋保育區內外的生態動態，並為漁業活動提供高解析度資料。

海報展示 P-OCA-7

海洋生物保育之冷凍基因庫技術之創新突破

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摘要

生物多樣性的維護至關重要，但目前眾多海洋生物族群因全球環境變遷的關係正在消失當中，本研究研發雷射機輔助裝置運用於玻璃化長期冷凍基因庫低溫保存及後續雷射激光回溫技術。經開發雙夾輔具裝置，並以玻璃化載體作為樣本支架，可使海洋生物之配子、胚胎和幼生能夠在不受到環境溫度影響下進行玻璃化長期基因庫冷凍保存及後續的雷射激光回溫。本研究結果顯示，我們自行設計之第二代及第三代雷射激光擊發精確度平均可達 75% 及 90%，並且對體積小於 1 微升的樣本玻璃化效率可達 60%。但這些速率也可能會受到玻璃化溶液濃度和操作技術掌握程度等因子的影響。本研究在全球冷凍保存領域為重大突破。

海報展示 P-OCA-8

2022-2023 年臺灣南部海域死亡擱淺海龜之死因探討
Causes of mortality in sea turtle strandings in southern Taiwan (2022-2023)

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摘要

據海保署統計於 2022-2023 年間全臺(含離島)海龜擱淺通報共有 636 件，其中活體擱淺有 148 件，488 件為死亡案件。擱淺海龜種類有綠蠵龜、玳瑁、欖蠵龜、赤蠵龜及革龜。因海龜多在水面以下生活，能被接觸到的機會很少，因此救傷中心的獸醫師與研究人員，在面對生病擱淺或野外死亡通報的海龜時，恰可增進我們對於海龜擱淺或死亡原因之瞭解。本研究是為了解臺灣南部海域死亡海龜之原因探討，進而提供活體擱淺海龜救傷之醫療及海龜保育工作相關資訊。我們將死亡海龜個體以腐敗狀況進行分級，取第二類級之個體進行剖檢與獸醫病理學檢查。海龜解剖病理學判讀後，將死因分為:感染原因(有細菌、黴菌或寄生蟲)；生理因子(為非感染因素，如腫瘤、氣泡栓塞、出血)；外部創傷(背/腹甲破裂、異物纏繞)；內部創傷(異物阻塞、線性異物、魚鉤或其他因素造成之消化道穿孔或壞死)；其他死後變化或未見異常者則歸納為未知等 5 類。結果方面，總計剖檢來自臺南(2 隻)、屏東(18 隻)、臺東(23 隻)、高雄(9 隻)及雲林(1 隻)等區域共 53 隻海龜，其中以綠蠵龜(37 隻)為最常見的海龜。在海龜性別比例方面，其中雄性海龜有 14 隻、雌性為 36 隻與無法判定其性別(因死後變化)者 3 隻，性別比約為 1:3(雄:雌)。統計本次 53 隻海龜，其感染因素死亡佔 36%、背甲破裂及誤食異物之內外創傷佔 23%，其他非感染因素佔有 15%，未知則有 26%。本次發現因外創傷而死亡的海龜共有 6 隻(5 隻綠蠵，1 隻玳瑁)，其中 5 隻海龜來自屏東。這些資料可做為南臺灣海域海龜保育工作之參考資訊。

海報展示 P-OCA-9

桃園藻礁附著性無脊椎動物之入添模式

The recruitment of sessile invertebrates in Taoyuan algal reef

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藻礁是鈣化藻體遺骸與週遭表層無脊椎動物膠合加上礦化作用所形成，為有機及無機物質結合的生物礁體，而入添(recruitment)為推動群集動態變化的重要關鍵之一，研究附著性無脊椎動物的入添模式能了解當地環境對幼生擴散與成體分布的影響，因此本研究利用藻礁本身地質獨特的特性探討附著性無脊椎動物的入添模式。

本研究以陶片附著板作為附著性無脊椎動物附生基底，放置於觀新藻礁區與大潭藻礁區，各劃設 3 條測線，分取低和中潮位樣點。自 2022 年秋季開始每季放置，於放置時間點半年後與一年後回收，同時測量水體之溫度、鹽度、酸鹼值、溶氧、懸浮固體含量等環境因子。附著板生物於實驗室進行物種辨識並記錄數量、覆蓋率與環境因子進行分析。本研究目前已完成四季的附著板設置並回收 2022 年秋、冬、春季放置半年與一年、夏季放置半年的附著板。

使用變方分析結果，地點及季節兩因子對於物種數的數量有顯著影響，物種數量則以環節動物多毛類與節肢動物藤壺為優勢類群。比較 G2(大潭藻礁區)及 KS(觀新藻礁區)的秋、冬、春季放置半年組，物種豐度(Species Richness)及覆蓋率皆為春季組大於冬季組大於秋季組，顯示於春季入添的生物種類及數量較高。結合環境因子的多變量分析結果，水溫及 pH 值為與物種分布相關性最高的兩因子，且物種分布多以季節分群。呈現藻礁地區的物種間因不同季節造成的環境差異而呈現季節性入添差異。

本研究結果可獲得藻礁地區不同時空之附著性無脊椎動物多樣性資料及各物種入添模式，推估影響生物入添的因子，增加藻礁地區生物保育及利用價值。

關鍵詞：藻礁、附著性無脊椎動物、入添

海報展示 P-OCA-10

海報展示 P-OCA-11

Entropy-based methods for automatic detection of dolphin whistles in coastal underwater soundscapes: A comparative study

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Abstract

Passive acoustic monitoring of cetacean vocalizations provides valuable information on their presence and habitat use. This study aimed to evaluate the performance of two entropy-based methods, permutation entropy (PE) and amplitude-aware permutation entropy (AAPE), for automatically detecting dolphin whistles in long-term underwater recordings from coastal areas of southwestern Taiwan. PE considers the arrangement structure of signals, while AAPE additionally incorporates amplitude information. The detection performance was assessed using manually-inspected ground truth data from 5-minute recordings in Yunlin (147 whistles) and 1-hour recordings in Anping (24 whistles). In Yunlin, PE and AAPE detected 58 and 82 whistles, respectively, with AAPE exhibiting a lower false alarm ratio (31%) compared to PE (82%). This difference is attributed to AAPE's sensitivity to whistle amplitudes, enhancing their prominence amidst ambient noise. In Anping, both methods initially detected 18 whistles out of 24 ground truth, but AAPE had a higher false alarm ratio (67%) compared to PE (18%), likely due to interference from snapping shrimp sounds. Simulations confirmed that high numbers of snapping shrimp clicks reduced the detection efficiency of AAPE. To address this issue, a click-removal function in Adobe Audition was applied to the Anping recordings. Post-processing, both PE and AAPE detected 18 whistles, with the false alarm ratio of AAPE decreasing to 33%. While AAPE theoretically performs better in low signal-to-noise conditions, the current results suggest it is more sensitive to impulsive noise like snapping shrimp clicks compared to PE. In conclusion, this study demonstrates the potential of entropy-based methods for automated dolphin whistle detection, but also highlights challenges posed by interfering sound sources in real-world recordings. Further work is needed to refine the algorithms, reduce false positives, and validate performance on larger datasets across a range of signal-to-noise ratios. With additional development, these techniques could become valuable tools for large-scale acoustic monitoring of cetaceans.

海報展示 P-OCA-12

Biodiversity Exploration of Scaphopoda around Taiwan

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計畫名稱：深海生物多樣性探勘（第三階段）：邁向新視野(3/3)
計畫編號：112-2611-M-002-025

Abstract

Scaphopoda is a marine molluscan class found worldwide, with individuals inhabit soft substrates on the seafloor ranging from subtidal to offshore zones. Members of Scaphopoda are widely known for their tusk-like shells and specialized burrowing foot. This class comprises 577 extant species in 45 genera, 12 families, and two orders: Dentaliida and Gadilida. Despite being relatively common compared to some other marine invertebrates, scaphopods are notably understudied, particularly in Taiwan, where their diversity may have been underestimated. According to the Taiwan Malacofauna Database and the Catalogue of Life in Taiwan, 33 scaphopod species are currently recorded in the surrounding waters. In this study, we aim to explore the biodiversity of Scaphopoda around Taiwan by examining specimens collected during five oceanographic expeditions conducted from 2019 to 2022. Morphological and molecular examinations identified the 985 collected specimens belonging to 11 groups, classified under nine currently recognized genera in five known families. Distribution data of collected specimens reveals that offshore waters between Yilan and Hualien, beyond the estuary of the Heping River, have the highest abundance of scaphopods. Additionally, the northern waters of Green Island harbor the highest diversity of Scaphopoda. Our findings have unveiled five additional genera that were not previously recorded, suggesting that the diversity of Scaphopoda in Taiwan surpasses previous estimations. Given the infaunal nature of scaphopods, research on these organisms is crucial for enhancing our understanding of marine benthic conservation efforts.

海報展示 P-OCA-13

Contrasting carbon cycling in the benthic food webs between river-fed, high-energy canyon and upper continental slope

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計畫名稱：Fate of Terrestrial/Non-terrestrial Sediments in High Yield Particle -Export River-sea Systems (FATES-HYPERS)
計畫編號：NSTC 112-2611-M-002-011

Abstract

The Gaoping Submarine Canyon (GPSC) off Southwest Taiwan has been extensively studied due to its unique geology, the role of transferring terrestrial material to the deep sea, and diverse biological communities. However, there is a lack of understanding of carbon cycling across the sediment-water interface in the canyon. This study aims to fill the gap by utilizing the field data collected between 2014 and 2020 and linear inverse model (LIM) to reconstruct the benthic food web (i.e., carbon flows through different stocks) in the head of GPSC and the upper Gaoping slope (GS). The biotic and abiotic organic carbon (OC) stocks were significantly higher on the slope than in the canyon, except for the bacteria stock. The sediment oxygen utilization was similar between the two habitats, but the magnitude and distribution of the OC flow in the food web were distinctively different. Despite a significant input flux of ~2020 mg C m^{-2} d^{-1} in the canyon, 84% of the carbon flux exited the system, while 12% was buried. On the slope, 84% of the OC input (~109 mg C m^{-2} d^{-1}) was buried, and only 7% exited the system. Bacteria processes play a major role in the carbon fluxes within the canyon. In contrast, the food web in the upper slope exhibited stronger interactions among metazoans, indicated by higher fluxes between meiofauna and macrofauna compartments. Network indices based on the LIM outputs showed that the canyon head had higher total system throughput (T..) and total system through flow (TST), indicating greater energy flowing through the system. In contrast, the slope had a significantly higher Finn cycling Index (FCI), average mutual information (AMI), and longer OC turnover time, suggesting a relatively more stable ecosystem with higher energy recycling. Due to sampling limitations, the present study only represents the benthic food web during “dry” period. By integrating the field data into a food web model, this study provides valuable insight into the fates of OC cycling in an active submarine canyon, focusing on the often overlooked benthic communities. Future studies should include “wet” period sampling to reveal the effects of typhoons and monsoon rainfalls on OC cycling.

海報展示 P-OCA-14

魚苗密度對存活率及多樣性之影響—以無機營養鹽養殖法為例

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摘要

水族展示作為教育資源是現今全球的趨勢, 然而展示的觀賞魚多為野外捕撈且難以人工繁養, 倘若能突破此瓶頸, 則能大大降低展示教育所造成的生態破壞。

本研究採用無機營養鹽施肥法, 在海水中添加無機鹽以控制氮磷比, 並加入微量鐵, 使藻類自然增生, 提升水體的浮游植物數量, 供給多樣的餌食給予剛出生的魚苗, 令其存活率提升。為進一步了解魚苗密度與浮游生物密度的關聯，及其對魚苗存活率的影響，甚至在混養的情況下, 魚苗密度的高低與魚種多樣性的關係, 本次研究分別在春季進行 2 次、冬季 1 次 14~15 天的養殖實驗。實驗中以高密度(H 組 4000-5000 顆卵/噸水)及低密度(L 組 500 顆卵/噸水)進行比較, 將兩組的氮磷濃度皆控制在 7:1 的比例(氮 700 μg/L，磷 100μg/L)，每日監測水質, 確保添加無機鹽不會對水質造成影響。魚卵取自國立海洋生物博物館主珊瑚池。

結果顯示, 兩組的葉綠素 a 濃度無顯著差異。浮游動物密度僅第 3 次實驗有較明顯差異, 且 H 組消耗較快。存活率部份, 雖然在第 3 次實驗中, 魚苗可能受到冬季水體蒸發率較高的影響, 鹽度節節升高, 導致整體存活率僅在 1%左右, 但其餘 2 次實驗皆有超過 3%的存活量, 且最高接近 10%。統計亦顯示兩組間無顯著差異, 表示無機鹽施肥法能供給魚苗足夠的食物, 且不受魚卵密度的影響。物種數的部份, 第 1 次實驗結果 H 組與 L 組的存活魚種數分別為 9 及 6 種, 第 2 次為 8 及 4 種, 以此 2 次的實驗結果看來, 高密度養殖較可以養出不同種類的珊瑚礁魚苗。

海報展示 P-OCA-15

Constructing an Indo-Pacific humpback dolphin (*Sousa chinensis*) ethogram using Unmanned Aerial System (UAS) footage

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Abstract

Unmanned Aerial Systems (UAS) are an emerging tool that provides a new perspective on wildlife observation, which complements existing methods. With the numerous coastal developments in the critical habitat of Hong Kong resident Indo-Pacific humpback dolphins (Sousa chinensis), the vulnerable animals are under threat. Behavioural studies, therefore, provide an insight on the species' status and aid conservation planning. In this study, an ethogram for humpback dolphins in Hong Kong waters was constructed using aerial footage collected by UAS. From March 2021 to August 2023, opportunistic UAS footage was taken when humpback dolphins were encountered during vessel surveys in Lantau waters. The footage obtained was used to construct an ethogram of the population by categorising and describing the recorded behavioural events. It was found that more behavioural events, including those underwater but still visible, could be recorded and a more detailed description of the behavioural events was made possible with the use of UAS. The ethogram constructed can enhance the current behavioural observation by enriching it with the new viewing perspective, and pave the way for a better understanding of the behaviour of coastal cetacean species under threats from human activities.

海報展示 P-OCA-16

臺灣周圍海域頭足類無鬚亞目及閉眼亞目幼生與環境因子之關係

Cephalopod paralarvae species (Incirrata and Myopsina) and their relationship with environmental factors in Taiwanese waters

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計畫名稱：頭足類幼生資源調查與環境變遷之關係、臺灣周邊海域頭足類幼生相調查_近岸底棲型

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摘要

臺灣近岸海域為章魚、烏賊、軟絲、鎖管等頭足類的重要產區，但目前對於臺灣頭足類分布的紀錄仍以成體為主，幼生的紀錄則極為缺乏。因此本研究與行政院農業部水產試驗所合作，配合臺灣周邊海域漁場環境監測計畫於周圍海域進行季節性的浮游動物採樣，並從中挑選頭足類幼生進行研究。透過分子證據，探討臺灣周圍海域頭足類幼生物種紀錄及形態特徵，並了解其分布及成長發育情形。本研究於 2020 年夏季至 2022 年春季共五季中採集約 1157 隻幼生個體，其中無鬚亞目與閉眼亞目共 148 隻。根據分子證據顯示總計採集到 3 種槍魷科、17 種章魚科、2 種船蜷科、1 種水孔蜷科頭足類幼生。影響幼生分布最主要的環境因子為深度及海水表面溫度（SST）。集群分析結果亦顯示主要可區分為兩群，大致以東北-西南向海域為交界，其交界深度約 100 m。SST 則受到季節及緯度的影響，在春季水深較深的東至西南海域，物種以扁船蜷 (*A. argo*) 與 *A. abaculus* 為主；而較淺的澎湖至西北海域冬、春季有較低的 SST 以中華蜷 (*O. sinensis*)、劍尖槍魷 (*U. edulis*) 及 Octopodidae sp. 2013Kam14 為主，有較高 SST 的夏季則以鹿兒島蜷 (*A. kagoshimensis*) 為主。根據臺灣北部劍尖槍魷文獻指出，性成熟個體主要出現於春秋兩季，本研究於春季在北部樣站捕獲數隻劍尖槍魷幼生，證實其利用北部海域作為產卵場的推測。臺灣西北、澎湖海域為底棲性章魚出沒熱點，但東部之黑潮影響區仍可採得底棲性章魚如條紋蜷 (*A. marginatus*)、藍蜷 (*O. cyanea*) 的擬浮游幼生，推測除了來自地形抬升的蘭嶼綠島海域，不排除南方海域順流黑潮而來的可能。此外本研究的參考序列也不乏來自印尼、日本甚至是僅記錄於關島、夏威夷水域的物種，顯示擬浮游幼生可能透過海流擴展其地理分布，並具有區域性及季節性的差異。

海報展示 P-OCA-17

以富磷改變氮磷比對不規則盤珊瑚生理反應的影響

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摘要

氮磷營養鹽是珊瑚生長的必要元素，但同時也是促成珊瑚衰退的原因之一。自然情況下珊瑚礁水域多為貧養環境，然而隨著沿岸開發和人為活動影響，沿岸營養鹽輸入增加，越來越多實驗證實養分的富集可能為珊瑚帶來正面或負面的影響，進而影響珊瑚在逆境的生存表現，其中氮磷比可能是影響珊瑚生理的關鍵。本實驗在氮磷皆富集的條件下，欲探討不規則盤珊瑚 *Turbinaria irregularis* 對養分富集的生理反應。實驗分為控制組和三個處理組：固定氮的濃度（6 μM NH_4^+），增加或減少磷的濃度（0.2μM、0.5μM、2μM PO_4^{3-}）以改變氮磷比，每組處理三重複。實驗期間測量珊瑚的浮力重量、光系統 II 的光化學效率（F_v/F_m），同時利用圖像判定珊瑚的色階變化。實驗結束後，測量珊瑚的共生藻密度和葉綠素甲濃度。經過十五天不同氮磷比處理的養分暴露，結果顯示短期的養分富集會滋養共生藻，且平衡的氮磷比會讓珊瑚在生理上有更好的表現。隨著陸域持續輸入營養鹽進入珊瑚礁水域，了解珊瑚對營養鹽的反應有助於珊瑚礁水質管理和珊瑚的保育，幫助珊瑚在氣候變遷中的生存韌性。

海報展示 P-OCA-18

Exploring the biodiversity and phylogeny of Caymanostellidae (Asteroidea: Velatida): A new record from the Nan'ao Basin

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計畫名稱：深海有機質落生物多樣性探勘與其依附生物之拓殖與演化(III)

計畫編號：NSTC 112-2611-M-291-004

Abstract

The family Caymanostellidae (Asteroidea: Velatida) comprises a group of sea stars that exclusively live attached to the sunken wood laying on the deep-sea floor. Currently, only seven species in three genera are recognized, with both records and samples being quite scarce. The diversity, phylogeny, and evolution of species within this family remains largely unknown. We aim to conduct a comprehensive survey of its biodiversity in the Indo-West Pacific (IWP) region, followed by the study of the taxonomy and phylogeny within this family. A new record of Caymanostellidae sp. was collected from the Nan'ao Basin at a depth of 3,575 m in 2022 by deep-sea trawling using R/V NOR1. Phylogenetic analyses are reconstructed based on the sequences of the newly collected species with those available in GenBank for other known genera within the Caymanostellidae family, the remaining three families within the order Velatida, as well as controversial taxa from the Valvatida. Combining with morphological and ecological evidence, hidden diversity within this family is revealed in the IWP region. Specimens from other IWP regions will be further included in our study for a precise taxonomic aspect. An integrative approach of systematic analysis based on the molecular, morphological, geographical, and ecological consideration will later be conducted.

海報展示 P-OCA-19

魚類環境 DNA 高通量分子條碼技術用於臺灣鯨豚多樣性及生態監測之可能性探討

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計畫名稱：112-113 年臺灣海域重要生態系調查及生態服務價值評估
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摘要

臺灣目前研究鯨豚物種組成與空間分佈的主要方法為調查擱淺與漁業混獲標本、船上目擊調查，以及水下聲學調查，而環境 DNA 高通量分子條碼技術（environmental DNA metabarcoding）作為新的偵測工具，具有以下優點：對海上調查人員的專業度較無需求、易偵測行蹤與聲音隱蔽的物種，並且可同時偵測採樣點的鯨豚與魚類物種，提供鯨豚與魚類物種空間分佈相關性的資訊。本團隊於 2021–2023 年利用環境 DNA 技術調查臺灣周邊海域的魚類空間分布，同時偵測到鯨豚物種達 250 次以上，共偵測到 24 種鯨豚，分屬於五個科（鬚鯨科、海豚科、鼠海豚科、抹香鯨科、喙鯨科）。其中總共有 17 種鯨豚被成功鑑定至種級，佔臺灣至 2019 年紀錄過的 32 種鯨豚的一半以上，前五名最常被偵測到的物種為熱帶斑海豚（*Stenella attenuata*）、寬吻海豚（*Tursiops truncatus*）、弗氏海豚（*Lagenodelphis hosei*）、印太瓶鼻海豚（*Tursiops aduncus*）與長吻飛旋海豚（*Stenella longirostris*）。本團隊亦在 2023 年夏天於澎湖外海偵測到臺灣西部海域未曾目擊過的物種角島鯨（*Balaenoptera omurai*）。本研究使用共現網路分析（Co-occurrence network analysis），發現 34 科、61 種的魚類與至少一種鯨豚存在顯著的共現關係，表示其可能與鯨豚有生態上的關聯性。環境 DNA 方法目前的有限之處則包含難以估計族群大小、DNA 序列資料庫內容有限而無法將部分物種鑑定至種級，以及使用的引子對（primers）可能無法對所有目標物種的基因片段進行複製。未來可進一步探究環境 DNA 方法作為臺灣鯨豚多樣性調查的主要或輔助工具的實用性。

海報展示 P-OCA-20

Exploring genetic diversity and population structure of the Little Tern (Sternula albifrons) in Taiwan based on mtDNA and ddRAD sequencing data

以粒線體 DNA 及雙限制酶切位點標定法探究臺灣小燕鷗的遺傳多樣性及族群結構

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計畫名稱：深海生物多樣性探勘 (第三階段): 邁向新視野
計畫編號：111-2611-M-002-025 -

摘要

In this study, Little Tern (*Sternula albifrons*) populations in Taiwan are examined based on two different types of data: mitochondrial control region DNA sequences and double digest restriction-site associated DNA (ddRAD) sequencing data. Feather samples were collected from 59 chicks across four known breeding colonies located on the eastern (Yilan and Hualien) and western (Penghu and Changhua) coasts of Taiwan. The results obtained are consistent in analyses and do not cluster into two geographical groups with respect to the eastern and western Taiwan. Furthermore, AMOVA analyses and pairwise ΦST/FST estimations based on both types of data reveal little to no differentiation among populations and between groups. The findings of this study suggest high population connectivity among Taiwan's breeding colonies. Additionally, control region sequences of Taiwan's Little Terns are compiled with those from Japan deposited in GenBank to compare genetic diversity and examine for phylogeographic breaks that could shape the diversity pattern of the species in eastern Asia. The resulting haplotype network does not clearly separate Taiwanese and Japanese populations, but the three most common haplotypes are prevalent for mainland Japan, Okinawa, and Taiwan. Little Tern populations may be frequently connected, but with some restrictions on gene flow causing moderate to great differentiation among the three. This is further supported by AMOVA analyses, pairwise ΦST estimations, and pattern of positive yet significant isolation by distance.

海報展示 P-OCA-21

Composition and Distribution of Floating Debris in Surrounding Waters of Taiwan

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Abstract

Marine floating debris is widely distributed in the global oceans. It poses not only aesthetic concerns, leading to a diminution in recreational values of the oceans, but also environmental and economic threats, severely impacting the biodiversity of marine ecosystems, fishery production, and vessel navigation safety. Well-documented negative interactions between marine debris and marine organisms include entanglement or ingestion of litter fragments, leading to mortality among sea turtles, marine mammals, and seabirds. Also, marine floating debris serves as a vector for the spread of algae, invasive species, and bacterial pathogens. In short, marine floating debris has caused significant socioeconomic and environmental impacts in the world's oceans.

Despite the growing concerns, research on floating marine debris monitoring in Taiwan's waters is relatively insufficient. Therefore, we conducted at-sea visual surveys onboard the New Ocean Researcher 1 (R/V NOR1) of National Taiwan University. The surveys followed the Marine Debris Monitoring and Assessment guidelines from the National Oceanic and Atmospheric Administration (NOAA) and spanned 12 research cruises from July 2019 to December 2023, comprising 114 observations. The total survey area covered approximately 11.71 km^2, with a total length of 1869.63 kilometers. We found that plastic debris accounted for 72% of the total marine debris in the surrounding waters of Taiwan. Particularly in the southwestern waters of Taiwan, plastic debris accounted for 79%, indicating the most severe pollution. Understanding the composition of floating marine debris can help identify its possible sources and potential impacts on marine ecosystems. This study provides reports on floating marine debris, contributing to future initiatives for identifying, monitoring, and cleaning up marine debris.

海報展示 P-OCA-22

A preliminary examination of the diversity of Tanaidacea (Crustacea: Peracarida) associated with coral reef and rocky shore habitats from Taiwan and the surrounding seas

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Project Title: the Higher Education SPROUT Project-Diversity of Peracarids in Sediment from Subtidal Coral Reefs on the Different Marine Environments of Taiwan
Project Number: 112L4000-1

Abstract

Tanaidacea, a significant order within Peracarida, boasts over 1,500 confirmed species, inhabiting diverse marine benthic environments worldwide. Despite their ecological importance, knowledge gaps persist in understanding their diversity and habitats. Research in Taiwan and nearby waters since the 2010s has unveiled nine new species and two new records across ten genera within seven families, primarily linked to coral reefs and rocky shores in eastern Taiwan. Furthermore, three new species from the Paratanaoidea superfamily were discovered in the South China Sea's coral reefs. Among these, five species—*Chondrochelia taitungensis*, *Paraleptochelia setosa*, *Synapseudes hansmuelleri*, *Zeuxo shitipingensis*, and *Zeuxo zorro*—dominate microhabitats like macroalgae, sand piles, and polychaete tubes, making up around 95% of total abundance on rocky shores in eastern Taiwan. Variations in species abundance and community structure stem from differing rock formations, microhabitat availability, and species behaviors. This study offers a comprehensive species list for Tanaidacea and investigates their microhabitat associations in Taiwan's rocky intertidal macrofauna.

Keywords: Apseudomorpha, Tanaidomorpha, Taxonomy, diversity, microhabitat association

海報展示 P-OCA-23

小魚總動員：探索仔稚魚的分布與多樣性

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摘要

仔稚魚為魚類的幼稚階段，為魚類早期生活使階段的漂浮性魚類，各鰭部尚在發展階段而史的一棟能力不佳（丘, 1999）。本研究在 112 年冬季、112 年春季及 112 年夏季，以 500μm-mesh, 135cm ring net，1m/s 的拖網速度，從 200m 水深往上斜拖至表水（若水深少於 200m，則下放至離底 20m）進行仔稚魚的採樣，並分析台灣周邊海域仔稚魚的群聚指數（abundance）、豐富度（richness）、香農多樣性（shannon diversity）及皮洛均勻度指數（Pielou's evenness）。結果顯示，在 112 年冬季總共採集 446 尾仔稚魚，包含 61 科 110 屬 149 種；112 年春季總共採集 379 尾仔稚魚，包含 57 科 109 屬 115 種；112 年夏季時總共採集 1305 尾仔稚魚，包含 76 科 150 屬 180 種。不同季節間，仔稚魚的群聚指數、香農多樣性及皮洛均勻度指數並無顯著差異，但在物種豐富度上存在季節上的顯著差異。不同海域間，仔稚魚僅在群聚指數有顯著差異，其餘均無海域間差異。另外，以相似性分析（Analysis of similarities）檢視仔稚魚在種別層級的群聚結構，發現在季節間存在顯著差異，且在冬季及春季時存在海域間的差異。總體而言，在 112 年冬季及春季採樣之仔稚魚總量相差不大，僅夏季之總量略高，可見台灣周圍海域仔稚魚來源尚稱穩定。但細究海域、季節、物種組成之差異，將可進一步了解不同類群之仔稚魚發育至入添的重要棲地位置和季節，有助規劃保育策略。

海報展示 P-OCA-24

海洋微塑膠：肉眼看不見的威脅

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摘要

塑膠是海洋垃圾的主成分之一（Galloway *et al*., 2017），經物理及化學作用崩解下分解成小塊狀，稱為微塑膠（Cole, 2014）。本研究在 111 年春季、111 年夏季、112 年冬季、112 年春季及 112 年夏季，使用 CTD 輪盤採水器搭配採水瓶，針對臺灣周邊海域進行海洋微塑膠/人造物的蒐集及分析，以了解微塑膠/人造物在各季節（春季、夏季、冬季）、各海域（北部、東部、西部）、各水層（表層、葉綠素最大層、中間層、底層）下的分布狀態，並針對微塑膠/人造物的型態（纖維狀、碎片狀、球狀）進行分析。研究結果指出，微塑膠/人造物數量在不同季節、不同水層下有顯著差異。綜合五季來看，111 年春季及夏季以北部海域之微塑膠/人造物濃度較高，112 年春季及夏及以東部海域之微塑膠/人造物濃度較高，112 年冬季則以西部海域之微塑膠/人造物濃度較高。微塑膠/人造物的型態在各季節、各水域及各水層下均以纖維狀佔據多數，且均無球型微塑膠/人造物。其中纖維狀微塑膠/人造物來源可為沿岸紡織工業所排放之廢水（Zubris *et al*., 2005）、家庭洗衣所排廢水（Napper *et al*., 2016），甚至是廢棄或流失漁具。因此，應更加重視紡織工業排水的處理及漁具回收或流失的狀況，並可進一步針對纖維狀微塑膠/人造物的材質做進一步的分析。

海報展示 P-OCA-25

潮境海灣的生態系統服務

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計畫編號：111-P-40

摘要

日益頻繁的海上活動及更加劇的海洋資源利用，使沿海生態系遭受更多來自於人類活動的曝險（exposure），因此迫切需要人為干預以防止不可逆的損害。生態系統服務是指在生態系中，人類直接或間接獲得來自生態系的所有福利，這些服務包括漁業捕撈、觀光遊憩、海岸保護等。海洋保護區（Marine protected area）的劃設經常引起漁業與保育兩個目標之間的衝突，使用生態系統服務進行評估則可以提供決策者一個評估的工具。本研究將評估強化的海洋保護區管理對生態系統服務的影響。研究地區為位於臺灣東北角的望海巷潮境海灣，這裡包含了潮境與瑞芳兩個保護區，共設定四種情境：現況、發展、保育、計劃管理，來分析海灣的生態系統服務的變化。結果顯示，保育和計劃管理情境可有效降低棲地風險，甚至計劃管理情境在僅微幅加強管理的情況下瑞芳保護區的棲地風險相較現況下降 70%、潮境保護區則下降 10%，然而，這種改善可能造成其它種類服務的損失，例如觀光服務的減少；相反地，在發展情境下降低管理力度會對兩個保護區都增加約 120%的棲地風險，卻能微幅提升觀光服務。總體來說，本研究強調綜合生態系統服務評估的框架和情境分析的重要性，也強調了需要細緻、靈活的管理策略，以在保育和人類需求之間取得平衡。

海報展示 P-OCB-1

Preliminary investigation of Brachyuran crab larvae in the Chiku Lagoon, Taijiang National Park, Southwestern Taiwan

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Abstract

Chiku Lagoon, located in Taijiang National Park, is a semi-enclosed shallow coastal lagoon connected to the Taiwan Strait by two narrow inlets. The lagoon's primary freshwater sources are the Chiku River and Daliao Creek. Based on previous surveys with bottom trawl, Taijiang National Park's marine area boasts 62 Brachyuran crab species, 21 of which belong to the family Portunidae. Notably, *X.hastatoides*, *P.sanguinolentus,* and *M.argentata* are dominant. Chiku Lagoon identifies 12 species: 11 from the family Portunidae, including *P. pelagicus, S.serrata, and S.paramamosain,* and one species from the family Varunidae. The reported link between the life cycles of certain Brachyuran crabs and lagoon environments has prompted this research. This study focuses on the abundance and composition of Brachyuran crab larvae, emphasizing the role of Chiku Lagoon as a nursery ground for Portunid crabs. Zooplankton samples were collected monthly at four distinct locations within Chiku Lagoon using a NORPAC net (330 μm), from November 2022 to February 2024. Eight families of Brachyuran crabs were identified based on larval morphology, which exceeds the reported family number of adults. The superfamily Grapsoidea and the families Ocypodidae and Pinnotheridae were found in every sampling month. Corystidae were present in August, September, and October; Leucosiidae and Xanthidae were present in April, October, and November; Calappidae were only found in July; and Varunidae were found in January. The analysis of crab larvae abundance across different months revealed the highest and the lowest average abundance in August (73.361 ind/m^3) and June (1.566 ind/m^3), respectively. A higher abundance of initial-stage larvae showed the importance of Chiku Lagoon as a nursing ground for brachyuran crabs. Future work will continue monthly zooplankton sampling and identify economic-valuable Portunidae crab species using DNA barcoding technique.

Keywords: Chiku lagoon, Brachyura, crab larvae, Portunidae

海報展示 P-OCB-2

臺灣沿近海南海帶魚之生殖生物學研究

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摘要

帶魚屬(Trichiurus)魚類為臺灣沿近海域重要的經濟性魚種之一，2022 年帶魚產量佔全國沿近海漁業總產量 7%，為僅次於鯖科(41%)、鯵科(14%)的第三大重要經濟性魚種。本研究主要針對臺灣沿近海域的南海帶魚(*Trichiurus nanhaiensis*)進行生殖生物學分析。採樣期間自 2019 年 11 月至 2023 年 10 月，總共蒐集南海帶魚 3753 尾樣本，肛前長(PL)介於 94.4 – 609.0 mm，平均值為 277.4 ± 76.3 mm；體重(BW)介於 11.1 – 2960.9 g，平均值為 375.5 ± 350.7 g。雌魚 1973 尾，雄魚 1766 尾，性別不明 14 尾，雌雄性比為 52.6 %(雌魚數/(雌魚+雄魚))。經由生殖腺指數 GSI 及各月份生殖腺成熟比例推估，南海帶魚為生殖高峰為 4 至 6 月，50%性成熟肛前長雌性為 423.6 mm、雄性為 326.0 mm。

海報展示 P-OCB-3

Microplastic ingestion in larval fish in the laboratory research and the coastal waters of Qieding, Taiwan

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計畫名稱：臺灣周邊海域仔稚魚攝食微塑膠之評估：野外暨實驗室研究（Ⅱ）

計畫編號：NSTC 112-2611-M-291-003

Abstract

Microplastics (MPs) have been documented in marine environments worldwide, where they pose a potential risk to biota. Coastal shelf seas are rich in productivity but also experience high levels of MP pollution. In their early life stages, planktonic fish larvae are vulnerable to pollution, environmental stress and predation. To date, the effects of MP ingestion in fish are still unclear. Marine fish eggs and larvae is a crucial part in the recruitment, but environmental interactions between MPs and lower trophic organisms are poorly understood. Here we assess the occurrence of microplastic ingestion in wild fish larvae. Fish larvae were taken across eight sites (approximately 1–3 km from shore) in the coastal waters of Qieding, Taiwan from June to October 2023. We identified 22.45% of fish larvae (n = 49) had ingested microplastics, of which were mainly fibres in shape (100%), clear in colour (100%), and 0.5–5 mm in size. Ingestion was observed in five species: blenny (*Omobranchus* sp., n = 3), goby (Gobiidae sp., n = 1), silver grunt *(Pomadasys argenteus*, n = 1), Bali sardinella (*Sardinella lemuru*, n = 5) and weedy stingfish (*Scorpaenopsis cirrosa*, n = 1). MPs analysed by Fourier Transform Infrared Spectrometer (FT-IR) were confirmed to be polymeric, identified as polyester. Furthermore, this study used polyethylene microplastic beads (PE 100–125 µm and 250–300 µm) to conduct exposure experiments on the eggs and larvae of the juvenile clown anemonefish (*Amphiprion ocellaris*). Fertilized eggs were exposed from 18 hours post-fertilization until hatching, and the larvae were exposed on the 10 day post hatching (10 dph) and 20 dph. Both the larvae and juveniles were exposed for 5 days. The concentrations of MPs were 0 p/m^3 (control group), 10^4 p/m^3 (1× concentration group), and 10^5 p/m^3 (10× concentration group), with a temperature control of 26 ± 0.5 °C. The mortality rate of *A. ocellaris* juveniles in the 10× concentration group was significantly higher ($p < 0.05$) than in the other groups. The results indicate that an increase in MPs concentration may lead to higher mortality in larvae and juveniles. More than 80% of the MPs were excreted within 2 h of ingestion. This study provides baseline ecological data illustrating the probability of MPs ingestion in marine larval fish in the Taiwan seawater, which could have an adverse effect on fish health as well as marine biota.

Keywords: Microplastic ingestion, Larval fish, Retention, Taiwan seawaters

海報展示 P-OCB-4

Diversity and antimicrobial activity of bacteria from cultured corals

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Abstract

A combination of culture-based and metagenomic approaches was used to characterize bacterial communities associated with five corals, *Sinularia heterospiculata*, *Sinularia cristata*, *Sinularia wanannensis*, *Fimbriaphyllia paraancora*, and *Sarcophyton glaucum*, cultured in the same tank at the Husbandry Center of the National Museum of Marine Biology and Aquarium (NMMBA) in Taiwan. A total of 160 bacteria were isolated, among which 12 isolates (7.5%) exhibited antimicrobial activity against at least one indicator pathogen using the agar block method. Phylogenetic analysis of the 16S rDNA sequences indicated that these isolates belong to the following five bacterial genera: *Bacillus* (4), *Rossellomorea* (3), *Pseudovibrio* (2), *Vibrio* (2), and *Leisingera* (1). Three isolates, namely SH-1-MA-4, SC-2-SYP-4, and SW-2-SYP3-1, which exhibited high antimicrobial activity, were considered good candidates for further research on natural product isolation and characterization. To understand the diversity of bacterial flora associated with corals, we also investigated coral samples using 16S rDNA high-throughput sequencing. A total of 751,421 sequences were obtained and clustered into 2,771 amplicon sequence variants (ASVs). These ASVs were assigned to 38 bacterial phyla and revealed an abundance of phyla Proteobacteria (28.1%), Bacteroidota (13.7%), and Acidobacteriota (10.9%). A multidimensional scaling (MDS) plot of similarity between ASVs obtained from corals revealed that the three *Sinularia* species have a similar bacterial composition compared to other corals. Our results demonstrate that cultured corals have high bacterial community diversity and these bacteria could be a source of bacterial strains with great potential in the discovery of medically useful molecules.

海報展示 P-OCB-5

Seagrass Distribution in Zenhai Harbor, Penghu, Taiwan

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Abstract

In response to Taiwan's policy of achieving net-zero emissions by 2050 and considering the future carbon trading market, there is an expectation to reduce emissions and adapt to climate change impacts through the carbon sinks of natural ecosystems. Blue carbon ecosystems are one such solution. Seagrass beds, one of the three major blue carbon ecosystems, not only sequester carbon but also mitigate the crisis of rising sea levels, making them crucial ecosystems for island nations. This study, conducted in 2023 at Zhenhai Bay, Penghu County, Taiwan, investigated the carbon sequestration data of the dominant seagrass species, *Halophila ovalis*, and *Halodule uninervis*, as well as other biological and environmental factors. The study revealed differences in seagrass coverage throughout the seasons, with the highest coverage observed in winter (CT1- *Halophila ovalis*: 37.77±23.06%, ZH- *Halodule uninervis*: 47.25±17.77%, JM- *Halodule uninervis*: 44.02±17.77%, CT2- *Halodule uninervis*: 43.19±15.86%) and the lowest in summer (ZH- *Halodule uninervis*: 28.78±9.58%, CT2 *Halodule uninervis*: 25.81±17.93%, JM- *Halodule uninervis*: 23.44±7.32%, CT1- *Halophila ovalis*: 22.1±18.55%). The annual carbon sequestration rate of *Halophila ovalis* is 0.88 ~ 1.91 tons C ha^{-1} yr^{-1}, while *Halodule uninervis* is 1.02 ~ 1.20 tons C ha^{-1} yr^{-1}. The total annual carbon sequestration in Zhenhai Bay, Penghu County, is 52.43 tons C yr^{-1}.

Key words: Seagrasses, Penghu Islands, Carbon sink, *Halodule uninervis*, *Halophila ovalis*

海報展示 P-OCB-6

Habitat utilization and movement behavior of dolphinfish in northwestern Pacific Ocean using pop-up satellite archival tags

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計畫名稱：使用漁業依賴及漁業獨立資料解析臺灣東部鬼頭刀棲地偏好

計畫編號：NSTC 112-2611-M-056-001

Abstract

Dolphinfish (*Coryphaena hippurus*) are an abundant, wide-ranging epipelagic predatory fish found in tropical, subtropical and temperate waters. The species is highly migratory, and is caught by many coastal fisheries of countries throughout its range and also exploited. Understand the ecology informing establish important ecological information and more informed and efficient management strategies. Based on the 5 to 42 days-at-liberty records of pop-up satellite archival tag (PSATs) attached on the dolphinfish in the northwestern Pacific Ocean. Dolphinfish linear displacements ranged from 28 to 296 km from deployment to pop-up locations, and visited depths between 0 to 250 m and experienced temperatures from 21 - 30.5°C. Obvious daily vertical patterns were observed for dolphinfish dove deeper and for longer durations during nighttime than daytime and active primarily at mixed-layer depths and spent>50% of their time near the surface and warmer waters, and the depth distributions appeared to be limited by 6° changes in temperature gradients. Vertical movement patterns of dolphinfish were surface dive, v-shaped dive, and w-complex dive. W-complex pattern occurred at night whereas the other patterns are mostly representative of daytime activity. Our results provide vertical distribution patterns of dolphinfish in a location that supports important fisheries. This information will establish ecological data needed for stock assessments, which support the sustainable use of this species.

海報展示 P-OCB-7

藉由個體辨識與賞鯨目擊資料解析臺灣東部海域抹香鯨生態
Assessing sperm whales through photo-identification and sighting records in the eastern waters of Taiwan

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計畫名稱：海洋綠洲東海岸鯨類保育計畫

摘要

黑潮海洋文教基金會於 2021 年啟動抹香鯨（*Physeter macrocephalus*）個體辨識（Photo-identification）計畫，將 1999 至 2016 年透過花蓮港賞鯨、石梯港賞鯨，以及往年東部海域系統性調查所蒐集的抹香鯨的影像進行比對。主要透過尾鰭特徵，本會至今共識別出 41 隻抹香鯨個體，並且發現部分抹香鯨每隔數年就會來到臺灣東部海域。藉由解說員提供的早期底片影像，我們發現一隻抹香鯨 KU_PM008（花小清）最初到最近一次目擊間隔長達 20 年，是目前臺灣追蹤時間最長的一隻抹香鯨。分析本會開放之賞鯨目擊資料，抹香鯨每年較常於花蓮近海出現的月份為 6-10 月，並以 7 月為高峰，而目擊海域的平均深度落在 1,711 m (95% CI = 1,612-1,809) ；在所有抹香鯨目擊中有 21.4% 有發現母子對，同時也有在少部分影像中記錄到抹香鯨排泄，顯示有覓食的情形。綜合目前分析的結果，我們認為夏季的東部海域對於抹香鯨來說是重要的育幼及覓食場域，未來本會將針對這片海域申請 IUCN 海洋哺乳動物重要棲息地（Important Marine Mammal Areas），以維護牠們的生存環境。同時若能有更多小尺度的環境因子圖資如：水表葉綠素、表層水溫等資料能夠支持，將會有助於未來建立抹香鯨及其他物種的物種分布模型（Species distribution modeling）。

海報展示 P-OCB-8

以單離技術獲取馬祖海域優勢矽藻種類之基因體資料

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計劃名稱：以高通量定序解析骨藻在藻華過程中感受環境營養鹽變化之調適機制
計畫編號：MOST 109-2628-M-019 -001 -MY4

摘要

馬祖地處東海海域閩江河口，相對其他亞熱帶海域具有較高的初級生產力，其中在春、夏兩季常有矽藻藻華發生，主要以骨藻屬 (*Skeletonema*) 是優勢矽藻種類。由於骨藻是全球沿海分佈廣泛的矽藻屬，且在各地經常被報導形成藻華出現，因此成為在浮游植物生態上廣泛研究的矽藻種類之一。然而骨藻體型小且外表型態相似，在顯微鏡下不易以矽殼形態特徵區分種類，且同一海域中常有不同種的骨藻一起出現，因此運用分子生物技術便成為鑑別骨藻屬種類及探討其如何適應環境變化生理生態相關研究的方法之一。近年來隨著基因定序儀的快速演進，全基因體定序則成為發展分子生態學的重要基礎。為建立馬祖骨藻種類的全基因體資料庫，在本研究中除了以純種分離培育方法，取得純化馬祖骨藻種類之基因組 DNA;另一方面也分離單串野外骨藻細胞，配合全基因組擴增法(whole genome amplification-X,WGA-X)，直接以單串細胞擴增基因體 DNA 的方式來獲取定序基因體所需之基因組 DNA，來解決部分骨藻種類難以在實驗室大量純種培養的限制。其中，以純種培養方式獲得骨藻全基因體定序共有兩株，由次世代及第三代定序經組裝後和基因庫對比得知為 *S. tropicum* 和 *S. dohrnii*。而在單串細胞擴增後由次世代定序所獲得 DNA 序列，經親緣關係樹檢視發現獲得與 *S. tropicum* 相似之基因體序列。兩方法皆可獲得馬祖海域骨藻種類之基因體資料，以純種培養方式獲得基因體資料量較高，但方法上較耗時；相對以單串細胞擴增所獲得的 DNA 品質通常較差，但毋須經過大量培養。這些由當地物種所建立的全基因體資料庫將有助於更深入地研究馬祖骨藻物種的種間差異、藻華形成的機制及適應季節變化等生理生態實驗。

海報展示 P-OCB-9

Comparative studies on stable carbon and nitrogen isotope values among tissues and hard structures in bony fishes

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abstract

Stable isotope analyses on fish tissues become a common approach to studying trophic ecology. However, stable isotope values (i.e. $\delta^{13}C$ and $\delta^{15}N$) could vary among tissues, depending on the biologically controlled fractionation and metabolic influences. Therefore, this study compared the $\delta^{13}C$ and $\delta^{15}N$ values of eye lenses, muscle and extracted organic matter from otoliths and vertebrae in 5 Sciaenidae species and evaluated the ontogenetic trends in these tissues and hard structures. We provide a protocol for different sample preparation and isotopic analyses and highlight that using different tissues/structures for trophic studies should be carefully evaluated in the future.

海報展示 P-OCB-10

Preliminary study on phenomenon of budding polyps after cutting the epidermal tissue in soft coral (*Sarcophyton* sp.)

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Abstract

The soft corals are known to be a rich source of marine natural products; most of them lack a hard external skeleton and instead contain small calcareous sclerites in their body. Despite their lack of reef-building capacity, octocorals are an important and diverse part of reefal and inter-reefal ecosystems. Most polyps of coral have the same basic body structure including tentacles and a similar appearance, which in the majority of cases is responsible for catching prey and reproduction. Some species of octocoral are dimorphic that have both autozooid and siphonozooid. The polyps of siphonozooid are smaller than autozooid and lack rudimentary tentacles. The study species are *Sarcophyton* sp. belong to the group of dimorphic, which is a genus of octocoral in the family Alcyoniidae that are able be found in shallow reefs of southern Taiwan. Although autozooid is necessary and important for heterotrophic energy acquisition to soft coral, siphonozooid more than autozooid in number is the fact on dimorphic of octocoral. In several experiment of asexual reproduction operations on *Sarcophyton* sp., we found that the proportion of new budding polyps will change after cutting epidermal tissue. The density of newly budding autozooids on traumatized parts will be higher than original parts. In addition, when surface epidermis is completely cut off, it means that the heterotrophic energy source is temporarily lost, and the dimorphic still have a chance to budding from the injured sites. This is an interesting and important preliminary study, although we don't yet know how corals regulate the proportions of different polyps to budding. Our inference is that less budding of siphonozooids allows more autozooids proliferated on new epidermal tissue, and the latter polyps with feeding tentacles conducive to obtaining more heterotrophic energy. Although the epidermal tissue of these traumatized sites has a temporary higher density of autozooid, but this state is not constant. Those dimorphic re-budding ratio eventually tends to a ratio similar proportion to the original epidermal parts.

Keywords: autozooid; siphonozooid; *Sarcophyton* sp. budding

海報展示 P-OCB-11

Relationship of *Scomber australasicus* eggs distribution with the hydrological variables

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Project name: Estimation the abundance of mackerel resources by fishery independent methods

Project number: 110AS-6.1.2-AI-A2(5)

ABSTRACT

The blue mackerel (*Scomber australasicus*) is the most important species supporting Taiwan mackerel fisheries. Mackerels (including *S. japonicus*) migrate to Yilan Bay to spawn from late winter to spring every year. There is little information about the spawning ecology of mackerel in Taiwan before our research. The *S. australasicus* egg is a sphere of approximately 1.1 mm in diameter, with single big oil globules, with pelagic and isolated characters. The *S. japonicus* egg has similar characteristics but is a little smaller, about 1.0 mm in diameter. Three hundred and fifty six eggs were collected from the Bay of Yilan off northeastern Taiwan during 23~27/March, 2021. Of the 35 sampling stations, 12 had *S. australasicus* eggs, the highest density of eggs was recorded in waters off Sandiaojiao（三貂角）. In the same survey, we also found *S. japonicus* eggs at 15 stations. We find the appearance of *S. australasicus* eggs is closely linked to seawater salinity less than 34.3‰ psu at 3 m deep, seawater temperature less than 24°C at 5 m deep and seawater density larger than 23.2 sigma-theta at 20 m deep. In 12 stations with *S. australasicus* eggs, there are 11 stations located within 12 miles offshore. Our findings provide the first report on the response of the *S. australasicus* eggs distribution to the specific hydrological variables in Taiwan. The methods and applicability of egg production methods provide progressed understanding of reproductive ecology of mackerel populations and aid advice for future stock management and sustainability.

Keywords: spawning ecology, fish egg, daily egg production method

海報展示 P-OCB-12

Investigation of the productivity of seagrass communities on the coast of Dongsha Island

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Abstract

Dongsha Island is located at the western opening of the Dongsha Atoll, presenting a horseshoe-shaped island that opens to the west. The land area is approximately 1.74 square kilometers. It is a sand island oriented in a northwest-southeast direction. The northern part of the island consists mainly of coral reef with rich coral reef biodiversity, while the southern part consists mainly of sandy substrates, covered with extensive seagrass beds. Despite being in a nutrient-poor area of the South China Sea, Dongsha Island receives abundant nutrients from internal waves effect, resulting in vast seagrass beds. Records show approximately 8 species of seagrass, providing high productivity on a daily basis.

To understand the contribution of seagrass beds to community productivity and the differences in community productivity among different seagrass beds, this study selected three of the main seagrass species for experimental analysis of community productivity. The results showed that the gross community productivity of Seagrass *Halodule uninervis*, *Cymodocea rotundata*, and *Cymodocea serrulata* beds were 110.20 (mmol O_2 m^{-2} d^{-1}), 85.27(mmol O_2 m^{-2} d^{-1}), and 93.49(mmol O_2 m^{-2} d^{-1}), respectively, with Seagrass *Halodule uninervis* beds contributing the highest productivity. The total estimated gross productivity of the overall seagrass beds was 2889.6(mmol O_2 km^{-2} d^{-1}), serving as a crucial energy source supporting the ecological system of Dongsha seagrass beds.

海報展示 P-OCB-13

Comparison of fish larvae assemblage in autumn and spring in the waters surrounding Taiwan Bank, western North Pacific

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計畫名稱: 台灣淺灘(Taiwan Bank)湧昇區暨周邊水域生態系動態特性影響之研究－子計畫:台灣淺灘周邊海域仔稚魚之群聚生態(III)

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Abstract

Temporal variation of fish larvae community related to the hydrographic characteristics in the waters surrounding the Taiwan Bank was studied in October 2021 (autumn) and March 2022 (spring). A total of 149 taxa of fish larvae were identified, belonging to 96 genera and 71 families. *Engraulis japonicus*, *Diaphus* slender type, unidentified Gobiidae, *Apogon* sp., unidentified Clupeidae, and *Benthosema pterotum* were the six most dominant taxa, together constituted 47.39% of the total catch. No significant temporal difference in abundance of fish larvae was found, but the species number of fish larvae was more diverse in spring than in autumn. The species composition showed apparent difference between cruises, and a clear temporal structure for the assemblage of fish larvae was revealed by the cluster analysis. The intrusions of monsoon-driven currents transported various fish larvae to this study area. The distributional pattern of fish larvae was closely related to the hydrographic characteristics, with seawater temperature, salinity, and zooplankton abundance being the significant explanatory variables affecting the assemblage structure of fish larvae in the waters surrounding the Taiwan Bank.

海報展示 P-OCC-1

Spatial Dynamics of Carbon Dioxide Gas Exchange in the Surface of the Tropical Western Pacific Ocean

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Abstract

The tropical western Pacific Ocean can act as a sink of anthropogenic carbon dioxide (CO_2), but our understanding of its dynamics during the turbulent typhoon season remains limited. Here, we measured the surface ocean partial pressure of carbon dioxide (pCO_2) and computed the air-water CO_2 exchange within the longitudinal bounds of 122 °E to 135 °E during two distinct periods: July 7th to 17th (Leg 1, pre-typhoon) and July 24th to August 3rd (Leg 2, post-typhoon) of 2023. Comparatively, cooler waters (29.2 ± 0.4 °C) were detected during Leg 2 and surface water temperature during Leg 1 was 30.1 ± 0.2 °C. Surface pCO_2 exhibited a slight decline during Leg 2 (382.6 ± 7.5 µatm) in contrast to Leg 1 (386.9 ± 5.9 µatm). Latitudinal temperature fluctuation was a major factor controlling the spatial pCO_2 variation in Leg 1 (44%) and Leg 2 (72%). The studied region acted as a strong sink for atmospheric CO_2 during the post-typhoon period (-7.2 ± 5.4 mmol m^{-2} d^{-1}), compared to the pre-typhoon period (-2.6 ± 2.5 mmol m^{-2} d^{-1}).

海報展示 P-OCC-2

eDNA analysis of marine macrophytes in two distinct coastal habitats in Palau and Northern China Sea (NSCS), Taiwan

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Abstract

Coastal macrophytes serve as a promising reservoir of blue carbon (BC) sequestered within the deep sea of Palau and the Northern South China Sea (NSCS). Utilizing 18S rDNA-based environmental DNA (eDNA) metabarcoding, sediment traps were deployed at 500-meter depth in the open sea southeast of Taiwan (NSCS-N) and northeast of Dongsha Island (NSCS-M).

In the NSCS, marine macrophytes, including macroalgae and seagrass, prevailed in the open waters. Seagrasses were particularly abundant in the NSCS-M middle site, comprising up to 89% of macrophytes. Conversely, the northeastern boundary of NSCS near southwestern Taiwan exhibited a distinct pattern rich in macroalgae, with Rhodophytes accounting for 57% of NSCS-N macroalgae, dominated by calcified crustose Peyssonnelia sp. (47% of macrophytes).

The eDNA analysis of sunken macrophytes revealed a correlation with coastal vegetation assemblage structures, with NSCS-M seagrass species aligning with those in Dongsha Island, and NSCS-N *Peyssonnelia* sp. being abundant in southern Taiwan coastal habitats. Stable carbon isotope (^{13}C) values in NSCS-M and NSCS-N, around 14% and 21% respectively, reflected the carbon signatures of seagrass and macroalgae, contributing to carbon sequestration in the deep sea offshore in NSCS. This highlights the role of Dongsha and southwestern Taiwan coast macrophytes in BC sequestration on the Northern South China Sea ocean shelf and deep sea, showcasing the lateral transport of coastal macrophytes to deep waters for BC contribution in deep sea environments.

Key words: Coastal macrophytes, Blue carbon (BC), Environmental DNA (eDNA), Sediment traps, Northern South China Sea (NSCS), Seaweed, Seagrass, Dongsha Island, Habitat vegetation, Lateral export, Deep sea, Carbon sequestration, Stable carbon isotopes

海報展示 P-OCC-3

西部及南部海域海洋基礎生產力之碳匯量

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計畫名稱：海洋棲地基礎生產力與水體碳輸出通量調查研究
計畫編號：112 前瞻-18.3.1-漁- F3-2 及 113 前瞻-18.3.1-漁-03

摘要

了解海洋藍碳循環是實現碳中和重要的手段之一。為了實現海洋藍碳中和我們必須先了解台灣周圍海域海洋碳匯之現況。因此本研究在漁業署 112 前瞻 18.3.1−漁−F3-2 及 113 前瞻−18.3.1−漁−03 的計畫補助下，實測了台灣西部及南部海域海洋棲地基礎生產力碳匯通量，以了解台灣周遭海域海洋基礎生產力之基線數值。研究成果顯示西部海域平均基礎生產力 797–845 mg-C m^{-2} d^{-1}，代表每年有 445,602 tons–C 進入西部海域；南部海域平均基礎生產力 562–674 mg-C m^{-2} d^{-1}，換言之，每年有 95,530 tons–C 進入南部海域。本研究未來研究方向將持續釐清台灣北部及東部海域海洋棲地基礎生產力碳匯通量，以釐清台灣周邊海域海洋基礎生產力及碳匯量。

海報展示 P-OCC-4

珊瑚白化：鐵供應對珊瑚共生藻於高溫高光效應下的作用

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摘要

高溫條件下活性氧物質（reactive oxygen species, ROS）在珊瑚體內的累積被認為是珊瑚白化的主因之一，共生藻光合作用在高光或高溫條件下將加速 ROS 的產生，在光系統中受到金屬酶調控，包含超氧化物歧化酶（superoxide dismutase, SOD）。根據本實驗室先前對於珊瑚共生藻鐵需求的實驗結果，我們提出以下假說:充足無機鐵供應得以合成共生藻 SOD 以降低 ROS 及珊瑚白化。本研究通過培養不同屬的共生藻，在各種光和熱緊迫條件下，觀察無機鐵（Fe′）濃度對生長速率、SOD 活性以及光合作用效率（F_v/F_m）的影響。結果顯示持續性熱緊迫（30℃）且無進行溫度馴養的情況下，無論何種無機鐵濃度的高低（10-400 pM），*F. kawagutii*（*F.k.*）均無法生長；然而，在進行溫度馴養後，*F.k.* 於 100 pM Fe′ 緩慢生長，而 10 pM Fe′則不生長；至於間歇性熱緊迫組別（30℃），不論於 100 pM Fe′ 或 10 pM Fe′，*F.k.*皆有較高生長速率且相對於持續性熱緊迫表現出較高的 SOD 活性。利用 SOD 活性及先前實驗所得 *F.k.*細胞體內鐵濃度回推 FeSOD 於整體細胞鐵含量的占比，持續性熱緊迫下，鐵供應和所估算 FeSOD 含量的呈正相關；將至於熱敏性共生藻種 *B. minutum* 及 *S. microadriaticum*，在短暫 34℃熱緊迫下，F_v/F_m 明顯下降，在回復正常溫度（26℃）及正常光照後，高鐵條件（1000 pM Fe′）的組別顯現出明顯恢復；同時觀察到細胞內金屬鐵的含量與鐵供給有相對應的表現。目前實驗結果顯示充足無機鐵供應對珊瑚共生藻細胞於光及熱緊迫修復過程扮演重要角色，進一步實驗將納入其他光合系統參數量測以確認鐵供應對系統修復的正面效益，提高對光系統修復機制的理解，並進一步定量 FeSOD 含量，以驗證上述假說。

海報展示 P-OCC-5

養殖海藻生長速率研究

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摘要

海藻養殖是臺灣達成「淨零碳排」的潛力選項! 由於海藻在海中的沉降速度極快，藻體一旦沉降到深海，透過光合作用所吸收的二氧化碳就得以封存在深海達數百年之久；臺灣東部鄰近深海，離岸海藻養殖極具空間優勢。野外離岸海藻養殖牽涉物種及環境選擇，生長速率和固碳成效緊密相關，然而我們對臺灣各式在地藻種的最佳生態區位，如溫度、光照、營養鹽、微量金屬濃度的最佳條件所知有限，本研究將利用化學穩定系統，先於實驗室內針對溫度、光照、營養鹽、微量金屬濃度進行調控及養殖實驗，用以了解其生長速率及生態區位，做為野外養殖場址選取依據。我們首先選用錯綜麒麟菜和蘇氏海木耳進行初步實驗，實驗組先採用微藻實驗養殖最常用超高濃度硝酸根(800 μM)做為初始條件，並對照海洋大學沿岸含 25 μM 硝酸根之天然海水，各二重複持續培養 7 週，每周換水量測藻體濕重和營養鹽濃度；我們發現各組海水硝酸根幾乎在 7 天內全被海藻吸收殆盡，顯見海藻具備超高硝酸根吸收能力! 但超高硝酸根濃度條件下海木耳與麒麟菜每日生長速率僅 0.32 與 0.37 %，天然海水每日生長速率則各為 1.3 與 0.75 %。目前正以錯綜麒麟菜為模式藻種，調控硝酸根濃度(1-20 μM)、磷酸根(0.1-2 μM)、光強度(20-200 μmol m^{-2} s^{-1})、溫度(15-35˚C)及微量金屬(鐵)濃度進行系列實驗取得生長速率最佳條件，做為野外養殖場址選擇的重要依據。

海報展示 P-OCC-6

臺灣海域碳匯係數評估

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計畫名稱：建立海洋棲地碳匯量測方法學研究-海洋棲地水體顆粒碳輸出通量調查與海洋量測方法學研究
計畫編號：113 前瞻-18.3.1-漁-03

摘　要

人為活動所產生的二氧化碳，已達到 20 世紀以來的高峰，導致全球正面臨極端氣候帶來的危害，而研究指出沿岸藍碳生態系的碳吸存效率是熱帶森林的 3 至 5 倍，對於移除大氣中的碳有顯著貢獻。海洋是世界上最大的活躍碳匯（Carbon sink），儲存了地球上 90%以上的 CO_2，因此，世界各國愈發認知到海洋作為氣候解方的重要性；而海洋吸收大氣 CO_2 的機制中，主導海洋藍碳的則是「生物幫浦」，其能夠透過浮游植物行光合作用，將海水中的無機碳轉換成顆粒有機碳 (Particulate organic carbon, POC)，再透過食物鏈、碎屑、排泄物或海洋雪的形式，將碳元素輸送至深海中儲存，形成碳匯。因此，透過測量海域顆粒有機碳通量(POC flux)可以示為該海域的碳匯係數，以評估臺灣周邊海域浮游植物吸收 CO_2 的能力及碳匯量。

本研究彙整歷年來臺灣西部及南部海域之顆粒性有機碳通量（亦稱海洋碳匯係數）資料，利用漂浮式沉積物收集器，佈放在該海域水深約 150 米處，佈放時間約 24 小時後回收，樣品攜回實驗室後再測量顆粒有機碳的濃度。海域實測資料來源包含春、夏、秋、冬四季，可探討海域季節。結果顯示臺灣西部海域之顆粒有機碳通量如下：春季 79 ± 14 mg-C m^{-2} d^{-1}、夏季 95 ± 6 mg-C m^{-2} d^{-1}、秋季 71 ± 6 mg-C m^{-2} d^{-1}、冬季 64 ± 5 mg-C m^{-2} d^{-1}；臺灣南部海域：春季 33 ± 11 mg-C m^{-2} d^{-1}、夏季 41 ± 2 mg-C m^{-2} d^{-1}、秋季 45 ± 8 mg-C m^{-2} d^{-1}、冬季 36 ± 3 mg-C m^{-2} d^{-1}；初步之研究結果顯示西部海域海域的碳匯係數具有些微之季節性變化; 但南部海域的碳匯係數則是夏秋兩季較高，整體來說西部海域的碳匯是比南部要高。這是台灣西部海域首次的海洋碳匯資料，彌足珍貴，而想了解台灣不同海域之碳匯係數，仍需仰賴大規模及較高頻率(如一個月一次)的現場碳匯調查數據，方能真實呈現海域的碳匯能力；但礙於經費的限制，這些大規模及較高頻率之採樣在短期內恐難實現。

太平洋暖渦流中微量金屬之濃度分佈

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本研究旨在利用溶解態稀土元素(rare earth elements, REE)探討海洋渦流對微量元素的分佈與生物地球化學作用之影響。雖然海水 REE 濃度相當低，相對有較高的分析難度；然而相對於其他生物相關的微量金屬元素，REE 在海水中的低生物可利用性和高穩定性使 REE 成為追蹤海水運動的有利化學工具之一。此研究為臺美合作航次於 2023 年五月在菲律賓海的渦流研究，藉由暖渦物理觀測結合海洋生物地球化學資料探析渦流對生物地球化學作用影響。初步研究結果顯示，除了 Ce 以外，絕大多數溶解態 REE 在上層 1000 公尺表現出類營養鹽的濃度分佈曲線，REE 空間變異與暖渦流溫鹽特徵相符，濃度呈現出暖渦海水向下運動特徵，影響深度達 400 公尺。不同於其他 REE 元素，Ce 最大濃度在 deep Chlorophyll *a* Maximum (DCM)處發現，且渦流邊緣的 Ce 濃度高於中心 Ce 濃度，由於 Ce 對氧化還原反應具高敏感度，推測 Ce 受渦流下沉表水供應較高含氧表水及有機物呼吸作用聯合影響而產生顯著的空間濃度變異。相關研究工作仍持續進行中。

海報展示 P-OCC-8

水產動植物繁殖保育區有機碳之分佈及儲量估算

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計畫名稱：水產動植物繁殖保育區水文及水體總有機碳儲量調查研究
計畫編號：113 前瞻-18.3.1-漁-04(3)

摘要

海洋作為世界上最大的活性碳匯，是減緩氣候變遷最佳、以自然為本的解決方案，且海洋生態系亦提供了重要的調適機會。漁業署公告「漁業資源保育區」係針對經濟性海洋生物作採捕體長或季節性的限制，然而漁業資源保育區多坐落在漁民賴以為生的重要漁場，其劃設及管理機制如何影響海洋碳匯尚未有所定論。因此，本研究於臺灣地區北部及中部水產動植物繁殖保育區包含貢寮(卯澳)漁業資源保育區、基隆望海巷潮境海灣資源保育區、以及王功螻蛄蝦繁殖保育區進行一年四季採集，並分析其溶解態有機碳(POC)、顆粒態有機碳(DOC)以及底棲藻類碳含量，以計算不同保育區之有機儲碳量。本研究調查結果顯示，在各保育區的水體有機碳庫大多以溶解態為主。貢寮水產動植物繁殖保育區的有機碳儲量最高(18.9±8.16 ton C)，其次望海巷潮境海灣資源保育區(3.65±1.22 ton C)，在王功螻蛄蝦繁殖保育區則相對較低(0.95±0.61 ton C)。另外在季節變化上，王功螻蛄蝦繁殖保育區的碳儲量在夏季有相對升高的情況，而貢寮水產動植物繁殖保育區的碳儲量具有較大的季節差異，望海巷潮境海灣資源保育區之碳量的季節變化則相對不明顯。本研究提供臺灣水產動植物繁殖保育區之有機碳化學變動及碳儲量數據，有助於進一步估算沿海碳匯潛力並提供養護管理建議，提升海洋碳匯效益。

海報展示 P-OCC-9

東海南部及南海北部衛星遙測及現場實測視深度之差異

黃彥鈞、姚俏君、成宗儒、沈雅庭
海軍軍官學校應用科學系

計畫名稱：建立臺灣周邊海域海水透明度預測模式研究
計畫編號：國防部112年「國防先進科技研究計畫」(突破式國防科技研發計畫)

摘要

海水視深度或稱海水透明度，無論是對於了解海洋生地化現象，或將其應用在軍事及民間用途上，都扮演著重要的角色，但若要獲得大範圍且沒有時間限制的海水視深度，透過衛星遙測的技術是目前最佳的方法之一，而現場實測資料則是驗證遙測資料準確性的最重要依據。初步研究成果顯示，衛星遙測與實測的海水透明度，在東海南部及南海北部約有−20~30 %的誤差，表示衛星遙測的視深度仍無法完全與實測海水透明度吻合。進一步分析認為，遙測與實測視深度的差異可能為水中葉綠素含量(即浮游植物生物量)所造成，當葉綠素含量越少視深度越深。本研究後續希望有更多實測及遙測視深度的比對，並針對其他參數對視深度的影響進行，以更深入釐清衛星跟實測視深度的差異。

海報展示 P-OCC-10

水產動植物繁殖保育區碳匯管理模式研究 - 潮池四季在淨群聚鈣化作用(NCC)及淨群聚生產力(NCP)的變化

Carbon sink management in aquatic organisms propagation and conservation zones and designated fishing forbidden zones – seasonal variation of NCC and NCP in the tidal pool

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計畫名稱：水產動植物繁殖保育區碳匯管理模式

計畫編號：112 年前瞻-18.3.1-漁-F4(2)

摘要

為了 2050 年實現淨零碳排放的目標，海洋是具極開發潛力的自然碳匯。本計畫旨在探討淺海藍碳的減排潛力，於台灣北部新北貢寮水產動植物繁殖保育區進行碳酸鈣逆幫浦及溫室氣體排放調查，並建立本土排放係數。目前已進行第一年度調查，並完成海域及潮間帶潮池在冬、春、夏、秋季之樣品分析。由潮池培養實驗結果顯示，冬季淨群聚鈣化作用(net community calcification, NCC)為-0.82 mmol m^{-2} h^{-1}，淨群聚生產力(net community productive, NCP)為 32.42 mmol m^{-2} h^{-1}；春季 NCC 為-30.26 mmol m^{-2} h^{-1}，NCP 為-75.01 mmol m-2 h-1；夏季 NCC 為 0.05 mmol m-2 h-1，NCP 為-6.27 mmol m^{-2} h^{-1}；秋季 NCC 為 2.53 mmol m^{-2} h^{-1}，NCP 為 20.49 mmol m^{-2} h^{-1}。詳細數據顯示春季數值較不穩定，推測與淡水流入有關，暫不納入排放係數估算。目前臺灣對於包含水產動植物繁殖保育區在內的淺海區域的藍碳資源現況並不是很清楚。為充分釐清水產動植物繁殖保育區的碳匯潛力，建立完善的藍碳資源基線數據是必要的。

海報展示 P-OCC-11

不同海洋環境之顆粒態有機碳與釷-234 之比例

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摘要

海洋碳循環與隨之而來的氣候變遷存在緊密的對應關係，顆粒有機碳輸出是碳封存的重要途徑，儘管利用沉積物收集器收集水層中特定深度的沉降顆粒是最直觀的方法，但是受限於時間與空間分佈，離散的觀測結果可能無法充分解釋序列變化。釷鈾不平衡法以顆粒活性放射性核種——釷-234 作為顆粒有機碳的示蹤劑，被廣泛運用在大尺度估算顆粒有機碳輸出通量 (particulate organic carbon flux，POC flux = [POC/Th-234] × Th-234 flux)，然而這個方法之主要參數 POC/Th-234 卻有很大的變異性，使碳通量測量結果始終偏離沉積物收集器測量的資料。本研究於臺灣西南沿海、南海北部與西北太平洋實際比較兩方法得到之數據與如何更佳使用 Th-234 示蹤劑。漂浮式沉積物收集器測量 POC flux 實測值為 29.7-131.1 (Average = 59.3 ± 2.8)、33.4-99.8 (56.1 ± 4.2)、39.5-96.7 (58.1 ± 7.2) (mgC m^{-2} d^{-1})，而 Th-234 方法得到的碳通量約為實測值的 1.1 ± 0.3 倍，顯示當 Th-234 的通量及 POC/Th-234 比例是直接使用 sediment trap 量測，此方法是可以用來直接估算碳通量。區域平均 POC/Th-234 (μmolC dpm^{-1}) 比值為 1.95、2.73、3.47，利用釷鈾不平衡法得到 POC flux 分別是 22.5-144.2 (64.8 ± 3.5)、36.2-116.0 (57.4 ± 4.1)、31.8-99.0 (60.2 ± 7.3)，平均的 POC flux 在三個海域無統計上的差別，但兩種方法所得的數據卻有很大的差異，最大可達到 1.7~2.5 倍左右，這可能是由於 POC/Th-234 的不確定性所導致。結果顯示，三個不同海洋環境顆粒態有機碳與釷-234 的比例具有顯著差異，西菲律賓海高於北南海並且有漸低的趨勢，當北南海偏向西菲律賓海水團性質的時候，也傾向測得較高的 POC/Th-234，而造成比值的變異主要來自不同海洋環境之間釷-234 活度的差異。

海報展示 P-OCC-12

海水及束毛藻中鎳同位素的組成及分化

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摘要

熱帶暨亞熱帶海洋溶解態鎳濃度的垂直分布趨勢和主要營養鹽高度相關，最新同位素研究亦發現其同位素組成呈現表水高值並隨深度逐漸降低，顯見鎳在海洋的生物地球化學循環深受浮游植物吸收及沉降有機物分解影響。本實驗室先前系列研究證實鎳對於固氮藍綠菌的固氮作用至關重要，主要固氮藍綠菌束毛藻（*Trichodesmium*）需攝取鎳用於合成鎳超氧化歧化酵素及氫化酶，以保護固氮酶在高光條件下光系統及固氮酶不受氧氣及活性自由基破壞，含鎳氫化酶則用以轉換固氮副產物氫氣。因此，海水及固氮浮游植物鎳濃度分布及其鎳同位素組成，對於探索鎳生地化循環及固氮作用將可提供重要訊息，目前相關研究仍十分缺乏。本研究旨在透過束毛藻培養實驗並分析其同位素組成及分化，我們發現束毛藻相較於天然海水具較高同位素組成並隨鎳攝取比例增加而上升，此實驗結果與生物吸收之理論值有顯著差異，我們推斷是養殖海水中所添加的 EDTA 所造成同位素分化效應所導致，後續實驗將調控 EDTA 濃度並分離及分析受 EDTA 螯合的鎳同位素組成以瞭解 EDTA 分化效應，並由改變光照強度、鎳供應量等相關束毛藻培養實驗，同時將採集分析野外束毛藻鎳的元素及同位素組成，深入瞭解固氮作用中鎳分化行為與探究鎳在海水中的生地化循環。

海報展示 P-OCC-13

東海南部及南海北部衛星遙測及現場實測視深度之差異

黃彥鈞、姚俏君、成宗儒、沈雅庭
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計畫名稱：建立臺灣周邊海域海水透明度預測模式研究
計畫編號：國防部112年「國防先進科技研究計畫」(突破式國防科技研發計畫)

摘要

海水視深度或稱海水透明度，無論是對於了解海洋生地化現象，或將其應用在軍事及民間用途上，都扮演著重要的角色，但若要獲得大範圍且沒有時間限制的海水視深度，透過衛星遙測的技術是目前最佳的方法之一，而現場實測資料則是驗證遙測資料準確性的最重要依據。初步研究成果顯示，衛星遙測與實測的海水透明度，在東海南部及南海北部約有−20~30 %的誤差，表示衛星遙測的視深度仍無法完全與實測海水透明度吻合。進一步分析認為，遙測與實測視深度的差異可能為水中葉綠素含量(即浮游植物生物量)所造成，當葉綠素含量越少視深度越深。本研究後續希望有更多實測及遙測視深度的比對，並針對其他參數對視深度的影響進行，以更深入釐清衛星跟實測視深度的差異。

海報展示 P-OCC-14

西部及南部海域海洋基礎生產力之碳匯量

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計畫名稱：海洋棲地基礎生產力與水體碳輸出通量調查研究
計畫編號：112 前瞻-18.3.1-漁- F3-2 及 113 前瞻-18.3.1-漁-03

摘要

了解海洋藍碳循環是實現碳中和重要的手段之一。為了實現海洋藍碳中和我們必須先了解台灣周圍海域海洋碳匯之現況。因此本研究在漁業署 112 前瞻 18.3.1−漁−F3-2 及 113 前瞻−18.3.1−漁−03 的計畫補助下，實測了台灣西部及南部海域海洋棲地基礎生產力碳匯通量，以了解台灣周遭海域海洋基礎生產力之基線數值。研究成果顯示西部海域平均基礎生產力 797–845 mg-C m^{-2} d^{-1}，代表每年有 445,602 tons–C 進入西部海域；南部海域平均基礎生產力 562–674 mg-C m^{-2} d^{-1}，換言之，每年有 95,530 tons–C 進入南部海域。本研究未來研究方向將持續釐清台灣北部及東部海域海洋棲地基礎生產力碳匯通量，以釐清台灣周邊海域海洋基礎生產力及碳匯量。

海報展示 P-OCC-15

水產動植物繁殖保育區水生植物儲碳量調查

Development of parameters for establishing and managing carbon sinks in aquatic organisms and conservation zones for aquatic plants

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計畫名稱：水產動植物繁殖保育區碳匯管理模式及本土碳匯係數研究-水產動植物繁殖保育區水生植物儲碳量調查及本土碳匯係數建立

計畫編號：112 年前瞻-18.3.1-漁-F4 (1)

摘要

海洋具有極高的碳匯潛力可協助政府達成 2050 淨零碳排的國家目標。本研究為完成保育區水生植物碳儲量的估算，針對臺灣北部及中部水產動植物繁殖保育區的(1)貢寮、(2)基隆市望海巷、(3)王功等保育區進行實施水生植物儲碳量調查，調查項目包含保育區範圍內植物性浮游生物、底棲藻類。並進一步整理成保育區範圍內植物性浮游生物碳儲量、底棲植物碳儲量。結果顯示在三處保育區中以貢寮水產動植物繁殖保育區水生植物碳儲量最高(4.80 ~ 15.41 ton C)，其次望海巷潮境海灣資源保育區(1.10 ~ 2.17 ton C)，在王功螻蛄蝦繁殖保育區則相對較低(0.026 ~ 0.043 ton C)。就單位面積碳儲量，貢寮水產動植物繁殖保育區及望海巷潮境海灣資源保育區兩處的單位面積碳儲量相當(0.058 ~ 0.21 ton C ha^{-1} vs. 0.073 ~ 0.14 ton C ha^{-1})，約為王功螻蛄蝦繁殖保育區的 10 倍(0.00062 ~ 0.0010 ton C ha^{-1})。王功螻蛄蝦繁殖保育區的碳儲量在夏季有相對升高的情況，而貢寮水產動植物繁殖保育區及望海巷潮境海灣資源保育區兩處碳量的季節變化則相對不明顯。

海報展示 P-OCC-16

自動化量測二氧化碳儀器之研發與應用

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計畫名稱：國科會計畫-人為活動對河流、近岸系統與大洋之氮循環研究

計畫名稱：國立高雄科技大學 112 年度高教深耕計畫-海洋特色學生專題研究計畫

計畫編號：NSTC 11-2611-M-992-001-

摘要

大氣中二氧化碳濃度自工業革命後持續得上升，對整個地球圈造成許多負面影響，如何量測各個生態系統中碳的變化，為現今相當重要的議題之一。目前市售測量大洋碳循環儀器主要是以非散射式紅外線（non-dispersive infrared, NDIR）為主，如 Apollo SciTech's incorporated (United States America) AS-P2，雖然具備可即時監測、操作簡單、量測範圍廣等優點，但造價非常昂貴。Arduino UNO 是一款開源板，配合 Arduino IDE 編程軟體與模組可以開發與應用於各式各樣的專案和儀器，如無人載具、影像追蹤等應用。目前應用於海洋方面上的監測有溫度、鹽度、溶氧、聲納等。為了量化海洋藍碳之循環，本研究將使用 Arduino UNO 結合 NDIR 感測器模組，自製二氧化碳量測儀，經過初步的驗證實驗後，未來將應用在近岸沉積物的培養實驗中。

本研究使用 SCD30 NDIR 感測器模組進行二氧化碳量測儀的研發，驗證實驗分為四個部分：（1）靈敏度反饋實驗：將感測器間歇式暴露於高濃度二氧化碳，觀察感測器腔室內的氣體交換速率及儀器靈敏度；（2）穩定度實驗：透過長時間且高頻率的不間斷量測，觀察感測器的量測穩定度；（3）準確度校正實驗：輸入氣體標準品，對儀器的讀值進行校正，並繪製出檢量線；（4）應用驗證實驗：植物於日間行光合作用，夜間行呼吸作用，透過此項機制驗證感測器於實際應用的可行性。

初步結果顯示：自製自動化量測二氧化碳儀器儀器可實現自動化量測及記錄數據的功能，SCD30 感測器在驗證實驗中有良好的穩定度及靈敏度的表現，感測器啟動後約有 30 至 120 秒的熱機時間，待電壓穩定後則不易有雜訊干擾，且在校正實驗中得到 $R^2 = 0.9999$ 的良好相關性，相對標準偏差落在 0.003 至 0.007 的區間，實際誤差值只有 1%。

海報展示 P-OCC-17

預測亞熱帶西北太平洋湧升海域中二氧化碳分壓的變化機制：初探

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計畫名稱:
計畫編號:

摘要

湧升海域僅佔全球海表面積的3%，卻能貢獻10-20%的海洋基礎生產力，有助於吸收大氣二氧化碳。然而，湧升海域中的二氧化碳分壓 (partial pressure of carbon dioxide, pCO_2)變化機制因受到複雜的物理及生物地球化學反應所控，導致目前仍無法清楚釐清湧升海域 pCO_2 變化機制並預測。為了了解台灣東北外海湧升海域的 pCO_2 變化機制，本研究於台灣東部海域收集三條橫跨黑潮的斷面資料，分別由台東外海至台灣東北角 (北緯 22-25 °N)，收集參數包含溫度、鹽度、總鹼度 (total alkalinity, TA)與溶解無機碳 (dissolved inorganic carbon, DIC)。依據 Kao et al., (2023)估算湧升海域中各效應對 pCO_2 變化的方法，初步結果顯示，以兩種全球暖化條件下 (RCP2.6 與 RCP8.5)，台灣東北外海湧升海域為大氣二氧化碳的匯，並且此方法具有潛力估算西方邊界流湧升系統中表水 pCO_2，嘗試釐清未來全球暖化下湧升系統中 pCO_2 時間變化。

海報展示 P-OCC-18

自製即定時連續監測營養鹽自動分析儀

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摘要

本研究介紹自製的即定時連續監測營養鹽自動分析儀，實現對水體中營養鹽含量之即時監測和分析。該系統結合了化學反應以及自動化控制，能夠精確地測定水體中的矽、氮、磷等營養鹽。由於自製設計使其成本相對較低，同時也提供了良好的可擴展性和可定制性，以滿足不同應用場景下的需求。該自動分析儀將有助於海水測定、環境監測、水質管理等領域的應用，為營養鹽監測提供了一個有效、可靠的解決方案。

海報展示 P-OCC-19

西部及南部海域海洋基礎生產力之碳匯量

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計畫名稱：海洋棲地基礎生產力與水體碳輸出通量調查研究
計畫編號：112 前瞻-18.3.1-漁- F3-2 及 113 前瞻-18.3.1-漁-03

摘要

了解海洋藍碳循環是實現碳中和重要的手段之一。為了實現海洋藍碳中和我們必須先了解台灣周圍海域海洋碳匯之現況。因此本研究在漁業署 112 前瞻 18.3.1−漁−F3-2 及 113 前瞻−18.3.1−漁−03 的計畫補助下，實測了台灣西部及南部海域海洋棲地基礎生產力碳匯通量，以了解台灣周遭海域海洋基礎生產力之基線數值。研究成果顯示西部海域平均基礎生產力 797–845 mg-C m^{-2} d^{-1}，代表每年有 445,602 tons–C 進入西部海域；南部海域平均基礎生產力 562–674 mg-C m^{-2} d^{-1}，換言之，每年有 95,530 tons–C 進入南部海域。本研究未來研究方向將持續釐清台灣北部及東部海域海洋棲地基礎生產力碳匯通量，以釐清台灣周邊海域海洋基礎生產力及碳匯量。

海報展示 P-OCC-20

Dual Isotope Composition of Nitrate in the Upper Water Column of the Seas Surrounding Taiwan

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計畫名稱：1. 建立海洋人工表層藻床增碳匯量測方法-苗栗藻場碳匯調查

2. 西北太平洋副熱帶環流區氮循環在現代和過去的變化 (2/3)

計畫編號：1. 113B 科-004V

2. 111-2116-M-002-032-MY3

Abstract

Nitrogen (N) is a key component for life in marine ecosystems, and its availability significantly influences the productivity of the ocean. Understanding the N cycle and its sources would therefore be crucial in assessing the efficacy of biological pumps, and ultimately the ocean's carbon sequestration potential. The dual nitrogen and oxygen isotopes in nitrate serve as a useful method for constraining nitrate source and understanding the nitrogen process within the ocean. Here we present findings on the spatial variations in the nitrate concentration and its dual isotopic composition in the upper 250 m water column of the seas surrounding Taiwan during February 2023. The hydrographic data revealed two primary water masses around Taiwan in early spring: the Mixed China Coastal Water, brought by southwest-flowing China Coastal Current to the Taiwan Strait, and the Kuroshio Water, which flows through eastern Taiwan, and branches into the Northern South China Sea as Kuroshio Branch Water and the East China Sea off northeast Taiwan. Our data show high surface nitrate concentrations with elevated dual isotopes associated with the Mixed China Coastal Water in the Taiwan Strait, suggesting that the nitrate originating from the Changjiang diluted water. The isotopic data revealed a greater increase in nitrate $\delta^{18}O\text{-}NO3^-$ than $\delta^{15}N\text{-}NO3^-$, indicating that nitrification and nitrate assimilation occur simultaneously in the Taiwan Strait. In contrast, the low surface nitrate concentration and lower $\delta^{15}N\text{-}NO3^-$ value observed in Northern South China Sea and East Taiwan, suggest nitrate sources originating from Kuroshio Water, which bears distinct signals of coupled nitrogen fixation/nitrification of regenerated nitrogen.

Keywords: Nitrogen Cycle; Dual isotopes of nitrate; Nitrate assimilation; Nitrification; Nitrogen Fixation

海報展示 P-OCC-21

淡水河口海域汞的時序研究：方法、分布、來源及汙染

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摘要

現今因人類活動與污水排放逐漸增多，河口沿岸水域的「汞」污染時有所聞，其對生態環境及民生健康影響艱鉅，故瞭解污染毒物「汞」在河口沿岸的生地化循環及來源至關重要。本研究建立了淡水河口及八里放流管附近海域「汞」之時序觀測，主要分析了水樣和沉積物之總汞含量。

本研究自 2005 年至 2020 年共 15 年、進行每年四季共 60 個季節之總汞測定及基本水文觀測，長時數據提供了淡水河口及離岸之汞濃度的連續時空分布變化、控制過程及來源並污染的資訊。在沉積物中，平均總汞濃度為 64.55±14.06 ng/g，在水體中則為 34.19±24.20 ng/L。時序變化呈現出沉積物的汞濃度有下降的趨勢，而水樣則顯示增加的趨勢。此外，研究還指出水體中的汞濃度會隨著季節變化，冬季時較高，夏季則較低，並觀察到了異常的高值。地區內汞濃度的變化明顯受到季節變化的影響，冬季可能因污水與淡水河流量比例增加而導致水體中的汞濃度上升；藉時序資料和各種參數對總汞做多變數迴歸分析 (Multiple Linear Regression)，模擬及預測未來淡水河口海域總汞的分布變化並建立盒子模式評估人為輸入通量及污染情況。總之，研究結果有助於未來對北台灣淡水河口地區環境保護和監測工作的設計和改進，減少汞污染狀況，並提供科學依據保護生態和人類健康。

海報展示 P-OCC-22

海藻元素組成特徵

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摘要

本研究採集以相同天然海水及生長環境條件培育15種海藻進行全元素組成分析，包含C, N, S, P, Mg, Na, K, Ca, Cd, Ba, Al, Ti, V, Cr, Fe, Mn, Co, Ni, Cu, Zn, As, Rb, Sr, Mo, Pb, REE等元素，過去的研究樣品中鮮少有多種海藻在相同條件下成長及適當的樣品前處理，並且量測多種元素，且過去習慣以乾燥海藻之重量濃度(ppm)呈現體內元素，卻忽略了海藻的含水率，且不同種間差異甚至能超過20%以上，因此與未脫水海藻之元素組成將會有極大的差異。本研究樣品前處理以大量純水沖洗藻體表面海水及附著物，以未脫水之海藻體積莫爾濃度(mol/L)表示體內元素，所取得之海藻元素組成將具高度代表性。

發現以體積莫爾濃度表示海藻體內元素組成，許多元素之間具有高度正相關，在以往乾燥海藻之重量濃度表示方式將會難以發現，例如:C與N, S, Fe,Cu程高度正相關等。在C:N:P比值中發現冬青葉馬尾藻、卡帕藻及硬毛藻有較高的C:N比值，冬青葉馬尾藻、紅葡萄藻、大野石蓴有較高的C:P比值。

研究各元素組成差異及特徵，不僅可提供元素需求資訊及反應獨特生理機制特徵，並用以探索大型海藻不同族群、型態或生理條件下元素組成特徵，同時選擇營養鹽運用效率較高的海藻，作為未來海洋碳匯的潛力物種。

海報展示 P-OCC-23

西部及南部海域海洋基礎生產力之碳匯量

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計畫名稱：海洋棲地基礎生產力與水體碳輸出通量調查研究
計畫編號：112 前瞻-18.3.1-漁- F3-2 及 113 前瞻-18.3.1-漁-03

摘要

了解海洋藍碳循環是實現碳中和重要的手段之一。為了實現海洋藍碳中和我們必須先了解台灣周圍海域海洋碳匯之現況。因此本研究在漁業署 112 前瞻 18.3.1−漁−F3-2 及 113 前瞻−18.3.1−漁−03 的計畫補助下，實測了台灣西部及南部海域海洋棲地基礎生產力碳匯通量，以了解台灣周遭海域海洋基礎生產力之基線數值。研究成果顯示西部海域平均基礎生產力 797–845 mg-C m^{-2} d^{-1}，代表每年有 445,602 tons–C 進入西部海域；南部海域平均基礎生產力 562–674 mg-C m^{-2} d^{-1}，換言之，每年有 95,530 tons–C 進入南部海域。本研究未來研究方向將持續釐清台灣北部及東部海域海洋棲地基礎生產力碳匯通量，以釐清台灣周邊海域海洋基礎生產力及碳匯量。

海報展示 P-OCC-24

東海南部及南海北部衛星遙測及現場實測視深度之差異

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計畫名稱：建立臺灣周邊海域海水透明度預測模式研究
計畫編號：國防部112年「國防先進科技研究計畫」(突破式國防科技研發計畫)

摘要

海水視深度或稱海水透明度，無論是對於了解海洋生地化現象，或將其應用在軍事及民間用途上，都扮演著重要的角色，但若要獲得大範圍且沒有時間限制的海水視深度，透過衛星遙測的技術是目前最佳的方法之一，而現場實測資料則是驗證遙測資料準確性的最重要依據。初步研究成果顯示，衛星遙測與實測的海水透明度，在東海南部及南海北部約有−20~30 %的誤差，表示衛星遙測的視深度仍無法完全與實測海水透明度吻合。進一步分析認為，遙測與實測視深度的差異可能為水中葉綠素含量(即浮游植物生物量)所造成，當葉綠素含量越少視深度越深。本研究後續希望有更多實測及遙測視深度的比對，並針對其他參數對視深度的影響進行，以更深入釐清衛星跟實測視深度的差異。

海報展示 P-OCC-25

澎湖水道溫度及硝酸鹽改變對於軟珊瑚覆蓋率的影響

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計畫名稱：海洋碳化學變化(V)
計畫編號：112-2611-M-110-011-

摘要

珊瑚礁生態系統在氣候變化影響下，就如同礦坑中的金絲雀一樣，對海洋健康狀況有示警的作用。公民科學家透過參與珊瑚礁體檢，記錄環境變遷並提供長期數據。為了分析軟珊瑚覆蓋率、海表溫度和營養供應之間的關係，本研究利用了 2010 至 2019 年間的珊瑚礁體檢數據、海水表面溫度記錄、船載 CTD 剖面、實驗室分析營養鹽數據以及全球混合座標海洋模式(HYCOM)結果。本研究聚焦位於台灣海峽東南部的澎湖水道及附近的小琉球和澎湖群島，研究期間的澎湖海水表面溫度下降，與小琉球附近海水表面溫度上升形成明顯的對比，推測與澎湖水道西側的湧升流，以及內潮和季風效應有關，研究結果也發現軟珊瑚在海水表面溫度變化大，和硝酸鹽濃度增加時會提高覆蓋率，表示冷水湧升強度影響軟珊瑚覆蓋率。

海報展示 P-OCC-26

西部及南部海域海洋基礎生產力之碳匯量

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計畫名稱：海洋棲地基礎生產力與水體碳輸出通量調查研究
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摘要

了解海洋藍碳循環是實現碳中和重要的手段之一。為了實現海洋藍碳中和我們必須先了解台灣周圍海域海洋碳匯之現況。因此本研究在漁業署 112 前瞻 18.3.1−漁−F3-2 及 113 前瞻−18.3.1−漁−03 的計畫補助下，實測了台灣西部及南部海域海洋棲地基礎生產力碳匯通量，以了解台灣周遭海域海洋基礎生產力之基線數值。研究成果顯示西部海域平均基礎生產力 797–845 mg-C m^{-2} d^{-1}，代表每年有 445,602 tons–C 進入西部海域；南部海域平均基礎生產力 562–674 mg-C m^{-2} d^{-1}，換言之，每年有 95,530 tons–C 進入南部海域。本研究未來研究方向將持續釐清台灣北部及東部海域海洋棲地基礎生產力碳匯通量，以釐清台灣周邊海域海洋基礎生產力及碳匯量。

海報展示 P-OCC-27

Nitrate $\delta^{15}N$ as a Tracer for Water Exchange Between the Western Philippine Sea and South China Sea

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計畫名稱:西北太平洋副熱帶環流區氮循環在現代和過去的變化(1/3)

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Water exchange in the Luzon Strait plays an important role in the circulations and climate changes in the South China Sea, and is subjected to seasonal and interannual variabilities regulated by local and regional climate variabilities including monsoon, ENSO, PDO on various timescales. Water masses from the Western Philippine Sea and the South China Sea have been traditionally traced by their representative temperature and salinity characteristics, but direct observations of these parameters are lacking in spatial and temporal resolution. In this study, we will demonstra te that the dual isotopes ($\delta^{15}N$ and $\delta^{18}O$) of nitrate can be used as a tracer for the water masses as well, and thus may have the potential to trace the exchange of water masses beyond instrumental records.

We conducted 10 cruises from 2018 to 2022 to cover the regions of the northern South China Sea (SCS), the Kuroshio Current (KC), and the Western Philippine Sea (WPS) between 11 to 25°N and 111 to 131°E . Seawater were collected from the whole water column for analyses of the dual isotopes of nitrate. The intermediate and deep waters of the SCS and WPS share similar isotopic signatures (5.7±0.3 and 5.8±0.4 ‰ in the SCS and WPS, respectively) of the North Pacific Intermediate Water (NPIW), which is elevated comparing to the mean ocean nitrate $\delta^{15}N$, and is a result of exchanges with the Oxygen Deficient Zone along the eastern Pacific margins. The thermocline and subsurface waters of the SCS and WPS, on the other hand, have distinctively different $\delta^{15}N$ signatures, with significantly lower $\delta^{15}N$ values at the WPS thermocline (-1.0 to 5.9 ‰) relative to that at the SCS thermocline (3.4 to 10.0 ‰). Together with the $\delta^{18}O$ of the nitrate, these results suggest different upper ocean N cycling processes. The WPS thermocline is dominated by newly fixed N from biological N_2 fixation coupled with recycling of the N within the euphotic layer and below. The SCS thermocline nitrate in comparison is strongly influenced by partial nitrate assimilation coupled with nitrification below the euphotic zone.

These distinctive isotopi c signatures of the thermocline nitrate in the two regions are mirrored by the salinity differences of the thermocline waters, mainly composed of the North Pacific Tropical Water and the South China Sea Tropical Water. Comparing winter and summer monsoon s easons, we further demonstrate that exchanges in the water masses across the Luzon Strait can be reflected by variabilities of the thermocline nitrate $\delta^{15}N$ in this region. During winter monsoon seasons, intensified Kuroshio intrusions to the SCS can be traced by lower nitrate $\delta^{15}N$ found in the northern SCS. Since thermocline nitrate $\delta^{15}N$ can be incorporated into newly formed biomass in the surface ocean, and preserved in coral, foraminifera, and other fossil records, Kuroshio intrusions may thus be reconstr ucted using $\delta^{15}N$ variabilities of these archives beyond instrumental records.

海報展示 P-OCC-28

Bioaccumulation of Polycyclic Aromatic Hydrocarbons from Oil Pollution in Corals: Physioecological Implications

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Abstract

Coral reefs, hosting diverse marine communities within marine ecosystems, play a pivotal role in the geology and ecology of tropical and subtropical oceans. However, these reefs predominantly thrive in densely populated coastal areas, rendering them vulnerable to numerous anthropogenic disturbances. Among these, pollution from petroleum hydrocarbons, stemming from various sources, poses a pervasive threat to coastal coral reef ecosystems, particularly in the wake of oil spill incidents. To investigate the impacts of the impacts of oil pollution on coral health, a 72-hour exposure experiment was conducted utilizing the stony coral *Euphyllia paraancora* subjected to varying levels of oil pollution, including concentrations of 10 g of motor oil per liter (10 g/L) and 1 g of motor oil per liter (1 g/L). The study aimed to assess the bioaccumulation of polycyclic aromatic hydrocarbons (PAHs,) in coral and its ramifications on lipid content, density, and symbiotic algae chlorophyll content of symbiotic algae (zooxanthellae). Results indicated a significant accumulation of PAHs in corals exposed to higher pollution levels. Interestingly, the lipid content of the coral remained relatively unchanged after 72 hours of exposure to oil pollution. However, both the density and the chlorophyll content of symbiotic algae exhibited significant declines under high pollution conditions compared to these in the low pollution group. This suggests a potential escape of symbiotic algae from corals under threat of oil pollution, potentially jeopardizing the survival and growth of corals.

Key words: Polycyclic aromatic hydrocarbons, Stony corals, Bioaccumulation, *Euphyllia paraancora*

海報展示 P-OCC-29

北太平洋暖渦流營養鹽、浮游植物色素與顆粒性有機碳氮分布
The distribution of major nutrients, phytoplankton pigment and particulate organic carbon/nitrogen in a North Pacific warm eddy

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摘要

2023 年 5 月 26 日至 6 月 12 日間，我們參與美國華盛頓大學研究船湯姆士·湯普森(R/V Thomas G. Thompson)的 TN417 航次，在北太平洋西部國際海域進行海上實驗。選定暖渦流AC4共計7個測站，探測表水 10 m 至 1000 m 研究主要營養鹽、浮游植物色素與顆粒性有機碳氮橫剖面之分布，用以了解暖渦流對海洋生物地球化學過程的影響。其中以 T3 為暖渦流正中心，T2~T6為暖渦流內部，T1 與 T7 為暖渦流外圍。主要營養鹽中亞硝酸鹽於 T5 的 160 m 有最大值 0.114 μM，而 T1~T5 與 T7 均可發現於葉綠素最大層 (Deep Chlorophyll maximum, DCM) 的下一個採樣水層有當站的最大值，但 T6 的亞硝酸鹽最大值於 DCM 水層，而除 T4 外亞硝酸鹽最大值水層亦有相對較低的溶氧。硝酸鹽、磷酸鹽與矽酸鹽於 200 m 以淺，可以觀察到暖渦流外圍同一深度水層的濃度相較中央值高，與暖渦流中心沉降之現象相符。色素資料中可明顯看出，藻類指標色素分布中沒有fucoxanthin (如矽藻)與 prasinoxanthin (如單細胞綠藻)等近岸優勢藻種，而是以 chlorophyll b (如綠藻)與 zeaxanthin (如藍綠藻)為主要色素，DCM 介在 110 m 與 140 m 之間，以 T2 的 125 m 有葉綠素最大值 0.31 μg/L。顆粒性有機碳氮 (POC/PON) 於暖渦流中央 (T3) 的 500 m 有最大值 (POC 6.0 μM, PON 1.2 μM)，而 DCM 以淺的深度，T1 - T3 的 PON 濃度相對 T4- T7 高，但 POC 沒有明顯趨勢，因此 T1- T3 碳氮比值相對偏低。由資料可知，海水中主要營養鹽、浮游植物色素與顆粒性有機碳氮受到暖渦流影響有中央有向下傳輸之現象。

海報展示 P-OCC-30

Exploring the Role of Nickel Superoxide Dismutase (NiSOD) in Direct Protection of Nitrogenase in *Trichodesmium*

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Abstract

Trichodesmium, a major diazotroph in the tropical and subtropical ocean, plays a crucial role in marine biogeochemical cycle by serving as a major contributor of essential nitrogen to other phytoplankton. In *Trichodesmium,* nitrogen fixation is carried out during day time. However, nitrogenase, the enzyme involved in nitrogen fixation, is highly susceptible to oxygen and reactive oxidative species (ROS). It seems that there is no specific compartmentalization to separate photosynthesis and nitrogen fixation processes. Many organisms possess superoxide dismutase (SOD) to prevent oxidative degradation by removing reactive oxidative species. *Trichodesmium* expresses both Nickel Superoxide Dismutase (NiSOD) and Manganese superoxide dismutase (MnSOD). Under high light conditions, the rate of photosynthesis increases, which would lead to elevated production of ROS in cells and SOD. Our previous studies have demonstrated that NiSOD plays a crucial role in protecting nitrogen fixation in *Trichodesmium* when exposed to high light conditions. Building upon our previous studies, our aim of this study is to determine whether NiSOD exclusively protects nitrogenase or if it extends its protective function to other proteins in photosystems. In this study, *Trichodesmium* cultures were treated with various nitrate levels. Theoretically, nitrate addition would cease nitrogen fixation and nitrogenase expression. NiSOD expression level shall indicate its role on other biochemical processes, particularly for photosynthesis. Our results indicate that the group treated with nitrate exhibited lower NiSOD concentration compared to the untreated group, suggesting a potential correlation between inhibition of nitrogen fixation and downregulation of NiSOD. Western blot results also supported the outcome, with visible bands in the untreated group and barely visible bands in the nitrate-treated group, further supporting that NiSOD expressed is mainly for nitrogenase protection. Nutrient analysis indicates substantial nitrate utilization in nitrated-treated culture. These results further support the role of NiSOD on protecting nitrogen fixation process in *Trichodesmium*. Further investigations are warranted to elucidate the importance of the interactive mechanisms between NiSOD and nitrogen fixation in the field.

海報展示 P-OCC-31

臺灣西南海域之碳儲量及海氣二氧化碳交換通量初步估算

Preliminary result of carbon reservoirs and air-sea CO_2 flux in the waters off southwestern Taiwan

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計畫名稱：建立海洋棲地碳匯量測方法學研究 - 臺灣東部與西部海洋棲地海氣二氧化碳交換通量調查研究

計畫編號：113 前瞻-18.3.1-漁-03

摘 要

海洋碳匯之效益作為「淨零碳排」之重要自然碳匯之一，世界多國家也根據其鄰近海洋環境之特徵，相繼提出海洋碳匯之量測方法。臺灣身為海洋國家，領海內水面積多達國土面積之 4.7 倍，因此如何評估臺灣海洋棲地之碳儲量及碳匯效益，對於臺灣自然碳匯之估算至關重要。然而臺灣鄰近海域之洋流與地形複雜，缺乏長期、系統性的碳匯調查資料。為瞭解臺灣鄰近海域之海洋棲地屬於大氣二氧化碳之"碳源"或"碳匯"，本計畫調查四季之海洋棲地之溶解無機碳資料，建立初步估算之量本土排放係數(Emission factor)及碳儲基線資料。

本計畫 2023 年於西部及南部海域之採集四季之海水樣本，收集 100 公尺以淺的水文及碳循環相關參數(溫度、鹽度、總溶解無機碳、總鹼度)，並依據實測資料、資料庫之數據、臺灣周圍海洋棲地之環境及物理預報模式，建立適用於臺灣儲碳量評估之模式與量測方法學。同時，依據表層海水之二氧化碳分壓(pCO_2)計算海氣二氧化碳交換通量。2023 年臺灣西部及南部海域 12 海里內之單位面積碳儲量分別為 14.107 及 107.929 tons C ha^{-1}。南部海域之海水深度較深，單位面積碳儲量比西部海域高。西部海域為大氣二氧化碳的匯(二氧化碳交換通量為-0.147 tons C ha^{-1} yr^{-1}，負值表示 CO_2 由大氣進入海洋)，南部海域則為較弱之匯(二氧化碳交換通量為-0.002 tons C ha^{-1} yr^{-1})。

海報展示 P-OCG-1

Late Holocene climatic variability in the Central Ganga Plain: Multi-proxy records from lacustrine sediments

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Summary

In spite of dedicated efforts to reconstruct the past variability in the strength of Indian Summer Monsoon (ISM), that is the rainfall intensity, a complete picture of the ISM variability and its forcing mechanisms remains elusive mainly because of large spatial inhomogeneity of the ISM precipitation. The Ganga Plain, which ranks among the world's most densely populated areas, and is well-known for its agricultural fertility and habitats for humans since early days, remains less explored in terms of paleoclimatic conditions. We conducted a multi-proxy (grain size, major elements geochemistry, clay mineralogy, and stable carbon ($\delta^{13}C$) isotope compositions of organic matter) study of the sediments from an AMS radiocarbon-dated mid-late Holocene trench from the Salona Tal (lake) in the Central Ganga Plain, India to quantify the changes in monsoonal precipitation. Temporal variabilities in our results suggest intense ISM precipitation during ~5 ka to ~4 ka, which was followed continuous weakening of ISM precipitation until ~2 ka. After that an amelioration of ISM precipitation occurred towards modern-day condition.

海報展示 P-OCG-2

典藏過去・介接未來：海洋岩心一站化服務與數位典藏發展

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摘要

透過『建置一站式海洋沉積物採樣技術與海陸域地質紀錄分析量能』此一策略平台，來落實臺灣周遭關鍵海域探勘、二氧化碳地質封存、礦產資源調查之目標是有其急迫性與必要性。據此，高品質 20 公尺長岩心紀錄與多面向岩心分析成為解密地質紀錄的重要關鍵。這不僅提供海域地質基礎資料與過去臺灣周邊海洋環境變遷，以探討地質災害事件型 vs 自然環境條件型之發生頻率與機制外，同時，呼應並落實政府「2050 年淨零排放」策略，支援黑潮海洋能與自主探勘能源等能源轉型所需之海域地質探勘、自然碳匯之大洋藍碳等的能力建構。國研院海洋中心打造國內首座完備『海洋岩心庫暨實驗室 (MCRL; Marine Core Repository and Laboratory)』，且為唯一首座連續十餘年取得 ISO 9001 國際品質認證。十年來海洋岩心庫暨實驗室大幅度的躍進，國際品質之實驗室維運以及科學儀器分析技術趨於成熟，搭配新的海洋研究船陸續正式服役。以海洋岩心庫暨實驗出發，結合勵進研究船 R/V *Legend* 海洋探測能量、科研服務與研究成果豐碩，繳交出漂亮成績單，於非破壞性岩心分析研究上開創一新的格局。發展成熟之多項岩心非破壞性分析技術，提供海／陸域地質紀錄之快速、經濟成本且具高解析度的量測，更精進勵進研究船海洋岩心採樣量能，活塞岩心樣本高回收率，維持 80%以上。並與國際接軌，參與數個重要國際聯合探測航次，貢獻於能源轉型－天然氣水合物探勘與海洋科學研究上，這包括 R/V *JOIDES Resolution* 之 IODP 368 航次、R/V *Marion Dufresne* 之台法 EAGER 航次和 R/V *SONNE* 之台德 SO-266 海床岩心淺鑽航次。一站式之高解析度岩心非破壞性分析技術於地質探勘上的運用，探究臺灣西南海域天然氣水合物儲集層之地質紀錄及其沉積物特徵。再者，為實現區域融合和均衡發展，海洋中心與東華大學攜手合作。透過設施共享、建置岩心倉儲跨網絡合作、深化一站式海陸域地質紀錄分析以及岩心設施平台經驗交流，逐漸形成跨海／陸域學術研究廊帶，以期能完備高精度地質探勘及關鍵樣本保存的核心基礎設置。該平台除進行專業海洋科研人才培育外，臺灣鄰近海域海洋岩心非破壞性資料以數位典藏方式展現，並於海洋知識教育上進行推廣與加值運用。

海報展示 P-OCG-3

臺灣海峽沉積物的來源與輸送

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摘要

臺灣海峽沉積物的輸送受到，包括颱風、河流系統和地質過程等，各種因素的影響 (Li et al., 2018)。臺灣海峽東側沉積物的沉積速率受臺灣河流快速輸送大量沉積物的影響，導致海峽東西兩側沉積物剖面的差異（Huh et al., 2011; Kao et al., 2008）。本研究利用沉積物中的重礦物和黏土礦物組成，釐清臺灣海峽沉積物的來源、傳輸機制以及沉積環境的演變，揭示區域沉積作用。

過去臺灣海峽沉積物取樣以表層沉積物為主，但隨著新型振動式岩芯技術的應用，目前已可取得一至三公尺的樣本，提供瞭解百年至萬年尺度沉積物組成和分佈的機會，進而推斷其傳輸路徑和源區。黏土礦物反映了不同源區的母岩，經歷風化侵蝕過程及傳輸機制搬運至海峽沉積，使我們能夠推斷各沉積物的來源區域和貢獻比例。而重礦物因其較高的密度，具有耐磨蝕和穩定的化學特性，能在遠離母源區後仍能展現出母岩特性（Mange & Maurer, 2012）。由於重礦物比重較大的特性，重礦物本身不易受再懸浮作用影響。將這兩種物理特性不同的礦物結合討論，可透過兩者之間的差異推斷該區域的沉積環境模式。

臺灣海峽黏土礦物分析結果顯示，其組成以伊萊石和綠泥石為主；高嶺石在濁水溪和淡水河出海口有較高的比例，而臺灣灘整體皆有較高的比例；澎湖以北順著澎湖水道延伸兩側的樣本都有膨潤石的出現，而臺灣灘靠近澎湖地區的兩個樣本站位亦有膨潤石出現，由於廣泛遍佈在臺灣海峽西側，推測為來自澎湖物源端的輸出。此外令人注意的是彰雲砂脊的表層沉積物存在膨潤石，然而澎湖水道的表層沉積物中並未發現膨潤石。重礦物分析結果指出，臺灣海峽中有高比例的不透光重礦物，主要為岩屑、磁鐵礦和少量海綠石。海峽東側站位的不透光重礦物佔比皆過半，西側站位點的不透光礦物佔比不到 30%；海綠石主要分布在臺灣灘站位。透明重礦物以角閃石為主，不同站位的角閃石種類具有差異，暗示可能為不同母岩來源。

整體而言，岩屑和磁鐵礦在臺灣海峽東側佔比過半的趨勢，顯示來自臺灣的粗顆粒岩屑主要在海峽東側沉積。澎湖水道站位中並未發現膨潤石，推測為黑潮支流經澎湖水道向北傳輸，水流作用強勁，不利於細粒沉積物沉積。彰雲砂脊之細粒沉積物，應為順著表層流向北跨越澎湖水道輸送至樣本站位。海綠石主要分布於臺灣灘表層沉積物，指示該地區沉積速率緩慢，生物活動旺盛。本研究透過比較黏土礦物和重礦物的結果，展現臺灣海峽不同區塊的傳輸特性、沉積作用及物源的差異。

關鍵字:臺灣海峽、黏土礦物、重礦物、沉積物源

海報展示 P-OCG-4

利用 TOMO2D 軟體分析海底地震儀與多頻道震測資料來建構地殼速度構造：以 OR1999-6 測線為例

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摘要

海域地球物理主動式聲源探勘中，多頻道震測與海底地震儀為瞭解地下地質與地殼構造的主要工具，係是由研究船利用空氣槍釋放能量，前者由後方尾拖的受波器電纜來接收地層的反射走時，後者則是利用固定在海床上的海底地震儀來接收更深部的廣角反射與折射訊號，兩者分別能提供我們淺層地層的形貌與速度與地殼深部的速度構造資訊。本研究針對重新處理分析一條位在南海北部大陸邊緣上的西北－東南向 OR1-999-6 多頻道反射震測與海底地震儀陣列測線進行逆推模擬，有別於過往正演模擬較為主觀且耗時，本研究採用基於 LSQR（Least Square Residuals Method）演算法為基礎的二維層析成像法（2D Tomography）的 TOMO2D 軟體來進行逆推模擬，其能夠同時逆推獲得地殼的速度資訊與反射面的幾何形貌，其過程與結果也較為省時且客觀。我們首先透過分析多頻道反射震測資料所求得的基盤形貌與淺層速度，以此獲得基盤以上沉積地層的速度構造，作為求地殼構造的初始速度模型。並由 19 顆海底地震儀陣列所收得的資料，辨識並挑選出來自地殼的折射訊號（Pg）以及來自莫荷面（Moho）的反射訊號（PmP），隨後我們將初始模型與所選取的走時資訊結合，利用 TOMO2D 軟體來進行反射與折射走時資訊的聯合逆推，其中走時資訊的選取、初始模型中莫荷面的位置形貌、下部地殼的速度，與逆推時的參數配置如相關長度（Correlation length）、平滑程度（Smoothing value）、權重值（Weighting Value）等，都會影響速度構造的計算結果，因此我們除了挑選並測試不同的參數外，對於速度構造結果也將進行棋盤格測試（Checkerboard test）與蒙地卡羅分析（Monte Carlo analyses）來評估地殼速度構造模型的不確定性與穩健性，完整建構一個在南海北部大邊緣的地殼速度模型剖面，提供莫荷面深度與高速帶分佈的可靠資訊。在最終速度構造模型中，我們觀察到地殼厚度向大陸側漸厚，而在這地殼漸厚的過渡帶之下部地殼發現有厚數公里的高速帶（Vp>7km/s）特徵，透過確立高速帶的分佈與性質，我們將再更進一步討論南海北部大陸邊緣在張裂期與破裂時之構造演化與岩漿活動的相互關係。

海報展示 P-OCG-5

臺灣海峽沈積物新調查資料

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計畫名稱：離岸風場海域地質調查及地質環境資訊服務－地質構造及海床底質調查暨資料庫建置（2/4）
計畫編號：112-5226904000-02-02-01

摘要

本研究調查在經濟部地礦中心（112 年中央地質調查所與礦務局合併）的計畫支持下，針對臺灣海峽東部水深大於 50 公尺之離岸風場區域進行調查。111 至 112 年主要調查區域為苗栗外海至澎湖群島。兩年總共執行 3 個航次，使用震動式岩心採樣器執行 32 次採樣，於海峽砂質沈積物取得大於 1 公尺岩心 28 站，為學界於臺灣海峽取得之少數公尺以上沈積物岩心。相關岩心分析結果提供調查離岸風機場址區域的沈積物屬性與分布，冀望提供廠商重要的參考依據與建立國家海洋國土基礎資料。

沈積物岩心首先進行多重感應元岩心掃描器（Multi sensor core logger，MSCL）分析，其資料將岩心區分成 Unit I（均質）、Unit II（特殊層位）、Unit III（混亂）三種型態。其後進一步進行沈積物粒徑與全岩礦物 X 光繞射分析，並繪製此三種型態沈積物的粒徑及礦物三角圖。112 年（NOR1-0052）岩心站位的全岩 X 光繞射分析結果顯示，岩心可分為兩群體，其中一群為高含量之石英礦物，物性與臺灣灘相似。新採集岩心之表層沈積物與過往研究的沈積物粒徑分布無太多差異，主要組成為細砂。此外，在雲彰隆起北側、臺中外海 55 公里處，利用底拖取得碳酸鹽礁、貝殼與海生植物碎屑。底層海水放射性鐳同位素測量結果，顯示明顯短半衰期 ^{224}Ra 核種活度，代表有新鮮的流體自海床湧出。其形成機制與周圍是否還有同樣的構造則有待後續調查研究。

本研究除進一步瞭解海峽表層 1-3 公尺沈積物組成之分布與變異，也新增澎湖群島西側海域的空缺資料。藉由地球物理探勘選擇取樣站位，再利用震動式採樣器取得岩心，並利用非破壞性檢測設備進行物理性質掃描區分層位，及進行沈積物粒徑與礦物分析，建立沈積物屬性與分類，進一步瞭解調查區沈積物之物性及來源。

關鍵字：臺灣海峽、沈積物、震動式岩心、多重感應元岩心掃描、X 光繞射分析

海報展示 P-OCG-6

勵進研究船之聲納系統載台的發展與維護

Development and Maintenance of Sonar System on R/V Legend

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摘要

勵進研究船之科儀設備當中最基礎卻十分關鍵的部分為聲納系統包括淺海與深海型多音束聲納(MBES)、單音束聲納(SBES)、底質剖面儀(SBP)和都卜勒流剖儀(ADCP)，營運以來所收集的資料在質與量上皆有明顯的提升。有別於國內其他研究船的聲納系統，勵進研究船之聲納系統皆裝載在位於船底下方1.2米之載台(以下稱為Gondola)上，此設計可以有效減少航行時產生的氣泡噪音來提升資料品質。

勵進研究船自2019年正式啟用以來進入第六年，因此定期的保養維護設備對於維持研究船航行與科學調查能力是必須的。不過相較於其他可拆卸式儀器設備能在岸上進行保養，Gondola之聲納系統維護受限於航次安排及作業環境，時間與空間上限制較多，保養維護成本也高上許多，除了能利用塢修期間來進行施作，於航次間隔中也能請專業潛水教練協助清理。在塢修期間Gondola的保養項目不單是清除附著生物，為了保持音鼓面的平整性，須將表面打磨平整至原廠建議粗糙度，並且拆下周圍蓋板檢視內部情況以確保聲納系統能夠保持在最佳狀態。

儘管海洋中心測繪團隊已成功使用勵進研究船收集數量龐大且高品質的聲納資料，但仍希望能夠更穩定地運作及維持聲納系統的工作量能，持續提供學研界更高精度的聲納資料，更加完善台灣周邊海域調查。

關鍵字：聲納載台、聲納系統、勵進研究船

Keyword: Gondola, Sonar System, R/V LEGEND

海報展示 P-OCG-7

勵進研究船岩心採樣系統服務發展現況

Service Status about Core Sampling System on R/V LEGEND

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摘 要

配合國研院海洋中心 海洋底質沉積物探測技術發展子計畫，勵進研究船之岩心採樣系統結合岩心採樣資料及採樣時之現場聲納資料，經實海測試及作業蒐集各項設備之相關參數，累積海洋底質沉積物採樣系統作業參數資料。透過海洋岩心實驗室分析結果，持續改進作業模式，以精進勵進研究船海洋岩心採樣技術與能量，優化岩心採樣品質。未來期能提供相關研究計畫一更加穩定之岩心採樣服務、確保精準採樣之岩心品質符合國內學研界海洋地質相關研究分析所需。

海報展示 P-OCG-8

反射震測資料中海床相關雜訊抑制(SRME)處理之成果：以台灣東北外海 MCS2-2047-03 測線為例

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摘要

在海域震測資料採集中，反射訊號在水層或沉積物中來回震盪，可能導致接收到多次來自同一反射層的訊號，造成海床相關長週期複反射常會掩蓋真實地層反射，為淺水區震測資料經常遇到的問題。因此，有效處理這些長週期複反射更能確保從震測資料中準確辨識地層反射訊號，以進行地下結構的解釋和分析。本研究以台灣東北海域的 MCS2-2047-03 測線為例，藉由兩個震測資料處理軟體中的表層相關雜訊抑制方法來進行討論，分別為 RadExPro 的 Surface-Related Multiple Elimination (SRME)和 Echos 的 Surface Related Multiple Attenuation (SRMA)，皆係利用波動方程式(WEMA；Wave Equation Multiple Attenuation)和波線追跡（Ray tracing）的原理，從震測資料中模擬出複反射模型，並將其從剖面中有效的去除，進而達到海床相關雜訊的消除。然而兩者在算法上有所差異，在 RadExPro 之 SRME 結合了時域和頻域處理的方法，利用信號的時域特性和頻率的分佈情況來識別並消除複反射。相比之下，Echos 則採用了更加專業的優化算法處理，仰賴高效的數學模型和信號處理不必人為設定複反射模型的運算，其將會自行計算遠支距所收到的複反射深度，對複反射快速且精確的識別，以達到更高品質的消除。而在參數測試部份，RadExPro 和 Echos 的 2D 震測資料都是更著重於 Correlation window 的設置，時間窗口大小的增加將會涵蓋到更廣泛範圍內的訊號特徵，從而提高多次反射的識別和消除效果，但也會導致處理時間及記憶體需求的提高。另在優化 SRME 前，必須對環境噪聲進行一定程度的抑制。本研究透過 SRME 之反覆測試與比較，期望能更瞭解並熟悉 SRME 的應用，能提高震測資料處理時的效率。

海報展示 P-OCG-9

Application of physical properties from non-destructive analysis to track the source-to-sink dispersal of modern sediments in the Taiwan Strait and offshore southwestern Taiwan

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Abstract

The Taiwan Strait is located between the Asian continent and Taiwan, which is surrounded by two large marginal seas (i.e., South China Sea and the East China Sea). The marine environment in the Taiwan Strait regulates water flow between two large marginal seas along the western rim of the Pacific Ocean, and receives sediments from the largest land mass as well as a mountainous island with the highest sediment. For in-depth understanding of the marine environmental and climate interactions that have occurred in nearby land-source areas, previous source-to-sink studies based on marine core concentrated on using clay minerals, magnetic properties, element geochemistry and biogeochemical index. However, there has been a lack of an independent proxy on non-destructive analysis for understanding sedimentation processes for the transport of water and sediments. To better address the source-to-sink dispersal of modern sediments around Taiwan, here we conduct non-destructive measurements on box cores representing characteristics of typical sediments and sedimentary structures in deposits of the Taiwan Strait and offshore southwestern Taiwan by analyzing multi-sensor core logger (MSCL). We observe that MSCL data-gamma density and magnetic susceptibility exhibit a better relationship in the Kaoping River and the East China Sea, which could be serve as an indicator of local coastal rivers and surface currents. This finding cannot be in agreement with those downcore results in the offshore southwestern Taiwan (i.e., Formosa Ridge, FWCR Ridge). This could be due to those fairly complicated environments at gas hydrate area.

海報展示 P-OCG-10

臺灣北部近海斷層構造特徵
Seismic Imaging of Fault Structures Offshore Northern Taiwan

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計畫名稱：112 年海域環境監測調查
計畫編號：NAMR112004

摘要

臺灣北部地質架構由造山碰撞的擠壓狀態轉為與琉球島弧和沖繩海槽張裂有關的拉張狀態，形成了多組斷層構造，地質環境相當複雜。相較於過去震測資料品質，本研究使用了新建置的多頻道反射震測系統，並且設計了震測資料進階處理流程，針對複反射、氣泡效應等雜訊進行抑制，大幅提升了剖面成像品質。根據震測資料分析結果顯示，臺灣北部近岸區域有 5 條主要的斷層，皆呈東北−西南走向，由西至東分別為外金山斷層、野柳斷層、小野柳斷層、八斗子斷層，與鼻頭角斷層。外金山斷層長度約 30 公里，且斷層由近至遠岸皆破裂至海床，且斷層下方不整合面與斷塊間形成的半地塹盆地特徵相當清楚，外金山斷層可對應至外金山海床線形特徵，並且依照地理空間分佈，其可能與陸地上的山腳正斷層相關。野柳斷層長約 26 公里，然斷層僅有在近海約 10 公里內破裂至海床，並可對應至野柳海床線形特徵，往外海則受沈積物覆蓋呈現盲斷層特徵。小野柳斷層長約 13 公里，呈現盲斷層構造特徵，且越朝東北外海方向發展，斷層可能轉為破裂成多組小斷層。由於野柳斷層與小野柳斷層在空間分佈上距離較相近，目前尚未能確認陸地上的崁腳逆斷層往海域延伸方向是對應至野柳斷層或小野柳斷層。八斗子斷層長約 28 公里，近岸 10 公里斷層破裂至海床，往外海斷層受沈積物覆蓋轉為盲斷層，可能對應至陸地上的基隆逆斷層。鼻頭角斷層長約 10 公里，僅有在極近岸處破裂至海床，可能與不整合面的基盤斷塊相關，往外海呈盲斷層特徵。本研究精進多頻道反射震測資料處理，使剖面成像品質提升，故能針對北部近海斷層進行分析與解釋，並進一步提出臺灣北部海域近海斷層構造分佈圖，亦能作為未來進行北臺灣地質災害風險評估之重要參考依據。

關鍵字：外金山斷層、野柳斷層、小野柳斷層、八斗子斷層、鼻頭角斷層、海床線型、震測成像、臺灣北部海域

海報展示 P-OCG-11

海報展示 P-OCG-12

海洋中心長支距多頻道震測設備之應用與發展

Development and Application of TORI's LMCS Equipment

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摘　要

由財團法人國家實驗研究院台灣海洋科技研究中心 (簡稱:海洋中心)所引進臺灣首套工業級長支距多頻道震測 (Long-offset Multi-Channel Seismic，簡稱: LMCS)設備，使用貨櫃模組化的方式安裝於勵進研究船，於2019-2023年之間配合科學家不同的研究目標 (如: 地質災害、火成活動、碳封存構造與斷層構造等)與海域 (如: 太平島、菲律賓海域、南海中部海域、台灣海峽與台灣西南海域等)，調整LMCS設備參數 (如: 空氣鎗容積、炸測間距與浮纜長度等)，已完成10個航次，目前共計蒐集約8,284公里長之震測測線。LMCS設備能夠彙整震測系統的各項設備資訊，並計算震測設備與炸點位置，進行等距炸測，以克服臺灣附近海域多變的海況，同時亦能夠利用尾端浮標RGPS的相對位置，重新解算於炸測作業時之浮纜姿態。此外，我們發展空氣槍近場訊號的即時監控程式，以保持震測探勘作業進行時之震源品質，並希望能夠藉此提高震測資料品質與訊號穿透度。然而，目前LMCS設備雖然已經能夠蒐集科學資料，但未來仍希望透過不同科學家使用後的回饋與實海作業等經驗，持續發展與改善LMCS設備，一方面發揮其系統最大性能，另一方面能夠更靈活應用LMCS設備，提高使用設備之效益。

海報展示 P-OCP-1

高頻相位陣列雷達系統關鍵元件開發：帶通濾波器與接收電路板之現地量測比較

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摘　要

財團法人國家實驗研究院台灣海洋科技研究中心於 2019 年引進高頻相位陣列雷達頻段 8 MHz 系統並設立於恆春貓鼻頭公園處(簡稱 KNTN)，雷達系統透過接收發出之電磁波與海面波浪產生之布拉格散射(Bragg scattering)回波訊號，進而推算出即時波浪與流場訊息。

在維運期間考量該雷達系統因實際可觀測距離未能滿足建置目標、資料收取期間發現周圍環境之干擾以及架設環境隨時間經過產生差異等問題，本團隊自 2021 年以強化雷達回波訊號接收能力為目的，提出雷達回波訊號帶通濾波器(Band-pass Filter, BPF)及接收電路板之研析，預期透過自製帶通濾波器與改良接收版，改善干擾及強化觀測訊號等問題，自製帶通濾波器與改良接收版已於 2023 年底完成設計與製作，本年度於 KNTN 雷達站進行帶通濾波器與接收版現地實驗，一併測試 2023 年 OceanPhysics 提供之原廠新版帶通濾波器。經由初步比較雷達回波頻譜之資訊，發現存在明顯差異，透過計算各測試結果之背景雜訊強度、有效訊號及訊噪比(Signal to Noise Ratio, SNR)等量化指標，討論系統受干擾期間與非干擾期間之回波訊號解析能力，分析結果顯示，帶通濾波器之比較在環境干擾影響嚴重時段，原廠新版濾除雜訊效果較差，而原廠舊版與自製版本則差異甚小；接收版比較則是改良接收版相較於原廠舊版與自製版本，在干擾與非干擾時期之 SNR 值表現皆為最佳。

Keyword：高頻相位陣列雷達系統、接收電路板、帶通濾波器、訊噪比

海報展示 P-OCP-2

南灣海域之水文特徵及流場趨勢分析

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摘要

本研究利用財團法人國家實驗研究院台灣海洋科技研究中心於南灣架設的三站 Codar Seasonde 高頻雷達所收集的高分辨率(1x1 公里)逐時表面流場數據來探究南灣海域複雜的潮汐與其他物理現象。Codar 雷達測量範圍廣、觀測時間長，且可全天候觀測。可通過針對該數據進行經驗正交函數分析(Empirical Orthogonal Function, EOF)了解該海域的流場趨勢，且結果顯示該海域具有週期性的渦旋運動，與前人文獻相符。此外，我們也利用底碇式 ADCP 的觀測數據進一步分析該海域較深處的潮汐變化與渦旋關聯性，雷達及 ADCP 的分析結果皆呈現週期性震盪，且頻率特徵與潮汐週期相符。

海報展示 P-OCP-3

A Numerical Simulation Study of Cold Event and Winter Monsoon in the Taiwan Strait: A Case Study of 2008 Extreme Cold Event

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摘 要

某些年份，寒冷的中國沿岸流（China Coastal Current, CCC）會跨越臺灣海峽（Taiwan Strait, TS），導致澎湖和臺灣西部區域海溫異常下降，進而造成海洋生物大量死亡，形成臺灣海峽寒害事件（Taiwan Strait Cold Shock, TSCS）。先前的研究顯示，2008 年的 TSCS 是二十一世紀以來澎湖地區觀測到的最強事件，並且指出發生在 TS 中部和南部的 CCC 離岸流對 2008 年的 TSCS 具有重要影響。然而，事件背後的詳細物理過程以及 TSCS 事件中寒冷海水與冬季季風間的海氣交互作用尚未獲得良好之理解。因此，本研究採用 Coupled Ocean-Atmosphere-Waves-Sediment Transport (COAWST) Modeling System 對 2008 年 TSCS 事件進行了背景環境重建和控制實驗。我們的分析發現，如同前人文獻，在 2008 年 TSCS 中，東北風強度變化和 TS 中部的 CCC 離岸流造成了 TSCS 的發生，並通過控制實驗首次確定了潮汐以及海氣交互作用在 TSCS 事件中的效應。這些結果有助於改進對於寒害事件的預測，並更好的應對未來可能發生的類似事件。

海報展示 P-OCP-4

臺灣海峽寒害事件之機制分析與探討

Analysis and discussion on the mechanism of Cold Shock events in Taiwan Strait

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摘要

臺灣海峽位處中國與臺灣之間，為平均寬度為 180 公里北窄南寬之經向淺水通道，連接北端的東海與南端的南海。臺灣海峽寒害事件（Cold Shock events in Taiwan Strait, CSTS）是由中國沿岸流帶來的冷水團及黑潮分支和南海帶來的暖水團，與臺灣海峽中的地形、風速風向與潮汐等共同影響而發生。本研究透過 1991 至 2020 年之衛星反衍海表溫資料分析出時空特徵後，利用統計結果定義出寒害事件之溫度門檻與時間長度，並透過該門檻發現 10 次 CSTS 事件。為了檢驗設定門檻與指標之有效性，我們將利用利用區域海洋模擬系統模式（Regional Ocean Modeling System, ROMS）重建 2008 年的 CSTS 事件，分析發生過程之物理機制後，校驗並改善設定值，使其符合 2008 年 CSTS 特徵。

海報展示 P-OCP-5

應用混合座標海洋模式(HYCOM)追算資料探討臺灣東北海域冷渦於垂直分層結構的消長機制

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摘要

黑潮主流受地形影響，於台灣東北角海域被抬升並產生冷渦的現象，已被發現並研究了數十年，惟仍多利用船隻定點量測或衛星判定海表面高度異常等方式判定及追蹤冷渦，受到垂直分層與時間連續觀測資訊的限制，無法深入瞭解其消長機制。混合座標海洋模式(HYbrid Coordinate Ocean Model, HYCOM) 採用混合座標，相較於採用單一座標的模式，可將淺海、混合層、及深層海水的資料同時詮釋得更加貼切。再透過每日與海軍耦合海洋資料（NCODA）系統進行資料同化，可提供未來七日海洋預報及過去一日的追算資料，是可信度最高的作業化海洋模式。國家海洋資料庫及共享平台(National Ocean Database And Sharing System, NODASS)自 2023 年 5 月 2 日起，開始提供台灣周遭海域完整的 HYCOM 資料，包含空間解析度 0.04˚x0.04˚、時間頻率三小時、垂直分層 40 層，範圍涵蓋 80˚S 至 90˚N 的海洋表面高度、溫度、鹽度、向東流速度及向北流速度。

本研究參考 Nencioli 等人所開發的演算法：基於向量幾何的渦旋檢測法，將台灣東北角海域的渦旋中心以三維的方式呈現於自行開發的三維海洋數值模式可視化介面。該演算法優點在於單純透過 u、v 速度做估量，並在有限的計算資源下取得良好的檢驗率。其中渦旋範圍以最外圍的流線函數所構成的閉合曲線所界定，其中必須滿足由渦旋中心向東、西、南、北四個方向延伸至曲線上所接觸的四個點速度相較向中心的前一個網格還大。此外，為量化渦旋範圍大小，本研究將東西及南北向網格的差值視為渦旋的長軸和短軸，再用橢圓面積公式概算。透過分析 2022/10/01 至 2023/9/30 共一年的 HYCOM 資料。對於臺灣東北海域的冷渦得到以下四點結論：1.夏季(六、七、八月)出現渦旋的頻率較春季(三、四、五月)高。2.夏季隨時間推移渦旋出現深度有加深的趨勢。3.春、夏季中八月出現最大渦旋面積。4.六月渦旋出現的深度是春、夏季中最小的。其中春季渦旋中心在水深 125 公尺處仍有出現。而六月至七月中上旬僅達水深約 30 至 40 公尺。七月下旬至八月底亦普遍出現於水深 125 公尺處。

海報展示 P-OCP-6

岸基海洋雷達系統於南灣區域表層海流觀測之 AIS 漂流浮標驗證分析

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摘要

過往為解決高頻雷達與一般儀器觀測空間及時間差距，OHLMANN et al.(2006)使用密集的漂流浮標群在與高頻雷達相近的觀測網格範圍(1 平方公里及 4 平方公里)，重複佈放漂流浮標，如若漂流浮標漂離框定網格範圍則撿拾回來並重複佈放，因考量了時間及空間尺度，與過去驗證方式而言，均方根差異較低。但其取樣空間平均大小及觀測時間並非完全與雷達觀測空間及時間一致，並僅能代表單一網格的準確度，單點網格比較差距也並不能說明整個面的觀測品質都相同。

為能廣泛了解雷達空間觀測品質，Rypina et al.(2014)於美國麻薩諸塞州外海一島嶼，位於鱈魚角（Cape Cod）以南的瑪莎葡萄園島(Martha's Vineyard)附近海域佈放浮標陣，於 8*6 公里的區域內在短時間內佈放 40 個漂流浮標，浮標每分鐘進行報位，以每 30 分鍾的報位資料進行時間平均，以修正隨機誤差，但空間上而言僅為一維線性的平均，並將雷達海流經由雙線性內插至軌跡位置進行比對，相關係數東西及南北向都高達 0.9，但並未對雷達觀測空間差異變化進行討論，且浮標速度空間平均並非和雷達海流一致。

本研究整合上述方法於小範圍但不侷限在單一網格重複佈放漂流浮標，以獲取更多二維平面觀測時間及空間上樣本，研究區域於台灣南部南灣區域，框定 10*10 公里的方框內，重複佈放浮標，並採用 Davis(1985)的浮標架構，使量測深度近似於高頻雷達量測深度，並且此架構能使表面波驅動的斯托克漂流影響降低(Lumpkin et al.2017)，本研究針對高頻雷達觀測之二維平面海流資料，非單站徑向海流資料，主要討論兩站以上合成後的海流資料產品，並了解此區高頻雷達測流品質空間差異並定義最佳效能位置，研究區域位於台灣南部南灣區域於框定範圍佈放多組浮標，分析方法使用兩種不同分析方法，方法一為和雷達二維海流相同的網格，收集與雷達觀測同樣空間及時間尺度的浮標平均流速，藉此與觀測區的雷達資料進行比對並量化兩者差異響數據，方法二為使用同樣資料採用距浮標位置同時間最近點的海流格點與其進行比對，以此量化空間時間平均對兩者比對數據的影響。

海報展示 P-OCP-7

結合 ROMS 與 variational 資料同化進行臺灣東部海域流場模擬

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摘要

資料同化（data assimilation）乃使用觀測資料對數值模式進行調整的技術，使數值模式的結果更接近觀測流場。資料同化的概念是一種最佳化內插，在模式與觀測資料間找到一個最佳的內插解。為與本中心 TOROS 岸基高頻雷達測流系統協同進行台灣週遭海域流場觀測，我們採用 Regional Ocean Modeling System（ROMS）建立環流模式，並以 ROMS 內建的 4D variational 資料同化演算法進行資料同化模擬，以期產生高可信度之台灣週遭流場。同化使用的觀測資料為 Copernicus Marine Service 的 Level-4 網格化的衛星水位高產品（水平解析度0.25° × 0.25°，每日一筆資料）。模擬結果顯示資料同化演算法對模式的水位高進行微調，是其貼近觀測水位高。模擬資料與 2018、2019 年在台灣東部外海的五個錨碇 ADCP 流速進行比較，初步分析結果顯示，未同化的模式在 2018 年 10 至 11 月出現黑潮流速減緩的情況，但錨碇觀測流速未出現此現象。檢視模式當地流場發現有一個直徑約0.5°的小尺度氣旋向渦旋出現在其中一個錨碇的位置，才會發生黑潮減速的現象。經資料同化後的模式，並無出現此渦旋，流速也與錨碇觀測流速一致，表示資料同化使得模擬結果獲得改善。雖然資料同化改善上述事件的模擬結果，但在其他時段並非都優於未同化的模擬結果，此資料同化模式尚待更進一步調整與分析。

海報展示 P-OCP-8

高頻雷達表面海流觀測資料品管及驗證

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摘要

財團法人國家實驗研究院台灣海洋科技研究中心(下稱海洋中心) 發展「臺灣四周海域表層海流即時觀測平臺」，提供台灣周遭海域近即時流場，於 2008 年著手進行高頻雷達測流系統建置作業，雷達測流系統採用 CODAR 公司生產之全向型精簡雷達，此系統精簡，佔地範圍小，天線依頻率不同，有接收及發射共位之標準型天線，或接收與發射各一的長距離型天線，至 2018 年完成環台觀測網路建置。為提供可靠資料供學界申請用，於硬體設備方面，海洋中心定期進行機器與天線等設備之保養，以確保正常運作且穩定產出，而本系統資料解算仰賴正確天線場型方能獲得合理且準確結果，天線場型亦定期檢視資料是否需更新。由於雷達回波資料包含環境的影響，如電離層變化，或人為影響，如相近頻率的無線電干擾，或是參數設定不恰當，致使資料品質不佳，此可導致所關注之訊號不易判斷，甚至周遭干擾訊號所掩蓋，針對此問題，海洋中心已完成品質管理程序之開發，提升高頻雷達遙測表面海流觀測之可靠度。回波資料之處理，先判斷檔案之格式與內容之完整性，排除系統軟體運作不正常之可能，統計資料平均值與標準差，剔除偏差過大或過小的資料，確保資料時間與空間的連續性與合理性，後續並分析資料，判斷流速趨勢是否與觀測區之歷史潮流特性一致。此外，為驗證本中心維運之高頻雷達測流系統測流之可信度，近年分區域以漂流浮標進行驗證作業，浮標於框定範圍內重複佈放，以獲取足夠多時間與空間之資料，貼近雷達資料特性，檢視遙測資料與浮標資料相關性及差異範圍，持續收集資料調整參數並優化系統，以提供品質穩定且可信度佳之資料。

海報展示 P-OCP-9

應用人工智慧技術之超解析度 GOCI-2 影像監測淡水河口總懸浮固體濃度之時空變化

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計畫名稱：基於深度學習之超解析度 GOCI-2 影像監測淡水河口總懸浮固體濃度之時空變化

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摘要

全球暖化的加劇使得劇烈天氣在世界各地造成的環境災害愈趨頻繁。台灣也因颱風和豪雨所帶來的災害不僅造成了巨大的經濟損失，更引發了土石流與崩塌等事件，這些事件成為河川淤積和河口沉積物的主要來源。淡水河是全台最高河水年逕流量的河流，大量陸源物質經由沖刷後進入台灣海峽，其分布狀態將影響河口與鄰近海域的生態系統。為了提升對海洋環境影響的評估和應對效能，有必要對陸源物質的時空分布進行更精確的掌握。全球第一顆地球同步海洋水色衛星(Geostationary Ocean Color Imager, GOCI)自其發射並成功運轉以來，其資料一直受到全球海洋學家的關注。儘管 GOCI 已於 2021 年 3 月 31 日正式退役，但南韓政府早已規劃於 2020 年 2 月 18 日發射了 GOCI-2，並於同年 9 月 23 日正式提供了資料下載。GOCI-2 每天上午 7 點至下午 5 點提供 10 張空間解析度為 250 公尺的逐時影像，光譜波段數量為 13 個波段。這為海水表面物質分布動態追蹤相關研究帶來了嶄新的契機。本研究旨在應用 GEOKompsat-2B/GOCI-2 地球同步海洋水色衛星影像的高時間解析度特性，結合人工智慧影像超解析度技術，開發淡水河口總懸浮固體濃度的高時空動態變化監測方法。通過分析淡水河口範圍內總懸浮物質的時空變化關係，提升對於海陸系統物質傳輸的掌握度。