2021 年

海洋科學年會

暨科技部海洋學門成果發表會

2021 Ocean Science Conference
MOST Ocean Science Project

OSROC
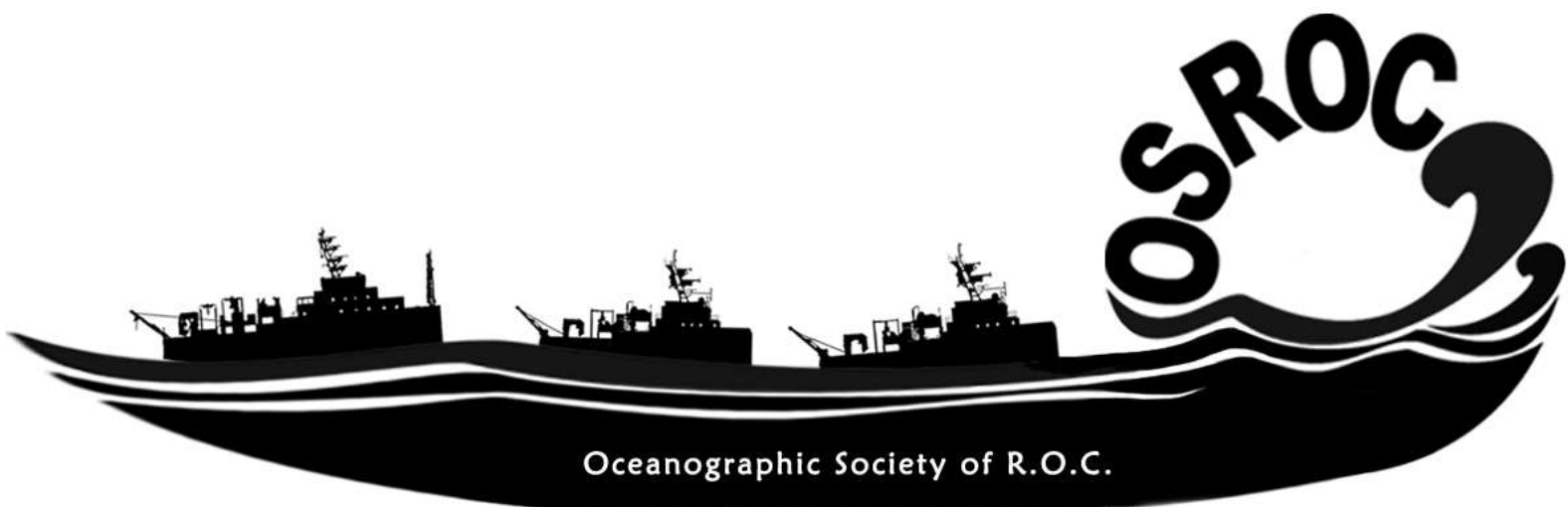
Oceanographic Society of R.O.C.

會議宗旨

海洋科學年會為臺灣海洋科學界每年一度的盛會，2020 年因武漢疫情因素暫停辦理一次，2021 年 4 月 28 日至 4 月 30 日於澎湖科技大學舉辦。本會議旨在推動「中華民國海洋研究與成果交流」，欲提供研究學人及學子們一個學術交流平台。本次年會舉辦方式由海洋學界相關領域教授、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，內容含括物理海洋、海洋地質和地球物理、海洋化學及生物海洋四大專業領域，以求更廣泛的學術交流。

年會內容涵蓋專題演講、海報展示及海報競賽；會議首日將邀請新海研 1 號、海研 2 號、海研 3 號、貴儀中心及資料庫發表科技部海洋學門最新研究成果。同時舉辦青年論壇及海報競賽以鼓勵青年學子學術發表。本會議期許能促進學者間相互瞭解與溝通，及各方研究成果分享與學術交流，由此深化海洋科學研究並推廣海洋科學教育。

會議組織

一、召集人：

詹森：國立臺灣大學海洋研究所特聘教授/中華民國海洋學會理事長

蔣國平：國立臺灣海洋大學海洋環境與生態研究所特聘教授

洪慶章：國立中山大學海洋科學系特聘教授

蔡安益：國立臺灣海洋大學海洋環境與生態研究所教授兼所長

許雅儒：中央研究院地球科學研究所研究員

二、共同主辦單位：

科技部自然司地球科學推動中心
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
國立澎湖科技大學

三、承辦單位：中華民國海洋學會

議程與召集人

	議程	召集人
OC	研究船事務/貴儀中心/資料庫報告 Marine Research Vessels/ Marine Instrument Center/ODB	蔣國平
海洋學門基礎領域(含貴儀及資料庫助理/技術員報告)		
OC1	海洋物理 Physical Oceanography	詹　森
OC2	海洋化學 Chemical Oceanography and Marine Chemistry	洪慶章
OC3	海洋地質/地球物理 Marine Geology & Geophysics	許雅儒
OC4	海洋生物/漁業 Biological Oceanography and Marine Biology	蔡安益

論文編號說明

※口頭報告 XM-N

X：代表場地之編號。詳細之對應關係如下表所示：

代號	4 月 28 日　　至　　4 月 30 日
A	海科大樓一樓國際會議廳
B	圖資大樓六樓國際會議廳
C	實驗大樓一樓演講廳

M：代表不同日期；N：代表報告於該日場次次序。

如 A1-3 為會議第一日當日 A 場次之第三位報告者。

※海報競賽：PC-MN

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：海報競賽生物組：如 PC-B1 為海報競賽生物組第一號

C：海報競賽化學組：如 PC-C1 為海報競賽化學組第一號

G：海報競賽地質/地物組：如 PC-G1 為海報競賽地質/地物組第一號

P：海報競賽物理組：如 PC-P1 為海報競賽化學組第一號

※海報展示：PMN

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：海報展示生物組：如 PB1 為海報競賽生物組第一號

C：海報展示化學組：如 PC1 為海報競賽化學組第一號

G：海報展示地質/地物組：如 PG1 為海報競賽地質/地物組第一號

P：海報展示物理組：如 PP1 為海報競賽組物理組第一號

會議議程

	4月28日(星期三)		
	海科大樓		
8:00-8:30	海科大樓一樓_簽到 / 報到		
8:30-8:45	【開幕式】海洋學會理事長致詞/海洋學門召集人/貴賓致詞		
8:45-9:00	新海研1號船務報告		
9:00-9:15	新海研2號船務報告		
9:15-9:30	新海研3號船務報告		
9:30-9:45	貴儀中心業務報告		
9:45-10:00	資料庫業務報告		
10:00-10:30	休息/茶點時間		
10:30-10:45	大會演講_陳鎮東教授		
10:45-11:00	「當年的一頭初生之犢：		
11:00-11:15	從第一篇Science及Nature論文所得到的教訓」		
11:15-11:30	大會演講_謝志豪教授		
11:30-11:45	「Trophic ecology of plankton in the seas around Taiwan」		
11:45-12:00			
12:00-13:00	午餐休息(海科一樓發放餐盒) 用餐地點：海科大樓四樓402-1&402-2教室		
	海科大樓	**實驗大樓**	**圖資大樓**
13:00-13:15	湯森林	陳冠宇	龔國慶
13:15-13:30	蔡安益	曾若玄	周文臣
13:30-13:45	陳仲吉	許哲源	陳鎮東(黃婷萱)
13:45-14:00	李明安	張凱富	陳宗岳
14:00-14:15	鍾至青	楊穎堅	白書禎
14:15-14:30	譚漢詩	鄭宇昕	曾鈞懋
14:30-14:45	陳孟仙	張明輝	何東垣
14:45-15:00	陳煦森	陳佳琳	謝志強
15:00-15:15	Sunhee Lee	詹森	簡國童
15:15-15:45	休息/茶點時間		
15:45-16:00	魏志漪	陳世楠	柯風溪
16:00-16:15	町田龍二	鄭志文	許瑞峯
16:15-16:30	塗子萱	汪佑霖	范瀞文
16:30-16:45	呂曉沛	辛宜佳	林卉婷
16:45-17:00	林芸琪	林依依	李宗霖
17:00-17:15	張峰勳	曾于恒	方天熹
17:15-17:30	何攖寧	曹俊和	曾筱君

大會演講	**海洋生物&青年論壇**	**海洋地質地物&青年論壇**
船務/業務報告	**海洋物理&青年論壇**	**海洋化學&青年論壇**

4月29日(星期四)			
	海科大樓	**實驗大樓**	**圖資大樓**
7:30-8:00	報到/簽到		
8:00-8:15	謝學函	詹宗翰(青)	李杰
8:15-8:30	施詠嚴	Lorenzo C. Halasan(青)	楊仁凱
8:30-8:45	洪慶章	曹德祺(青)	劉祖乾
8:45-9:00	林曉武	黃文謙(青)	林玉詩
9:00-9:15	范嵐楓	林玉婷(青)	林慧玲
9:15-9:30	黃蔚人	鄧勝元(青)	張詠斌
9:30-9:45	雷漢杰	粘育苓(青)	賀詩琳
9:45-10:00	魏慶琳	洪偉哲(青)	沈川洲
10:00-10:30	休息/茶點時間		
10:30-10:45	趙守恩(青)	陳昱安(青)	Thi Hong Nhi Vuong
10:45-11:00	吳心儼(青)	童一軒(青)	吳祚任
11:00-11:15	Sanjaya Weerakkody(青)	柯叡澤(青)	林慶仁
11:15-11:30	袁菲翎(青)	蕭博元(青)	張翠玉
11:30-11:45	陳彥榕(青)	李佩玟(青)	陳松春
11:45-12:00	林家加(青)	林樸仁(青)	黃碧淳
12:00-13:00	午餐休息 (海科大樓一樓發放餐盒) 用餐地點：海科大樓四樓402-1&402-2教室 (12:15-12:55理監事會議：海科大樓一樓MN-104)		
	海科大樓	**實驗大樓**	**圖資大樓**
13:00-13:15	劉正千	朱軒立(青)	陳韋仁
13:15-13:30	黃世任	方慧詩(青)	藍國瑋
13:30-13:45	何宗儒	許蓁(青)	張以杰
13:45-14:00	李逸環	Muhamad Naimullah(青)	陶曉航
14:00-14:15	錢樺	江俊億(青)	王怡甄
14:15-14:30	吳朝榮	Priyanka Muthu(青)	謝泓諺
14:30-14:45	鍾曉緯	黃群淳(青)	陳瑞谷
14:45-15:00	黃千芬	Gowri Krishna Girija(青)	廖德裕
15:00-15:15	黃志誠	李良能(青)	陳國書
15:15-15:30	休息/茶點時間		
15:30-15:45	海報競賽評分時間15:30-17:30 海科大樓一樓走廊 (請各組參賽者與評審提前至海報區準備)		
15:45-16:00			
16:00-16:15			
16:15-16:30			
16:30-16:45			
16:45-17:00			
17:00-17:15			
17:15-17:30			
18:30-21:00	晚宴(阿東海鮮餐廳) 備有接駁車：澎科大-餐廳(回程需自理)		

大會演講	海洋生物&青年論壇	海洋地質地物&青年論壇
船務/業務報告	海洋物理&青年論壇	海洋化學&青年論壇

	海科大樓	實驗大樓	圖資大樓
		4月30日(星期五)	
7:30-8:00	報到/簽到		
8:00-8:15	張頌平	TRAN THI LINH CHI(青)	
8:15-8:30	陳姿婷	Ly Trung Nguyen(青)	
8:30-8:45	林亮甫	曾博森(青)	
8:45-9:00	曾湧翔(青)	許家鈞(青)	
9:00-9:15	林怡彣(青)	張琳(青)	黃雍晉
9:15-9:30	鄭厚昇(青)	陳冠宇(青)	李欣庭
9:30-9:45	李芳儀(青)	李維德(青)	墨心慈
9:45-10:00	莊智凱(青)	郭嘉穎(青)	藍國維
10:00-10:15	李佩庭(青)	盧靖元(青)	鄭群學
10:15-10:30	Akanksha Singh(青)		葉宗旻
10:30-10:45	樂思成(青)		
10:45-11:00			
11:00-11:15	【閉幕式】海科大樓一樓國際會議廳 會員大會／薪傳&探測貢獻獎頒獎 青年論壇&海報競賽頒獎		
11:15-11:30			
11:30-11:45			
11:45-12:00			
12:30-13:30	接駁車 (澎科大-機場)		

大會演講	海洋生物&青年論壇 / 海洋地質地物&青年論壇
船務/業務報告	海洋物理&青年論壇 / 海洋化學&青年論壇

4 月 28 日星期三下午議程

13:00-15:15 主持人：鍾至青/陳煦森　　海科大樓一樓國際會議廳

13:00-13:15 A1-1 湯森林

尋找在珊瑚共生體中降解二甲基巰基丙酸之內生桿菌

13:15-13:30 A1-2 蔡安益 (摘要 p.39)

副熱帶海洋生態系中病毒生產量的日夜變化

13:30-13:45 A1-3 陳仲吉 (摘要 p.40)

近岸抬昇現象對台灣東部黑潮生態系之影響

13:45-14:00 A1-4 李明安 (摘要 p.41)

台灣淺灘周邊海域之環境與生態系動態特性

14:00-14:15 A1-5 鍾至青 (摘要 p.42)

氧化自營菌, Thiomicrorhabdus spp., 應是龜山島熱泉區水層中重要的初級生產者

14:15-14:30 A1-6 譚漢詩 (摘要 p.43)

化學預測分析的計算機模擬研究在龜島淺層熱液噴口的環境毒性評估

14:30-14:45 A1-7 陳孟仙 (摘要 p.44)

臺灣西部沿海底棲蝦類群聚的時空分布

14:45-15:00 A1-8 陳煦森 (摘要 p.45)

七股沿岸海域底棲蝦類群聚組成 10 年變遷

15:00-15:15 A1-9 Sunhee Lee 李仙喜 (摘要 p.46)

氣候控制對缽水母綱物種年際變異度及物候學特性的影響：以朝鮮半島海月水母(Aurelia Aurita)及越前水母(Nemopilema nomurai)為例

15:45-16:00 A1-10 魏志溓 (摘要 p.47-48)

比較台灣西南海域活體及死亡有孔蟲群聚結構

16:00-16:15 A1-11 町田龍二 (摘要 p.49)

多源轉錄體學提供比以 PCR 為基礎的方法更接

近形態學估量的多樣性及組成：浮游動物模擬群

落案例研究

16:15-16:30 A1-12 塗子萱 (摘要 p.50)

東沙海草床微生物代謝作用日週期變化

16:30-16:45 A1-13 呂曉沛 (摘要 p.51)

現地培養實驗檢測湧升海水營養鹽對表層浮游生

物群聚結構的影響

16:45-17:00 A1-14 林芸琪 (摘要 p.52)

副熱帶西北太平洋海域綠藻的種類組成與分布

17:00-17:15 A1-15 張峰勳 (摘要 p.53)

異營性鞭毛蟲對海洋細菌組成的影響受空間尺度

決定

17:15-17:30 A1-16 何攖寧 (摘要 p.54)

海洋塑膠碎片上的微生物：塑膠生物圈的生態

與潛在風險

13:00-15:15 主持人：周文臣/陳宗岳　　圖資大樓六樓國際會議廳

13:00-13:15 B1-1 龔國慶 (摘要 p.55)

臺灣四周海域海洋基礎生產力長期觀測與研究

13:15-13:30 B1-2 周文臣 (摘要 p.56)

內波是否有利於大氣二氧化碳的吸收？

13:30-13:45 B1-3 陳鎮東(黃婷萱) (摘要 p.57)

黑潮源區營養鹽通道之變化

13:45-14:00 B1-4 陳宗岳 (摘要 p.58)

台灣東北角沿岸顆粒態與溶解態基礎生產力的季節性變化

14:00-14:15 B1-5 白書禎 (摘要 p.59)

海水營養鹽自動分析系統回顧與前瞻

14:15-14:30 B1-6 曾鈞懋 (摘要 p.60)

汞在西北太平洋的生地化及生物累積研究

14:30-14:45 B1-7 何東垣 (摘要 p.61)

鎳在海洋藍綠菌中的重要性：鎳超氧化歧化酶及氫化酶的角色

14:45-15:00 B1-8 謝志強 (摘要 p.62-63)

氣膠鐵在西北太平洋表水的循環:來源和轉變

15:00-15:15 B1-9 簡國童 (摘要 p.64)

台灣附近海域顆粒及沉積物中重金屬濃度差異

15:45-17:30 主持人：許瑞峯/林卉婷　　　圖資大樓六樓國際會議廳

15:45-16:00 B1-10 柯風溪 (摘要 p.65)

塑膠微粒吸附海洋環境有毒污染物之潛能

16:00-16:15 B1-11 許瑞峯 (摘要 p.66)

西北太平洋中海洋微型塑膠的傳輸

16:15-16:30 B1-12 范瀞文 (摘要 p.67)

含抗菌劑微膠囊於海洋防污漆之應用及其測試驗
證

16:30-16:45 B1-13 林卉婷 (摘要 p.68)

人造海水環流示蹤劑鈾 236：多接收器感應耦合
電漿質譜儀分析方法之建立

16:45-17:00 B1-14 李宗霖 (摘要 p.69)

多環芳烴和多氯聯苯在港水海面微層的富集行為

17:00-17:15 B1-15 方天熹 (摘要 p.70)

淡水河河口海域水中磷物種分佈研究

17:15-17:30 B1-16 曾筱君 (摘要 p.71)

城市河口水質的社會環境分析-以淡水河河口為
例

13:00-13:15 C1-1 陳冠宇 (摘要 p.72-73)

內波流場與葉綠素甲分佈

13:15-13:30 C1-2 曾若玄 (摘要 p.74)

臺灣東北角外海的海洋鋒面與洋流

13:30-13:45 C1-3 許哲源 (摘要 p.75)

電磁探測垂直剖面浮標於上層海洋觀測之應用

13:45-14:00 C1-4 張凱富 (摘要 p.76)

應用省電型波浪儀量測颱風期間之波浪變化

14:00-14:15 C1-5 楊穎堅 (摘要 p.77)

應用海氣象浮標觀測資料估算颱風期間之海氣能

量通量變

14:15-14:30 C1-6 鄭宇昕 (摘要 p.78)

南海內孤立波的傳遞速度: 衛星遙測與理論解釋

14:30-14:45 C1-7 張明輝 (摘要 p.79)

東沙環礁以東內孤立波之不穩定及紊流

14:45-15:00 C1-8 陳佳琳 (摘要 p.80)

Mixing Enhancement Modulated by Unsteady

Shear

15:00-15:15 C1-9 詹森 (摘要 p.81)

北半球夏季季風期南海中部顯著的海流季內振盪

及其動力機制

15:45-16:00 C1-10 陳世楠 (摘要 p.82)

Eddy equilibration in baroclinically unstable, frictional flows

16:00-16:15 C1-11 鄭志文 (摘要 p.83)

海氣耦合模式對海燕颱風強度變化之研究

16:15-16:30 C1-12 汪佑霖 (摘要 p.84)

全球暖化變異下聖嬰現象對越南湧升流的影響

16:30-16:45 C1-13 辛宜佳 (摘要 p.85)

南海中部夏季湧升之年際變化及機制

16:45-17:00 C1-14 林依依 (摘要 p.86)

Rapid Intensification of Super Typhoon Hagibis (2019)

17:00-17:15 C1-15 曾于恒 (摘要 p.87)

TIMCOM model datasets for CMIP6 Ocean Model Intercomparison Project

17:15-17:30 C1-16 曹俊和 (摘要 p.88-90)

南中國海北部渦旋中心產生明顯湧升與沉降之條件

4 月 29 日星期四上午議程

08:00-10:00 主持人：施詠嚴/范嵐楓　　　海科大樓一樓國際會議廳

08:00-08:15 A2-1 謝學函 (摘要 p.91)

內波對南海北部的碳輸出之影響

08:15-08:30 A2-2 施詠嚴 (摘要 p.92)

南海北部以遙測及現場觀測估算 VGPM 基礎生產力的潛在誤差

08:30-08:45 A2-3 洪慶章 (摘要 p.93)

南海颱風誘發之碳通量及無法預測的深海碳源

08:45-09:00 A2-4 林曉武 (摘要 p.94-95)

南海活動與被動大陸邊緣區域氣液洩漏環境之差異

09:00-09:15 A2-5 范嵐楓 (摘要 p.96)

東沙環礁潟湖碳化學之季節間及年間變化

09:15-09:30 A2-6 黃蔚人 (摘要 p.97)

如何量測潟湖與濕地中水體二氧化碳分壓之時空變異？

09:30-09:45 A2-7 雷漢杰 (摘要 p.98)

黑潮入侵有助於降低北南海沿岸的低氧程度

09:45-10:00 A2-8 魏慶琳 (摘要 p.99)

利用浮標觀測估算西菲律賓海淨社群生產量和氧及二氧化碳的海氣通量

10:30-10:45 A2-9　趙守恩

　　　　　　黑潮二氧化碳海氣吸收之減弱與酸化加速

10:45-11:00 A2-10 吳心儼 (摘要 p.100)

　　　　　　海水有機配體與氣膠鐵的互動

11:00-11:15 A2-11 Sanjaya Weerakkody (摘要 p.101)

　　　　　　Carbon fixation by Red Macroalga, Sarcodia

　　　　　　suiae, using aquaculture wastewater

11:15-11:30 A2-12　袁菲翎 (摘要 p.102)

　　　　　　七股潟湖紅樹林濕地中無機碳動力學之時間變

　　　　　　化：初探

11:30-11:45 A2-13　陳彥榕 (摘要 p.103)

　　　　　　探討持久性有機汙染物在恆春半島沿海海參之生

　　　　　　物累積

11:45-12:00 A2-14　林家加 (摘要 p.104)

　　　　　　淡水河河口的甲烷濃度及其氧化速率季節性變化

08:00-08:15 C2-1 李杰 (摘要 p.105)

珠江沖淡水傳播路徑上懸浮顆粒特性受水動力影響變化之探討

08:15-08:30 C2-2 楊仁凱 (摘要 p.106)

季風轉換下台灣海峽西側陸海相互作用的典範更迭

08:30-08:45 C2-3 劉祖乾 (摘要 p.107)

物理驅動力、水團特性、和水體懸浮沉積物之共變特徵研究

08:45-09:00 C2-4 林玉詩 (摘要 p.108)

南海北部兩個源匯系統陸棚沉積物的氧氣消耗速率比較

09:00-09:15 C2-5 林慧玲 (摘要 p.109-110)

現生有孔蟲在水體及沉積物的分布：南海沈積物收集器與西南海域的箱形岩心記錄

09:15-09:30 C2-6 張詠斌 (摘要 p.111)

臺灣東部海底峽谷高頻率濁流事件機制探討

09:30-09:45 C2-7 賀詩琳 (摘要 p.112)

熱帶海洋之冰期冷卻的規模與模式

09:45-10:00 C2-8 沈川洲 (摘要 p.113)

解密'太平洋的威尼斯'

10:30-10:45 C2-9　Thi Hong Nhi Vuong (摘要 p.114)

用 Bingham 模式探討山崩海嘯

10:45-11:00 C2-10　吳祚任 (摘要 p.115)

以精進之雙黏性流模型進行泥石流模擬

11:00-11:15 C2-11　林慶仁 (摘要 p.116)

海底觀測儀器的研發與資料應用

11:15-11:30 C2-12　張翠玉 (摘要 p.117)

利用機器學習法則研究海域地震紀錄：台灣西南

海域 OBS 紀錄的訊號種類及分析

11:30-11:45 C2-13　陳松春 (摘要 p.118)

臺灣海洋地質調查及有待釐清的海陸地質構造問

題

11:45-12:00 C2-14　黃碧淳 (摘要 p.119-120)

台灣東北海域龜山島北側崩塌與海底山崩研究

08:00-10:00 主持人：陶曉航 **實驗大樓一樓演講廳**

08:00-08:15 B2-1 詹宗翰 (摘要 p.121)

溫度對仔稚魚異速生長的影響：以兩種亞熱帶礁魚為例

08:15-08:30 B2-2 Lorenzo C. Halasan (摘要 p.122)

熱帶西太平洋木葉鰺（Carangidae）的種群遺傳結構和形態學研究

08:30-08:45 B2-3 曹德祺 (摘要 p.123)

以生命條碼及形態評估台灣�納科魚類生物多樣性

08:45-09:00 B2-4 黃文謙 (摘要 p.124)

不同種亦或表型變異？西太平洋海域姐妹種鯙科魚類之基因多樣性、雜交、基因滲入與形態分析研究

09:00-09:15 B2-5 林玉婷 (摘要 p.125)

棲地和岩礁魚類專一化程度在生物地理過渡帶中的改變

09:15-09:30 B2-6 鄧勝元 (摘要 p.126)

氣候變遷對烏魚洄游和棲地衝擊之評估

09:30-09:45 B2-7 粘育苓 (摘要 p.127)

臺灣河口三個隱蔽種烏魚苗種類組成之年間差異

09:45-10:00 B2-8 洪偉哲 (摘要 p.128)

西北太平洋秋刀魚性成熟度之時空變化

10:30-10:45 B2-9　陳昱安 (摘要 p.129)

臺灣東北海域湧昇流站磷蝦物種及生長階段組成的季節變化

10:45-11:00 B2-10　童一軒 (摘要 p.130)

中南美白對蝦 Penaeus vannamei 對聚丙烯微塑膠纖維之攝入與行為影響

11:00-11:15 B2-11　柯叡澤 (摘要 p.131)

南海原核生物群聚結構短時間和長時間尺度變化研究

11:15-11:30 B2-12　蕭博元 (摘要 p.132)

評估夏季臺灣淺灘湧升生態系統中初級生產需求量與海洋環境的變化

11:30-11:45 B2-13　李佩玟 (摘要 p.133)

亞熱帶城市河口區之浮游動物群聚研究

11:45-12:00 B2-14　林樸仁 (摘要 p.134)

浮游植物關聯群聚的空間β多樣性在翡翠水庫的時間變化

4 月 29 日星期四下午議程

13:00-15:15 主持人：李逸環/鍾曉緯　　　海科大樓一樓國際會議廳

13:00-13:15 A2-15 劉正千 (摘要 p.135)

地球同步衛星逐時影像推導之徑線與流線產品與

服務

13:15-13:30 A2-16 黃世任 (摘要 p.136)

北太平洋的葉綠素濃度與氣膠間的相關性探討

13:30-13:45 A2-17 何宗儒 (摘要 p.137)

衛星觀測綠島尾渦的空間結構與時間變動

13:45-14:00 A2-18 李逸環 (摘要 p.138)

北南海非線性內波於東沙島淺化之現象

14:00-14:15 A2-19 錢樺

應用陣列式高頻雷達監測波浪場之演算法開發、

驗證與應用

14:15-14:30 A2-20 吳朝榮 (摘要 p.139)

大西洋氣候變異對太平洋海洋環流的影響

14:30-14:45 A2-21 鍾曉緯 (摘要 p.140)

臺灣海域衛星遙測開放資料建置處理與加值服務

14:45-15:00 A2-22 黃千芬 (摘要 p.141)

利用沿岸聲層析術之自主海洋測繪

15:00-15:15 A2-23 黃志誠

桃園市海岸帶懸浮沉積物的觀測

13:00-13:15 B2-15 陳韋仁 (摘要 p.142)

航向藍海: 新海研 1 號首航之台灣周邊海域探測

13:15-13:30 B2-16 藍國瑋 (摘要 p.143)

氣候變遷對生態系統與海洋頂端掠食者年齡組成時空間分布之影響:以太平洋大目鮪為例

13:30-13:45 B2-17 張以杰 (摘要 p.144)

利用地理統計方法評估西北太平洋秋刀魚之時空動態

13:45-14:00 B2-18 陶曉航 (摘要 p.145)

探討魚類種內不同大小個體群的棲地重複度隨時間之變化- 以北海三個魚種為例

14:00-14:15 B2-19 王怡甄 (摘要 p.146)

夏季台灣淺灘湧升水域之魚類組成及食階研究

14:15-14:30 B2-20 謝泓諺 (摘要 p.147)

高屏海域中深水層魚仔稚魚之成長、死亡及對浮游動物的攝食需求:以七星底燈魚及智利串光魚為例

14:30-14:45 B2-21 陳瑞谷 (摘要 p.148)

以魚卵生產模式推估宜蘭灣海域花腹鯖產卵親魚量

14:45-15:00 B2-22 廖德裕 (摘要 p.149)

南海魚類環境 DNA 之垂直分佈

15:00-15:15 B2-23 陳國書 (摘要 p.150)

中華白海豚食餌魚類在臺灣西南海域的空間分布特徵———以研究船桁桿式底拖調查資料分析

13:00-13:15 C2-15 朱軒立 (摘要 p.151)

龜山島海底熱泉對於烏龜怪方蟹季節性與生理特徵之研究

13:15-13:30 C2-16 方慧詩 (摘要 p.152)

人類世脈絡下臺灣魚類年菜的生物多樣性

13:30-13:45 C2-17 許蓁 (摘要 p.153)

評估空間劃分對單位努力漁獲量標準化之影響：以西北太平洋秋刀魚漁業為例

13:45-14:00 C2-18 Muhamad Naimullah (摘要 p.154)

影響臺灣海峽三種商業性游泳螃蟹漁獲量之因素：環境因子與網具浸泡時間

14:00-14:15 C2-19 江俊億 (摘要 p.155)

穩定同位素技術於萊氏擬烏賊之生態研究應用

14:15-14:30 C2-20 Priyanka Muthu (摘要 p.156)

海洋水母對泌尿道感染病原菌的抗菌效果

14:30-14:45 C2-21 黃群淳 (摘要 p.157)

圈養白鯨的聲音分類與夜宿對其聲音的影響以評估其動物福利之研究

14:45-15:00 C2-22 Gowri Krishna Girija (摘要 p.158-159)

來自不同海域的無共生藻石珊瑚 Tubastraea coccinea 相關菌群分析

15:00-15:15 C2-23 李良能 (摘要 p.160)

探討夜光蟲有性生殖的機制

4 月 30 日星期五上午議程

08:00-08:15 A3-1 張頌平 (摘要 p.161)
高解析反射震測與離岸風力發電場址調查之應用

08:15-08:30 A3-2 陳姿婷 (摘要 p.162)
東海陸棚花瓶嶼與彭佳嶼周圍海域的高解析地形與冒氣特徵探討

08:30-08:45 A3-3 林亮甫 (摘要 p.163)
台灣西南海域被動與活動邊緣之天然氣水合物與流體系統震測特徵分布及意涵

08:45-09:00 A3-4 曾湧翔 (摘要 p.164)
彰濱外海淺部地層流體特徵辨識與分布

09:00-09:15 A3-5 林怡彣 (摘要 p.165)
台灣北部貢寮外海地質構造之研究

09:15-09:30 A3-6 鄭厚昇 (摘要 p.166)
利用海底地震儀的記錄分析北南海海槽之亞重力波

09:30-09:45 A3-7 李芳儀 (摘要 p.167)
不同滑脫面深度對地表斷層發育的影響

09:45-10:00 A3-8 莊智凱 (摘要 p.168)
西赤道太平洋所羅門海域岩芯發現的中更新世鈣質超微化石橋石屬新種 Gephyrocapsa kennettii sp. nov.

10:00-10:15 A3-9 李佩庭 (摘要 p.169)
發展單隻有孔蟲鎂鈣比分析之清洗步驟

10:15-10:30 A3-10 Akanksha Singh (摘要 p.170)
Freshwater and riverine input in central Arctic system: insight from biomarker proxy

10:30-10:45 A3-11 樂思成 (摘要 p.171)
臺灣周遭海域表層沉積物浮游及底棲有孔蟲比例之空間分佈與應用潛能

09:00-09:15 B3-1 黃雍晉 (摘要 p.172)

運用經驗動態模型搭配巢狀訓練集分析法偵測非線性系統的改變

09:15-09:30 B3-2 李欣庭 (摘要 p.173)

鎳對固氮藍綠藻(Cyanothece)產氫及固氮之影響: 氫化酶及固氮酶的表現

09:30-09:45 B3-3 墨心慈 (摘要 p.174)

臺灣小琉球珊瑚與藻類群聚分析和海洋食藻動物的關聯

09:45-10:00 B3-4 藍國維 (摘要 p.319)

台灣南部海域熱韌性尖枝鹿角珊瑚的生殖與培育

10:00-10:15 B3-5 鄭群學 (摘要 p.175)

珊瑚照相監測、影像自動分析與交流網絡的建立與推廣

10:15-10:30 B3-6 葉宗旻 (摘要 p.176)

水溫、珊瑚白化與死亡型態顯示湧升流礁區具有熱緊迫庇護所的潛力

08:00-08:15 C3-1 TRAN THI LINH CHI (摘要 p.177-178)

　　　　　　　應用無人機與物件檢測評估海漂寶特瓶數量-以大

　　　　　　　園海灘為例

08:15-08:30 C3-2 Ly Trung Nguyen (摘要 p.179)

　　　　　　　Sediment Concentration and Particle Size

　　　　　　　Variability over the Algal Reef Bottom in

　　　　　　　Taoyuan Coastal area

08:30-08:45 C3-3 曾博森 (摘要 p.180)

　　　　　　　以 COMCOT-SS 預報印度洋之風暴潮

08:45-09:00 C3-4 許家鈞 (摘要 p.181)

　　　　　　　以影響強度法分析與重建 1845 雲林口湖風暴潮事

　　　　　　　件

09:00-09:15 C3-5 張琳 (摘要 p.182)

　　　　　　　GNSS 反射計風速反演算法優化及品質評估

09:15-09:30 C3-6 陳冠宇 (摘要 p.183)

　　　　　　　利用移動載具進行沿岸流場之最佳測繪研究

09:30-09:45 C3-7 李維德 (摘要 p.184)

　　　　　　　季內環流變異對台灣西南海域渦漩之影響

09:45-10:00 C3-8 郭嘉穎 (摘要 p.185)

　　　　　　　以淺水方程模擬探討 beta 平面上中尺度渦旋傳遞

　　　　　　　的不對稱性

10:00-10:15 C3-9 盧靖元 (摘要 p.186)

　　　　　　　台灣島嶼陷流之研究

海報競賽及海報展示

海報競賽 4 月 29 日 15:30-17:30　　　　　　　海科大樓一樓走廊

海報競賽 海報編號	姓名	題目
PC-C1	賴承煬	南海北部 13C 及 14C 培養法之基礎生產力差異探討(摘要 p.187)
PC-C2	蘇渝婷	海水中硝酸鹽測定新技術:釩還原偶氮法 (摘要 p.188)
PC-C3	蘇郁芬	以陰離子交換樹脂分析自然水中溶解態銀物種的可能性 (摘要 p.189)
PC-C4	施守平	Aeroplysinin-1 藉由氧化壓力誘導細胞凋亡與調控 EMT 相關蛋白表現之抗癌作用 (摘要 p.190)
PC-C5	王姵云	鈷在都會區感潮河道中的動態平衡與反應性 (摘要 p.191)
PC-C6	林家加	淡水河河口與其外海的甲烷濃度季節性變化 (摘要 p.192)
PC-C7	陳宣邑	不同年間雲彰隆起海域海洋環境與基礎生產力季節性變化與差異(2017-2018) (摘要 p.193)
PC-C8	廖哲瑄	夏季北南海與西太平洋間表層水總鹼度之關聯性 (摘要 p.194)
PC-C9	賴加育	海水酸鹼度分光法測量系統開發 (摘要 p.195)
PC-C10	鄭勝文	台灣西部沿海牡蠣對持久性有機污染物環境調查及生物累積(摘要 p.196)
PC-C11	陳韋名	高時間解析度之表水二氧化碳分壓自動量測浮標 (摘要 p.197)

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Diel variation of viral production and burst size in a coastal subtropical marine system

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Abstract

Viral production and burst size critically influence the production and mortality of aquatic bacteria. Although bacterial production, bacterial mortality by viral lysis, and viral density have been found to exhibit diel variations, the diel change in viral production and burst size has rarely been investigated. In this study, we conducted two modified diel dilution incubation experiments in a semi-enclosed, nutrient-rich coastal region in northeastern Taiwan to estimate the diel viral production. We further developed a method for estimating in situ burst size of aquatic host-virus systems. We found that viral production and burst size were 1.2 to 5.5 times higher during the daytime than during the nighttime. However, the bacterial mortality by viral lysis and bacterial growth rate did not differ between daytime and nighttime. One possible explanation for high viral production at daytime but constant diel bacterial mortality is that bacterial communities composed of cell types with different burst sizes regulate the diel change in viral production. During the day, viral community was composed of large cells or species with large burst size, and thus viral production increase despite non-changing bacterial mortality by viral lysis. This study offered preliminary observations of diel variation in viral dynamics in marine environment.

Effects of near-shore uplift on the Kuroshio ecosystem, eastern Taiwan, the western boundary current of the North Pacific Ocean

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Abstract

Kuroshio is the western boundary current of the North Pacific Ocean. Apart from the upward diffusion through the bottom layer, its nearshore uplift is another source of surface inorganic nutrients. Therefore, the uplift intensity may affect the biogeochemical response of the Kuroshio ecosystem. To explore the impact of the Kuroshio nearshore uplift on the ecosystem, hydrographic data along the transect line at 23.75°N were measured between September 2012 to September 2014. Results show that nearshore uplift intensity is significantly related to the fluxes and distance of the fastest velocity of the Kuroshio. This may be due to that its fluxes change locally in the upper layer, which causes vorticity imbalance. To maintain vorticity balance, the isopycnic lines steepen and uplift to the nearshore. The significant positive linear relationships are also observed between the uplift intensity and averaged values of inorganic nutrients or chlorophyll *a* over the 100m of water column. In addition, the abundance of picoeukaryotes is positively correlated with nitrate concentration in this pelagic ecosystem. Overall, the results suggest that the nearshore uplift of the Kuroshio has significant effect on its pelagic ecosystem.

台灣淺灘周邊海域之環境與生態系動態特性

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摘　要

　　台灣淺灘水域，為我國沿近海漁業的重要地形性湧升漁場之一，因有高基礎生產力與高營養鹽之特徵，且複雜的環流與水文環境變化，也造就豐富且多樣性高的漁場環境與棲地特性。本研究於2018年至2020年間，透過海研三號研究船、商業性拖網漁船、商業性燈火漁船等方式，進行海上現場之水文資料及底拖網生物、浮游動物、浮游植物、底泥沉積物及水體等蒐集水文環境資料及生物樣本，並配合部分衛星資料及海流模擬等方式，進行台灣淺灘水域之整體環境變化及生物相調查。整體結果顯示，湧升現象之發生多係在夏季，其湧昇強度最高出現在6月間，且位在淺灘之東南側、約水深50m處，並呈一帶狀，其成因可能與南海海流有關；浮游動物方面，密度最高成以橈足類為主，其種類組成及變化與季節間不同各水團交匯而有所變化，但主要優勢種多為暖水性種類，而湧昇發生之水域亦有較高之多樣性；仔稚魚方面，透過群集分析後可發現，種類組成較不受湧昇位置影響，而與各採樣位置之水深有較大之關聯性；商業性拖網結果方面，2018年之四季採樣已獲得魚類76科192種、蝦類6科14種、蟹類13科33種、螺貝類2科2種，其他尚有裸鰓類、多毛類及海綿類等。另，透過各生物之食性、營養位階等資料，本研究嘗試利用上述之初步結果，劃分出34個功能群(functional group)，以期後續能逐步增加、並修正為建立Ecopath with Ecosim 模式所需之資料。

硫氧化自營菌, *Thiomicrorhabdus* **spp.,** 應是龜山島熱泉區水層中重要的初級生產者

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摘　要

　　龜山島淺海熱泉區為研究生命起源以及極端環境生態之得天獨厚的天然實驗場。2019年4月使用海研二號研究船對此水域之超微原核浮游生物族群生態進行研究：(1) 碳-14放射性同位素培養實驗中，在暗瓶培養組測得高固碳速率，顯示化學自營菌在此擔任重要初級生產者角色 (龔，未發表數據)；(2) 進行16S rRNA V3-V4基因片段序列多樣性分析，*Thiomicrorhabdus* spp.佔總超微原核浮游生物組成比例高達75%，顯示其為此熱泉區水域的主要優勢化學自營菌菌種；(3) 同以16S rRNA基因表現量作為超微原核浮游生物族群活性指標，結果指出 *Thiomicrorhabdus* spp.也為此水域最活潑的菌種；(4) 轉錄體分析結果，發現參與固碳生化反應Calvin-Benson-Bassham cycle過程中多個關鍵酵素的基因顯著表現 (例如：RuBisCO)，這些基因經比對後，也多屬*Thiomicrorhabdus*所有。因此，根據以上證據，我們推論硫氧化菌*Thiomicrorhabdus* spp.應是龜山島熱泉區水層重要的初級生產者。

化學電腦計算有助於評估快山套淺層熱液噴口的環境毒性

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摘　要

　　化學信息學是對化學信息資源的搜索，化學信息資源通常將數據轉換為信息，然後將其轉換為可以更快地做出決策的技術。計算機方法是指計算機應用程序或計算機模擬。使用信息技術將污染研究中的計算機方法最好地理解為化學信息學，該信息技術應用於與毒理學和污染物影響有關的化學領域中的一系列問題。以一個評估計算機方法的例子為例，VEGA in silico平台通常通過使用三種不同的計算機生態毒理學模型（即SarPy / IRFMN，KNN / Read-Across和NIC模型）來預測"魚"的急性毒性。 。為了進行該評估，三丁基錫（TBT）化合物的SMILES來自PubChem數據庫。通過使用MarvinSketch，此處介紹的所有化學藥品均基於PubChem的結構數據。通過VEGA中的KNN / Read-Across（Model-1）和NIC（Model-2）模型預測了TBT對魚類的急性毒性。 VEGA in silico預測方法–1預測低濃度0.0276 mg / mL時TBT魚的急性毒性作用。在計算機上，預測模型為所需的和其他復合屬性提供了快速而經濟的篩選工具。更高的吞吐量和持續的優化是可能的。它們更便宜，更省時，重現性更高，並且通過替代它們減少了對實驗工作的使用。如此處所示，計算方法還可優先考慮化學物質的毒理學評估，以減少昂貴的體內和體外毒理學篩查，並為新開發的物質提供早期預警。局限性包括不考慮ADME方面（吸收，分佈，代謝和排泄-它們是基本的藥代動力學指標），缺乏實驗數據和程序的訓練集的質量和透明度，有時描述符和適用性不足不清楚。此外，致癌性預測不適用於非遺傳毒性化合物。

臺灣西部沿海底棲蝦類群聚的時空分布

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摘要

　　本研究是利用海研三號研究船在台灣西部沿岸的 7 個測站，分別 2019 年的春末(五月)及秋末(11 月)進沿岸 15-25 米水深之底拖採樣調查。兩航次的調查總共記錄了 27 種蝦種，蝦種數在秋末有 20 種比春末的 15 種為多，秋末出現的蝦種為狹溫性的亞熱帶蝦種而春末出現的蝦種為廣溫性的熱帶蝦種。這些底棲蝦種類組成可以明顯地區分為以長角仿對蝦和中華仿對蝦為優勢種的北群和以婆羅門赤對蝦為優勢蝦種的南群。此分群的情形反應台灣沿岸海域大尺度季節海溫的變化，冬季中國沿岸水(CCC)南下到七股，溫暖的黑潮水(KBC)和南海表層水(SCSSC)則終年存在七股以南海域，使得該海域水溫終年維持在 25 度 C 以上，有利於熱帶型婆羅門赤對蝦的生存，反之，在七股以北海域因冬季 CCC 的南下，春季 CCC 的消退 KBC 的北流，夏季 KBC 和 SCSSC 的北流，形成季節性的水溫變化，有利於熱帶型長角仿對蝦和中華仿對蝦的生息。除此之外，長期海流所形成的底質粒徑的差異，也因蝦種的不同喜好，形塑了蝦類群聚以七股為界明顯南北分群的現象。本研究是首次報導熱帶及亞熱帶蝦種類組成，因大尺度季節性水團的影響，有明顯的水溫及底質粒徑的差異，而形成南北分群的現象。此外，與 20 年前的歷史數據比對，發現長角仿對蝦的族群有向北移零點五度的情形，這項研究結果可以在未來持續全球暖化下，探討熱帶蝦種向北分佈的基線資料。

關鍵詞: 溫度耐受性、粒徑大小、婆羅門赤對蝦、長角仿對蝦、季節變化、水團

Mpal=*Metapenaeopsis palmensis*, Phar=*Parapenaeopsis hardwickii*, Psin=*Parapenaeopsis sinica*.
WC=Wuchi, WG=Wanggong, TS=Taisi, CK=Chiku, JD=Jiading, LY=Linyuan, FL=Fangliao.
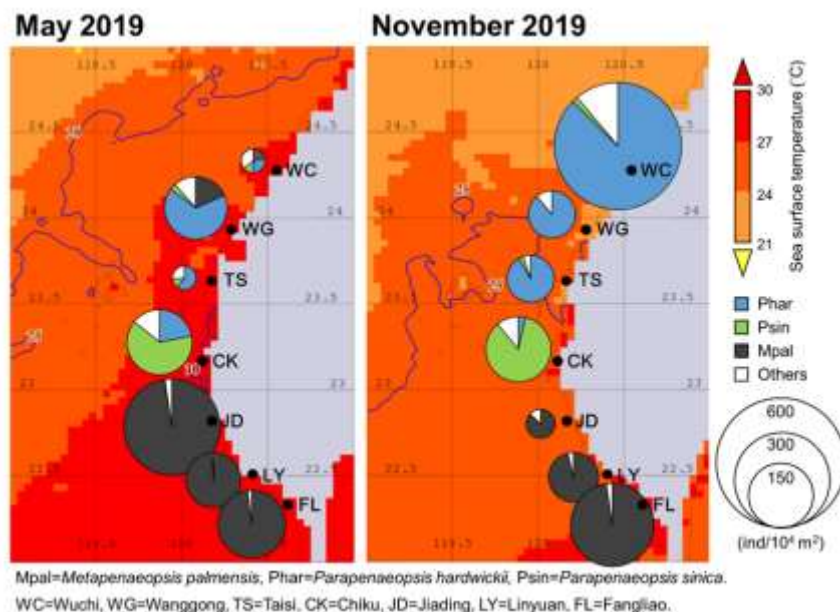
台灣七股海域底棲蝦類群聚組成 **10** 年變遷

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摘　要

　　為了解過去 10 年在七股海域底棲蝦類群聚組成的變化，本研究比較了早期（2006–2010 年）與近期（2016–2019 年），利用海研三號研究船桁桿式底拖網採集之蝦類組成資料。期間共計進行了 24 航次的採樣，累計捕獲底棲蝦類 11 屬 16 種 3,394 尾。結果顯示，過去 10 年間，七股海域的蝦類群聚組成，不論在種類數及優勢種上已經有明顯改變。近期的蝦種數（15 種）較早期新增了 5 種。早期蝦種數以春季最低（4 種），夏季最高（8 種）；近期則以夏季的蝦種數最低（5 種），秋季為蝦種數最豐富的季節（13 種）。後期未被紀錄的種類為冷水性的日本對蝦，且多數冷水性蝦種的豐度在後期皆呈現下降的現象。相反的，部份暖水性蝦種的豐度則有增加的現象，如婆羅門赤蝦。優勢種組成亦從早期以長角仿對蝦（31.6±87.1 尾/10^4 m^2）、角突仿對蝦（21.1±42 尾/10^4 m^2）及鬚赤對蝦（3.0±7.8 尾/10^4 m^2）為優勢的群聚類型，逐漸由中華仿對蝦（44.4±77.8 尾/10^4 m^2）、彎角鷹爪對蝦（10.3±19.2 尾/10^4 m^2）及婆羅門赤對蝦（3.1±9.6 尾/10^4 m^2）所取代。近期群聚溫度指數的增加（早期：119.6；近期：128.3），反映出蝦種組成呈現以暖水性蝦種為主的群聚類型。蝦種組成的消長可能與海溫的改變及底質粒徑變粗有關。海溫的增加促使暖水性的蝦種出現，較粗的底質粒徑，提供適當的棲息環境給中華仿對蝦及彎角鷹爪對蝦等，能適應粗底質環境的蝦種。未來在全球暖化海溫持續升高的趨勢下，亞熱帶海域將熱帶化形成以暖水性物種為優勢的群聚類型。

關鍵字：亞熱帶、氣候變遷、物種轉換、熱帶化

氣候控制對缽水母綱物種年際變異度及物候學特性的影響：以朝鮮半島海月水母（*Aurelia aurita*）及越前水母（*Nemopilema nomurai*）為例

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摘 要

　　東亞邊緣海是最有生產力的海場之一，但近幾十年來，水母大量增生使得漁獲資源管理備受挑戰。其中在朝鮮半島常見到導致水母爆發的缽水母綱（*Scyphozoa*）物種海月水母（*Aurelia aurita*）及越前水母（*Nemopilema nomurai*），因為這兩種水母對沿海社會生態系統所帶來的負面影響，成了主要擔心的問題。本研究執行超過14年的多年期實地觀察，測試氣候對年際變異度以及海月水母、越前水母爆發動態的影響程度。為描述氣候與水母間的互動關係，我們評估了分配效應、直接或間接連結、水體氣候作用力對該物種變異度的相對重要性，結果顯示水母的年際變化模式以及爆發動態受到規模截然不同的作用力所決定，海月水母受局部環境條件所影響，越前水母則受區域氣候過程所影響。本研究描繪了在朝鮮半島由大規模氣候至水母爆發動態間的級聯效應，並透過探討上述水母物種對海域的嚴重負面影響，為漁業永續性提供參考。

Assessing living and dead benthic foraminiferal assemblages on the heterogeneous seafloor off SW Taiwan

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Abstract

Submarine canyons are major conduits of terrestrial and shelf organic matters, potentially benefiting the seafloor communities in the food-deprived deep sea; thus, canyons are usually the hotspots of benthic biomass and diversity. However, the Gaoping (高屏) Submarine Canyon off the SW Taiwan was an anomaly (i.e., with low benthic standing stocks and diversity) due to strong bottom currents driven by internal tides and the turbidity flows triggered by storm surges, river flooding, and earthquakes. Besides the Gaoping Canyon, the continental margin off SW Taiwan is punctuated by multiple canyons with complex topography. Therefore, an intriguing question is how the benthic communities in the Gaoping Canyon compare to other canyons off the SW Taiwan? Whether the environmental controls on the benthic communities may differ among the river-fed Gaoping Canyon, slope-incision Fangliao (枋寮) and Hongchai (紅柴) Canyons (Type 3), as well as the continental slope and shelf adjacent to these canyons ?

Gaoping Canyon is dominated by riverine processes (e.g., hyperpycnal flows during flooding), causing intense erosion, resulting in the sinuous submarine channel. Fangliao Canyon was initially caused by the slope failure along the shelf edge and further evolved due to subsequent sediment sliding and slumping and thus are characterized by the V-shaped canyon heads. Further south, the Hongtsai Submarine Canyon originates from both the tectonic and submarine erosional processes and develops into a U-shape channel west of the Hengchun Peninsula. Could these canyons of different origins, evolutions, and morphologies result in the benthic communities ranging from diversity coldspots (i.e., Gaoping Canyon) to hotspots (other canyons)? How does the heterogeneous seafloor contribute to the benthic diversity of the otherwise monotonous muddy seafloor off SW Taiwan? What's the ecological contribution of these geologically prominent but little-

studied ecosystems?

In this study, we used benthic foraminifera collected during 2018 and 2019 as a bio-indicator to investigate the effects of seafloor heterogeneity and food supplies (using proxies such as TOC, C/N ratio, sediment oxygen demand) on benthic diversity. We tested the working hypotheses that the foraminiferal diversity may differ 1) between living (dyed) and dead (non-dyed) assemblages, 2) among the canyons, slope, and shelf habitats; 3) and among different geographic regions (e.g., Gaoping, Fangliao, Hongchai, and South Bay).

We found that bottom environmental conditions varied by region and habitat. There was little to no foraminifera in the Gaoping Canyon, and the total abundance (planktonic + benthic) of forams increased toward the Fangliao and Hongtsai regions. We also observed significant regional and habitat variations of foraminifera diversity for both the living and dead specimens. Specifically, we detected a statistical difference between the living and dead forams on the Gaoping Shelf, Hongtsai Canyon, and South Bay Shelf but not in the Gaoping Canyon and Fangliao Slope. Also, we observed typical hump-shaped diversity-depth relationships, but the hump-shape diversity patterns were not different between the living and dead forams. The sediment oxygen demand and % Clay were among the best drivers to predict species richness variations and the diversity of abundant and very abundant species. We also detected (significant or marginal) regional and habitat effects on the foraminiferal species composition. The sediment oxygen demand, light transmission, temperature, and grain size were among the best predictors for species distribution of living or dead forams.

In conclusion, except for a few regions and habitats, we found that the living and dead foraminiferal diversity and distribution were similar off SW Taiwan. The effect of the region appears to be stronger than the effect of habitat on the foraminiferal species composition. This could indicate that the influence of taphonomic processes, including differential transportation, destruction, and other postmortem processes related to regional oceanography (e.g., current patterns) may be stronger than the influence of seafloor heterogeneity on the foraminiferal diversity and distribution.

Metatranscriptomics provides closer diversity and composition estimats with morphology than PCR-based methods: a zooplankton mock community case study

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Abstract

Studying complex metazoan communities requires taxonomic expertise and laborious work if done using the traditional morphological approach. Nowadays, the popular use of molecular-based methods accompanied by massively parallel sequencing (MPS) provides rapid and higher resolution diversity analyses. However, diversity estimates derived from the molecular-based approach can be biased by the co-detection of environmental DNA (eDNA), pseudogene contamination, and PCR amplification biases. Here, we constructed microcrustacean zooplankton mock communities to compare species diversity and composition estimates from PCR-based methods using genomic (gDNA) and complementary DNA (cDNA), metatranscriptomic transcripts, and morphology data. Mock community analyses show that gDNA mitochondrial cytochrome c oxidase I (mtCOI) amplicons inflate species richness due to environmental and nontarget species sequence contamination. Significantly higher amplicon sequence variant (ASV) and nucleotide diversity in gDNA amplicons than cDNA indicated the presence of putative pseudogenes. Last, PCR-based methods failed to detect the most abundant species in mock communities due to priming site mismatch. Overall, metatranscriptomic transcripts provided estimates of species richness and composition that closely resembled morphological data. The use of metatranscriptomic transcripts was further tested in field samples. The results showed that it could provide consistent species diversity estimates among biological and technical replicates while allowing monitoring of the zooplankton temporal species composition changes using different mitochondrial markers. These findings show that community characterization based on metatranscriptomic transcripts reflects the actual community more than PCR-based approaches.

Diurnal variation of microbial metabolism in seagrass meadow on the Dongsha Atoll

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Abstract

Seagrass meadows are widely distributed in subtidal coastal regions and featured by high productivity. They sequester and store significant amounts of coastal blue carbon in the sediment from the atmosphere and ocean, and hence are regarded as significantly carbon sinks in the global carbon cycle. Dongsha Atoll is characterized by the dense seagrass beds with the mean percentage of cover ranging from 20 to 95%, yet in summer 2014 more than 25 km^2 of seagrass beds in Dongsha Atoll disappeared within three months. Based on the long-term monitoring system established by Dongsha Atoll Research Station, in summer time the dissolved oxygen in in seagrass meadows exhibited significantly diurnal variation, ranging from over 100% air saturation in the afternoon to almost 0 before sunrise. Generally, the high photosynthetic efficiency and biomass are dominant factors controlling the diurnal variation of dissolved oxygen in water column. However, the contribution of microbial activites in both the production and consumption of oxygen is neglected. Therefore, we aim to clarify connections between microbial activities and diurnal variation of dissolved oxygen. We filtered water samples every 6 hours and collected a sediment core in lagoon mouth of Dongsha Atoll during September 4th and 5th 2020. Currently, based on 16S rRNA amplicon, we reconstruct the microbial community composition in both water column and seagrass bed sediment. The results demonstrated that sequences associated with *Litoricola* were the most dominant group in both water column and top 10 cm of the sediment, and their activities exhibit obvious diurnal variation in water column. Furthermore, we also observed that both active microbes and the concentrations of chlorophyll A varied across time. In the next step, we will integrate concentrations of dissolved organic carbon in both water column and porewater in sediments, and fluxes of oxygen and sulfide between the interface with the diurnal variation of dissolved oxygen in water column to estimate the contribution of microbial activities. Since the diebacks of seagrass meadows are generally associated with the accumulation of toxic sulfide and hypoxia, clarification of microbial actives in seagrass meadows will be for seagrass conservation and restoration purposes when facing the more frequent occurrence of eutrophication and gradually increased temperature.

In situ experiments of upwelling nutrient effects on the dynamics of plankton communities in surface oceans

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Abstract

Plankton production has been suggested to be constrained by the availability of inorganic nutrients that are limited in surface oceans while rich in deep waters. A phenomenon called upwelling bringing nutrients from the ocean depths to the surface layer would likely stimulate plankton production and increase the turnover of plankton communities. However, the impact of upwelling nutrient supply on the dynamics of plankton communities could be hardly detected, because the nutrients carried by upwelling deep waters may only exist in surface layers for a short period of time (quickly depleted or washed away) and the nutrient impact may only sustain for few hours to few days. To fill the knowledge gap, we conducted on-board nutrient enrichment experiments on surface plankton communities, using seawaters directly from deep layers of the same station to mimic *in situ* upwelling nutrient effects. In each set of experiments, in addition to the measurements of production and biomass, high-throughput sequencing data of the 16S rDNA and the 18S rDNA reads were respectively generated to estimate prokaryotic and eukaryotic plankton community profiles. Results from five stations of the cruise Or2Cr2304 demonstrated that: the upwelling nutrients remarkably stimulated bacterial production within 24-hr, coupled with the changes in both prokaryotic and eukaryotic plankton community structure. Moreover, chemical compound compositions (dissolved organic matter) in seawaters varied quickly over 24-hr, suggesting the roles of plankton on marine biogeochemical cycling. Overall, our *in situ* experimental designs allow us to reveal how nutrient-rich deep waters stimulate the growth of surface plankton as well as plankton community turnover in marine ecosystems.

副熱帶西北太平洋陸棚生態系中綠藻的種類組成與分布

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摘　要

在小型浮游植物中，綠藻是相當重要的組成。但目前對於副熱帶海域的綠藻種類組成與生態分布並不清楚。本研究利用大規模定序18S rRNA基因的V4區段來檢視東海海域表層水與葉綠素極大值層的綠藻種類組成，並探討與環境間的關係。本研究的結果顯示，以垂直分布來看，綠藻在表層水有較高的生物多樣性。營養鹽較高的沿岸海域、葉綠素極大值層與湧昇水是以Mamiellophyceae為優勢群，營養鹽較低黑潮水與表層水則是以Chloropicophyceae為優勢群。另外，黑潮水有較高的生物多樣性，綠藻組成除了Chloropicophyceae外，還包含有Chlorodendrophyceae、Palmophyllophyceae、Prasino-Clade-V、Prasino-Clade-IX。本研究結果發現綠藻的種類組成與水文環境有密切關係。

The importance of heterotrophic nanoflagellates in shaping bacteria community compositions depends on species pool size

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Abstract

Differences of marine bacteria compositions are commonly shown to be determined by environmental and spatial discrepancies. The influences of heterotrophic nanoflagellates (HNF), marine bacteria's major predators, should be, but has rarely been investigated. In addition, the effects of these variables could depend on the size of species pool from which the bacteria communities are formed. To investigate the effects of HNF and species pool size, we collected samples from 6 stations in south East China Sea from 14 cruises. We applied high throughput sequencing techniques to obtain 16s and 18s rDNA sequences for bacteria and HNF compositions respectively. We performed variation partitioning methods to examine the effects of HNF in addition to environmental and spatial discrepancies. The size of species pool was considered by the number (2 to 6) of stations within a cruise. We then performed variation partitioning methods at each levels of species pool size. We found that, besides the environmental and spatial discrepancies, HNF diversity significantly affected bacteria's compositional differences. In addition, the effects of HNF diversity were more important than environmental discrepancies when the size of species pool was at the intermediate levels. Our results reveal the importance of top-down controls in shaping marine bacteria communities. Moreover, the relative importance of top-down controls and environmental variables depends on the size of species pool from which the bacteria communities are formed.

Microorganism on marine plastic debris: the ecology and potential risks of plastisphere

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Abstract

According to a scientific estimation, more than 10 million tons of plastic waste enter the ocean every year from river due to mismanagement. This phenomenon is the most serious in East Asia and Pacific. Due to the non-decomposability of plastic waste, plastic debris in the marine environment are very likely to become new vehicles/vectors as the novel habitat of microorganisms, we called the "plastisphere". Plastisphere is a new marine ecosystem comprises the microbial community (such as bacteria, fungi, and diatom) on plastic debris, and could be considered as a marine invasion of microorganisms. Could the emerging contaminants, microplastics be as vectors attached aquatic microbes to impact the natural marine microbial ecology and affect the biogeochemical cycle in marine, while marine plastic debris flooded the ocean? It is very worth to investigate. In this study, we collected samples from northeast coast of Taiwan. For evaluation of the potential risk of plastisphere-associated microbes, we collected the plastic debris (trapped plastic debris in seagrass ecosystem) and then used the Oxford Nanopore Technologies for total DNA sequencing, and analyzing the microbial community (bacteria and eukaryote) of plastisphere ecosystem. Results show that some risk pathogens and antibiotic resistant genes can exist on the surface of plastic debris in the plastic-seaweed ecosystem. The ecologies of seaweed and plastic are totally different. The bacterial diversity of surface of seaweed is higher than plastisphere, but eukaryotic diversity is opposite. Some opportunistic pathogens such as *Vibrio* spp. (including *V. harveyi*, and *V. parahaemoluticus*), *Candida* spp. (*Candida albicans*, and *C. tropucalis*) and virus (*Taterapox* virus and *Ectromeloa* virus) could be found in plastisphere. Microorganisms in ecosystems of plastisphere might have potential risk to marine organisms even humans.

臺灣四周海域海洋基礎生產力長期觀測與研究

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摘 要

海洋基礎生產力是推動海洋生態系食物網運轉以及海洋透過生物幫浦機制將大氣二氧化碳埋藏於深海的原動力。臺灣四周海域擁有豐富的生物與非生物資源，瞭解或是預測海洋基礎生產力的長期變動是生態保育與資源開發的關鍵指標。雖然現今我們可以透過所謂的 VGPM 經驗模式(Behrenfeld and Falkowski, 1997)結合衛星海洋水色資料推算出全球海洋基礎生產力(簡稱 OCP)，但是 OCP 之結果在區域性海洋研究的適用性仍需進一步評估。在科技部計畫的補助與農委會的支持下，本研究使用農委會水產試驗所的水試一號和水試二號航次，於 2018 年進行臺灣周邊海域海洋環境與基礎生產力四季的現場調查。各季節現場實測基礎生產力的變化範圍分別介於 42-911 mgC m^{-2} d^{-1} (冬天)、113-456 mgC m^{-2} d^{-1} (春天)、124-832 mgC m^{-2} d^{-1} (夏天)、249-1898 mgC m^{-2} d^{-1} (秋天)。為評估 OCP 的適用性，我們首先以現場觀測資料測試得到 OCP 所依據之 VGPM 模式的適用性，發現 VGPM 模式的結果與現場觀測值有顯著的線性正相關(R^2=0.85)，但是 VGPM 的模式結果高於實測值約 1.3 倍。其次，我們將各季節現場實測基礎生產力的結果與 OCP 之結果比較，發現兩者之間並無任何相關性，夏天 OCP 之結果低於實測值–13±67%，其它三個季節 OCP 之結果反而高於實測值 284±453%。為瞭解 OCP 與實測值差異的原因，我們進一步檢視運用 VGPM 模式得到 OCP 所需之海洋水色衛星海面葉綠素濃度(C_{SAT})、利用 C_{SAT} 推算之有光層深度(Ze)、利用海面溫度推算之有光層內最高之單位葉綠素基礎生產力(P_{opt}^{B})等三個關鍵參數與實測值的關係，發現 C_{SAT} 與實測值雖有線性正相關的趨勢，但相關係數(R^2)僅為 0.26；Ze 與實測值有顯著的線性正相關(R^2=0.83)；P_{opt}^{B} 與實測值則無任何正相關的趨勢，夏天 P_{opt}^{B} 之結果低於實測值–28±27%，其它季節 P_{opt}^{B} 之結果反而高於實測值 230±201%。綜合以上之分析顯示 C_{SAT} 和 P_{opt}^{B} 這兩個參數的不準確性是造成 OCP 不準度的主要原因，特別是 P_{opt}^{B}。因此目前透過 VGPM 模式結合衛星海洋水色資料推算出之全球海洋基礎生產力，尚無法應用於臺灣四周海域海洋基礎生產力時空變化的長期觀測與研究。

May internal waves contribute to atmospheric CO_2 sequestration?

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Abstract

To understand the potential impact of internal waves (IWs) on the surface CO_2 system, the short-term variabilities in temperature, salinity, nitrate, chlorophyll a (Chl a), and carbonate chemistry data (i.e., pH, partial pressure of CO_2 (pCO_2), total alkalinity, and dissolved inorganic carbon) were concurrently investigated in the shallow and deep water areas in the northern South China Sea, where the largest internal waves (IWs) in the global ocean have been recorded. The results show that surface temperature and pCO_2 were lower but that upward nitrate flux and Chl a were higher in the upper euphotic zone at the shallow-water area (dissipation zone of IWs) than those at the deep-water area (transmission zone of IWs). We suggest that the observed contrasting biogeochemical properties between the two areas could be attributed to the impact of IWs. As IWs may induce stronger vertical mixing in the shallow-water dissipation zone than in the deep-water transmission zone, more nutrient-replete subsurface water can be transported into the euphotic zone and thus stimulate phytoplankton production, which may subsequently drive surface pCO_2 down. Though the present short-term hydrological and CO_2 data, which to our knowledge were concurrently investigated in IWs prevalent areas for the first time, reveal that the dissipation of IWs could be a favorable mechanism for atmospheric CO_2 uptake, more long-term observations are still needed to confirm that the similar processes can repetitively take place in the IWs dissipation zone.

Variability of the nutrient stream near Kuroshio's origin

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Abstract

The Kuroshio—literally "the Black Stream"—is the most substantial current in the Pacific Ocean. It was called the Black Stream because this oligotrophic current is so nutrient-poor in its euphotic zone that the water appears black without the influence of phytoplankton and the associated, often colored dissolved organic matter. Yet, below the euphotic layer, nutrient concentrations increase with depth while current speed declines. Consequently, a core of maximum nutrient flux, the so-called nutrient stream, develops at a depth of roughly between 200 and 800 m. This poorly studied nutrient stream transports nutrients to and supports high productivity and fisheries on the East China Sea continental shelf; it also transports nutrients to and promotes increased productivity and fisheries in the Kuroshio Extension and the subarctic Pacific Ocean. Three modes of the Kuroshio nutrient stream are detected off SE Taiwan for the first time: one has a single-core; one has two cores that are apparently separated by the ridge at 120.6–122° E, and one has two cores that are separated by a southward flow above the ridge. More importantly, northward nutrient transports seem to have been increasing since 2015 as a result of a 30% increase in subsurface water transport, which began in 2013. Such a nutrient stream supports the Kuroshio's high productivity, such as on the East China Sea continental shelf and in the Kuroshio Extension SE of Japan.

Annual variability of particulate and dissolved primary production in the coastal NW Taiwan

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Abstract

Marine primary production is considered the ultimate organic carbon source in the ocean. Particulate primary production (PPP) is usually transferred to higher trophic levels through grazing, whereas dissolved primary production (DPP) may drive the microbial loop. This study investigated both PPP and DPP in the coast of the subtropical northeastern Taiwan from January 2018 to March 2019. Total of 42 photosynthesis-irradiance (P-E) curves for DPP and PPP were obtained. The results showed that PPP was generally higher than DPP. The daily PPP ranged from 8.10 to 122.79 mgC m^{-3} d^{-1}, while the daily DPP ranged from 2.84 to 98.55 mgC m^{-3} d^{-1}. Daily PPP and DPP both peaked during the late summer and the early autumn, indicating irradiance could be an important controlling factor for primary production. However, the percentage of extracellular release (PER; =DPP/TPP) showed no significant seasonal difference in the range between 17 to 45%. The factors affecting the PER variations need further investigations.

海水營養鹽自動分析系統回顧與前瞻

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摘　要

海水中營養鹽通常指(1)亞硝酸、(2)硝酸鹽、(3)磷酸鹽、(4)矽酸鹽與(5)氨氮五個項目。在測定分析上最大的困擾點是：樣水中這些項目濃度可能變化非常快速，欲縮短從採樣到分析完畢的時間，又冀望各項目能同步執行，則需要仰賴快速而準確的自動分析技術。從上世紀末迄今，各式各樣的自動分析系統發展得非常蓬勃且多元化。從第一代的氣泡中隔式流動分析系統(air segmented flow analysis SFA)、第二代的流動注入分析系統(flow injection analysis FIA)，到第三代的序列注入分析(sequential injection analysis SIA)及最近的盤式分光檢測儀(microplate reader)等等。然而因為各分析項目的化學條件各不相同，目前的商業機種於同步分析仍有其限制。針對海水的特殊性，我們仍然秉持自行設計的理念去發展。有幾個基本方向:

1. 化學方法的改進與優化：例如測硝酸鹽不再使用鎘銅還原管、測矽酸鹽由酸式矽鉬藍法改成鹼式矽鉬黃法、測氨氮改用無毒性催化劑等等。

2. 液體在微管路中傳輸模組：傳統的蠕動幫浦是等速而且同步的，未來將改成非同步變速，或採取另一種步進式活塞推動配合選擇閥控制流向、流速。傳統用載流方式的非平衡動態測量有很多缺點，將全面改變為無載流完全反應靜止測量。

3. 光學測定方式：將傳統的鹵素燈分光光度計，改變成混光式多點LED燈源透過光纖做全光譜同步偵測。有效縮小儀器體積及加快偵測速度。

本研究目前已完成數組prototype機型及韌體，未來將致力於建立營養鹽五同步的分析系統。

Biogeochemistry and Bioaccumulation of Mercury in the Northwest Pacific Ocean

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Abstract

A study to investigate biogeochemistry of mercury (Hg) and to increase understanding of its bioaccumulation and food chain transfer in the Northwest Pacific Ocean (NPO), including the East China Sea (ESC) has been initiated. The talk will thus present some results we obtained through the methods we developed as followed: (1) A custom-made Mercury Speciation Analyzer (MSA) was successfully developed and performed on-board; (2) The investigation of gaseous (GEM) and dissolved elemental mercury (DEM) was carried out in the South China Sea (SCS) and East China Sea (ECS) that revealed a multi-faceted understanding of Hg^0 distribution, cycling and source; (3) A broad examination of Hg in demersal fish explores the Hg pollution in the ECS. The mercury accumulation rate (MAR) was examined for each fish species associated with trophic levels. The biomagnification indicators show the ECS is much greater than those in other marginal seas, suggesting high regional Hg pollution impacts from Mainland China; (4) The MAR in Pacific Bluefin Tuna (PBFT) was also examined with other global BFT populations. The MARs in BFT as a global pollution index can reveal global patterns of Hg pollution and bioavailability in the oceans and further reflect both anthropogenic emissions and regional environmental features. The results of this study make us understanding critical information in biogeochemistry and trophic transfer of Hg in the highly anthropogenic disturbance marginal seas and open oceans.

鎳在海洋藍綠菌中的重要性：
鎳超氧化歧化酶及氫化酶的角色

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摘　要

　　鎳在海洋中的生物地球化學特性如同主要營養鹽，不僅溶解態鎳濃度和主要營養鹽濃度顯現高度線性關係，溶解態鎳元素及同位素的垂直分布特徵更顯現是因浮游植物吸收所形成，然而學界對於浮游植物為何吸收鎳或是鎳在浮游植物體內生理功能的了解均極為有限。　我們實驗室近年的研究發現鎳對海洋固氮藍綠菌的光合作用、固氮作用及氫氣生地化循環扮演關鍵角色，我們發現鎳超氧化歧化酶是束毛藻(*Trichodesmium*)在高光環境下進行光合作用及固氮作用的必要生長因子；利用模式固氮藍綠菌(*Cyanothece*)，我們並發現鎳鐵氫化酶的表現對海洋固氮作用所生成累積的氫氣通量變動扮演關鍵角色。　全球表層海水相對高量的溶鐵態鎳濃度，有可能是固氮藍綠菌得以在熱帶亞熱帶高光條件下生存的關鍵成因。

Aerosol Fe cycling in the surface water of the NWPO: Sources & Transformation

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Abstract

Receiving extremely high anthropogenic aerosol deposition during winter and spring seasons, the Western Philippine Sea (WPS) provides an ideal platform to investigate the transformation processes of lithogenic and anthropogenic aerosol Fe in the ocean. Previous study found that the seasonal variations of aerosol Fe fluxes in the surface water is reflected in particulate pool but not dissolved phase in the WPS (Wang and Ho, 2020). It has thus been proposed that soluble aerosol Fe is transformed to biologically labile amorphous particulate Fe, which may be largely adsorbed on cyanobacteria. In this study, we used the modified oxalate-EDTA method proposed by Revels et al. (2015) to leach the operationally defined 'labile Fe fraction' in the suspended particles of the surface water and investigate the elemental and isotopic signatures in the leached fraction. The results show that the averaged labile particulate concentrations were 0.39 ± 0.10 nmol/L, comparable to dissolved concentration level in the surface water. In terms of isotopic composition, the averaged $\delta 56Fe$ of total suspended particles was 0.18 ± 0.04 ‰, which is much closer to lithogenic Fe value than anthropogenic aerosol Fe, indicating that lithogenic particles is the major source of the total suspended particulate Fe. The values observed in the labile fraction for most of the samples were significantly lighter than total particulate Fe, ranging from X to -0.6‰, but were much higher than the end member value, ~ -4 ‰, in anthropogenic aerosol Fe. These results suggest that the labile fraction in total suspended particulate Fe is mainly originated from lithogenic particles.

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Trace metal concentrations in suspended particulate matter and sediments from coastal and offshore Taiwan

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Abstract

Terrestrial material transported from Taiwan often carry characteristics of mountainous rivers and/or anthropogenic influence, with the extent of variability dictated by seasonally variable river discharge rates resulted from predominant monsoon and locality of watershed. Once reaching the coast, terrestrial material are mixed with marine particulate matter that are largely of biogenic sources. In the last few years, suspended particulate matter and surface sediments (<20 cm deep) had been collected from Taiwan's coastal and offshore waters, and their trace metal concentrations determined. Some particulate matter were further size-fractionated in order to assess trace metal contents in different material or of various nature.

Using Al concentration for normalization purpose, mineralogical and biogenic contributions in SPM can be estimated, as well as mud content in sediments. For particulate matter, distinctive difference in Al concentration, therefore various contribution from minerals and biogenic matter can be derived to reflect source strength of terrestrial transport. Some trace metals showed large concentration differences for different sampling times because of the different sources of material present. Cd showed significant bio-magnification as its concentration increased with increasing particle size (from <10 m to >153 m). For sediment trace metal concentrations, they generally had linear relationship with Al concentration, suggestion grain size effects. This indicates that localized enrichment of sediment trace metals is limited, probably caused by dynamic transport of sediment in the coastal area. However, some elevated trace metal concentrations were observed in a small number of coastal regions that receive strong anthropogenic influence from the land.

Sorption of Toxic Contaminants onto Microplastics in Contaminated Ocean

塑膠微粒吸附海洋環境有毒污染物之潛能

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Abstract

Marine microplastics (MPs) have been increasingly detected in marine environments and there are growing concerns about the potential impact on marine ecosystems. MPs are typically hydrophobic and have large surface areas, allowing them to accumulate persistent organic pollutants (POPs) such as polycyclic aromatic hydrocarbons (PAHs). In this study, we used the well-developed environmental trace chemical analysis technology to investigate the sorption behavior of PAHs on/in marine microplastics. Six common MPs (PP, PE, PS, PET, PLA, PBTA) were exposed to PAHs and analyzed for PAH levels over different time periods (days, weeks, and months) to obtain the sorption tendency and sorption rate of PAHs. Before the exposure experiment, PAH levels were highest in PS, followed by PP, PBTA, PE, PET, and PLA. Over three months of exposure, concentrations of PAHs accumulated in the MPs ranked PE>PBTA>PS>PP>PET>PLA. Based on the partition coefficients (Kp), most PAH compounds reach sorption equilibrium on MPs in the three-month exposure. Sorption rates vary by plastic and contaminant type. In this study, PS and PE have greater affinity for PAHs than the other MPs. More research is needed to investigate the complex interactions of each contaminant with MPs and the surrounding environmental factors to better understand the kinetic sorption of POPs in MPs.

Keywords: marine debris, microplastics, persistent organic pollutants, sorption

Transport of Microplastics in the Northwest Pacific Region

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Abstract

Marine microplastics (MPs) are ubiquitous in oceans and their transboundary transport and fate have aroused global attention. However, sparse spatial observational data of MPs and uncertainty in their compositions might difficultly assess their ecological impacts. This study is the first to investigate the occurrence of MPs off east of Taiwan, to understand MPs contribution from Taiwan to Northwest Pacific region including the Kuroshio Current. MPs concentrations in the study area varied from N.D. to 0.15 items m^{-3} with an average concentration of 0.05 ± 0.03 items m^{-3}. Approximately 55% of analyzed particles were polypropylene (PP) polyethylene (PE) and polyethylene terephthalate (PET). The highest MP concentration was observed near the rivers, confirming the role of rivers in transporting MPs to the ocean. Interestingly, high concentrations of MPs also existed in Kuroshio current stations, revealing that MPs have contaminated relative "ultraoligotrophic" and "clean" Kuroshio water. This is because the local currents from land entering into the inside of the Kuroshio Current, possibly causing one of MP hotspot in the area. These findings provide useful information for the distribution and transport of MPs in the Northwest Pacific region, and further raise warnings about plastic applications.

含抗菌劑微膠囊於海洋防汙塗料之應用

范瀞文

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摘 要

　　船艦行駛於海洋環境中，船殼因海洋生物附著將造成嚴重的生物汙損問題，導致油耗增加並加速船體表面腐蝕，嚴重影響船舶正常航行。國際海事組織於2008年後，全面禁止使用含有三丁基錫(Tributyltin, TBT)的海洋防汙塗料，因此發展新型環保海洋防汙塗料技術已成為國際海事技術主要發展方向。

　　本文探討微膠囊包覆環保型抗菌劑於海洋防汙漆之應用效益；將防汙面漆混摻含10%抗菌劑微膠囊，透過微膠囊長效緩慢釋放抗菌劑，可降低抗菌劑釋放速率1.7倍，進而延長抗菌劑極限濃度的作用時間。最後並針對含微膠囊防汙漆進行生物防汙效能驗證；經過6個月興達港海曝掛板實驗，採用微膠囊包覆抗菌劑之防汙漆，相較無微膠囊包覆之對照組，可減少34%之汙損面積。

Conservative anthropogenic ocean tracer ^{236}U/^{238}U: analysis of femtogram ^{236}U by MC-ICPMS

人造海水環流示蹤劑鈾 236：多接收器感應耦合電漿質譜儀分析方法之建立

Abstract

The surface ocean circulations are important in regulating heat, energy, nutrients and marine life throughout the world. Yet, the responses of surface circulation to global warming have not yet fully investigated, leading to a large uncertainty in predicting future responses. Model results suggest that the warming has slowed down the meridional overturning circulation in the upper Pacific Ocean since 1950 but instrumental record of surface ocean current measurement has only become available after 1988. Thus, there is a need to use geochemical records from coral skeletons to reconstruct surface current flow speed in the past. Uranium (^{238}U, ^{235}U and ^{234}U) is highly dissolvable in the ocean and has a conservative type profile in the water column. On the contrary, anthropogenically produced isotope, ^{236}U, from nuclear power plant reactors and nuclear fuels during 1946 to 1958, making ^{236}U/^{238}U a unique point-source anthropogenic tracer in the ocean. Due to the low abundances, accelerator mass spectrometer is currently the only available instrument to quantify the ^{236}U/^{238}U at 1×10^{-9} in natural samples. However, analytical costs for AMS are high and not all AMS facilities capable of providing a low enough ^{236}U/^{238}U abundance sensitivity at the order of 1×10^{-9}.

A new analytical method has been developed to determine atomic ^{236}U/^{238}U ratios in samples with only femtograms of ^{236}U using a secondary electron multiplier (SEM) on a multi-collector high-resolution inductively coupled plasma mass spectrometer (MC-ICPMS). The abundance sensitivity of ^{238}U tail at 236 atomic mass unit is reduced from 10^{-6} to 10^{-10} with the deployment of retarding potential quadrupole lens. This method features the reduction of isobaric interferences from hydride, nitride, and plutonium and the evaluation of non-linear SEM behavior. The instrument sensitivity is 1-2%, and the detection limit of ^{236}U/^{238}U atomic ratio is as low as 2×10^{-10}. Measurements on reference materials with ^{236}U/^{238}U ratios of 10^{-7} to 10^{-9}, including the IRMM-075 series and the ETH Zurich in-house standard ZUTRI, demonstrate the accuracy of our MC-ICPMS technique. The analytical precisions (2σ) are $\pm 4\%$ for 5 fg ^{236}U at ^{236}U/^{238}U of 1×10^{-8} and $\pm 8\%$ for 2 fg ^{236}U at ^{236}U/^{238}U of 4×10^{-9} level. Compared to state-of-the-art accelerator mass spectrometry techniques and triple quadrupole-based ICP-MS, our detection limit is not as low, but the required sample size is three to forty times lower, and the throughput is as high as 3-4 samples per hour. The new MC-ICPMS-SEM technique is sensitive enough for determining ^{236}U/^{238}U in various small natural samples, such as marine carbonates and seawater.

Enrichment behavior of PAHs and PCBs at the sea-surface microlayer in harbor water.

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Abstract

Polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in the sea-surface microlayer (SML) and sub-surface water (SSW) were analyzed to determine the microlayer enrichment behaviors in Kaohsiung Harbor and adjacent area. PAH and PCB concentrations in the SML were found higher than those in the SSW, indicating the enrichment in the SML. In addition, their concentrations in particulate phase were all higher than those in dissolved phase. Correlation analysis showed significant relationships between dissolved organic carbon and the concentrations of total PAH, particulate PAH, and dissolved PCB. The results confirm SML enrichments for PAHs, but PCBs less significantly, since PAHs are still produced while PCBs had banned years ago. However, PCBs still leak to the environment from contaminated sites. The results showed the sources and transport of PAHs and PCBs were different, but both are enriched in the SML. Total particulate PAHs at most sites are below the toxicity thresholds, with a few individual PAHs between the ERL (effects range-low) and ERM (effect range-median) even higher than the ERM. Total particulate PCBs might cause occasionally adverse effects in sensitive species and pose a risk to the organisms. The particulate phase in the SML poses a higher risk to the marine ecosystem than in the SSW although not all organisms will make direct use of the microlayer. Principal component analysis (PCA) of PAHs indicated the important contribution of traffic engine emission in the particulate samples of the SML and SSW and revealed that probably the petroleum pollutants are a predominant source for the dissolved phase. Cluster analysis revealed that PAH-PCB patterns in the river and anchorage channels were different to those in the wetlands and open harbor. However, PCA of PCBs showed differences in the congener profiles for the two phases, with highly chlorinated PCBs more abundant in particles, while less chlorinated PCBs were more abundant in dissolved.

Dissolved and particulate phosphorus species partitioning and distribution in the Danshuei River Estuary, Northern Taiwan.

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Abstract

Different fractions of phosphorus, including total dissolved P (TDP), dissolved inorganic P (DIP), total particulate P (TPP), and particulate inorganic P (PIP), were analyzed in the Danshuei River Estuary (DRE), northern Taiwan to study the P partitioning within the estuary. The relatively higher Different tests have been made to determine some characteristics of the persulphate oxidation method for the simultaneous determination of total nitrogen and total phosphorus in water. Different tests have been made to determine some characteristics of the persulphate oxidation method for the simultaneous determination of total nitrogen and total phosphorus in water. Different tests have been made to determine some characteristics of the persulphate oxidation method for the simultaneous determination of total nitrogen and total phosphorus in water.concentrations of TDP (4.3-12.4 μM) and TPP (2.3-8.7 μM) were generally found in the upper estuary, salinity < 5 region, during the four surveys. The concentration of DIP generally dominated the total P pool (TDP+TPP) within the estuary. However, dissolved organic P (DOP) became the important fraction in the salinity > 25 region, probably attributed to phytoplankton production because the higher DOP concentration was generally accompanied with the higher chl. a concentration. The TPP concentrations generally correlated well with the total particulate Fe and Mn concentrations, suggesting that particulate Fe and Mn played crucial roles influencing the P distribution within the DRE.

Social-environmental analysis of water quality in a populous urban estuary, a case study of Tamsui River estuary

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Abstract

Taiwan was one of the four Asian dragons that underwent rapid industrialisation and exceptionally high growth rates between the early 1960s and 1990s, but at a high cost to the environment which was heavily polluted. Estuaries are highly dynamic and diverse ecosystems. They provide multiple ecosystem services that maintain marine ecosystem health and benefit mankind. However, estuaries and the ecosystem services they provide, are degrading rapidly due to increasing pressures and changes. Because of the great physico-chemical variability of the water column, estuaries have been regarded as naturally stressed areas. In addition, they are exposed to high anthropogenic pressures, especially in populous, urban estuaries. Social-environmental analysis integrates not only scientific information but also social activities, and therefore provides the comprehensive knowledge for multi-party, joint decision-making processes necessary for successful, sustainable management. In response, the government of Taiwan took measures to lower human activities, diminish the pressures, improve the water quality, enhance the state of the estuarine systems, and decrease the negative impacts on human welfare. In this study, historical data and information, including 60 years of economic data and 26 years of water quality data, are examined using social-environmental frameworks, the driver-pressure-state-impact-response (DPSIR) framework and the systems approach framework (SAF), to analyse the management of water quality in the most populous urban estuary, Tamsui River estuary, in Taiwan. Finally, possible societal responses and management measures that can be implemented to ameliorate the water quality in the Tamsui River and its estuary are identified.

Flow and Chlorophyll-a Distribution in an Internal Solitary Wave

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Abstract

Dissolved oxygen and Chlorophyll-a records during previous conductivity, temperature and depth (CTD) casts are analyzed. By assuming quasi-steady, the flow field measured by shipboard ADCP are transformed into a snapshot along the propagation direction of an internal solitary wave. The flow and chlorophyll-a distribution is then discussed based on the conservation of mass.

Introduction

The chlorophyll-a records reported by Wang (2016) vary significant variation before and after an internal solitary wave. It was expected that the vertically integrated chlorophyll-a should be conservative, only the altitude is shifted downward during a depression internal wave. Some people thus suggest an internal solitary wave absorbs chlorophyll as it propagates in the ocean, just like a vacuum cleaner. We check the chlorophyll-a concentration based on in-situ measurements of Wang, as the example shown in Fig. 1, and try to explain the inconsistency of chlorophyll-a concentration. The data is measured by Wang Y.H and provided by Ocean Data Bank which is founded by Taiwan's Ministry of Science and Technology (MOST) and operated by the Institute of Oceanography, National Taiwan University.

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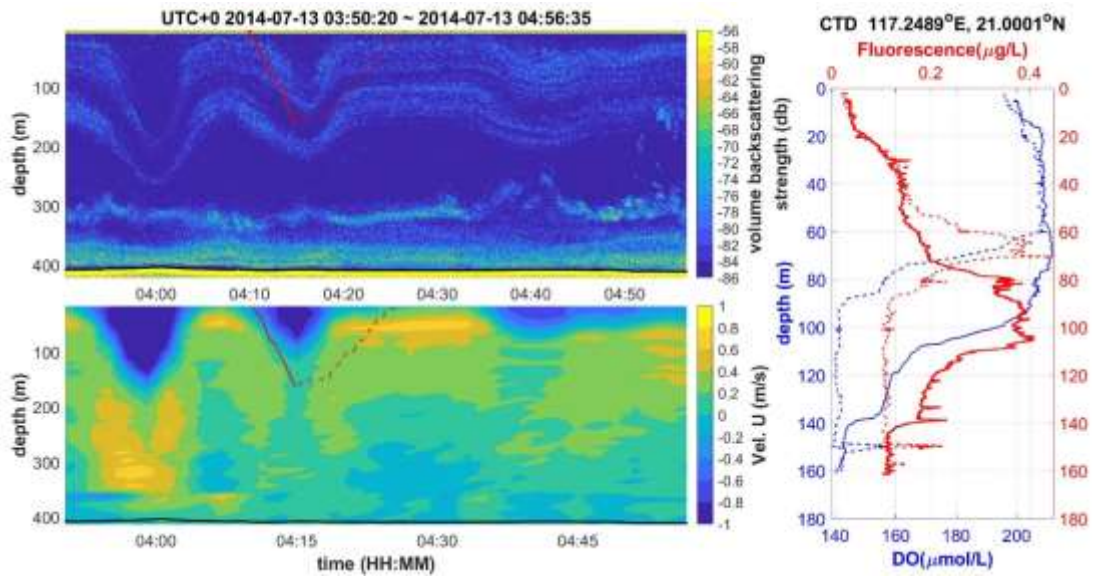
Figure 1. An example of in-situ measurement executed by Wang in 2014 in the South China Sea near Dongsha. The upper left panel is the backscattering of echo sounder and the lower left panel is the eastward velocity along time, with the solid red line the track of the downcast CTD and the dashed red line the track of the upcast CTD. The right panel shows the distribution of dissolved oxygen (blue) and   chlorophyll-a (red), the solid line represents downcast data and the dashed line represents upcast data.

Thermal front and surface currents off northeastern Taiwan

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摘　要

Ocean currents in the southern East China Sea (ECS) are complex and have long lacked systematic observational data. In this study, observations from coastal radars in northern Taiwan along with several drifters and satellite data reveal a detailed ECS surface flow structure, thermal front, and dynamic mechanism. The trajectories of the drifters indicate that they followed the movement of the seasonal flow field and were affected by strong tidal currents to oscillate and become trapped. Three drifters were observed to cross the oceanic front just offshore of northern Taiwan in the form of tidal motion processes, with a rapid rise in sea surface temperature of 2.5°C recorded within a small distance of 500m. A significant, periodic water mass exchange cycle occurs in the southern ECS. Starting in October, the Kuroshio Current gradually invades the ECS shelf, causing the formation of a southwestward Northern Taiwan Coastal Current that mixes with the China Coastal Current to form a southward flow in the northern Taiwan Strait. Beginning in February, the flow field in western Taiwan shifts northward, and then gradually flows eastward into the Kuroshio region. With high temperatures, high salinities, and low chlorophyll concentrations, the Kuroshio Current's movement results in a pronounced oceanic front in winter. In cases of satellite-derived and model-simulated surface currents contradicting each other over long periods of time, hourly coastal radar data have not only successfully explained such changes in satellite ocean parameters but have also clarified many years of disputes over surface currents in the southern ECS.

電磁探測垂直剖面浮標於上層海洋觀測之應用

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摘　要

在物理海洋研究中，因為無論是在動力機制上的解釋又或是數值預報上的預測都與海水的運動息息相關，如何精確地量測各種尺度下的海流流場變化一直是極為重要的課題。在各種量測海流速度大小的方法中，有別於傳統的聲學都卜勒流速剖面儀(ADCP)，電磁探測垂直剖面浮標(EM-APEX float)可藉由量測海水運動所造成的電流，進而得到不同深度的水平流速和方向。在設計上，儀器可以從海表面觀測至2000米深的海底，並取得垂直解析度3-4米的流場資料。同時間，儀器上面所搭載的CTD可以量測溫度和鹽度的垂直剖面。自2000年起，電磁探測垂直剖面浮標已經被廣泛地運用在各種上層海洋觀測的研究，尤其是在劇烈天氣下的觀測，像是颱風。所以，本次報告將會講述float的原理和過往已經量測到的數據。之後，將會概述通過這些數據所完成的研究，以使聽眾對於海洋探測技術有更進一步的了解，並期待未來能在臺灣周遭的海域有更多動力機制上的研究。

應用省電型波浪儀量測颱風期間之波浪變化

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摘 要

　　現今布放於大洋浮標量測波浪之主要方法為量測水面垂直加速度變化，經過函數轉換及分析後可得示性波高、主波週期、波向，其量測頻率通常設定為每 20 分鐘記錄 2048 筆加速度資料，因此每小時只有 2 至 3 組統計結果。然而，在極端天氣下：如颱風過境，需要有連續觀測的波浪資料方能得知其密集變化，為此，波浪計需要能不間斷地採樣。為了減少於颱風期間因強風所造成的晃動與破壞，布放於海洋的儀器必須捨去太陽能電板以降低風阻，除此之外，儀器探針與外殼要能抵抗高溫日照、強烈紫外線、巨大海浪襲擊、抗鹽分腐蝕、與耐震等，而一般商售的儀器大都無法滿足上述需求，因此有必要開發可耐惡劣環境、省電、低成本的海氣象觀測儀器供海氣象浮標使用。本研究乃使用行動裝置配備的運動傳感器(motion sensor)、同步動態隨機存取記憶體與數位訊號處理晶片，快速量測東西向、南北向與垂直方向之加速度並紀錄之，同時使用數位訊號處理器連續計算波浪參數，進而獲得大洋中在惡劣海況(如颱風過境)下長時間連續的波浪資訊，本報告將介紹此省電型波浪計、波浪參數計算理論、即其在實海域之測試結果。

應用海氣象浮標觀測資料估算颱風期間之海氣能量通量變化

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摘　要

　　臺灣位處於西北太平洋副熱帶，東部海域為颱風生成之熱區，此海域的颱風較其他海域多且強，平均每年約有三至四個颱風侵襲臺灣，其伴隨的強風與暴雨往往造成沿岸與山區大量生命與財產的損失。颱風生命週期中，大多時間滯留於海面上，因此除了當時的大氣環境會影響其生長，海洋狀態亦非常重要，若能即時掌握上層海洋與底層大氣間的改變，將有助於改善對颱風強度的預報。國立臺灣大學海洋研究所不放於臺灣東南外海的海氣象即時傳輸浮標，在 2019 年及 2020 年的颱風季節期間曾經分別進入 2019 年的丹娜絲(Danas)、利奇馬(Lekima, C4)、白鹿(Bailu, TS)、玲玲(Lingling, C1)、米塔(Mitag, C1)與 2020 年的閃電(Atsani, TS)等 6 個颱風的 8 級風暴風圈內。本研究乃利用浮標於颱風期間所測得的氣溫、氣壓、相對溼度、風速、短波輻射量、淨輻射量、雨量、海表面溫度、示性波高等高時間解析資料，並搭配最新的 TOGA COARE V3.6 演算法計算颱風暴風圈內海氣能量通量隨時間之變化，其結果將於演討會中報告。

Propagation Speeds of Shoaling Internal Solitary Waves in the South China Sea: A satellite Investigation and Theoretical Interpretation

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Abstract

Through the high temporal resolution geostationary satellite providing wide spatial coverage and sequential images (10 mins), nonlinear internal solitary waves (ISWs) potentially were tracked from source to sink in the South China Sea. Most of ISWs become traceable east of 120ºE. The propagation speeds of the ISWs were estimated by the time evolution of the surface manifestation of ISW characterized by the sunlight reflectance pattern. The ISW in the deep basin begin at a mean speed of 3.0 ± 0.2 m s^{-1} and then decay ~10% before propagating up the continental slop. As it propagated up the slope and shoaled onto the plateau east of Dongsha Atoll, the wave propagation speed decreased dramatically from 2.5 to 0.5 m s^{-1}. The speed was verified by a mooring array off east of the atoll (RMSE ~ 0.2 m s^{-1}). The propagation speeds of ISWs have a strong dependence on the local depth, decreasing at a hyperbolic tangent function with depth decreases, and generally can be explained by the Dubreil–Jacotin–Long equation. The reflection waves were generally traceable 50 km east of the atoll and propagated eastward at a mean speed of ~40% slower than the incoming waves, unadapting the fully nonlinear wave theory.

Instabilities and turbulence observed within large internal solitary waves east of Dongsha Atoll

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ABSTRACT

Internal solitary waves (ISWs), predominantly generated by the tidal flow interacting with abrupt topography, are ubiquitous in coastal regions and marginal seas of the world's oceans. As the ISWs shoal shoreward, they lose the energy obtained from ocean tides through globally significant turbulent mixing and dissipation and consequently pump nutrient-rich water to nourish coastal ecosystem. However, the physical processes leading to turbulence in an ISW remain unclear due to the difficulty of collecting the necessary observations. Here, we present fine-scale, direct measurements of shoaling ISWs which allow for a novel examination of the physical processes triggering the intensive turbulence mixing in the interior of ISWs: (1) convective breaking in the wave core and (2) the collapse of Kelvin-Helmholtz billows in the wave rear and lower periphery of the core, often occurring simultaneously. The former is due to the particle velocity exceeds the wave's propagating velocity. The latter is caused by the instability induced by the strong velocity shear overcoming the stratification. The instabilities generate turbulence levels four orders larger than that in the open ocean.

黑潮與海底地形作用引起之混合增強效應探討

Mixing Enhancement Modulated by Unsteady Shear Flow in the Kuroshio above a System of Seamount

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Abstract

Proper parameterization of small-scale physical processes is required in large-scale ocean models because the horizontal grid resolution (O(km)) in these models is typically much greater than the size of shear instabilities. The accurate prediction of shear instabilities and the corresponding mixing efficiency can improve model accuracy of the large-scale circulation and transport in the ocean. Therefore, studies on small-scale processes, for example, shear instabilities, provide insight into turbulent mixing processes in the ocean. Field observations in the Kuroshio above the peak of a seamount demonstrates the spatial distribution of lee waves and shear instabilities by shipboard instruments. The computational Fluid Dynamics (CFD) model OpenFOAM with Large Eddy Simulation (LES) turbulent closure was applied to investigate dominant mechanisms that control the spatial and temporal scales of instabilities in the stratified shear flow at high Reynolds Number. The analyses based on model experiments and direct measurements of turbulence suggest that high turbulence is mainly populated in the forward inclined, asymmetric, cusp-like bands with a specific period. We also found that the criterion of bifurcation slope determines the frequency of mixing enhancement behind the sharply varying topography along the route of Kuroshio. The frequency of mixing enhancement is proportional to the criterion of bifurcation slope, which indicates the significance of non-hydrostatic effects in the upper layer of the shear flow. The strong flow on the top of the shear zone leads to flow instabilities with greater TKE dissipation rate, which is considerably elevated in the braid mixing zone of shear instabilities with a period of *5-15 minutes*.

Distinct intraseasonal oscillations during the boreal summer monsoon months in the central South China Sea and the underlying dynamics

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Abstract

The South China Sea (SCS), which serves as an important maritime route between the Indian and Pacific Oceans, is characterized as a high biodiversity region in the world ocean, supports abundant fishery resources to the peripheral nations, and affects weather/climate in southeast Asia. A better understanding of its circulation is thus crucial for better prediction and sustainable management of the SCS. An unprecedented dataset obtained from an acoustic Doppler current profiler (ADCP) observation in the central eastern SCS from December 2016 to December 2017 reveals distinct intraseasonal (one to three months) oscillations in the upper layer ocean current. The physical processes underlying the intraseasonal oscillations, particularly between May and November 2017, were hypothesized and a numerical model was used to examined the hypothesis. To the observations and results from semi-idealized numerical simulations, we conclude that, during the boreal summer, the strengthening (weakening) of southwesterly monsoon led to the increase (decrease) of the onshore Ekman transport to the eastern boundary of the SCS, which resulted in coastal sea level rise (fall) off Palawan. Additionally, Rossby waves with relatively high sea level anomalies (>0.2 m) east of the Philippines may penetrate through a series of islands and the Sulu Sea to the west of Palawan and thus contribute to the coastal sea level rise. As the alongshore wind reduced, the resulting sea level rise off Palawan was relaxed to create Rossby waves propagating westward at speed ~0.24 m s^{-1} in the central SCS. These Rossby waves caused noticeable intraseasonal oscillations, particularly in the zonal velocity at the ADCP mooring site. The correlation between the other velocity intraseasonal variations and sea level variations in winter months was not as clear as those in summer, and the associated dynamics merits a future study.

Eddy equilibration in baroclinically unstable, shallow flows

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Abstract

Building upon the work of Held and Larichev (1996), we examine the equilibration processes of geostrophic turbulence for continuously stratified, baroclinically unstable flows in a wide channel, using a primitive-equation ocean model. This problem represents an idealization of eddying ocean and atmosphere where the properties of baroclinic eddies are studied as macroturbulence. Attention is placed on evaluating and constructing theoretical closures for the equilibrated eddy length scale (i.e. energy-containing scale) and eddy kinetic energy level. Key closure ingredients are eddy kinetic energy balance and turbulence phenomenology of inverse cascade. Consistent with prior studies, the volume integrated energy balance is dominated by eddy energy production and boundary layer dissipation. The energy production, manifested in meridional eddy buoyancy fluxes, is well represented by diffusion of buoyancy field passively stirred by barotropic eddies. However, inconsistent with prior closure assumptions, the turbulence cascade does not exhibit a clear inertial range where the cascade rate matches the energy injection/dissipation, although the cascade is indeed upscale. Unlike the Quasi-geostrophic system in which the mean static stability cannot change with time, the mean buoyancy field is adjusted to achieve a balance between restratifying eddy buoyancy transport and destratifying forcing that acts to replenish the potential energy. Incorporating these modifications leads to a new closure that is found to improve the predictions of equilibrated eddy scales and mean static stability. The new closure is also shown to recover prior theories in the weak-drag limit.

A more violent Haiyan!? The role of NECC

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Abstract

In this work, the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) model is used to hindcast typhoon Haiyan (2013), an extremely intense tropical cyclone striking Philippine in 2013. Given the record breaking intensity of Haiyan, the upper ocean condition underlying the severe storm is considered as relative favorable for storm intensification, in addition to existing favorable atmospheric conditions. However, out of expectation, our simulations indicate a systematic result that Haiyan is not the combination of "worst conditions" from both atmospheric and oceanic frames. On the contrary, our results shed light on a possibility that Haiyan might have an even worse situation (develop to be more violent storms), given identical atmospheric conditions. Subsequently, this possible over intensify is diagnosed to be associated with an extra horizontal heat advection resulting mainly from extremely strong current contributions tied to unusually northward shift of North Equatorial countercurrent (NECC).

全球暖化變異下聖嬰現象對越南湧升流的影響

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摘　要

　　位於南海的越南外海夏季湧升流對於漁業經濟及氣候變遷扮演著重要的指標。偶然發生的湧升流減弱或消失引起了人們的廣泛關注，並在往昔研究中被歸因於聖嬰現象關聯的季風衰減。然而，本研究藉由分析約70年的觀測資料發現，聖嬰現象對於越南外海湧升流的優勢程度並不穩定。我們指出，當全球暖化處於趨緩時期時，聖嬰現象對於越南湧升流的調節並不明顯。反之當全球暖化處於暖化加速時期時，聖嬰現象的調節能力較為良好。這種不穩定的調節我們歸因於暖化趨緩下、聖嬰現象的強度減弱，使得它經由印度洋暖化及西北太平洋異常反氣旋去影響夏季季風的能力減少，因此不易影響越南外海湧升流。

Interannual variability and mechanism of summertime upwelling in the central South China Sea

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Abstract

Summertime upwelling off the southern Vietnamese coast is one of the most essential oceanographic features in the South China Sea. Based on analyzing the sea surface temperature (SST) images in 1982-2019, locations of summertime Vietnamese upwelling centers are found to be classified into three sub-regions: the Southern Coastal Upwelling (SCU; south of 12.5°N), the Northern Coastal Upwelling (NCU; north of 12.5°N), and the Offshore Upwelling (OU; east of 110°E). Variations of upwelling intensities in the three sub-regions are further quantified via an adaptive SST-based upwelling index, and possible processes relevant to wind field (including wind stress and its curl) and currents are proposed seperately based on satellite altimeter-derived surface geostrophic current and wind upwelling index.

Rapid Intensification of Super typhoon Hagibis (2019)

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Abstract

Category-5 Super typhoon Hagibis is one of the highest impact typhoons in recent years. In October 2019, Japan's densely-populated Kanto region (including the capital Tokyo and surrounding area) were hit by Hagibis. Though having already weakened to a moderate category-2 typhoon at landfall, torrential rain and wind from Hagabis still caused significant loss of life and widespread damage. While heavy rainfall was the main cause of damage at landfall, one of the most striking characteristics of Hagibis was its rapid intensification (RI, Kaplan and DeMaria 2003) over the ocean. In 24 h, Hagibis intensified from Tropical Storm (TS) to Category-5 (i.e. 55 kt to 140 kt) intensity. This 'explosive' intensification of 85 kt in 24 h is 283% of the RI threshold of 30 kt in 24 h, making Hagabis one of the most rapidly-intensifying typhoons on record. This work aims to study Hagibis's RI by examining the structure of Hagabis and its surrounding environment. .

TIMCOM Model Datasets for the CMIP6 Ocean Model Intercomparison Project

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Abstract

Two ocean-sea ice datasets of Ocean Model Intercomparison Project (OMIP) simulation experiments from the Taiwan Multi-scale Community Ocean Model (TIMCOM) are described and compared in this paper, forced by two different atmospheric forcing states. One is based on the CORE-II (Co-ordinated Ocean–Ice Reference Experiments, Phase II) data (1948–2009) while the other one is forced by the recent JRA55-do reanalysis data (1958–2018). Climatologically mean and interannual variability are validated with the observation. We find that the mean states and interannual variabilities can be well reproduced by these two experiments. Long-term global linear trends are consistent with imposed surface forcing. The differences between these two datasets are also discussed to enhance our understanding of the potential causes of the systematical biases in the global fully coupled model (doi:10.22033/ESGF/CMIP6.14323).

The condition for significant upwelling and downwelling at eddy centers in the Northern South China Sea

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Abstract

Cyclonic eddies (CEs) and anticyclonic eddies (AE) are usually characterized by upwelling and downwelling, respectively, near the eddy cores. However, we found that not all CEs and AEs were accompanied by this eddy pumping in the northern South China Sea (SCS), based on a repeated Expendable-bathythermograph (XBT) transect and Argo floats. The weakening of background thermocline was attributed to the strengthening of eddy pumping. Our finding showed that the background thermocline was modified by the northward Sverdrup transports from southern SCS and the Kuroshio intrusion into the SCS, affecting the eddy pumping near the eddy cores. A significant upwelling with bio-chemical response was observed in a small cyclonic eddy with a diameter smaller than 100 km, via a cruise experiment and an Argo float in May 2014, when the northward Sverdrup transports carried warmer and lighter water below the thermocline into the northern SCS from the south. The nitrogen-limitation transition was found near the surface and sub-surface at where the significant upwelling occurred, according to the nitrogen-to-phosphate ratio above the Redfield ratio (16:1). This finding in May 2014 showed that small ocean eddies should be also concentrated for the study of eddy roles in changing the marine environment, under the global warming with the general increasing in the upper-ocean stratification.

Introduction

To the best of knowledge in the literature to date, the mechanisms of global eddy-induced Chl variation could be classified into several types [Siegel et al., 2011; McGillicuddy, 2016]: (1) the eddy pumping (a general type), (2) eddy-wind interaction (or so called "eddy-Ekman pumping"), (3) eddy stirring/advection [Chelton et al., 2011; Chow et al., 2017], (4) strain-induced submesoscale upwelling along the eddy peripheries [McGillicuddy, 2016; Chow et al., 2019; Zhang et al., 2019], (5) eddy trapping [McGillicuddy, 2016] and (6) eddy-induced mixed-layer deepening [Gaube et al., 2014; McGillicuddy, 2016].

Warm-core cyclonic eddies and cold-core anticyclonic eddies could be even detected in the Pacific and Atlantic [Itoh and Yasuda, 2010; Flagg et al., 1997; Sun et al., 2019], reversed to a generally-known situation that the cyclonic and anticyclonic eddies are usually characterized by cold and warm cores, respectively. In the SCS, about 60% of the anticyclonic and cyclonic eddies are corresponded to the positive and negative anomalies of sea surface temperature (SST), respectively [Liu et al., 2020], based on the satellite observation.

According to the previous studies reviewed above, it is known that not all eddies have the eddy pumping that is significant enough to affect the biogeochemical environments occurred near the eddy cores. Then, what is the condition for the upwelling and downwelling to occur near the cores of cyclonic and anticyclonic eddies, respectively, in the SCS? To comprehend this scientific question, we studied the spatial and temporal variability of ocean profiles corresponding to the eddies in the NSCS, where the temperature-salinity (TS) properties of sea water are largely affected by the ocean currents from its boundary, such as the Kuroshio Intrusion. We used the ocean profiles obtained from the repeated transects of Expendable Bathythermographs (XBTs) (Figure 1) that passed through the core of satellite-detected ocean eddies in the NSCS, combining with the observation of Argo floats and cruise experiments.

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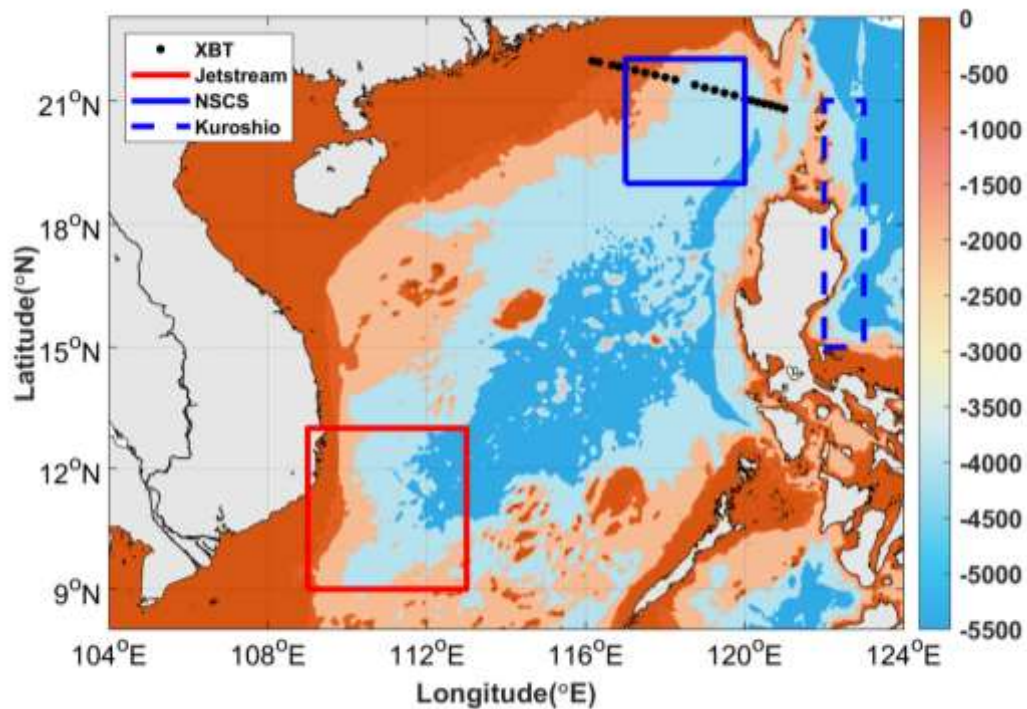
Figure 1. The bathymetry in the SCS. The black dots show the repeated hydrographic surveys PX44 of XBTs. The blue-solid, blue dashed and red-solid rectangles show the region of NSCS, Kuroshio and Vietnam Coastal Jets using to test the long-term water TS properties.

內波對南海北部的碳輸出之影響

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摘要

　　南海為貧營養鹽海域，有光層之顆粒碳輸出通量約為 36-72 mg-C m^2 day^{-1}。然而，內波通過後造成海水劇烈的垂直移動，使深層海水能藉由此機制與表層海水混合，將富營養的水輸送至表層，促進表層物質循環。然而，當內波通過後帶來的營養鹽是否會改變海洋的顆粒碳循環及造成其改變的機制未有明確的定論。因此我們在南海內波好發的海域佈放漂浮式沉積物收集器，搜集內波通過及無內波影響時的水文參數及顆粒碳通量(POC flux)，並取該海域的藻進行培養實驗，了解內波通過後的浮游植物反應。經過野外採集，我們觀測到內波通過後，硝酸鹽躍層(Nitrate cline)向淺提升約 30 米，且透光層中的葉綠素濃度在內波通過後提升 1.2-2 倍。內波通過後的顆粒碳輸出通量則為 54.3 - 110.9 mg-C m^2 day^{-1}，為北南海的 1.6-2 倍。在實驗室進行溫度驟變實驗中發現，當藻類面臨溫度驟降(cold shock)後一小時，其存活率減至原先的 70%，而迅速增溫(warm shock)一小時後的存活率為 80%，證明藻類可能因內波造成溫度迅速地改變死亡，使觀測到的顆粒碳通量增加。然而內波造成的改變不僅是溫度變化，有更多因子亦會改變表層生物生理作用、物質循環，改變輸出碳通量。未來需要更多現地觀察及試驗，了解內波影響顆粒碳循環的機制。

Assessing potential uncertainties of VGPM-primary-production estimated from remote and in-situ observations in the northern South China Sea

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Abstract

The temporal variations and potential bias of *in situ* incubated and VGPM-derived primary production were assessed within the euphotic zone (PP_{eu}) according to the SouthEast Asian Time-series Study (SEATS) occupied from 2003 to 2016 and located in the basin area of South China Sea (SCS), one of the largest marginal sea in the world. It shows apparent peak values of the monthly mean PP_{eu} both by *in situ* observation and the modeled estimate in cold season (December and January). This similar trend of high PP_{eu} found in the cold period is likely due to the presence of prevailing northeastern monsoon and stimulates the phytoplankton photosynthesis rate in the SCS. Multiyear averages of in situ PP_{eu} exhibit a decreasing pattern with an increasing trend of the sea surface temperature (SST). Concomitantly, similar situations of the modeled PP_{eu} and satellite-based SST do not be captured in our study. After examining the potential uncertainties of *in situ* observed and remote sensed parameters applied for the PP_{eu} estimate empirical algorithm, the elevated deviation of *in situ* and modeled PP_{eu} are probably resulted from the satellite-derived depth of euphotic zone and surface chlorophyll measurements. It is mostly attributed to the fact that the remote sensing only reflects the surface biogeochemical variation, revealing that a reliable model should be applied for the PP_{eu} estimate considering the deeper waters oceanic biogeochemistry in the SCS.

Carbon fluxes caused by typhoons and un-predicted deep-water carbon sources in the South China Sea

南海颱風誘發之碳通量及無法預測的深海碳源

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Abstract:

Satellite remote sensing of chlorophyll *a* (Chl) has produced evidence of tropical cyclones (called typhoon) induced phytoplankton blooms in the ocean but it is difficult to evaluate if the particulate organic carbon (POC) fixed by marine organisms can be transported into deep waters. Here we report on C fluxes in the northern South China Sea (NSCS) before and shortly after the passage of typhoons from 2012 to 2014. The integrated inventories of nutrient (N) 8, 3, 2, and 5 days after the passage of typhoons Tembin, Soulik, and Knongrey were 0.44, 0.16, 0.36, and 0.48 mol m^{-2}, and these values were not significantly different from inventories of N under non-typhoon conditions. POC fluxes after the passage of typhoons Tembin and Soulik were 1.6 and 2.4 times higher than those obtained before the typhoon. Additionally, variations in both surface and depth-integrated Chl were decoupled from POC fluxes. This decoupling may be attributed to a change in the plankton community composition due to water column instability or to lateral inputs of particles released from shelf or slope sediments. Additionally, we also observed elevated carbon fluxes in deep waters of the NSCS. The higher carbon fluxes in deep waters can't be modeled using traditional Martin's decay curve. If this un-predicted C flux phenomenon is ubiquitous between shelf and basin in the SCS, this deep carbon sequestration can't be ignored in future carbon budget. Overall, the 2-year dataset highlights the spatial and temporal variability of the factors controlling biological carbon pump to the deep NSCS.

Key words: carbon flux, particulate organic carbon, tropical cyclones, biological carbon pump

Differences of seep environments at the SCS active and passive margins, Results from SO266

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Abstract

Taiwan is situated at a unique geological-oceanography location where active and passive continental margin exist side by side within very short distance.   In both margins, rivers, either large river (e.g., the Pearl River), or small (e.g. Kao-ping River and Tseng-wen River) are delivering huge quantity of terrigenous materials to the region and able to facilitate organic carbon burial.   An upwelling also exists in between the margins and should be able to supply organic carbon and may further facilitate its entering into the sedimentary system.   One major difference between the systems is the tectonic activity in the margin southwest of Taiwan, which differed this margin from the passive margin further west in the South China Sea.   One of the major objectives for the SO 266 cruise is to understand what and how different it would be for the methane and fluid migration between these two systems.   In this report, we will show and discuss what we have found from this cruise.   A set of Mebo drill cores, gravity cores, OFOS surveys, among others were conducted at these two sets of margins, in particular, the Formosa Ridge (FR) at the passive margin and the Four-Way-Closure Ridge (4WCR) at the active margin.   Pore water samples were obtained and analyzed for dissolved chloride, sulfate, sulfide, stable isotopic values of oxygen, deuterium, alkalinity, ammonia, as well as sedimentary organic carbon, carbonate carbon, pyrite concentrations, grain sizes, TON, and stable isotopic variations of pyrite-S, TOC-C, and carbonate-C.

Our results show that significant variations exist between these two seep environments.   Between the systems, similarities include: 1) rapid sulfate depletion with increasing depth, 2) two pyrite S peak values, 3) high concentrations of dissolve barium, 4) little TOC concentration variations, 5) peak carbonate appeared at subsurface, 6). Peak alkalinity appeared near the SMTZ, 7) peak dissolved calcium appear near the SMTZ, 8) dissolve ammonia peak(s) appeared at depth, 9) dense benthic community.   Differences include: 1) Shallower SMTZ at the FR, 2) the depth of first pyrite peak at FR appeared at shallower depth than 4WCR and second pyrite peak at FR is at a depth deeper than that at the 4WCR, 3) higher dissolve iron found at the FR at depth, 4) Two dissolve Ba peaks at the FR but one peak at the 4WCR, 5) low TOC at the 4WCR, 6) high carbonate content

appeared at mid-depth of 4WCR, 7) broader alkalinity peak at the 4WCR, 8) linear increase of ammonia at the 4WCR, 9) different community structure.

Our results demonstrate that AOM is the primary driving mechanism for both seep environments, however, organic carbon decomposition played a more important role in the FR seep. Advection of methane, on the other hand, drove the pore water variations more significantly at the 4WCR.

東沙環礁潟湖碳化學之季節間及年間變化

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摘　要

　　本篇為2015年夏季、2016年夏季和2016年秋季在東沙環礁潟湖(DAL)海水碳化學的研究成果。根據總鹼度異常(ΔTA)計算，DAL呈現淨鈣化作用的狀態，夏季有較高的鈣化潛力，秋季相對較低。由二氧化碳分壓異常(ΔpCO$_2$)計算，相較於大氣環境DAL呈現出碳源特性，在夏季的ΔpCO$_2$較高、秋季相對較低。此外，二氧化碳分壓(pCO$_2$)也出現明顯的年間變化，2016年夏季 pCO$_2$的數值高於2015年夏季。由經溫度標準化之二氧化碳分壓(npCO$_2$)與氧氣利用率(AOU)關聯性分析顯示，夏季npCO$_2$的年間變化可能與DAL當地有機碳代謝特性發生變化有關，在2015年夏季為自營性，而在2016年夏季是異營性。推測這些代謝特性的變化可能與採樣期間的天氣狀況不同有關(2015年為晴天、2016年為暴雨)。進一步分析經鹽度標準化之總鹼度與溶解性無機碳之間的關係顯示，鈣化作用是調控2015年夏季CO$_2$動態的主要機制，而2016年夏季CO$_2$則分別受鈣化作用和有機呼吸作用的調控。這項結果也支持有機碳代謝特性的變化可能是pCO$_2$年際變化背後的驅動力。

How to measure temporal and spatial variations in the partial pressure of carbon dioxide at a lagoon?

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Abstract

Waters in a lagoons or wetland experience substantial temporal and spatial variations in the carbonated system, including tidal effect, river-to-sea mixing effect, wind-driven current, photosynthesis, respiration, benthic flux, and other minor factors. Heterogeneous variations in the partial pressure of carbon dioxide (pCO$_2$) from 600 ppm to ~6000 ppm complicate the measurement of air-sea CO$_2$ gas exchanges. Commercial equipment is usually expensive or oversize to fulfill our purpose. Here we provide a unique method to measure temporal and spatial variations simultaneously. We made mini pCO$_2$ buoys in the laboratory at the National Sun Yat-sen University. These buoys have a high temporal resolution (every 1 minute, ±5 ppm) and can be calibrated before and after each deployment. We have successfully deployed five mini pCO$_2$ buoys simultaneously at the upper, middle, and lower lagoon at Chiku Lagoon in Taiwan for more than 36 hours during summer 2020. This high-resolution pCO$_2$ result may solve the covariations between temporal and spatial variations in a lagoon and a wetland.

Intrusion of Kuroshio Helps to Diminish Coastal Hypoxia in the Coast of Northern South China Sea

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Abstract

Since half a century ago, the number and area of dead zones (dissolved oxygen (DO) < 2 mg L–1 or 30% saturation) in the coastal oceans has increased dramatically. As widely recognized, the increased terrestrial nutrient and organic matter inputs are the two main factors causing the eutrophication of many coastal oceans. Here we show with decadal observed time series data from stations off the Pearl River Estuary and in the northern South China Sea (nSCS) that a strong intrusion into the nSCS of the West Philippine Sea (WPS) seawater in the form of Kuroshio branch occurred during the warm phase of the Pacific Decadal Oscillation (PDO) around 2003–2004 and 2015–2016 (also a strong El Niño event). Consequently, the DO concentration increased but NO_3^- and PO_4^{3-} concentrations decreased in the subsurface layers of the nSCS. The WPS seawater was observed to reach the hypoxic area off the Pearl River Estuary in 2003–2004. Likely, due to the oxygen supply carried by the Kuroshio, little hypoxia developed. Yet, anoxic condition developed in the cold phase of PDO or strong La Niña years with weak Kuroshio intrusions.

Net community production and air-sea exchange of oxygen and carbon from buoy observations in the Western Philippine Sea

利用浮標觀測估算西菲律賓海淨社群生產量和氧及二氧化碳的海氣通量

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Abstract

As a continuous effort of buoy project, we have successfully obtained time-series data of dissolved oxygen and pH in the surface ocean at NTU1 (123.9°E, 21.2°N) during 25 Sept.~ 12 Nov. 2020. Along with high-resolution oxygen and pH data, complete set of meteorological and hydrographic data was also collected. We will report temporal variation of carbonate parameters and estimate air-sea exchange of CO2. We will also present the net community production based on the mass balance of oxygen in the euphotic layer.

海水有機配體與氣膠鐵的互動

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摘　要

　　西北太平洋及其邊緣海在東北季風及西南季風的季節接受了截然不同來源及通量的氣膠，氣膠沈降至表層海水後將與有機配體互動才得以形成溶解態鐵，形成浮游植物潛在可利用的鐵物種，這反應包含與氣膠可溶解鐵的螯合及與顆粒表面鐵與有機配體的反應。本研究使用採集於彭佳嶼及馬祖一整年度五種不同粒徑氣膠，以兩種模式有機配體(Siderophore and glucuronic acid)進行氣膠鐵與海水有機配體模擬實驗，探索不同形態氣膠鐵在與不同有機配體反應後，在表層海水的溶解轉換過程及其可溶解鐵通量估算。

Carbon fixation by Red Macroalga, *Sarcodia suiae*, using aquaculture wastewater.

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Abstract

Culturing macro seaweed in the discharged marine aquaculture wastewater will mitigate the effect of hypoxia through eutrophication as well reduce the greenhouse gases emissions in coastal environments. Few scientific evidence have shown that macroalgae which are grown in coastal rocky environments without sediment may highly contribute to carbon storage after sequestering atmospheric CO_2. In this study, we try to investigate the amount of carbo fix by the red macroalga, *Sarcodia suiae* in wastewater discharge from shrimp and lobster rearing system through outdoor 7 tons fiberglass tanks without controlled atmosphere. Water temperature, salinity, and nitrite were measured daily. Wet weight of seaweed was recorded once a month to calculate average carbon fixation rate. Elemental analysis data revealed 26.7% was represent by the carbon with the dry weight of 12.7%. The average carbon fixation rate is 0.99 ± 1.36 c-g.m^{-2}.day^{-1} with showing highest, 3.82 c-g.m^{-2}.day^{-1} in early spring indicating higher than the phytoplankton primary production in the ocean. Lowest carbon fixation rate was found in the June to September with high temperate water. Water salinity and pH of high nutrient aquaculture wastewater was not affected to the survival and growth rate of seaweed other than the temperature. Overall, high carbon fixation was found in the late fall to end of spring in low temperature and vice versa in the summer.

Key words: Carbon fixation, Aquaculture wastewater, Red Macroalga, Temperature

The Preliminary Results of Diel Carbonate Systems

in Chiku Lagoon

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Abstract

Chiku lagoon is a highly productive subtropical coastal region in Southern Taiwan. The lagoon is nourished with both freshwater and seawater. About 0.1 km^2 area of the mangrove forest covers in South-eastern part of Chiku lagoon. Previous research has studied the carbonate system and carbon sequestration rate in mangrove sediments. Yet, the diel carbonate dynamics and possible mechanisms behind such changes in Chiku lagoon are not well understood.

In the wet season (August 22nd-23rd, 2019) and the dry season (October 3rd-4th, 2019 and January 20th-21st, 2020), our laboratory made a buoy attached with pH, temperature, and salinity probes and a CO_2 sensor with an equilibrator to measure partial pressure of CO_2 (pCO_2). Dissolved oxygen (DO) concentration was also monitored by a probe. The discrete water samples were collected every a few hours to analyze total alkalinity (TA), dissolved inorganic carbon (DIC), and pH. The measured pCO_2 data were consistent with those pCO_2 values calculated by TA and DIC values. The pCO_2 and pH variations agreed with each other over day and night. Furthermore, the pCO_2 and pH values in the wet season showed larger differences than those in the dry season. DIC and TA in the dry season followed a clear mixing pattern with high TA values in freshwater inlet end-member. In both seasons, the result showed a net DIC and TA removal in the lagoon water. Future investigations are required to understand the effect of freshwater input, air-water CO_2 gas exchange, and biological processes, including photosynthesis, respiration, calcification, and calcium carbonate dissolution on the carbonate system in Chiku lagoon.

Keywords: Chiku lagoon, diel variations, pCO_2, dissolved inorganic carbon, total alkalinity

探討持久性有機汙染物
在恆春半島沿海海參之生物累積

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摘要

　　由苯環所構成的持久性有機汙染物(Persistent organic pollutants,POPs)因化合物結構穩定，一旦進入環境中難以被分解、去除，而進入生物體內形成累積作用而影響其生理健康。由於 POPs 具有親脂特性較容易吸附於有機顆粒，進入海洋中吸附水中顆粒而隨之移動而淤積於海底的底泥中，底棲無脊椎動物海參攝食方式以濾食水中有機顆粒為主，來源包括懸浮顆粒(suspended particles)及底泥湧起顆粒(resuspended sediment particles)，因此 POPs 可能隨著有機顆粒一同進入海參體內累積。本研究探討多環芳香烴、多氯聯苯、有機氯農藥與多溴聯苯醚在恆春半島沿海的四種海參(黑海參、斑錨參、蕩皮參、黑刺星海參) 肌肉壁及消化道之POPs 生物累積，比較其個體大小、生長環境及攝食方式對 POPs 累積之影響，並探討海參成為 POPs 的環境汙染指標生物之實用性。分析結果顯示多環芳香烴在海參體內濃度為 11-51ng/g dw，黑海參及蕩皮參以觸手攝取表層底泥的有機物質為主，故體內 POPs 組成與底泥 POPs 組成相近，而斑錨參及黑刺星濾食水中的有機物質，故其 POPs 汙染物組成則是與水中顆粒相近。多氯聯苯及有機氯農藥在恆春半島水中及底泥的為濃度較低，可能導致其累積在海參體內濃度不明顯，多氯聯苯在海參體內濃度為 ND-0.0183ng/g dw，而有機氯農藥為 ND-0.0079ng/g dw。多溴聯苯醚在海參體內濃度在 1-109ng/g dw，以十溴的 PBDE209 為主。海參中的 POPs 累積濃度依序為黑海參>黑刺星海參>斑錨參>蕩皮參，但在同種海參間在大小及生長環境上 POPs 累積差異上並不明顯，而不同海參間的皆發現其消化道濃度高於肌肉壁的現象。

淡水河河口的甲烷濃度及其氧化速率季節性變化

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摘　要

甲烷全球變暖潛勢(Global warming potential, GWP_{20})在20年的時間尺度下，是二氧化碳的84倍，即使二氧化碳的排放量多於甲烷，仍不能低估甲烷對於全球溫室效應的影響力。在水體中有不同生成甲烷的來源，如沉積物及有機質分解等，但不是所有生成的甲烷都會從水體釋放到大氣，有部分甲烷會經細菌作用進行氧化，此氧化反應被認為是減少甲烷排放至大氣的生地化過程，回顧以前文獻關於甲烷氧化速率培養實驗的研究區域大多設置在湖泊，目前沒有在河口進行甲烷氧化速率培養實驗的相關研究，本研究在淡水河河口進行甲烷氧化速率培養實驗，觀察在受到海水影響的河口區域，甲烷氧化速率的變化。此研究在淡水河河口內分別設置7個測站，每個採樣點進行0、12、24、48、72、96小時的甲烷氧化速率培養實驗，分別在2019/11(秋季)、2020/2(冬季)、2020/5(春季)及2020/8(夏季)進行採樣及培養，研究結果指出河口的甲烷濃度及氧化速率都有隨著鹽度上升有降低的趨勢。

Hydrodynamically induced variability in the characteristics of suspended particles on the dispersal pathway of Pearl River plume

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Abstract

Pearl River is considered the largest terrestrial source in the northern South China Sea (NSCS). Previous works show complicated hydrodynamic systems along the dispersal pathway of Pearl River plume. Firstly, the SW monsoon winds drive the Pearl River plume to disperse northeastward along the Guangdong coast, resulting in strong stratification in the upper water column. Secondly, nonlinear internal waves from the NSCS intermittently disrupt and weaken the stratification. Thirdly, the SW-wind triggers upwelling, causing the landward intrusion of cold-water mass near the bottom. In this study, a 5-day fix-point measurements at 98 km away from Pearl River mouth in 2016 were designed to investigate the couplings between suspended particles and hydrodynamics on the dispersal pathway of the Pearl River plume. Continuous hourly onboard hydrographic profilings were conducted, and water samples were collected at 3-hours intervals for analyzing suspended sediment concentration (SSC) and Chl-a. Two ADCPs (upward and downward looking) mounted on a nearby mooring were used to measure the flow field. One Laser In-situ Scattering and Transmissometry (LISST) was mounted on the CTD rosette and the other on the mooring to measure the volume concentration (VC) of 32 suspended particle sizes. In the upper water column, light transmission profiles show the turbid river plume water with diurnal oscillations, which were caused by the on-offshore diurnal tidal flow (or currents). In the river plume water, the total SSC ranged from 5 to 15 mg/l and was contributed mostly by particles <10 µm. The VC of suspended particle was mainly composed of >153 µm, but the 10-63 µm size class gradually increased with Chl-a., indicating the size of growing primary producers. Light transmission profiles show the bottom water mass was more turbid than the surface water and formed a 10-m thick benthic nepheloid layer with the SSC ranged in 2 to 20 mg/l, contributed mostly by particle <10 µm. The VC of suspended particle was mainly composed of 10-63 µm and >153 µm. Based on Sedtrans05 model, only suspended particles <63 µm was resuspended. However, the lateral transport processes should be considered in the further investigation to include all particle sizes.

The regime change of the monsoon climate that affected land-sea interactions on the western side of the Taiwan Strait

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Abstract

Located in the realm of Asian monsoons, the Taiwan Strait is not only connected two major marginal seas, the East China and the South China Seas, but also affected by the terrestrial material exported from the two world-major rivers, the Changjiang (Yangtze) and the Zhujiang (Pearl) Rivers. Understanding how monsoon changes would affect long-distance transport of the two major river-sea systems through the Taiwan Strait conduit, and how these changes affect land-sea interactions along the transport pathways are of major scientific interests. Most previous studies have focused on winter or summer conditions, and rarely discussed the regime change triggered by the seasonal transition. This study presents rare observations during the short monsoon transition period off the mouth of the Jiulongjiang River at a center location of the western Taiwan Strait to provide valuable insight into how the transition affected the land-sea interaction. Overall, water masses off the mouth of Jiulongjiang River can be roughly divided into nearshore plume water, Zhejiang (Zhe) and Fujian (Min) Coastal Current (ZMCC) water, and South China Sea Warm Current (SCSWC) water during the transition period. In the nearshore area, river plume water dominated the surface, and the bottom is dominated by the mixture of ZMCC and SCSWC water masses. In the offshore area, the ZMCC and SCSWC compete with each other. The frontal zone formed by the two water masses is dynamic and changes with the season. From spring to summer, the front is pushed northward by the southwesterly monsoon. In winter, the front is extended southward to reach the Jiulongjiang River mouth driven by the northeasterly monsoon. EOF analysis of co-variability among tides, winds, water-borne properties and surficial sediment ($^{210}Pb_{ex}$, ^{7}Be) was conducted. Results show there was a demarcation around 10:00 May 10, 2015 that marks the change of two monsoon regimes both in the surface water and at the water-sediment interface. Two proxies are accentuated in the regime change. Water borne N/P ratio changes reflect water masses carried by the ZMCC and SCSWC. Changes reflect the alternative influence of the major distal fluvial sources of the Changjiang and Zhujiang River. To summarize, the regime change was brought about by the alternative influence of the ZMCC and SCSWC driven by the monsoon.

Coupling between Physical Processes and Suspended Sediment in the Water Column as Revealed by A Sediment Trap Mooring

物理驅動力、水團特性和水體懸浮沉積物之共變特徵研究

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Abstract

We applied detailed analysis of the data measured on a sediment trap mooring deployed over the mud belt off the Zhejiang coast. The dataset of 29-day time series records include salinity (measured at 8 meter above bed-mab), temperature (measured at 8, 12 mab), flow field measured by a downward-looking ADCP, Aquadopp, (bins located at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 m above bed), and wave field also measured by Aquadopp. All the data were downloaded, checked for errors and then synchronized at 1-hr intervals before further analyses. The backscatter signals at 1-m intervals of the ADCP bins were converted to suspended sediment concentrations (SSC). This study used the shear stress induced by wave-current interaction (U*wc) to represent the forcing that resuspended sediment off the seafloor. We used EOF analysis to establish the process-response relationship between forcing (flow and U*wc), water mass properties (salinity and temperature), and the SSC.

The first 5 eigenmodes cumulatively explain 84.8% of the data correlations (standardized co-variance). SW-directed alongshore flows were the most important process (Mode 1, 3) that transported water masses of Changjiang buoyant plume and the Zhe-Min Coastal Current (Mode 1, 4) to the study site. These factors imply Changjiang-sourced material. Seafloor resuspension and landward flows are of secondary importance (Mode 2, 5). They imply marine-sourced and reworked materials. Particle settling has a relatively small influence on the vertical and temporal variabilities of SSC in the water column (Mode 5).

Oxygen Consumption in the Shelf Sediments of Two Distinct Source-to-Sink Systems in the Northern South China Sea

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Abstract

Two distinct source-to-sink systems, a passive margin fed by a large river (Pearl River) and an active margin fed by a small mountainous river (Gaoping River), coexist in the northern South China Sea. The deltaic deposits of the former type of system is known to be active organic carbon (OC) incinerator and main repository of buried OC, whereas the latter type of system exhibits efficient preservation of terrestrial OC, which contains a substantial fraction of lithic carbon. The sedimentary carbon remineralization rate, a parameter that can be used to assess the OC preservation efficiency, was barely studied in the two systems in the northern South China Sea. Here we present a comparative study on the OC remineralization (assessed by oxygen consumption) and burial efficiency in the shelf sediment of the two distinct dispersal systems in the northern South China Sea, with the working hypothesis that the Gaoping River Shelf (GRS), receiving lithic OC from a small mountainous river, should have lower OC remineralization rates and higher burial efficiency than the Pearl River Shelf (PRS). Our results reject the hypothesis by showing higher total oxygen utility in the GRS mud sites (15.4 ± 9.3 mmol $O_2/m^2/d$) than in the PRS mud sites (5.2 ± 1.2 mmol $O_2/m^2/d$). The elevated total oxygen utility was mainly contributed by benthic fauna, the activity of which was controlled by bottom-water temperature. Total oxygen utility of the sandy sediment in the PRS (5.8 ± 1.1 mmol $O_2/m^2/d$) was comparable to that of the neighboring muddy sediment. The GRS sediment consumed 12.8% of the OC input from fluvial discharge and primary production, whereas the value dropped to 8.6% for the Pearl River estuary and mud belt. Characterization of sedimentary lignin and amino acids is currently in progress and may help to explain why the GRS sediment exhibits such high OC consuming activity.

Distribution of Modern Foraminifera in the Water Column and Sediment Records: Results from the SEATS traps and Box Cores off the Gao-Ping River

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Abstract

The study presents the distribution of modern planktonic foraminifera from water column and marine sediments.   **The first part** is about species composition of planktonic foraminifera collected by sediment traps deployed at the South East Asia Time-Series Station (SEATS) between 2017 and 2019.   Succession of species was revealed benefitted from the 24 sequential 8-day collecting intervals designed for the moorings. Even though the hydrographic parameters adopted in this study was not contemporary with trap deployments, the corresponding subsurface thermal structure for the shift of dominant species was discussed based on the ATLAS buoys (Chang *et al.*, 2010). *Globigerinodes sacculifer* (*Trilobatus sacculifer*) is the most dominant species in the South China Sea almost all year round. The relative abundance of *Globigerinoides ruber* increases as the surface water temperature gets warm.   Of special interest is the rise of *Neogloboquadrina dutertrei*, followed by *Orbulina universa*, occurred when the stratification in the upper water column diminished.   *Globigerinoides conglobatus*, on the contrary, significantly increased its test number and size shortly when the water column was highly stratified.   **The second part** of this study is about the stable isotopic composition of planktonic foraminifera tests preserved in the marine sediments.   A suite of 13 short cores were collected from the continental slope off SW Taiwan during the FATES program conducted between 2004 and 2006. Sedimentation rates derived from fallout radionuclides (^{210}Pb, ^{137}Cs, and ^{7}Be; Huh *et al.*, 2009) indicate fairly constant hemipelagic accumulation for the last century.   Most of the δ^{18}O values fall in the range between -2.5 and -2‰.   The range and fluctuation pattern of planktonic δ^{18}O are very similar, particularly the broad δ^{18}O-enriched interval between 1950 and 1990. The carbon isotope δ^{13}C record, however, fluctuates around 1.5 ‰ and starts to decline after 1970. Similar depletion of δ^{13}C trend was also found in the coral reefs collected from the Xiao Liuqiu and Dongsha (A. Ren, unpublished data). The decline trend is coherent with the global average rate of change in δ^{13}C, which was estimated -0.01‰ yr^{-1} based on a compilation of coral records from throughout the ocean.   The results of Lagrangian approach based on the HYCOM simulation indicate the water masses between our study

sites might not exchange well or directly, causing the difference of the T-S patterns in the collected historical data. However, a model, HYSPLIT, simulates the back-trajectories of air parcels and shows the two possible atmospheric systems (in the troposphere and stratosphere) could contribute to the ^{13}C-depleted trend at these study sites. Therefore, this decrease of δ^{13}C is attributable to the addition of anthropogenically derived CO_2 (^{13}C Suess effect) to the atmosphere (Swart *et al.*, 2010).

臺灣東部海底峽谷高頻率濁流事件機制探討

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摘　要

　　海底峽谷為陸源物質往海洋輸送的重要通道，是深海平原沉積物的重要來源之一。臺灣因位處亞洲大陸邊緣，板塊構造活動頻繁，又因為地處熱帶-副熱帶氣候區內，特殊的地質及氣候條件，使得臺灣單位面積輸砂量為世界平均值的一百倍以上。如此多河流輸出之沉積物在近岸堆積後，遇到地震或邊坡崩塌時，便會形成濁流夾帶大量顆粒物質往深海傳輸，而若發生颱風或強降雨事件時，大量沉積物往外輸出容易導致異重流的形成，沿著海底峽谷往深海傳輸而在海洋沉積環境中形成快速沉積層。本研究於臺灣東部海域臺東海底峽谷系統中，取得海洋沉積物岩心MD183538(22º35.51'N，122º19.59'E，水深4799公尺，岩心長度12.77公尺)，距離卑南溪口直線距離約有100公里遠。分析其沉積物粒徑組成、有機碳組成及碳同位素等，藉此了解事件型沉積物之特徵與組成，並更進一步研究事件層長期的發生頻率與影響。由已完成的岩心影像與描述資料來看，以粉砂為主要組成的濁流事件層在臺灣東部海域沉積物中普遍存在，在岩心中共發現超過700層事件層，濁流事件層通常具有較低的TOC(%)與C/N值，而其有機碳同位素值主要介於-23~-22‰間，沒有明顯的陸緣有機物質的訊號，應是由於其距離河口較遠，陸源有機質在傳輸過程中為海源物質稀釋所致。

Constraining the magnitude and patterns of glacial cooling in the tropical ocean

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Abstract

Upper ocean (0-200 m) temperature reflects large-scale ocean circulation and the atmosphere-ocean heat exchange. It is therefore a useful metric in characterizing paleoclimate, including the roles played by the East Asian Monsoon and the Indo-Pacific Warm Pool in driving climate change in the low-to-mid latitude Western Pacific. Biomarker- and calcite-based geochemical proxies are widely used to reconstruct past ocean temperature, but may yield discrepant estimates due to chemical and ecological differences of the proxy carriers. Deriving temperature estimates from multiple proxies for the same site may shed light on proxy systematics and improve the robustness of ocean temperature reconstruction, yet there are few multiproxy-based upper ocean temperature records in the aforementioned region. Therefore, our research aims to constrain ocean temperature reconstruction, using a network of sediment cores, plankton tow samples and sediment trap samples from the South China Sea, Indo-Pacific Warm Pool and Okinawa Trough. We generate paleotemperature estimates of the sea surface and thermocline, inferred from geochemical proxies based on vastly different proxy carriers, namely planktic foraminifera-based Mg/Ca and clumped isotopes (Δ_{47}), algae-based $U^{K'}_{37}$, and archaea-based TEX_{86}. Depth-stratified plankton tow samples shed light on the ecology (depth habitat) of the proxy carriers, whereas sediment trap samples allow us to examine seasonal proxy variations, thereby determining if the sedimentary proxy values are skewed towards a particular season. Together, these pieces of information will help improve proxy record interpretation. Calibration, which is used to convert raw proxy unit to temperature estimate, directly scale the value and magnitude of change of a proxy temperature record. We therefore also assess this factor by comparing temperature records calculated using different calibrations, namely authors' choice, commonly applied calibration for each proxy type, and recently developed Bayesian statistics-based calibration. We then characterize the spatial patterns of the offsets stem from calibrations and proxy discrepancy at single site, as this may provide insights into the spatial heterogeneity in glacial cooling maps that cannot be reproduced by state-of-the-art climate models. We envisage that such a systematic multiproxy approach will refine our understanding of past climate change in the tropical oceans surrounding East Asia as well as proxy interpretation in general.

解密"太平洋的威尼斯"

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摘 要

現代人 (智人，*Homo sapiens*) 出走非洲後，在全球遷徙，最後抵達太平洋島嶼，幾千年來，發展出多樣的文化。現今許多海島上還存有許多史前遺蹟，例如復活節島上的巨石人像群、科斯雷島上的珊瑚金字塔等，而在密克羅尼西亞的波納佩島 (Pohnpei) 的東部海岸，則有一座稱為南馬都爾 (Nan Madol) 的廢棄古城。該城占地約18平方公里，19世紀時被歐洲人發現。由於它是以超過100座皆使用柱狀玄武岩和珊瑚砌造而成的人工島與運河所組成，因此也被暱稱為「太平洋的威尼斯」。透過口述歷史的彙整與歐美亞各國百餘年研究，再加上當地政府的努力，使得這個人類在太平洋上最大規模的遺址，於2016年7月由聯合國教科文組織正式認定為世界文化遺產。

南馬都爾是中央集權的紹德雷爾王朝 (Saudeleur Dynasty) 的首都，自1965年第一批碳十四定年報告出爐，迄今已累積超過50年的定年資料。據此推論該王朝可能興建於1100-1200年之間；並在1500-1600年間，由於王朝被推翻，遭到棄用而荒廢。但是確切的建造和廢棄時間，學界則尚無定論。

為了解開南馬都爾的謎團，我們團隊在2016年7月和2018年1月，於14個有代表性的人工島上採集超過150個珊瑚標本，篩選148個新鮮標本進行鈾釷定年。結果顯示南馬都爾的建造經過兩期大型工程，第一期約在900-1100年之間，規模較大的第二期則約落在1150-1350年。3個最年輕的標本年齡為1403±4年、1410±9年、及1411±3年，顯示該城最後工程時間約在15世紀初。

國王居住的Pahnkadira島，測定的11個珊瑚年齡落在930-1403年之間，且分布狀況與所有標本的年齡特性一致；有4個標本在930-1140年之間，6個標本集中在1220-1340年，最年輕的標本則是1403±4年。珊瑚鈾釷年齡與過去發表的遺址碳十四年齡分布相符，說明珊瑚年齡應可代表南馬都爾的歷史。

綜合分析後推論，該址的大規模建造約始於10世紀，比過去的認知早了200年，第二次大型工程在12世紀中葉到14世紀，持續約200多年。王朝崩落，南馬都爾被棄用的時間應在15世紀初期，比先前的推估早了100、200年。

Study on Landslide Tsunami using Bingham Model

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Abstract

This paper incorporates the Bingham rheology model with the Navier–Stokes solver to simulate the tsunamis excited by a slump-type landslide. The slump is modeled as the Bingham material, in which the rheological properties changing from the un-yield phase to yield phase is taken into account. The volume of fluid method is used to track the interfaces between three materials: air, water, and slump. The developed model is validated by the laboratory data of the benchmark landslide tsunami problem. A series of rheological properties analyses is performed to identify the parameter sensitivity to the tsunami generation. The results show that the yield stress plays a more important role than the yield viscosity in terms of the slump kinematics and tsunami generation. Moreover, the scale effect is investigated under the criterion of Froude number similarity and Bingham number similarity. With the same Froude number and Bingham number, the result from the laboratory scale can be applied to the field scale. If the slump material collected in the field is used in the laboratory experiments, only the result of the maximum wave height can be used, and significant errors in slump shape and moving speed are expected.

Study on Mudslide using modified Bi-viscosity Model

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Abstract

This paper incorperates Bingham and bi-viscosity rheology models with the Navier–Stokes solver to simulate the dynamics and kinematics processes of slumps for tsunami generation. The rheology models are integrated into a computational fluid dynamics code, Splash3D, to solve the incompressible Navier–Stokes equations with volume of fluid surface tracking algorithm. The change between un-yield and yield phases of the slide material is controlled by the yield stress and yield strain rate in Bingham and bi-viscosity models, respectively. The integrated model is carefully validated by the theoretical results and laboratory data with good agreements. This validated model is then used to simulate the benchmark problem of the failure of the gypsum tailings dam in East Texas in 1966. The accuracy of predicted flood distances simulated by both models is about 73% of the observation data. To improve the prediction, a fixed large viscosity is introduced to describe the un-yield behavior of tailings material. The yield strain rate is obtained by comparing the simulated inundation boundary to the field data. This modified bi-viscosity model improves not only the accuracy of the spreading distance to about 97% but also the accuracy of the spreading width. The un-yield region in the modified bi-viscosity model is sturdier than that described in the Bingham model. However, once the tailing material yields, the material returns to the Bingham property. This model can be used to simulate landslide tsunamis.

海底觀測儀器的研發與資料應用

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摘　要

　　自2009年中央研究院結合國家實驗研究院與國立中山大學組成的海底地震儀（ocean bottom seismometer, OBS）研發團隊一起合作研發次寬頻庭園鳥海底地震儀（Yard bird OBS），經過多次的水下佈放實驗所獲取的海床地震資料可用來研究區域板塊構造、地震活動度、震源特性…等已經有了不錯的成果。藉由這些技術的開發，目前除了寬頻海底地震儀(Yardbird-BB OBS)之外，本團隊也研發了海底電磁觀測儀（Ocean bottom electro-magnetometer, OBEM）、海床絕對水壓計（Seafloor absolute pressure gauge, SAPG）、海底水流計（Ocean bottom current meter, OBC）等海下設備，這些儀器已經有實際佈放在台灣周圍海域，本研究將展示其儀器結構、規格和資料應用。

關鍵字： 寬頻海底地震儀, Yardbird BB-OBS, 海底電磁觀測儀, Ocean bottom electro-magnetometer, OBEM,海底絕對水壓計, Seafloor absolute pressure gauge, SAPG, 海底水流計, Ocean bottom current meter.

根據訊號特徵分類：討論西南外海不同地震紀錄波形以及對應的訊號源

Toward data-driven seismic signals detection: the variety of OBS events in the SW offshore Taiwan and their implications

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摘　要

The seafloor OBS records every ground motion energy reaching the stations, which can be caused by the tectonic origins or by the transformed signals converting from the acoustic waves propagating in ocean water. Except for the ambient noises which are the random vibrations in amplitudes (but maybe frequency-dependent), most of the OBS signals can exhibit the specific waveforms corresponding to the different mechanical causes. However, it is a tedious task to recognize all these waveforms by the conventional way of human identification, and the quantification of the occurrences of those waveforms is never been complete. Our study applies the machine Learning algorithm to the continuous OBS seismograms. The OBS data are acquired from two OBS arrays deployed in the SW offshore Taiwan, where is well known to be the plate convergent boundary and the gashydrate storage field. The fingerprint extraction and similarity searching is a novel method for large-scale event detection. We apply the unsupervised detector which does not require any examples of known event waveforms or waveform characteristics for detection. This allows to discover new waveforms with the OBS data. The preliminary result shows that the tectonic earthquakes are very numerous in the offshore area; most of them are microseisms that are not detectable for the inland stations. Taking the occurrence of the tectonic earthquakes as references, we found that a few T-wave signals seem to occur solely. And the short-duration events (SDEs, in a duration less than 2 seconds) are also abundant in the SW offshore Taiwan. The SDEs can be classified into two groups, one with a specific monotone vibration attenuating with time; the other in an abrupt emerges without any specific waveforms. We consider the monotone SDEs are the methane bubbles bursting at the sediment /water interface. The other SDEs are mostly detected at the mid-slope stations. They may be caused by the animal touch or the unknown local geological events. Our study demonstrates that with good identification and classification, the OBS seismic records can be a proxy in studying the marine environment.

臺灣海洋地質調查及有待釐清的海陸地質構造問題

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摘　要

　　臺灣是歐亞板塊和菲律賓海板塊碰撞擠壓所造成的島嶼，從大地構造觀點而言，臺灣本島的地質構造和海域是一體的，無法切割。經濟部中央地質調查所(地調所)，執掌全國地質調查，當然也包含「海洋地質」在內，但因專長人力不足及經費匱乏，我國海洋地質調查 (海洋地質圖)，一直處於幾乎空白狀態。

　　論及海域地質災害的潛在威脅，近10年來，臺灣核電廠的海域地質安全(包含海陸域斷層是否連接)、20180206花蓮地震米崙斷層錯移活動，米崙斷層之海域延伸如何??而鄰國日本2011年311地震及海嘯、2018年印尼海底山崩引發海嘯，乃至現正在如火如荼興建的離岸風力發電風機，彰顯我國對海域地質、海底山崩及海陸域地質構造連結的了解及掌握很有限，另近2~3年來，南二高中寮隧道的快速抬升破壞、台南地區10多處學校校舍(含高鐵路段抬升)抬升破壞，研究指出是「泥貫入體」快速抬升所致，而這泥貫入體可能是從海域泥貫入體延伸進入陸地，但各界仍有存在許多質疑，還必須進一步釐清海陸域泥貫入體的特性及泥地體構造模式。在學界的研究環境，海洋和陸地的調查研究幾乎都是各自獨立，即使有部分海域地質調查資料，也鮮少有「海軍陸戰隊」的姿態，進行海陸地質構造的整體研究，地調所專責全國地質調查，自是必須承擔這「海軍陸戰隊」的角色，提供海域地質及釐清海陸域地質構造關聯。

　　以往國內僅三艘研究船(海研一~三號)，船期不敷使用，而部會用船更是排序最後，即使有經費也未必能租得到船期使用，自107年勵進研究船、109年新海研一~三號陸續加入海洋調查行列，船舶載具已就緒，而108年4月27日海洋委員會國家海洋研究院(國海院)正式成立，國家有海域統籌規劃、管理、科研等專責機關，加上地調所海洋地質調查業務職掌，如果有足夠經費，正是展開海域地質調查的時機。目前國海院擬提出111~114年「全海域海底地形底質基礎調查及應用服務」計畫與地調所聯手執行、地調所111年在經濟部經費支持下將進行「離岸風場海域地質調查及地質環境資訊服務」計畫及中央大學團隊(包含中研院地科所、地調所及成功大學)在科技部研提「110年海洋與地科學門重點助攻計畫-台灣南部陸海域泥地體構造與其致災性整合研究」計畫、地調所規劃111年出版「南沖繩海槽活動斷層及火山分布主題地質圖」，以及地調所持續進行「臺灣東北部礦產地質調查」計畫(109~112)，期望未來這數項大型計畫，在地調所參與下，展開海域地質調查，並彙整海域地質及海陸地質構造連結資料，逐步完成海洋地質圖編撰，提供各界海域防災及藍色國土開發使用之基礎參考資料。

Flank collapse of Kueishantao volcanic island and related submarine landslides deposits in the South-Westernmost Okinawa Trough

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Hummocky morphology feature distributes in the north, south and east sides of the Kueishantao volcanic island. Previous studies have shown that in the northern flank of the island posts a horseshoe-shaped of scar with area of ~0.3 km^2 and estimated collapse volume of ~0.012 km^3 from DTM data. To better understanding the relationship between onshore scar and the offshore hummocky terrain, we focus on the northern part of the island by using multibeam bathymetric data, sub-bottom profiler, side-scan sonar and sparker seismic reflection data. Around the Kueishantao volcanic island, there are lots of submarine landslide at the island slope or the continental slope of NE Taiwan. The mass wasting deposits along the north flank has runout distance of ~4 km northeastward and exposed over an area ~4 km^2 of the seafloor. Hummocky blocks are up to 50 m high and more than 100 m wide, draped by a thin (< 5 m) young sediment. Five different echo types offshore the north of Kueishantao island (types I, II, III, IV, V) were identified on the sub-bottom profiler data. The scatter hummocky blocks show the prolonged and strong reflection (type IV) which indicates the different features from the surrounding sediment (type V). Four different seismic reflection facies (Volcanic facies, chaotic facies, sedimentary facies) were interpreted from the sparker seismic reflection profiles. The chaotic facies contain broken and discontinuous lateral reflections could be classify into Deposit 1 and Deposits 2a & 2b depending on the depositional depth and internal

characteristic. Deposits 1 located at shallowest strata corresponding to the hummock morphology and accommodated a total volume of ~0.077 km^3. Another deposit unit (2a, 2b) can also be found northeastern of the island and might tentatively be associated with multiple landslide events. This study constitutes the first clear evidence of a submarine landslide event of offshore Kueishantao island. Such volcanic behavior, previously unknown for Kueishantao Volcanic Island, has likely triggered tsunami waves over the adjacent Ilan plain raising the inquiry of their impact on prehistorical/historical communities.

Effects of temperature and body size allometry on larval growth for two subtropical reef fishes

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Abstract

Being influenced by the metabolic and developmental rates, larval growth rates should reflect environmental temperature and species body size based on the allometry law. However, the effect of body size on larval growth rates has been overlooked, which may compromise assessment of temperature-related changes in population recruitment. Here, we developed an allometric growth model to evaluate simultaneous changes in settlement size, pelagic larval duration (PLD), and larval growth in relation to temperature by accounting for the size scaling for larval growth. To simulate temperature variation, we used a latitudinal design with two intertidal reef fish surveys from Taiwan (22-25 °N) and Japan (28-32 °N) in the northwestern Pacific. Between two common fishes in tidepools, the cold-affiliated, resident *Bathygobius fuscus* vs. the warm-affiliated, transitory *Abudefduf sordidus*, we hypothesized that the temperature-induced changes in settlement size and PLD will lead to nonlinear thermal responses of larval growths, which varies between species especially at warmer environments. We found that rising temperature elicited unimodal responses of both PLDs and settlement sizes for both species, with greater increases in these traits for the *B. fuscus* at the warmest temperatures. Furthermore, the responses of allometric larval growth rates to temperature varied between these species: a unimodal change for *B. fuscus* but declining growth rates for *A. sordidus*. Compared to the conventional larval growth estimates, our model revealed more pronounced temperature- and species-related changes in larval growth. Consequently, our results demonstrate that the allometric growth model evaluates temperature effects on larval growth rates, which serves a tool for assessing warming effects on recruitment for marine fishes.

Population Genetic Structure and Morphological Studies of the *Selaroides leptolepis* (Carangidae) in the Tropical Western Pacific

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Abstract

The yellowstripe scad, *Selaroides leptolepis,* is an important fish commodity in the Tropical Western Pacific (TWP), particularly in the Southeast Asian region. However, this region's fishing grounds have long been a hotspot of unsustainable fish exploitations, therefore threatening the remaining wild populations. Despite commercial significance, a deep understanding on the biology and genetic diversity of *S. leptolepis* is also limited. Herein, the population structure of *S. leptolepis* in TWP was examined using two mitochondrial DNA genes and classical morphometry. 269 sequences of 604 bp of CO1 and 182 sequences of 527 bp of CytB genes were analyzed. Both markers denoted a significant population structure (p=0.00) with an overall Φ_{st} values of 0.845 for CO1 and 0.924 for CytB. Hierarchical AMOVA further revealed the occurrence of two major subgroups: a Southeast Asian and an Australian population (K2P distance=0.066 for CO1 and 0.062 for CytB). Genetic differentiations across populations within each subgroups were significantly low (p=0.00). Haplotype distribution of Southeast Asian populations appeared to be widespread, indicating a high gene flow throughout the region. High haplotype (h=0.792 for CO1 and 0.702 for CytB) and low nucleotide diversities (π=0.011 for CO1 and 0.011 for CytB) were also detected. On the other hand, there were no significant variations detected from the discriminant analysis of the morphological features. In conclusion, this shows a clear *S. leptolepis* genetic structuring in TWP yet indiscernible through morphometrics alone. This investigation contributes to the limited knowledge of the population structure of the species and will serve as baseline for its future conservation, given its high economic relevance.

Keywords: *Southeast Asia, Yellowstripe scad, CO1, CytB*

Evaluation of the Scorpaenidae diversity in Taiwan through DNA barcoding and morphological data

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The Scorpaenidae are a large family which are famous for camouflaged ability and venomous spines. Species of the Scorpaenidae inhabits widely from inshore to continental shelf. In Taiwan, the first taxonomic review of the Scorpaenidae was published by Chen (1981) who listed 21 genera and 40 species from waters of Penghu Island and Taiwan. Twenty-four genera and 73 species had been gradually recorded in Taiwan by several authors until 2019. However, fishes of the Scorpaenidae were easily misidentified due to high intraspecific variation in morphology. In addition, the taxonomic revisions of the Scorpaenidae were frequently proposed in the past decade. Several species of Taiwanese record were actually unavailable names or misidentifications based on recent taxonomic studies. Hence, a reexamination of the Scorpaenidae in Taiwan is necessary. The present study aims to investigate the diversity of the Scorpaenidae in Taiwan based on morphological and molecular evidences. One hundred and fifty specimens were collected from fish markets in the Penghu Island, Taiwan and loans from museums. A total of 106 COI barcode sequences were obtained, belonging to 23 genera and 55 species. Eight species were newly recorded to the Genbank and BOLD online databases. The mean Kimura-2-Parameter (K2P) genetic distances within species and genera were 6.7% and 17.4%, respectively. In total, the combined morphological and molecular analyses confirmed 72 species of 25 genera in Taiwan. *Sebastes* is a new record genus represented by one species, *S. thompsoni*. The taxonomic statuses of three species were uncertain, including *Parascorpaena* sp., *Phenacoscorpius* sp. and *Scorpaenopsis* sp. Five species were considered misidentifications in previous studies, including *Parascorpaena picta*, *Rhinopias aphanes*, *Scorpaena hatizyoensis*, *Scorpaena izensis*, *Scorpaenodes minor*, and were excluded from the records of the Scorpaenidae in Taiwan.

Phenovariant of moray eels: hybridization, introgression, and morphological differences between sympatric sibling species in the western Pacific

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The phenomenon "phenovariant" stands for a pair of species with distinct phenotypes but little to no genetic divergence, which may be resulted from hybridization or recent split of two species that changes of phenotype have exceeded the genotype. Phenovariant species pairs commonly occur allopatrically in nearby areas with little or no overlap of their distribution ranges. Sympatric phenovariant species pairs are less common and the evolutionary process might be more complex. In the present study, three pairs of sympatric sibling moray eels with phenovariant in *COI* gene inferred from previous studies were collected from the Philippines, Taiwan, and Vietnam and examined molecularly and morphologically, including (1) *Gymnothorax intesi* vs. *G. neglectus*; (2) *G. kidako* vs. *G. pseudokidako*; (3) *G. pseudothyrsoideus* vs. *G. reevesii*. Fragments of two mitochondrial (*COI* and *Cytb*) and two nuclear (*EGR3* and *Rh*) markers were amplified for evaluating hybridizations and genetic diversities of pair species. Morphological variations were assessed using principal components analysis (PCA). *Gymnothorax intesi* and *G. neglectus* were distinguishable based on *Cytb*, *EGR3*, *Rh*, and PCA, where the broader distributed *G, intesi* has higher nucleotide diversity (π), indicating *G. neglectus* might be a recently split species that secondary contacted with *G, intesi* but hybridization has yet been detected. *Gymnothorax kidako* and *G. pseudokidako* were well separated by nuclear markers and PCA; nevertheless, these two species showed non-reciprocal monophyly in mitochondrial markers. Although hybridization was not found between *G. kidako* and *G. pseudokidako*, two specimens from Taiwan were accidentally detected as hybrids of *G. kidako* and *G. prionodon*, a species pair with 7% of interspecific K2P genetic distance of *COI*. Hybridization and introgression were detected in species pair *G. pseudothyrsoideus* and *G. reevesii* according to the strong mito-nuclear discordance. PCA revealed a statistically distinguishable but highly overlapped morphological characters of these two species. Despite a broad overlap of distribution ranges in the western Pacific, *G. pseudothyrsoideus* has a π less than half of *G. reevesii*, implying a recently rapid expansion. The present study revealed a diverse evolutionary history among moray eels in the western Pacific.

Habitat change and reef fish's specialization across the biogeographic transition zone

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Abstract

Anthropogenic activities lead to a rapid biotic homogenization of the marine fish assemblages and a raise of 'generalists' species throughout the oceans. Meanwhile, the tropicalization of high-latitude environments sees the poleward expansion of species with warm-affinities. This apparent paradox may originate in the delineation between generalists and specialists and the relatively poor understanding of the interplay between habitat and fish across the biogeographic transition zone. Here, we aimed at evaluating to which extend the reef fish assemblages specialized to habitats differentiated along a latitudinal gradient. For this purpose, we first examined the relevance of different habitat partitions at 24 locations spanned across tropical and subtropical areas in Taiwan. We then scrutinized the perception of the reef fish fauna to this change in habitat. We further calculated a species specialization index (SSI) and its significance in distinguishing specialists of a given habitat or generalists of all habitats being considered. Eventually, we typified habitat-related fish assemblages for their α- and β-diversity to evaluate the potential impacts of habitat range shifts across the biogeographic transition zone. Our analyses revealed two habitats responding to the latitudinal gradient of Taiwan and differentiating habitat communities dominated by diverse morphologies of corals in the South (tropical) and a community dominated by macroalgae and crustose coralline algae in the North (subtropical). On the 184 fish species identified, 8 and 51 species were diagnosed as sub-tropical and tropical specialists respectively, whereas none of them revelated to be generalists. The tropical fish assemblage had higher species richness and evenness (α-diversity) than subtropics' but their abundance and biomass did not differ across latitudes. β-diversity analysis revealed that the turnover rather than nestedness is the main driver of differentiation of both assemblages. The findings suggested fish faunas are extremely specialized to habitats constrained by latitude. It implies that a tropicalization is more likely to see the raise of tropical specialists than habitat generalists as previously identified. It may be accompanied by an abrupt species loss in subtropical locations with further consequences on local fisheries.

氣候變遷對烏魚洄游和棲地衝擊之評估

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摘　要

　　烏魚為臺灣沿近岸漁業冬季重要的經濟物種之一。其廣泛分佈於42°N-42°S間海域，以西北太平洋為例，每年冬天隨著中國沿岸流往南洄游，至臺灣海峽之20.5~23℃水域。根據漁業署統計，近年來臺灣捕獲烏魚的歷年漁獲量呈現相當大的波動，亦有文獻指出氣候變遷造成洄游路徑改變是造成漁獲量波動的主要原因之一。綜上所述，本研究欲掌握西北太平洋烏魚最適棲地和其影響因子，除先前探討之烏魚棲地變動外，亦蒐集臺灣、日本、韓國三國烏魚漁獲資料(1971-2006年)，分析西北太平洋不同區域烏魚漁獲變動特性和其與氣候因子之相關性。結果顯示，烏魚最適水溫介於20.2-22.5℃，隨時間推移，高棲地指數從中部沿岸水域逐漸往北和東北沿岸移動。此外，透過群集分析法將63個區域分成8個group，亦發現漁獲量與東海之最適溫度水團之分佈有相關，當最適水團往北推移時，臺灣和日本該年漁獲量會較多；反之，當往南推移時，韓國漁獲量則會增加。

臺灣河口三個隱蔽種烏魚苗種類組成之年間差異

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摘　要

西北太平洋之三種隱蔽種烏魚 (*Mugil cephalus*) 共同以臺灣各河口作為哺育場，每年秋天至隔年春天皆可發現大量烏魚苗入添至河口。過去研究發現，三種烏魚苗的出現時間可能受水溫影響，其中西北太平洋洄游種 (Northwestern Pacific species 1, NWP1) 屬溫帶種，產卵月份較其他兩種晚，產卵月份的高峰為 1 月，黑潮種 (NWP2) 和中國南海種 (NWP3) 則偏好較高的水溫，其產卵月份的高峰分別在 11 月和 10 月，故各河口在不同月份間的魚苗種類組成並不相同。然在氣候變遷的影響下，各種類烏魚的產卵時間可能會發生推移，導致入添時間及河口魚苗種類組成可能發生改變，因此本研究利用分子生物學技術，分析了反聖嬰年 2011-2012 年、正常年 2013-2014 年和聖嬰年 2015-2016 年之主要漁季的烏魚苗，樣本分別採樣自宜蘭、淡水、台西和屏東地區之河口，並探討年間及月份間的種類組成差異。整體來說，各年間烏魚苗種類組成以 NWP2 為主要物種，佔總數的 75-90 %，而 NWP1 和 NWP3 則分別佔了整體的 1-8 %以及 2-17 %。反聖嬰年間，淡水河口 12-2 月全為 NWP2 魚苗， 3 月則轉為 NWP1 魚苗，而屏東河口各月份皆為 NWP2 和 NWP3 兩種混合組成。平常年間，NWP2 在各河口及月份間為主要的優勢種 (17-100%)，NWP3 僅少量 (<23%)出現於屏東河口，且隨月份推移比例逐漸降低月份，NWP1 則在三個河口之 2-3 月皆有出現，且在宜蘭河口的比例隨月份自 56%上升至 83%。聖嬰年間，NWP2 亦為主要的優勢種 (43-100%)，NWP3 在北部河口出現的月份為 12 月至隔年 3 月，其比例隨月份自 13%降至 1%，而在屏東河口 1 月份為優勢種，其比例達 56%，NWP1 的出現時間為 1 月至 3 月，比例雖隨月份有些微上升，於淡水河口地區可自 1%升至 4%，然整體的數量相較其他年份明顯減少。本研究結果顯示，氣候變遷引發的海水溫度變化，可能推移各種類烏魚的產卵時間，改變其入添時間及河口魚苗種類組成。

Monthly and spatial variability in maturation status of Pacific saury in the Northwestern Pacific Ocean in main fishing season

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Abstract

Pacific saury, *Cololabis saira*, is one of the most commercially important species in the Northwestern Pacific Ocean. However, the information on spawning fish (distribution, age, and body length) and their maturation status is insufficient in the main fishing season due to the seasonal large-scale migration pattern of Pacific saury. Here, we collected otoliths and gonads from 852 samples of Pacific saury in the high sea fishing ground (40 -50 °N；149 - 166 °E) during the main fishing season (July to November) from 2018 - 2019 to clarify the monthly and spatial variability in maturation status and to determine the relationship between the maturation status and the environmental factors (e.g., sea surface temperature, SST). The age and length composition of Pacific saury exhibited a bimodal distribution, most of the age-0 fish were 26-27 cm (Knob length, KnL), and most of the age-1 fish were 29-30 cm (KnL). Significant monthly and spatial variation in the Gonadosomatic index (GSI) was found. The fish with low GSI value (GSI < 0.5) were mainly found in the Northeastern area (45 -50 °N) during July and August, and the fish with high GSI value (GSI > 1) were found in the Southwestern area (40 - 44 °N) from September to November. Pacific saury in maturing or spawning state were mainly found in the southern region (41°N) from September to November. This study suggests that Pacific saury spawned in the high sea during the main fishing season, where the fish with high GSI value increased in the southern area from September to November. The spatio-temporal changes of the maturation status in relation to environmental variability would be determined by a statistical model.

Seasonal variation of euphausiid species and life stage composition in the upwelling site north-east of Taiwan

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Abstract

Euphausiids play a critical role in marine ecosystems, as they are commercial fishery target and main prey of marine mammals, fishes, and seabirds. Although understanding their community is essential, it is relatively unknown in the East China Sea. The seasonality of euphausiid was found in other oceans, thus we hypothesized that there is seasonal variability in the East China Sea. The main goals of this study are (1) to find the seasonal change of euphausiid community structure, and (2) to examine the relationship of euphausiid community with environmental variables. Euphausiid samples were collected from 21 cruises at a fixed upwelling site between 2010 and 2016, and the environmental data were measured. A total 20 species were identified throughout the study, and two dominant species, *Euphausia nana* and *Pseudeuphausia latifrons*, occupied up to 95% of total euphausiid abundance. In seasonal distinction, *E. nana* was dominant in spring and summer sample (95% and 85% respectively). In autumn samples, besides *E. nana, P. latifrons* also played a significant composition. Furthermore, the result of redundancy analysis (RDA) shows obvious seasonal group that larval stages relate to salinity and chlorophyll concentration in spring; on the other hand, post-larval stages associate to temperature in summer and autumn. In summary, this study demonstrates apparent seasonality of euphausiid stage and species composition off north-east of Taiwan, and relationship between this seasonality and environmental variables.

中南美白對蝦 *Penaeus vannamei* 對聚丙烯微塑膠纖維之攝入與行為影響

Ingestion of polypropylene microplastic fibers by whiteleg shrimp *Penaeus vannamei* and its behavioral effects

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摘　要

　　微塑膠的污染廣泛分布於整個海洋環境，其中二級來源的纖維型態佔多數，主要來自紡織品與線繩的分解，而 PP(聚丙烯)為調查中發現最常見的材質之一。微塑膠對生態危害的研究逐漸興起，過去研究多數以球型微塑膠與魚類作為實驗材料，常見的微塑膠纖維與有更高暴露風險的底棲甲殼類相關研究卻仍是少數。本研究以 PP 微纖維作為實驗材料，利用尼羅紅螢光染色標記，透過食物暴露探討中南美白對蝦(白蝦)與微塑膠纖維之間的交互影響。結果顯示，單次攝入並連續監測排遺中纖維量顯示白蝦能在 12 小時內排出超過 98%纖維，75%個體在 30 小時內排出所有纖維。比較體內各消化階段與攝入前纖維尺寸無顯著差異，亦無發現纖維有明顯變形、糾結甚至牙齒造成的刻痕，顯示白蝦的攝入與消化不會對纖維大小、型態造成影響。透過食物暴露於不同濃度纖維(0、50、500、5000 pcs/g) 14 天後進行行為分析，觀察游動距離、游動時間、最大泳速三種行為參數皆無顯著影響；經過 24 小時排空後分析鰓、肌肉、前腸、中後腸纖維累積量，僅在最高暴露濃度 5000 pcs/g 組的中後腸、口與鰓有觀察到微量的殘留。這些結果顯示白蝦的攝入不會影響纖維型態，但可能將其包覆於排遺中改變微塑膠宿命；長時間暴露不會造成行為影響，在消化道內沒有滯留或隨時間累積情形，但是否有其他潛在風險仍需後續進一步研究。

The long and short temporal variation of prokaryotic community structure in the South China Sea

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Abstract

Marine ecosystem functions are mediated by prokaryotes. To realize how ecosystem functions vary, it's essential to investigate the drivers of prokaryotic community structure. Many studies have indicated that the temporal variation of community is attributable to environmental effects; however, the comparison among distinct temporal scales is relatively scarce. In this study, we attempted to clarify (i.) whether the drivers of community structure are different between long temporal scales (in three years) and short temporal scales (three-hourly), and (ii.) what taxonomic groups are influenced by environmental factors (e.g., temperature, salinity, nutrients, and light intensity).

To achieve the goals, we utilized 138 prokaryotic communities from the surface and deep chlorophyll a maximum (DCM) layers of the South China Sea (SCS) in three years. The samples were collected three-hourly to investigate the short temporal variation. After sequencing, we employed non-metric multidimensional scaling (nMDS) to display the dissimilarity among communities, and environmental factors were regressed against the scores from nMDS biplot.

The results revealed that the communities were mainly separated by depth, driven by environmental gradients. In long temporal scales, the surface-layer communities were shaped by temperature and light intensity, while salinity was the major driver of the DCM-layer communities. In detail, the abundance of proteobacteria and marinimicrobia were influenced by temperature and salinity. Besides, in short temporal scales, the dissimilarity among communities wasn't correlated with environmental factors. Instead, we speculated that interaction occurred between bacteroidota and proteobacteria. Our findings suggested that prokaryotic community compositions in different temporal scales would be driven by different effects. We therefore argued that the reaction time of prokaryotic community to environmental and biotic effects could be various.

Assessing the variation of Primary Production Required and Marine Environments in Upwelling Ecosystem of Taiwan Bank in Summertime

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Abstract

The Taiwan Bank (TB) is located in the southern Taiwan Strait, where the marine environments are affected by South China Sea Warm Current and Kuroshio Branch Current in summer. The bottom water flows upward along the edge of the continental shelf, forming an upwelling region that is an essential high-productivity fishing ground. Using trophic dynamic theory, fishery resources can be converted into primary production required (PPR) by primary production, which indicates the environmental tolerance of marine ecosystems. This study calculated the PPR of benthic and pelagic species, sea surface temperature (SST), upwelling size, and net primary production (NPP) to analyze fishery resource structure and the spatial distribution of PPR in upwelling, non-upwelling, and thermal front (frontal) areas of the TB in summer. Pelagic species, predominated by those in the Scombridae, Carangidae families and *Trachurus japonicus*, accounted for 77% of PPR (67% of the total catch). The benthic species were dominated by *Mene maculata* and members of the Loliginidae family. The upwelling intensity was the strongest in June and weakest in August. Generalized additive models revealed that the benthic species PPR in frontal habitats had the highest deviance explained (28.5%). Moreover, frontal habitats were influenced by NPP, which was also the main factor affecting the PPR of benthic species in all three habitats. Pelagic species were affected by high NPP, as well as low SST and negative values of the multivariate El Niño–Southern Oscillation (ENSO) index in upwelling habitats (16.9%) and non-upwelling habitats (11.5%). The composition of pelagic species varied by habitat; this variation can be ascribed to impacts from the ENSO. No significant differences were noted in benthic species composition. Overall, pelagic species resources are susceptible to climate change, whereas benthic species are mostly insensitive to climatic factors and are more affected by NPP.

Keywords: Taiwan Bank; primary production; primary production required; upwelling; climate change

Zooplankton fluctuations in the surface waters of the estuary of a large subtropical urban river

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The Danshuei River has the third largest catchment area and third-longest in Taiwan. It flows through the capital, Taipei, and more than 6 million people live within its catchment area. Its estuary is characterized by a highly variable chemical and physical environment that is affected by the interaction of inland freshwater runoff with wastewater, and towards the coast is also influenced by the China Coastal Current and the Kuroshio Current. By collecting zooplankton bimonthly in 2014 from the surface layer (0–2 m depth) at five sites in the estuary, we were able to demonstrate that the composition of the zooplankton, and particularly its copepod fraction, varied significantly among sampling stations and months, thereby revealing seasonal succession. Fourteen higher taxa or other categories of zooplankter were identified, with the following being most common taxa: Decapoda, Copepoda (including Calanoida, Cyclopoida, and Harpacticoida), and "other larvae". The Copepoda comprised 44 taxa (including 8 only identified to genus) belonging to 3 orders, 17 families, and 29 genera, the 5 most abundant of which were *Bestiolina* n. sp. (undescribed), *Corycaeus* spp., *Parvocalanus crassirostris*, *Acartia* sp., and *Paracalanus parvus*. Observed changes in abundance of many kinds of copepod appeared to be significantly related to changes in physico-chemical parameters (e.g., salinity, temperature, pH, and dissolved oxygen concentration). Cluster analysis confirmed the existence of distinct copepod communities, each characterized by a preference for a different set of environmental conditions. They represent 58.2% of the total number of brackish- and freshwater copepod species in Taiwan, and 5 of them have so far only been recorded in the Danshuei River: the calanoids *Acartiella sinensis* and *Pseudodiaptomus forbesi*, the cyclopoids *Oithona fragilis* and *Oithona simplex*, and the harpacticoid *Tachidius discipes*.

Temporal change of the beta diversity of phytoplankton metacommunity in Feitsui Reservoir

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Abstract

Beta diversity is one of the main topics in ecology for the last twenty years, and there are already many studies focusing on the spatial structure of metacommunity, including the analysis of beta diversity patterns and their drivers. However, almost none of the research have examined how spatial beta diversity varies along time. The aim of this study is to give insight into the temporal variation of beta diversity structures of phytoplankton and its drivers in Feitsui Reservoir in 17 years. We hypothesized that the spatial pairwise beta diversity and environmental difference between sites have the similar monthly fluctuation. All of the pairwise total beta diversities were separated into nestedness and turnover compartments following the Sørensen-based Baselga's approach. Then, variation partitioning of the environmental difference and geographic distance showed their respective contribution to beta diversity; this procedure was repeated for every month. Finally, total environmental difference between sites was used to regress against beta diversity. The total beta diversity and its components exhibited clear monthly variation but no clear temporal trend among years, and the high beta diversity was observed from March to May. The result of variation partitioning indicates that both total beta diversity and species turnover can be explained by environmental difference and geographic distance, but the environmental difference was relatively important. The hypothesis that the monthly fluctuation of beta diversity was consistent with the environmental difference between sites was generally supported. In general, beta diversity exhibited seasonal variation and was mainly influenced by the environmental difference between sites, and this pattern was persistent inter-annually.

地球同步衛星逐時影像推導之徑線與流線產品與服務
Pathlines and streamlines services derived from hourly imagery acquired by Geostationary Ocean Color Imager

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摘　要

　　南韓的千里眼衛星一號所搭載之地球同步海洋水色成像儀(Geostationary Ocean Color Imager; GOCI)，自2011年起持續無償地提供全世界海洋環境監測與研究等需求。國際上已經有許多應用GOCI逐時影像追蹤海水表面流場之研究發表，但幾乎都只能使用晴朗無雲的影像，空間上的精度也只能達到像元等級，也就是13.89 cm/s。此外，考慮大氣效應對於光學衛星影像的影響，相關研究也都使用GOCI影像第二級的產品來進行匹配。

　　Liu (2021)使用適用於海水範圍的光學衛星影像最佳的經驗值$\alpha = 10.78$，開發了一個可以由GOCI第二級標準產品490nm波段的漫衰減係數K_d490，反算海水表面流場徑線 (pathline) 與流線 (streamline) 的模組，其空間解析度之均方根誤差約為1/4個像元 (RMSE=0.2435)。此模組已整合至「臺灣海域衛星影像供應平臺/ Taiwan Ocean Satellite Imagery Supply Platform (TOSISP) 」，提供GOCI衛星逐時影像推導徑線與流線產品與服務。使用者可於網頁介面上設定時空區間條件，快速檢視所有GOCI衛星影像，並挑選雲覆情況合適之影像，接著在平台上標定徑線起點位置，就可以使用此模組計算徑線與流線，並套疊於影像後，在平台上同步展示，提供大範圍海面流場之定性與定量資訊。

關鍵字：地球同步衛星、逐時影像、徑線、流線、GOCI 衛星、K_d490、TOSISP。

北太平洋的葉綠素濃度與氣膠間的相關性探討

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摘要

沙塵暴除了對人體、生態及環境造成嚴重的影響，也會對海洋中基礎生產者造成影響，因為沙塵暴中的鐵元素為進行光合作用的限制因子之一。然而目前全球所關注的氣膠(Aerosol)，沙塵也包含其中。因此本研究使用西元 2000 年至西元 2018 年的海面葉綠素甲濃度(Chlorophyll a, Chlor_a)、氣膠光學厚度(Aerosol Optical Depth, AOD)，再配合海表風場，探討氣膠與水色資料於北太平洋之相關性。研究結果顯示高 AOD 值覆蓋區增廣時間與沙塵好發時間相同；AOD 與 Chlor 的相關性統計結果顯示，季節性變化十分明顯。在中高緯度(30°N~60°N)，春季 R^2 大於 0.5 的範圍最廣，受西風影響，分佈於 120°E~140°W 之間，夏季高相關海域向北偏移，秋季消失，冬季中緯度 120°E~180°E 海域重新出現高相關數值。其中最高峰值出現在春季。

衛星觀測綠島尾渦的空間結構與時間變動

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摘　要

　　洋流引起的島嶼尾流動力一直是全球海洋學中重要問題之一。本研究以台灣東南部黑潮路徑上的綠島為研究區域，以了解黑潮與綠島作用形成的島嶼尾渦漩空間結構和時間變動。衛星影像使用向日葵 8 號(Himawari-8)衛星和全球變化觀測任務(Global Change Observation Mission – Climate "Shikisai", GCOM-C)的第二代全球成像儀(Second generation Global Imager, SGLI)，空間分辨率為 250 公尺的海面溫度和葉綠素甲濃度衛星影像數據，並應用麻省理工學院的環流模式(MITgcm)模擬驗證。研究中在島嶼後方設計水平觀測線，觀測冷水區渦流的轉變。從衛星影像及數值模擬，可觀測到正渦漩和逆渦漩在數小時內依次分離。根據每小時一筆的 Himawari-8 影像，計算 2015 年 7 月至 2019 年 12 月的 101 個渦漩，平均渦漩傳播速度為 0.95 m/s。從其中 38 例有連續兩次渦漩的計算，平均渦漩脫落時間為 14.8 小時，平均入射綠島的表面流速為 1.15 m/s，此結果符合 Strouhal-Reynolds 數的擬合曲線關係。結合衛星觀測和數值模擬，本研究結果顯示綠島尾流區域的結構會迅速變化，而每個觀測的水體會以不同的渦度狀態混合。

北南海非線性內波於東沙島淺化之現象

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摘　要

　　南海非線性內波(NIW, Nonlinear Internal Waves)源於呂宋海峽並向西傳播，最後破碎消散於東沙環礁附近的大陸棚(Alford et al., 2015)。Ramp et al. (2010)於2005.04-2006.06進行的實驗中，推測出了NIW的傳播速率，並發現會受水深、波動振幅及海水分層條件影響。本研究探討NIW在東沙環礁外淺化的現象，分析錨碇於東沙環礁外東北角水深約20公尺的底碇式都普勒流剖儀(ADCP)之觀測資料，觀測時間為2006年8月到2007年9月，發現流速與水溫變動強烈受到NIW的影響，日溫差變動大，夏季甚至達6~8℃，根據Ramp et al. (2010)，南海NIW有兩種主要型態　A-wave　與　B-wave，本研究發現造成東沙環礁溫度與流場變動的NIW僅有B-wave。

Impact of the Atlantic climate variability on the ocean circulation in the North Pacific

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Abstract

Interbasin interactions have been increasingly emphasized in recent years due to their roles in shaping climate trends and the global warming hiatus in the northern hemisphere. The profound influence from the North Atlantic on the Tropical Pacific has been a primary focus. In this study, we conducted observational analyses and numerical modeling experiments to show that the North Atlantic has also strongly influenced the Extratropical North Pacific. A rapid and synchronous change in the atmospheric and oceanic circulations was observed in the North Pacific during the late 1990s. The change was driven by the transbasin influence from the Atlantic Ocean. During the positive phase of the Atlantic Multidecadal Oscillation (AMO) since the 1990s, the anomalously warm North Atlantic triggers a series of zonally symmetric and asymmetric transbasin teleconnections involving the Inter-tropical Convergence Zone (ITCZ), Walker and Hadley circulations, and Rossby wave propagation that lead to a decrease in wind stress curls over the Pacific subtropics, resulting in an abrupt weakening in the North Pacific subtropical gyre (NPSG) and the Kuroshio Current.

臺灣海域衛星遙測開放資料建置處理與加值服務
Taiwan ocean satellite remote sensing open data processing and value-added service

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摘　要

　　世界的科技與觀念都同時在快速進步。拜資料開放(open data)政策之賜，國際上已有許多先進的地球觀測衛星支持資料開放政策，例如：南韓的千里眼衛星一號(Communication, Ocean and Meteorological Satellite-1; COMS-1)所搭載之地球同步海洋水色成像儀(Geostationary Ocean Color Imager; GOCI)或歐洲太空總署(European Space Agency; ESA)，所提供的哨兵系列衛星(Sentinel-1、Sentienl-2與Sentinel-3)資料等，都已穩定上線且持續無償地提供全世界海洋環境監測與研究等需求。同時，許多政府機關部門也積極在建置臺灣本島的衛星遙測影像，部分也包含了周遭海域，同樣具備長時間大範圍觀測的優勢，可以顯著提升海洋環境的觀測資料。行政院海洋委員會國家海洋研究院提出「臺灣海域衛星遙測開放資料建置處理與加值服務計畫」，主要目標為蒐集、建置與處理臺灣周遭海域衛星遙測開放資料，並提供各種加值服務產品作為海域環境監測與評估等相關事務所需之關鍵資訊，包含：水質、海溫、海高、海風、船隻偵測與海流等。再建置一個可以有效彙整、展示、倉儲、管理與分析巨量遙測影像與空間資訊的模組：「臺灣海域衛星影像供應平臺/ Taiwan Ocean Satellite Imagery Supply Platform (TOSISP)」。透過盤點國內外海洋衛星相關技術發展現況、研究能量與資源，以期能發展整合一套具前瞻性的海洋觀測/監測之遙測資訊整合系統，供海洋科研及事務發展規劃之用，並為海洋廢棄漂流物防治、海域安全監控管理、及海岸線防護等問題提供解決方案。
關鍵字：臺灣海域、衛星、開放資料、資料展示、資料加值。

利用沿岸聲層析術之自主海洋測繪

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摘　要

　　本計畫「邁向利用沿岸聲層析術的自主海洋測繪」研發一套自主聲層析海洋測繪系統，以水面無人載具酬載沿岸聲層析儀器的聲學遙測方法，依觀測海域之時空變異性，自主地調整群隊位置收集聲線聯網資料，獲得海洋內部溫度與流速場的綜觀影像。為建構此一兼具理論與技術創新的海洋觀測系統，本研究結合了移動載具聲層析學（Moving Vehicle Tomography; MVT）、機器人自動控制、海洋物理數值模式等跨領域的研究能量與自行研發儀器能力。在觀測系統硬體設備上，完成三艘無人水面載具之建置並引進之三組鏡射式沿岸聲層析儀，整合成具高精度定位及流速測繪功能之水面載具系統。在區域海洋模式上，完成基隆望海巷海灣之模式初始條件與邊界條件之蒐集，在平行運算環境中完成海洋模式模擬，並與潮汐資料進行驗證。在反算理論上，以開放邊界模態分析法所獲得的空間模態集合來表示海流空間分佈；以海洋模式仿真模擬驗證其反算效能，並應用於實測資料改善海流重建結果。在載具群隊控制上，發展了可同時控制多載具編隊與移動軌跡追蹤的回饋控制器，使得無人載具可依循規劃之軌跡收集聲層析數據。本研究根據聲層析遙測數據，即時規劃無人載具群隊隊形，以提升觀測解析度，獲得精確與即時的近岸海域聲速場及流場。除增進開發系統之原型應用外，其原理與建置亦可延伸到淺海或深海，達成以聲層析方法進行自主海洋測繪的目標。

航向藍海: 新海研1號首航之台灣周邊海域探測

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摘　要

本航次(NOR1-0002)分三段 (A, B & C)進行。團隊成員包括來自台灣大學、海洋大學、中山大學、澎湖科技大學及嘉義大學的研究人員及學生共19名。第一段於2021年1月11日下午1:00點由高雄港出發沿台灣西海岸往北航行及作業，於1月13日下年6點抵基隆港。第二段於1月15日下午12:15由基隆港出發，沿台灣東海岸往南航行至宜蘭及花蓮外海作業，隨後因天候因素於1月16日下午6:30進花蓮港避風。第三段於1月18日早上7:00由花蓮港出發，持續在花蓮外海作業並於次日出發前往菲律賓海作業，途經加瓜海脊(1月18日下午5:00)及未命名海山(PS1, 1月21日下午9:00) ，最後於1月22日下午3:30抵達本航次最東之測站 Vinogradov 海山。作業完成後先前往其西南方向之鄰近Yakal 海山作業，完成後往台灣方向返航，於1月25日早上3:00抵達台灣西南海域作業，最後因新海一右陣故障，於當天晚返回高雄港。本航次完成航程沿途共20個測站(CTD/plankton/larva fish nets: 12; 底拖網:8)之生物/非生物(垃圾)、水文/地質資料之收集與調查，最大作業深度為4940米 (PS1 測站)，總航程為1581海哩。本航次科學目標為進行跨食階生物多樣性(Multiple trophic-level biodiversity)跨經緯度調查，以了解以下問題及生態機制：1) 海洋物理、化學過程如何影響各食階生物多樣性(包括：微生物，浮游植物，浮游動物，魚類等)；2) 食階間生物多樣性之交互作用；3) 食階生物多樣性如何影響海洋食物網、生態系統功能、以至於生物地球化學循環。在海底山生態系統的研究上，我們希望透過多種採樣技術(目前為底拖網及E-DNA)且具系統化的生態調查及分析，以驗證海底山生態學、生物地理學及演化生物學上的假說。

Case study of using spatiotemporal age structure information of bigeye tuna to detect effects of climate change on marine ecosystem in the Pacific Ocean

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Abstract

How top predators behave and are distributed depend on the conditions in their marine ecosystem through bottom-up forcing; this is because where and when these predators can feed and spawn are limited and change often. This study investigated how the catch rates of immature and mature cohorts of bigeye tuna (BET) varied across space and time; this was achieved by analyzing data on the Taiwanese longline fishery in the western and central Pacific Ocean. We also conducted a case study on the time series patterns of BET cohorts to explore the processes that underlie the bottom-up control of the pelagic ecosystem that are influenced by decadal climate events. Wavelet analysis results revealed crucial synchronous shifts in the connection between the pelagic ecosystem at low trophic levels in relation to the immature BET cohort. Many variables exhibited decreasing trends after 2004–2005, and we followed the Pacific Decadal Oscillation as a bottom-up control regulator. The results indicated that low recruitment into the mature cohort occurs 3 years after a decrease in the immature cohort's food stocks, as indicated by a 3-year lag in our results. This finding demonstrated that, by exploring the connection between low-trophic-level species and top predators at various life stages, we can better understand how climate change affects the distribution and abundance of predator fish.

KEYWORDS: Bottom-up forcing, Climate change, Bigeye tuna, Pacific Decadal Oscillation, Spatiotemporal age structure, Marine ecosystem

Evaluating the spatiotemporal dynamics of Pacific saury in the Northwestern Pacific Ocean by using a geostatistical modelling approach

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Abstract

Pacific saury (*Cololabis saira*) is an important fisheries resource and an ecologically important fish in the Northwestern Pacific Ocean. Some evidence indicates that its distribution is affected by the environmental variability, but the relative importance of environmental effects versus those of other unmodelled spatiotemporal processes has not been investigated. For this reason, fisheries data from members of the North Pacific Fisheries Commission, were analyzed using a geostatistical modelling approach to examine interannual variation in the spatiotemporal distribution of Pacific saury in the Northwestern Pacific Ocean during the fishing season (May-December) from 2001-2017. The objectives were to investigate the extent to which this can be attributed to changes in the local (e.g., sea surface temperatures), regional environmental variables (e.g., Southern Oscillation Index), and the unmodelled spatiotemporal variables (e.g., species interaction). We found that the centroid of gravity of Pacific saury had an apparent eastward shifting after 2013, and a further shift with a lower relative abundance in 2017. We also found that neither a single local or regional environmental variable nor any combination of them could explain the distributional shift of Pacific saury. Instead, the change in spatial distribution is mostly attributed to the "unmodelled" spatiotemporal variables. We emphasize that developing a quantitative understanding of the underlying mechanisms is a critical area for future work. In the future, environmental data is expected to become increasingly available. However, we caution that before projecting the Pacific saury distribution resulting from climate change or other environmental phenomena, analysts should first determine whether the hypothesized driving variables account for a meaningful proportion of variability in the historical distribution data.

Reference:

Hsu, J., Chang, Y.J.*, Kitakado, T., Kai, M., Li, B., Hashimoto, M., Hsieh, C.H., Kulik, V., Park, K.J. (2021) Evaluating the spatiotemporal dynamics of Pacific saury in the Northwestern Pacific Ocean by using a geostatistical modelling approach. *Fisheries Research*, **235**, 105821.

Habitat overlap between intra-population size groups of fish decreases over 50 years in the North Sea

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Abstract

Sustained fishing and climatic change have altered the spatial dynamics of marine fishes over the past decades, threatening the stability of these populations. Understanding the temporal changes in intra-population spatial dynamics is essential to explain and predict population-level spatial patterns. In this study, we explored temporal changes in habitat overlap among intra-population size groups for Atlantic cod, haddock, and whiting in the North Sea between 1965 and 2015. When dividing each population into eight size classes, we found that the mean pairwise habitat overlap between size groups decreased over 50 years. Such reduction is due to 1) an overall temporal decline in proportional occupied area for individual size groups, which is associated with temporal expansion in population home range and the shrinkage of occupied area for large size groups over time; and 2) a temporal increase in the distance between centroids of occupied area for individual size groups, which is related to size-dependent distribution shift over time. We discussed how these ontogenetic temporal-spatial dynamics are linked to overfishing and climatic change, and their implications to population stability.

Keywords: size-dependent distribution, habitat shift, ontogeny, age structure, overfishing, temperature change.

夏季台灣淺灘湧升水域之魚類組成及食階研究

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摘　要

　　台灣淺灘水域，位於台灣海峽的南端，因海底地形極為複雜，加上有黑潮支流、南海水或大陸沿岸水等在該處交匯，形成包括湧昇與水溫鋒面兼具之獨特複雜的海洋環境，更成為我國傳統重要漁場之一。為了解台灣淺灘水域之整體生態動態特性，本研究利用商業性拖網漁船及燈火漁業漁船，於2018-2019年之夏季間，於台灣淺灘之湧昇水域進行生物樣本採集，嘗試透過生物種類組成及其攝食種類、營養位階等結果，建構出 Ecopath with Ecosim 模式所需之部分基礎資料。初步結果顯示，其包含魚類16科21種、蝦類6科14種、蟹類3科8種、螺貝類2科2種，其他尚有頭足類、多毛類、海綿類、海星及海膽等生物；初步檢視之14種魚類樣本之胃內容物組成，共計有22種餌料生物，其主要餌料種類多為長尾類、橈足類、糠蝦類及毛顎類等，部分體型較大之魚種(如紅甘鰺、白帶魚、藍圓鰺、日本竹筴魚及小鱗脂眼鯡等)，則有攝食其他小型魚類、甚至有同類相食之結果。透過各魚種之食性、營養位階等資料，本研究初步將台灣淺灘之湧昇水域，依照種類鑑定出之各物種科別、生態習性、棲息水層及部分攝食結果等，共劃分出34個功能群。

高屏海域中深水層魚仔稚魚之成長、死亡及對浮游動物的攝食需求：以七星底燈魚及智利串光魚為例

謝泓諺 邱韋倫 廖阡君
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摘要

中深水層魚類為世界上最豐富的魚類，佔了深海水域 10%的初階生產力，由於中深水層魚類會有垂直遷移的習性，因此他們會和小型中上層魚類相互競爭，所以瞭解其在海洋生態系中成長與死亡的情形有其必要性。本研究利用魚類的耳石作為工具，分析高屏海域兩種數量優勢中深水層魚類七星底燈魚($Benthosema$ $pterotum$)及智利串光魚($Vinciguerria$ $nimbaria$)仔稚魚的生長、死亡及攝食需求，並透過生長與死亡的數據對仔稚魚的族群補充量進行評估。結果顯示，七星底燈魚及智利串光魚的體重特異性生長係數(G_w)分別為 0.0587 d^{-1} 及 0.1278 d^{-1}，瞬時日死亡率(M)分別為 0.037 d^{-1} 及 0.119 d^{-1}，G_w/M 比值說明了兩個魚種的族群補充量都相當足夠，都是穩定生長的物種。另外，兩個魚種仔稚魚的攝食需求分別為 0.013 ± 0.017 mg C $m^{-2}d^{-1}$ (七星底燈魚)及 0.105 ± 0.140 mg C $m^{-2}d^{-1}$ (智利串光魚)，我們推測此差異可能是由於兩個魚種的進食能力的不同，但也有可能是智利串光魚為了在早期快速生長，所以其攝食需求高過於七星底燈魚。

以魚卵生產模式推估宜蘭灣海域花腹鯖產卵親魚量

陳瑞谷

行政院農業委員會水產試驗所海洋漁業組

摘要

鯖鰺漁業是臺灣重要沿近海漁業之一，自 2012 年以來都佔總漁獲量一半以上，因過漁徵候出現已導入管理措施，生殖生物學研究顯示，花腹鯖每年約在 1 - 5 月至宜蘭灣等臺灣東北部海域產卵，惟未實際進行海上產卵生態調查。本研究是臺灣首次嘗試運用日魚卵生產模式 (Daily Egg Production Method, DEPM) 進行宜蘭灣產卵場海域花腹鯖產卵親魚重量推估，期望能永續利用此漁業資源。親魚生殖學參數計算自 845 尾花腹鯖樣本，批次成熟雌魚平均全魚濕重 528.0g，批次雌魚平均佔重比 0.472，平均個體孕卵數 43,733 eggs/fish，當日產卵比例為 0.267。宜蘭灣海域 18 個測站中有 11 個樣站採得花腹鯖魚卵，確認宜蘭灣為花腹鯖產卵場之一，以東澳灣口與龜山島東方海域是主要熱點，產卵面積為 1.55×10^8 m^2。從魚卵發育程度回推可能產卵高峰約在 20:00-21:00 間，利用指數衰減模式推估此時單位面積產卵數約為 38.3 或 52.7 eggs/m^2。將上述參數帶入 DEPM 模式後計算，推估宜蘭灣產卵群四月殘存量約為 6,262 - 22,992 噸之間。未來研究應擴大產卵場調查海域與精進產卵比例估算方法，並設法觀察產卵時間與取得水溫-魚卵發生曲線，期望減少 DEPM 各參數誤差以增加推估資源量可用度。

Vertical distribution of fish environmental DNA in the South China Sea

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Abstract

Environmental DNA (eDNA) has been broadly applied to studies on microbiota, species compositions of food contents, detections of particular species and fauna/flora of a given habitat, including substances such as soil, freshwater and saltwater. Despite of extensive applications, fish eDNA in the deep seas has never been studied. The present study is aimed to evaluate the species compositions using eDNA along different depths of a sampling site in the South China Sea. There will be two scenarios, one with homogeneous eDNA and the other with diverged eDNA compositions at each ocean layer. Water samples of SEATS were collected to the depth of 3700 m. In this study, we totally got 53 eDNA samples from SEATS, of which 31 samples were sequenced successfully, and a total of 64 species of 33 families were detected. Among the detected species, the Pomacentridae are the most dominant, and Gempylus serpens and Sardinella lemuru were broadly detected in various depths. The cluster analysis showed that all the samples were divided into two lineages; however, most of the groupings were not significant. Samples from the same or adjacent depths were not clustered, implying vertical mixture of eDNA in SEATS. In addition, samples of each sampling trip were not clustered either. According to the results, eDNA distribution in SEATS is homogeneous, probably due to vertical migration, sinking detritus of fish body and mixing of water column.

中華白海豚食餌魚類在臺灣西南海域的空間分布特徵——以研究船桁桿式底拖調查資料分析

Spatial distribution patterns of prey fish by the Chinese white dolphin (*Sousa chinensis*) off southwestern Taiwan revealed by scientific beam trawl surveys

陳國書、陳煦森、陳志遠、賴建成、徐軒耀、陳孟仙

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Abstract

To understand the spatial distribution patterns of the Chinese white dolphin (CWD, *Sousa chinensis*) prey fish off southwestern Taiwan, we analyzed the beam trawl survey data collected during the scientific expeditions of RV *Ocean Researcher III* in years 2001–2019.The beam trawl data demonstrated 24 families of CWD prey fish. Additionally, we grouped our sampling sites into three CWD foraging habitat types, that is, Preferred ("P", 37 hauls), Temporarily Preferred ("TP", 42 hauls), and Non-preferred ("NP", 193 hauls) based on the CWD distribution range reported in literature. Using multivariate ordination approaches, we demonstrated that prey taxa of Sciaenidae, Cynoglossidae, Ariidae, and Polynemidae discriminated the CWD-preferred foraging habitat (P) from the other two habitats (i.e., TP & NP). In addition, prey taxa of Paralichthyidae and Synodontidae distinguished the TP habitat from P and NP habitats. Our results demonstrate the spatial variability of CWD prey taxa off southwestern Taiwan and have implications for ecosystem-based conservation of the CWD.

Keywords: Croaker; Food resource; Foraging; Prey taxa; Indo-Pacific humpback dolphin

Seasonally sexual dimophoism and physiologicl features of the hydrothermal vent crab *Xenograpsus testidunatus* near the Kuishan Island

龜山島海底熱泉對於烏龜怪方蟹季節性與生理特徵之研究

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Kueishan Island (121º75'E, 24º50'N) off the northeastern coast of Taiwan houses a series of shallow hydrothermal vents. The hydrothermal vent crab, *Xenograpsus testudinatus*, is an endemic metazoan in an acidic and sulfur-rich environment. In this study, *X. testudinatus* were seasonally collected via field-sampling (pH: 6.4~7.7; [H_2S]: 0~3840 μM) from their native habitats during Feb., May, Aug., Nov. in 2020. Seasonal gender- and ovigerous-ratio implied that the mature female individuals would migrate to the moderate circumstance to release their offspring. This distribution significance may prevent larvae to be exposed to the high toxic plumes. Moreover, expressions of neuropeptides and metabolites that involve in physiological regulations were estimated. UMAP statistical analysis showed these physiological features among sampling seasons were significantly different. The results indicated that the ambient physiolchemical compositions would correlate with the adaptive physiological responses of *X. testudinatus*. In conclusion, our seasonal estimations toward the biogeographic realm and physiological features provide a better understanding of this dominant metazoan in the hydrothermal vent system.

Key words：Kueishan Island, hydrothermal vent crab, acidic, sulfur-rich, sexual dimorphism, seasonal distribution, neuropeptides, metabolites

The Biodiversity of New Year's Fish Dishes in Taiwan in the Context of Anthropocene

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Abstract

In Taiwan, the Chinese Lunar New Year's Eve's "reunion dinner" features diverse seafood. This feature is also reinforced by the New Year's lucky slang "Nién Nién Yô Yú" (年年有魚), with the last word "Yú" meaning fish as a pun for sufficiency. Looking back on the New Year's fish dishes through the years, the top-ranking options have been changing with years, showing markedly low fidelity of the consumers' preference as well as the increasing availability to different fish species. However, behind the diverse fish dishes are ecological and industrial problems, and climate issues.

The paper aims to showcase the change in the fish species diversity in Taiwan's New Year's Eve's reunion dinner postwar, by means of statistical analysis on news reports concerning New Year's fish dishes from 1965 to 2020, and conducting interviews. The result reveals the difference in species richness and composition between two time periods, 1965 to 1994 and 1995 to 2020. Imported fish and cultured fish have also increase in the more recent time period. Such information together with the current fishery studies and data could provoke more discussions on the factors affecting our New Year's culinary culture and shed a light on the challenges of food systems in the future. Furthermore, the paper would also introduce the fish diversity in other ethnic groups' festival cuisine in Taiwan, hoping to provide a more sustainable model of fish consumption for the New Year culture.

評估空間劃分對單位努力漁獲量標準化之影響：以西北太平洋秋刀魚漁業為例

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　　單位漁獲努力量（catch-per-unit-effort，CPUE）可視為資源豐度的指標之一。然而，CPUE 易受到作業時間及努力量或魚群密度的空間分布差異而導致漁獲能力係數（catchability）變化而造成偏差，因此需要進行標準化，得以作為資源評估中相對資源豐度的指標。而在傳統的標準化分析中（如泛線性模式），空間效應是將作業海域劃分成數個區域後並以類別解釋變數方式考慮進模式中。然而魚群的空間分布除了受到環境因子的影響外，亦可能受到其他生物間的交互作用所影響（例如競爭及掠食），因此在空間或時空變動上存在相關性，即空間自相關（spatial autocorrelation）或時空自相關（spatio-temporal autocorrelation），該現象會隨著空間上距離增加而遞減，或同時隨著空間距離與時間的增加而遞減。本研究使用泛線性混合模式（Generalized linear mixed model，GLMM）考慮年、區域、漁船、水溫及年與區域交感效應，標準化秋刀魚棒受網 1997 – 2019 年的 CPUE 資料。並應用五種區域劃分法：目視法（ad hoc approach）、二元遞迴分法（binary recursive partition approach）、空間集群分析（spatial clustering approach）並考慮兩種距離權重（$w = 0.1$ and 1）及地理統計方法（geostatistical approach）於模式中。結果顯示五種方法皆消除 CPUE 資料之變異，而根據模式套適結果（goodness-of-fit）及交叉驗證（cross validation）皆顯示地理統計方法可帶來較高的解釋力，而目視法則為最差。本研究另探討各效應在標準化 CPUE 資料時的相對影響力，結果顯示早期年與區域的交感效應的相對影響力較大，而近期影響力則以漁船效應為主。

Factors Affecting Three Commercial Swimming Crabs Catches in the Taiwan Strait: Environmental and Soak Time

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Abstract

Trap are one of the commercial fishing gears targeting swimming crab in Taiwan's coastal waters. However, the management strategy for swimming crab still lacks crucial information in Taiwan Strait (TS). The purpose of this study was to understand the affect of environmental and soak time factor on the catches of three commercial swimming crab in the TS. We collected the logbooks and voyage data recorder data from Taiwanese crab vessels (2011–2016), and developed a species distribution model for swimming crab species based on the generalized additive models (GAMs) to determine interaction between spatiotemporal and environmental factors. Three commercial swimming crabs of *Charybdis feriatus*, *Portunus pelagicus* and *Portunus sanguinolentus* showing the highest percentage of catches during the study periods. The results showed that a maximum 48-hour soaking time is required to reach the high catch rates of three swimming crab species in TS. The chlorophyll-*a* concentration was related to the high catch rates of *C. feriatus* and *P. sanguinolentus*, whereas bottom temperature was related to high catch rates of *P. pelagicus*. The model predicted high catch rates of *C. feriatus* in the north of the TS during autumn and winter, whereas *P. pelagicus* was observed to the south during summer and autumn. *P. sanguinolentus* was predicted to be widely distributed around the TS and distributed further to the northern area during autumn and winter. These findings revealed that each species responds to spatiotemporal environmental variations. Understanding the distributions and habitats of these three crabs is vital in fisheries resource management and conservation planning.

穩定同位素技術在萊氏擬烏賊生態研究之應用

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摘　要

　　穩定同位素分析技術已被應用在各種海洋生物生態研究上，但針對頭足類之應用仍屬少數。萊氏擬烏賊(*Sepioteuthis lessoniana*)廣泛分布在印度至太平洋中表層水域，由於缺乏該物種各生活史階段間之棲地利用、移動模式、新陳代謝及食性轉移等生態相關資訊，導致其漁業資源管理不易。本研究目標係以臺灣周邊水域之萊氏擬烏賊為例，透過穩定同位素技術進行生態研究。首先，收集臺灣北部及澎湖海域之成熟個體樣本，分析平衡石核心至邊緣之$\delta^{18}O$值，推定各發育階段之經歷溫度，並結合鹽度、推定與模式水溫及生態習性，推論三組季節群個體之各生活史階段於特定海域的出現機率。結果顯示，平衡石之$\delta^{18}O$值反映了臺灣周邊海域的水溫季節變化，證明臺灣東北部沿海及澎湖水域為該物種之重要產卵場，且各季節群間具有高度散布及不同移動模式。根據預測模式，萊氏擬烏賊的分布可能與適水溫及湧升流所產生的高基礎生產力及餌料生物有關。地理分布重疊及潛在的洄游路徑亦暗示東北部海域與澎湖海域之兩族群間具有一定程度的連結性。本研究接著分析肌肉組織內$\delta^{15}N$及$\delta^{13}C$值，並進一步計算代謝衍生碳的比例（M值）。隨著成長發育，肌肉內較重的$\delta^{15}N$值及相對穩定的$\delta^{13}C$值，指出該物種在相同緯度區域攝食的餌料組成相似，而所攝食餌料體型隨成長而增加。成熟個體較高的M值反映了較快的新陳代謝率，暗示其在越冬期間的高度移動行為，且在生殖季節具有較高的攝食及耗能。這些發現延伸了我們對於萊氏擬烏賊有限的認識與瞭解。持續發展穩定同位素技術於頭足類生態研究之應用，將能提供更精確且專屬於頭足類物種之生態意義。

Bactericidal Activity of Marine *Aurelia Aurita* (Jellyfish) Against Urinary Tract Infection Pathogens

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Abstract

Jellyfish is a soft-bodied and free-swimming aquatic animal with a gelatinous Umbrella- Shaped bell and trailing tentacles. The bell can pulsate to acquire propulsion and Locomotion. The tentacles may be utilized to capture prey or defend against predators by the emitting toxin in a painful sting. The jellyfish species are classified in the subphylum *Medusozoa* which makes up a major part of the phylum Cnidaria, although not all *Medusozoa* species are considered to be jellyfish. The antibacterial activity of jellyfish crude was partially purified from (*Aurelia Aurita)* by liquid-liquid extraction. Bacterial Activity was assayed on only gram-negative bacterial which isolated urinary tract infected (UTI) patients. The antimicrobial activity of jellyfish Crude extract against multi-drug resistant strains of UTI pathogens was investigated. As result, the highest inhibition activity showed against *Pseudomonas aeruginosa* (25mm) and *Enterobacter* sp (24mm). at very lowest concentration 100 µg/ml. It performed better inhibition activity against *Staphylococcus aureus, Klebsiella pneumonia, Proteus* mirabilis were observed. Hence, the present study proved as the jellyfish extract has more antibacterial activity against selected uropathogens.

Keywords: Jellyfish, Crude extract, Urinary tract pathogens.

圈養白鯨的聲音分類與夜宿對其聲音的影響以評估其動物福利之研究

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摘要

近年來圈養動物的福利日益受到關注，對於照護者而言，如何讓圈養動物擁有合適環境及妥善照顧是一個很重要的議題。動物福利評估是一項困難的任務，除了利用行為觀察及血液皮質醇測量以了解其緊迫指數外，聲學活動也是一項作為評估動物狀態的參考依據。在本研究中我們嘗試將三頭圈養於國立海洋生物博物館的白鯨(*Delphinapterus leucas*)發聲分類，分成：哨聲、脈衝聲及混合聲三大類型，探討2020年3至8月期間旅客夜宿海生館活動舉辦的有無，是否會對白鯨的發聲造成影響，並進行已知緊迫聲學活動及夜宿活動有無之關聯性分析，期望能建立另一環境及生理緊迫監測方法來評估圈養白鯨的動物福

Associated microbiotas of azooxanthellate scleractinian coral *Tubastraea coccinea* from different marine environments

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Abstract

The azooxanthellate scleractinian *Tubastrea coccinea* native to the Indo-Pacific region has wide distribution along the coast of Taiwan. These corals are found in both reef and non-reef habitats with varying environmental conditions. In the present study, we investigated the potential compositional changes in bacterial communities associated with *T. coccinea* tissue and mucus, collected from four different habitats across Northeastern Taiwan, including hydrothermal vent (HV), copper mining site (CM), the inlet of nuclear power plant (NPP), and conservation zone (CZ). To reveal the influence of environmental factors, we collected sediment and water sample from the immediate surroundings. Using 16SrRNA gene primers we amplified the V1-V9 full-length (~1.5 kbp) 16S rRNA gene. Following the SQK-LSK109 protocol (Oxford Nanopore Technologies, Oxford, UK) performed nanopore sequencing libraries. A total of 11,174,143 reads were obtained from the 48 samples collected, among which an average of 167,745±154600.08 annotated reads from tissue samples, while an average of 254,411±131301.93, 267,611±409043.60, 237,959±135518.91 annotated reads were obtained from coral mucus, water, and sediment samples respectively. In further alpha-diversity of microbiotas in the water and sediment of four environments are different (one-way ANOVA, $p < 0.05$) while alpha-diversity of bacterial communities from coral tissue are significantly higher in CZ than HV (one-way ANOVA, $p < 0.05$). However, the relative abundance of each species varied among samples in the same site as well as different sites. *Synechococcus* was the highly abundant bacterial genus in coral tissue

from CZ (7.89%) and NPP(10.61%), while *Clostridum* (12.48%) and *Brevundimonas* (8.9%) were the most dominated species found in the tissue samples from HV and CM, respectively. The difference in bacterial community abundance can be attributed to the change in habitat condition which was proved by the analysis of hydrographic parameters. In general, our results suggest that variation in the environmental conditions influenced the microbiota structure in the coral. Further study on the functional pathway of the dominant bacteria and the host metabolism might unlock the secret about the wide distribution of the scleractinia *T. coccinea*.

探討夜光蟲有性生殖的機制

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摘　要

Noctiluca scintillans，俗稱:夜光蟲，是一種大型的雙鞭毛蟲，直徑大約400-1000μm，在受到應力時會發出生物冷光，並且是個常見的赤潮種類。如果在一個水域爆發性的繁殖，容易形成缺氧區域，並造成當地漁業資源損失。夜光蟲的繁殖方式可分為有性與無性生殖兩種，無性是以二分裂來繁殖，有性生殖則是以配子生成(Gametogenesis)的形式產出。目前關於夜光蟲有性生殖的過程已經有些許的了解，但是其轉換的機制以及其生態意義上幾乎沒有相關研究。過去研究認為夜光蟲的有性生殖只會在承受環境壓力時發生，但是在何種環境壓力或特定狀態下發生還尚未確定。所以此研究中，我們嘗試去尋找是何種因子會驅使夜光蟲進行有性生殖以及推論這種行為對於夜光蟲的族群的意義。目前已知夜光蟲的成蟲會在有性生殖發生時轉換成配子母細胞，而其所產生的配子，會在成熟後脫離配子母細胞自由游動，最終會與其他配子結合形成合子，成長成新的成蟲。平均每一隻成蟲可以產生約512-1024顆配子。依照已知的有性生殖過程以及其他類似物種的生殖習性，我們整理出一些可能是影響因子的培養條件。我們把夜光蟲培養在不同的溫度、餌料濃度、夜光蟲族群密度、培養時間、培養容積、光照時間以及搖晃頻率(模擬海水搖晃)下，並且觀察在何種組合的培養條件下夜光蟲的有性生殖比率會有所提升，並且每天計數配子母細胞的生產量來判斷有性生殖的發生率。結果顯示，多數組合有性生殖比率都維持在<1%，只有在調整初始餌料濃度以及初始夜光蟲濃度的組別的有性生殖比率有明顯上升的跡象。經過數據以及確認整理後發現，有產生大量配子母細胞的組別，餌料/夜光蟲的比例會降到200(prey/cell)以下，有性生殖發生比率會上升至10%以上，發生時間剛好都落在指數期的末端或結束後。這可能代表者驅使夜光蟲從成蟲轉換成配子母細胞，是夜光蟲與餌料的接觸率有關。因為時間以及條件都剛好吻合，我們推論說:在發生赤潮即將結束時，應該會發生大量的有性生殖，形成另一個在赤潮結束時族群數量減少的途徑之一。至於是因為是赤朝結束造成有性生殖大量發生，還是因有性生殖大量發生造成赤潮結束，還有待考證。

高解析反射震測與離岸風力發電場址調查之應用
High-Resolution Seismic Image and Its Implication for the Site Investigation of the Offshore Wind Farm in Taiwan Strait

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摘　要

　　臺灣地區因造山運動，每年陸地輸往台灣海峽的沉積物量大且沉積速率快，地層也存在岩漿入侵等地質現象。這些獨特且多重因素主導的地質環境，皆對在台灣海峽興建離岸風力發電廠的基樁架設有深遠的影響。特別是在淺層地層中，近年來已知有高孔隙水壓地層移棲和玄武岩層的分布。故本研究欲利用高解析度地球物理和地質資訊，調查彰濱外海鄰近濁水溪出海口的離岸風力發電風場，探討淺部地層是否存在造成地層不穩定的潛在因子。

　　本研究使用的高解析度震測資料使用火花放電(Sparker)作為聲源，聲源頻率介於數百至數千赫茲，並理論解析度可達數公尺等級。在淺層地層的解析度與傳統空氣槍為聲源相比有顯著的提升，能獲得高解析影像。經過一系列資料處理提高訊噪比，並利用消除覆反射有效呈現海床以下數百公尺深的地層。其資料處理成果利用反射訊號的振幅屬性展示地層特徵外，也利用其他震測屬性分析作為判釋輔助用。

　　彰濱外海風場的南區接近澎湖群島，在淺層地層中有玄武岩層的出現。利用高頻資料型態可有效的解析薄層的玄武岩的上下界，顯示該火成岩體的頂部和底部兩層反射層，此作為相同強振幅的反射層中，提供更有力的判斷依據。並在調查區域中，可觀察到玄武岩層隨深度不同有多層岩體分佈，並且在最淺層的岩層展示出噴發岩，而深部的岩層為侵入岩。其岩層大致往東與往北逐漸變深，因此在靠近西側的風場如欲架設風機，則需避開玄武岩層分布的位置。

　　靠近濁水溪出海口的風場地區，則有許多高孔隙水壓地層的移棲特徵。利用高解度震測資料的震測屬性分析，可突顯出剖面上接近富含流體的震測相。全面而完整的檢視離岸風電潛力場址的淺部地層中是否有富含流體及顯示流體移棲的地層分布，探討分析這些流體移棲地層的成因以及流體對於地層穩定度的影響，將能提供風機場址建設工程設計上所需的重要資訊。

　　以上皆顯示高解析反射震測的資料型態能夠提供海洋淺層工程有適當的地層資訊，以利開發離岸風機發電的選址。如另外整合地工資訊，可進一步建立地工、地物、地質之地下構造模型，以提供未來海域工程或埋設電纜時找尋適當場址之參考。

High-resolution Bathymetry and Shallow Seafloor Gas Emissions near Huaping Islet and Pengjia Islet, East China Sea Shelf

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Abstract

The Northern Taiwan Volcanic Zone (NTVZ) is dominated by post-collisional magmatism and extensional structures of collapsed Taiwan orogenic wedge. In this study, we use multi-beam echosounder (MBES) and multi-channel seismic (MCS) data to explore the volcanic and associated influence on bathymetric and stratigraphic features near the Huaping and Pengjia islets in the NTVZ. High-resolution MBES data collected by R/V New Ocean Researcher 2 reveal several sloping cliff toes, semi-circular topographic rims, and a linear topographic high in water depths between 120~250 m. The semi-circular topographic rims are between 100 to 500 m in diameter and near the Huaping Islet. One of the semi-circular features is composited with several volcanic edifices which are up to 40 m above seafloor. Hydroacoustic flares have been observed at two sites on the semi-circular topographic rims via water column image (WCI) collected together with the bathymetric data. The backscatter seafloor images also present high amplitude signals near the flares, indicating that the seafloor is covered mostly by hard material. The MCS profiles here show high amplitude reflections and chaotic seismic facies beneath the semi-circular features. We interpret that the seafloor is dominated by physically hard, probably volcanic-associated material, and is controlled by subsurface volcanic sills. We suggest that those sites with flares are fed by recent volcanism which causes intrusive sills, extrusive volcanic edifice and associated hydrothermal features on the seafloor. While this study provides the first evidence of submarine gas escapes offshore Huaping Islet, it remains to be proved whether or not there is a hydrothermal ecosystem in the area. Studies of biogeochemical cycles are proposed for future research.

台灣西南海域被動與活動邊緣之天然氣水合物與流體系統震測特徵分布及意涵

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摘　要

　　台灣西南海域是一個探討天然氣水合物與流體系統在不同構造條件下的天然實驗室，不論在被動邊緣與活動邊緣，皆可觀察到許多流體活動與水合物形成特徵。然而，在缺乏鑽井資料的情況下，多頻道反射震測能反映地下地層的特性，便是探討本區域天然氣水合物與流體分布特性最重要的資料。本研究利用研究區域中既有之震測剖面，辨識出由於流體的聚集、移棲、天然氣水合物形成所造成的各種聲學指標，並繪製各項指標的分布，再藉由已知的構造、地層、海床地球化學特性等資訊，來探討再不同構造條件下的天然氣水合物與流體移棲系統。結果顯示，不論在活動邊緣與被動邊緣，地形高區都是游離天然氣聚集的重要場所，但在活動邊緣的褶皺逆衝斷層帶形成了受構造控制的流體移棲網絡，除了更容易使游離氣體聚集，也使這些游離天然氣更容易進入天然氣水合物穩定帶形成水合物，進而出現高飽和度的天然氣水合物地層。本研究總結了從被動邊緣到活動邊緣可能的流體移棲、聚集、水合物形成等特性，呈現區域地質尺度天然氣水合物與流體系統的架構。

彰濱外海淺部地層流體特徵辨識與分佈

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摘要

在淺海具有快速沉積作用發生的區域，特別是高孔隙的砂質沈積環境，常會有流體填充，若再有適當的封閉地層，便可能形成超孔隙水壓，當極端事件發生且造成地層擾動時，這些流體便可沿著壓力梯度方向移棲，形成流體移棲特徵，進而造成海床下的沉積物液化現象，成為海床不穩定的因子之一。臺灣海峽的彰濱外海區域鄰近濁水溪出海口，環境中具有大量砂質沉積物堆積，且因地震、颱風、洪泛等極端事件發生頻繁，大量沉積物於短時間內輸入此區，快速沉積有利於流體封存於地層中，且極端事件也可能造成地層擾動，觸發流體移棲與沉積物液化作用的發生。本研究根據火花放電(sparker)震測調查的地層剖面分析結果，辨識彰濱外海地層中的流體特徵，結果顯示彰濱外海近岸區的流體特徵主要分為兩大類型，分別為垂直移棲型與水平富集型，而垂直移棲型又可依震測相中出現的流體指示特徵，分為Pa(反極性)、Pb(無反極性)、Pc(頂部連結麻坑)三種，其移棲通道直徑皆介於數公尺到一百公尺間，多位於淺部地層且皆移棲至海床下十公尺左右，有少數幾個突破海床，其中，Pa 有觀察到極性反轉的特徵，推測當中可能含氣體；Pc 表示流體移棲衝破海床而形成麻坑或古麻坑特徵，垂直移棲型主要分布於古濁水溪口與現今濁水溪口，故推測是因濁水溪輸入大量砂質沉積物，快速沉積後，流體被封存於一定深度地層中，之後因地震、颱風等事件擾動，使被封存的流體向上移棲。水平富集型的流體特徵則呈連續性分布，主要分布在東彰雲砂脊下方、楔型體下方與楔型體內部，其規模水平延伸數百公尺到數公里，厚度則介於數公尺到十多公尺，深度約為海床下十到二十公尺，其中，楔型體發育可分為兩期並皆向海進積，兩期內部皆有部分反白特徵，且在其下方觀察到透鏡狀反白特徵，其分布鄰近古濁水溪出海口，故推測為過去古濁水溪輸入大量沉積物，因快速堆積而形成部分富含流體的鬆軟地層，此地層的分布區域亦可能成為日後可能產生液化或流體移棲的高風險區。根據彰濱外海近岸區的流體特徵與分布，我們認為此區的流體賦存與移棲可能與古代及現今的濁水溪出海口位置有所關聯，濁水溪的快速堆積作用是影響彰濱外海地層中流體封存的重要機制之一，而封存的流體受極端事件的擾動後，即可能造成流體移棲，並形成土壤液化風險。本研究區域正為臺灣離岸風電發展的重要區域，透過本研究對彰濱外海淺部地層流體特徵的探討，不僅能對相關可能的地質風險能有更進一步的掌握，也應能對離岸風場的建設及營運有所助益。

關鍵字:流體移棲、沉積物液化、震測、火花放電(sparker)、離岸風力發電

台灣北部貢寮外海之地質構造研究

Geological Structures off Gongliao District, Northern Taiwan

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摘 要

　　台灣東北海域在造山活動結束後轉為山脈垮塌，而形成一系列東北-西南方向的正斷層構造。而在台灣貢寮地區的逆斷層，澳底斷層、蚊子坑斷層及枋腳斷層似乎與海域上的線型特徵有相關性，推測斷層可能有往外海延伸。為了了解海陸斷層間的關聯，以及這些斷層在海域中是否為活動斷層，使用火花放電反射震測來針對貢寮外海地區做探討，此系統適合淺海區域，且對於淺層構造可以有很高的解析度。

　　在震測剖面中，此區大致上的形貌為東西兩側基盤較高，中間為堆滿沉積物的盆地。資料中可觀察到兩大重點，一是盆地中的沉積層有層序地層的特徵、二是盆地西側邊界的斷層構造。在剖面中可清楚辨識出一侵蝕面，在此不整合面上可觀察到許多水道切蝕填充的樣貌，因其深度大約在 100-200 公尺深，與一萬八千多年前的末次最盛冰期海水面下降 120 公尺左右相近，推測可能為當時所產生的侵蝕面。除此侵蝕面外，也依據震測相的差異定義出沙波基底面、海進面、上一期的最大海泛面及聲學基盤面。而在構造上，可看到一斷距大的高角度正斷層，此斷層有切穿基盤且在近海床的地層也有明顯的錯動。目前懷疑此斷層是因為張裂環境而形成的正斷層斷塊，在斷塊的頂部皆可看到明顯的強反射層。認為這個強反射是在受造山作用影響時，此區域擠壓而抬升，因此在基盤位置堆積了許多粗顆粒的沉積物。後期，造山活動結束改為張裂環境，受沉降作用的影響而形成這些正斷層斷塊與盆地。

關鍵字: 台灣北部海域斷層、火花放電反射震測、層序地層、末次最盛冰期侵蝕面(LGM)

Infragravity waves recorded at the seafloor OBS network in the northern Nankai Trough

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The ambient seismic noise is mainly excited by oceanic gravity waves. It can be categorized as primary microseisms (0.05–0.1 Hz), secondary microseisms (0.1–0.2 Hz), and low-frequency infragravity waves (< 50 mHz). The energy of the primary and secondary microseisms mainly transfers from the short-period wind waves. Whereas the infragravity waves are one subcategory of gravity waves, which refer to all gravity waves with periods greater than 30 seconds. Its generation has been explained by the sea-level oscillation affected by the traction force converting from the regional wind field. A wave packet of ocean infragravity waves propagates with the group velocity of shallow-water waves ($\sqrt{gD}$, D is water depth), which significantly differs in frequency and depth. When reaching the shallow water, IGWs can transfer part of their energy back to higher frequencies, a process that is highly dependent on the underwater topography. In deep water, the IGWs can be also influenced by both offshore leakage and the coastally generated free waves to form the deep-water standing waves. It is observed that the IGWs are trapped within the continental shelves or the ice shelf with a frequency close to the natural frequencies of the trapped media. Physically, the IGWs can travel over a thousand kilometers with little energy decay.

In this study, we proceed with a comprehensive analysis of the infragravity waves (IGWs) (typically below 40 mHz) recorded at the Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET) in the northern Nankai trough. The spectral analysis. shows significant IGWs with the DONET data. The peak frequencies of IGWs are in a frequency range of 0.008~0.02 Hz, while they perform a systematical frequency drifting corresponding to the water depth of stations. We also proceed with the cross-correlation function analysis (CCF) and cross-correlation beaming function (CCBF) with the DONET data to discuss their propagation. Besides identifying the potential conversion environment for the IGWs, our study provides information for the spatial and temporal variation of IGWs in the northern Nankai trough.

Surface Faults under Varied Décollement Depths

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Abstract

Fold-and-thrust belt (FTB) develops under lateral convergence. FTBs show various features in field. In this study, we aim to reproduce the evolution of FTBs by numerical simulation and discuss how the characteristics of décollement and the surface processes influence the evolution of FTBs.

The formation of the thrusts follows Mohr-Coulomb failure criterion. The yield shear stress is a function of normal stress, which is almost proportional to the confining pressure. Confining pressure is determined by the loading of covering materials. The depth of the décollement controls the thickness of the deforming zone. Hence, the depth of the décollement is the primary factor that we would like to discuss its effect to the thrust belt evolution. Furthermore, surface processes modify the topography during the thrust belt development, which affect the normal stresses as well. While the depth of the décollement controls the normal stresses initially, surface processes influence normal stresses dynamically. Besides, the friction of the basal décollement decides the degree of coupling between the upper deforming zone and the basement. High basal friction provides high basal traction in the convergence. In this study, we use the program DynEarthSol to simulate the FTB evolution with the varied depths (thickness of the deforming zones) and basal friction of the decollement. The depths of décollement are 3, 6, 9 and 15 km in this study. The friction angle of the décollement is set to be 1° and 3°. Besides, the effect of the surface erosion is discussed in the 2D rates of 3.15 (low erosion) and 31.5 (high erosion) m^2/yr.

Our result demonstrates that the propagation rate of the thrust development and the lateral scale structures highly depend on the depth of the décollement. The development of thrusts is totally in-sequence when the décollement is very shallow, here ~ 3 and 6 km. However, out-of-sequence development of thrusts may occur when the décollement is deeper than 9 km. A high-friction décollement creates steep surface slope and more backthrust development. Active surface processes erode materials during thrusting. Thrusts cost more time to reach the topographic height to supply enough normal stress to stop the slipping thrust. Active surface processes lead to thrusts with longer active span and larger fault displacements.

Gephyrocapsa kennettii sp. nov., a new calcareous nannofossil species from the Middle Pleistocene, Solomon Sea, western equatorial Pacific

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Abstract

Detailed examinations of middle Pleistocene sediments of ODP Hole 1115B and Core MD05-2925 in the Solomon Sea, southwest equatorial Pacific, reveal a distinctive new form of the calcareous nannofossil group of gephyrocapsid which has peculiar elongate kite-shaped slits on the distal shields of the coccolith. A new species, *Gephyrocapsa kennettii* sp. nov., is proposed and described in this study with SEM (scanning electron microscope) images. The coccolith of this new species is elliptical in shape, bearing 2 to 19 kite-shaped slits on the distal shield and a low-angle, raised arch-like bridge. The distal shield has fewer slits than *G. protohuxleyi* which has slits in between all elements. The bridge is orientated clockwise with a ~10° angle to the long axis when viewed distally. The average length of the distal shield is 3.26 ± 0.22 (1σ)   m (n = 36), and, by definition, this new species belongs to the small *Gephyrocapsa* group. The chronologic range of this species is short, spanning only from 0.520–0.465 Ma. Its last occurrence datum is almost coeval with that of *Pseudoemiliania lacunosa* at the bottom of Marine Isotope Stage 12. Morphologically, *G. kennettii* sp. nov. is intermediate between *G. ericsonii* and *G. protohuxleyi* and considered to be a transitional species originated by hybridization between them.

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Developing Cleaning Procedures for Individual Foraminifera Analysis of Magnesium/Calcium Paleothermometry

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Abstract

Sea surface temperature is an important parameter in global climate due to its influence on the air-sea exchange process. One of the main approaches to reconstruct past sea surface temperature is the magnesium/calcium ratio (Mg/Ca) of foraminiferal tests. Planktic foraminiferal tests are typically hundreds of micrometers in length and can be tens of micrograms in weight, thus Mg/Ca measurements are traditionally conducted on samples consisting of 20-30 foraminifer tests (also known as bulk measurement) to ensure a detectable signal on the mass spectrometer and to give a representative climate signal. Recently, with advances in technology, it has become possible to analyze a single foraminiferal test. Individual foraminifera analysis (IFA) has been used to study the variability of individual foraminifera within a sediment layer due to the habitat depth, seasonality of foraminifera, and climate change. However, the cleaning procedure for IFA Mg/Ca remains technically challenging. Clay minerals and organic matter are the two main contaminants for IFA Mg/Ca and may lead to elevated Mg/Ca values. Due to the small size of the foraminiferal tests, it is critical to minimize sample loss while cleaning to ensure a detectable signal on the instrument. Here, we report an improved IFA Mg/Ca cleaning procedure. We tested several methods by adjusting the crushing of foraminifera, the amount of reagent, the duration and intensity of reaction to achieve sufficient cleaning while resulting in minimal sample loss. The techniques were applied on different sample types, including marine sediment, and suspended and sinking particulate matters with different preservation states. Our results show that the Al/Ca values of samples are lower than the threshold of 2000 µmol/mol, indicating that the sample Mg/Ca values are not biased by clay minerals. The IFA Mg/Ca values are also comparable to those obtained using the traditional bulk cleaning procedure. Furthermore, temperature estimates calculated from the IFA Mg/Ca value for different species of foraminifera are consistent with their habitat depth in the water column. In conclusion, our IFA Mg/Ca cleaning procedure can be used for different species of foraminifera and sample types.

Keywords: Individual foraminifera analysis; Mg/Ca.

Freshwater and riverine input in central Arctic system: insight from biomarker proxy

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Abstract

Studies have shown that Arctic sea ice variability conditions influence the earth's energy budget by affecting its albedo and global ocean circulation. To understand the Arctic sea ice distribution, we need to first understand its behavior during varying environmental and climatic conditions. One of the factors that affects the sea ice and Arctic ocean surface water conditions is freshwater and riverine input into the Arctic pool from different sources. The shelves near major riverine sources of the Arctic circle can be used as the ideal locations to study various processes like sea ice distribution and production and flow of freshwater and terrigenous matter. The proxy which I would like to use to accomplish my objectives of identifying the organic carbon sources (marine, terrigenous or aquatic) and sea ice extent would be compound specific organic geochemical tracer known as biomarkers which has already been well established as a paleo environmental tracer in mid and low latitude open ocean areas. I would like to start the study by measuring bulk parameters i.e. TOC and C/N ratio and then will move towards the compound specific biomarkers which are n-alkanes and GDGT to understand the organic matter source and the use of IP_{25} to understand the sea ice extent. This multi-proxy biomarker analyses could give us a better insight of relation between sea ice extent and riverine inflow and give us an understanding of global ocean water circulation.

Planktic benthic foraminiferal ratio in surface sediments off Taiwan: Spatial patterns and potential applications

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Abstract

The abundance of planktic foraminifera tests in marine sediments usually decrease from ocean to land, as the life cycle of some species involves migrating through water column down to thousands of meters. Meanwhile, the species composition and abundance of benthic foraminifera in marine sediments show the opposite trend, as the food availability increases towards the land. These trends are reflected in the proportion of the planktic foraminifera in the total pool of foraminiferal tests in sediments (termed %P). Consequently, sedimentary %P has been used to assess the influence of terrestrial input (terrestrial vs marine) and water depth. However, previous studies show that the relationship between %P and water depth may vary regionally. Furthermore, there is yet a comprehensive study that maps the benthic foraminifera assemblage off Taiwan. Therefore, in this study we aim to (1) systematically examine the %P in surface sediments off Taiwan and explore its applicability to discriminate in-situ hemipelagic sediment and allochthonous sediments; (2) determine the spatial distribution of recent benthic foraminifera in marine sediments off Taiwan. Here we present results from 100 sites off Taiwan, grouped as Midwest, Southwest, East Taiwan, and Bashi Channel. Overall, our data show an increase in the %P with water depth that can be described as: Depth (m) = e ^ (0.0591*%P + 1.965), albeit with considerable scatter. Interestingly, the strong deviation in the %P values from the general relationship at 2 bathyal sites may suggest allochthonous sediment from shallow waters, as it is accompanied by the presence of coral fragments and shallow water benthic foraminifera species. Benthic foraminifera census counts, mostly at genus level, suggest a higher diversity and lower dominance at <100 m in Southwest Taiwan compared to Midwest Taiwan. This regional difference might be driven by the larger grain size of the sediments in Midwest Taiwan. Future work will focus on defining bathymetric ranges of key benthic foraminifera species, evaluating the influence of other environmental parameters on %P off Taiwan, and finally assessing the usefulness of %P as a tool for tracing displacement of sediments from shallow shelf into the deep basins around Taiwan.

Detecting shifts in nonlinear dynamics using empirical dynamic modeling with nested-library analysis

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Abstract

Abrupt and persistent changes in system dynamics are often observed in natural systems; such phenomena are explained as transitions between alternative equilibria and/or attractors. Concerned with changes in the system behavior and structure, scientists have suggested methods to detect regime shifts in time series data. Nonetheless, a generic method virtually connecting with the system dynamics (i.e. the governing equation) is lacking. For this purpose, we propose a novel method named Nested-Library Analysis (NLA), using empirical dynamic modeling rooted in Takens' embedding theory of attractor reconstruction. Specifically, NLA determines the cutting point by sequentially constructing the historical library set that optimizes attractor reconstruction for prediction. We illustrate this method by employing it on a pedagogical model, where a hidden regime driver exerts an influence on the governing equation of a chaotic three-species food chain. Results show that NLA can detect the abrupt change in system dynamics; in comparison, the existing approaches based on statistical characteristics fail to detect the transition. Importantly, our method requires no assumption about the explicit form of the governing equation but only a single time series.

Keywords: Regime shift, Empirical dynamic modeling, Nested-library analysis, Chaos

The interaction of Ni availability, hydrogen production, and nitrogen fixation in *Cyanothece*: evidence from hydrogenase and nitrogenase expression

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Abstract

H_2 production is regulated by uptake hydrogenase, a Ni containing enzyme in most of marine diazotrophic cyanobacteria. Here, we investigated the effects of highly varied Ni concentrations on hydrogen production and nitrogen fixation in a model marine diazotrophic cyanobacterium, *Cyanothece*. We showed that Ni availability is closely and positively associated with the expression of HupL, the major subunit in uptake hydrogenase. Low Ni availability resulted in low HupL expression and led to high H_2 accumulation and vice versa. The threshold of Ni concentrations resulting high or low H_2 accumulation in the diazotroph is between 0.2 and 2 nM under 20 µM ethylenediaminetetraacetic acid (EDTA) buffering condition. With Ni concentrations higher or lower than the range, all parameters measured, including HupL expression, H_2 accumulation, and growth rates, show highly comparable patterns. Different from some previous studies reported, we found that H_2 accumulation did not affect nitrogenase expression and nitrogen fixation rates at all in *Cyanothece*. These findings indicate that the concentrations of H_2 in the ocean is not only associated with nitrogen fixation activities but is also regulated by Ni bioavailability in ambient seawater. High H_2 accumulation may be a promising indicator of Ni limitation for marine diazotrophic cyanobacteria in the ocean.

Coral-algae community analysis in relation to marine herbivores in Xiaoliuqiu, Taiwan

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Abstract

Human activities and climate change in the past several decades have had destructive effects on coral reefs globally. It is crucial to survey the benthic community in order to determine coral reef resilience and to implement proper reef management strategies in various locations. This study aimed to compare coral and algae percentage covers at two different sites in Xiaoliuqiu, a coral reef island that has experienced a dramatic decline in live coral cover since the 1970s: Houshi Fringe Reef (HS) and Shanfu Fishing Harbor (SF) (the southern and western sides of the island, respectively). Sea turtles, sea urchins, and fishes were identified and measured for potential correlation with coral and algae percentage covers. Benthic images were analyzed via CoralNet (Beijbom, 2015). Since the southern side of Xiaoliuqiu has a larger temperature variability as well as less severe pollution and anthropogenic activity, HS was hypothesized to have greater live coral cover. Hard coral cover was 38.2% at HS, significantly higher than SF's hard coral cover of 29.1%. SF had significantly higher algae percentage covers (i.e. macroalgae and turf algae) than HS. The rock boring sea urchin (*Echinometra vanbrunti*) was extremely dominant at SF. Damselfish (*Stegastes nigricans*) dominated both sites. More attention needs to be directed towards indirect effects on coral reef health, including the depletion of natural predators due to overfishing and the overharvesting of herbivorous fishes, which can lead to reduced food competition for damselfish, increased algal growth, and the consequent decline of coral cover.

珊瑚照相監測、影像自動分析與交流網絡的建立與推廣

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摘要

全球和臺灣的珊瑚已因人為不當活動與氣候變遷衝擊而快速減少和改變，必須客觀、正確、迅速、有效地掌握珊瑚的最新狀況，以提升經營管理與生態保育的成效。珊瑚的數位照相監測與利用人工智慧自動分析，如自 2015 年推出的珊瑚網 (CoralNet, https://coralnet.ucsd.edu/)，已成為國際珊瑚監測標準化作業的有力工具；我們已應用在恆春半島和小琉球珊瑚礁底棲群聚、2015-2016 與 2020 年珊瑚大白化事件、以及珊瑚礁水族缸的監測，其辨識目標物的正確率分別為 70%、54%以及 88%。經由數位照相調查，能夠容易、普遍且快速地獲得大量影像，儲存在網站作為永久紀錄，供後續分析、比對和查考。經由珊瑚網大數據資料庫和社群媒體交流網絡的建立與連結，能快速獲得標準化且容易比較的珊瑚類群與數量的高品質分析結果，並透過辦理工作坊，訓練海域活動愛好者具備珊瑚調查能力，共同合作協助珊瑚的監測與保育，期許經由當地社區居民的參與和投入，以行動支持與強化珊瑚礁的恢復力，促進人類與珊瑚間的永續發展。

水溫、珊瑚大白化與死亡型態顯示湧升流礁區具有熱緊迫庇護所的潛力

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　　2020 年全球和台灣很多海域皆發生海洋熱浪引發珊瑚大白化和死亡事件。在 4、9 和 12 月，監測墾丁國家公園海域的 4 個淺海地點(3 公尺)，包括合界、後壁湖、核三廠的出水口與進水口內，以及 1 個深海地點(7 公尺，進水口外)，珊瑚礁底棲群聚結構、珊瑚白化和死亡率、與水溫的時空變化。結果顯示深海地點的珊瑚白化率僅 7.4%，3 季節珊瑚(包括石珊瑚、軟珊瑚、柳珊瑚和水螅珊瑚)覆蓋率，與其對藻類(包括大型藻和毛叢藻)覆蓋率的比值，分別介於 44.8-54.6%與 0.9-1.3，維持穩定和以珊瑚為優勢。然而，4 個淺海點的珊瑚白化率為 58.2-94.3%，以軸孔珊瑚屬(88.6-99.3%)、萼柱珊瑚屬(99.7-100%)和列孔珊瑚屬(61.1-85.3%)的白化率最高；而珊瑚覆蓋率與其對藻類覆蓋率的比值，在白化事件前為 44.8-56.9% 與 0.98-1.5，事件後則顯著減少為 17.1-34.2% 與 0.2-0.52，呈現明顯衰退和相變為以藻類為優勢。值得注意的是，受間歇性湧升流和電廠溫排水影響的核三廠出水口海域，雖然水溫(最高水溫 34.2°C)高於不受湧升流影響的合界(最高水溫 31.8°C)，但珊瑚白化和死亡率與合界相似，顯示具有較高的耐熱性，並且湧升流礁區，尤其是較深海域，具有熱緊迫庇護所的潛力。

Estimation of bottle marine debris on Dayuan beaches using unmanned aerial vehicles and object detection

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Abstract

Bottle marine debris (BMD) has been still one of the global urgent concerns. An alternative approach to estimating BMD is suggested to tackle this issue by the aggregation of unmanned aerial vehicle (UAV) surveys and machine learning for images. Drinking bottle litters were randomly deposited on Dayuan sandy beaches and a UAV was operated from resolution 0.12 cm to 1.54 cm to obtain aerial images of the experimental sites. The YOLO version 2 object detection system using UAV-derived data permitted BMD to be detected through image processing. The results were then compared with each other to highlight the role of data augmentation on the training process and the performance of background subtracted images for detecting precision and accuracy. In comparison to different resolutions, the ones around 1 cm were the optimal resolution suggested for aerial surveys. The upshot of all analysis results at various study sites is this novel approach, especially background subtraction, can help accurately, quickly and objectively identify BMD on beaches. This method can be used to improve the efficiency of beach surveys.

Key words: bottle marine debris, UAV, machine learning, object detection, background subtracted image, data augmentation.

Introduction

Beach litter is such a global essential problem related to the issues it causes to the environment, economy, society and human health (Shevealy, Courtney, & Parks, 2012), and bottle marine debris (BMD) has been still one of the top 10 items removed from the global coastline and waterways since 1991 (Conservancy, 2010). There is no denying that the estimation of BMD is such an urgent need. Essentially, traditional beach monitoring mostly focuses on the visual census method, and this has some notably negative sides including subjective, time and labor-consuming (Martin et al., 2018). The use of unmanned aerial vehicle (UAV) imagery is therefore a new method suggested to addressing this problem.

Since the first gunshot of Martin (2018) (Martin et al., 2018), some recent studies

such as Goncalves (2020) (Gonçalves, Andriolo, Pinto, & Bessa, 2020) and Kako (2020) (Kako, Morita, & Taneda, 2020) referenced that bright opinion and highlighted the efficiency of aerial surveys in monitoring the marine debris abundance. Nevertheless, the burning question is what the optimal resolution of aerial images should be to satisfy flight time, coverage and image quality?

This study demonstrated the efficiency of using artificial intelligence (AI) with UAV surveys to measure BMD abundance in both experimental sites and real sites on Dayuan beaches. The BMD quantity was investigated by counting the number of items detected via the YOLO version 2 object detection system (Joseph & Ali, 2017). The main objective of this work is to find out the optimal resolution of aerial images and some methods for increasing the research efficiency in large-scale studies related to BMD.

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Sediment Concentration and Particle Size Variability over the Algal Reef Bottom in Taoyuan Coastal area

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Abstract

Recent findings proved that suspended sediment concentration (SSC) is an important factor affecting the ecological system in an intertidal algal reef. There are some studies mentioned the affecting threshold of SSC on these environmental systems. However, the variability of the SSC over the algal reef is still not clearly observed and studied to compare with the affected threshold. The monitoring system is a potential tool that could be applied to measure waves and SSC with significant detail, flexible, and precision supported to guide decision concerning critical environmental issues as algal reef conservation. The SSC over the algal reef is quite high with seasonal variation; it was higher during the winter and lower during the summer. The comparison of the seasonal averaged SSC and the affected threshold showed the lower during summer and higher in the winter. This study also found that during the high wave condition, there is a good relationship of SSC with the near-bottom horizontal orbital velocity and wave bed stress. Moreover, the sediment particle sizes were seasonal variation, in which D_{10} was higher during the summer; D_{50} was almost similar between two seasons while D_{90} was higher during the winter. The sediment particle sizes were stronger variation during the winter compared to the summer due to the higher wave condition.

以 COMCOT-SS 預報印度洋之風暴潮

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摘　要

　　印度洋北方之孟加拉地區經常遭受熱帶氣旋侵襲。由於當地沿海人口密度高且多為河流及泥沼地，熱帶氣旋所引致之風暴潮往往對當地造成嚴重破壞。如發生於孟加拉灣之 1970 孟加拉風暴潮，造成近 50 萬人死亡，為人類史上死亡人數最高之熱帶氣旋；2020 年之氣旋 Amphan 與風暴潮事件，亦造成近 13 億美元之損失及 128 人死亡。本研究旨在以台灣 COMCOT 風暴潮預報系統為基礎，發展適用於印度洋之風暴潮速算系統。於印度洋所發展之熱帶氣旋，其結構與強度有別於太平洋之颱風與大西洋之颶風，因此適用於太平洋與大西洋之風暴潮模式是否適用於求解印度洋之熱帶氣旋型風暴潮為本研究之分析重點。本文以 2020 氣旋 Amphan 為研究案例，分析 5 種不同參數化風場於風暴潮生成之適用性，並利用歷史案例（2019 年氣旋 Fani 以及 2013 年氣旋 Phailin）進行模式準確度比較。分析結果發現，修正後之 Holland 模式模擬之氣象場於風速剖面、風暴潮溢淹範圍、及時序潮位高程上與觀測資料有最佳之匹配。本研究所採用之 COMCOT 風暴潮預報系統求解球座標非線性淺水波方程式，搭配巢狀網格系統與移動邊界法，可於沿岸求解高解析度之風暴潮溢淹範圍。同時可結合 TPXO 全球天文潮模式，以掌握高低潮位對溢淹範圍之影響。本研究建立適用於孟加拉灣氣旋之 COMCOT 風暴潮速算系統，期待未來對於孟加拉灣地區風暴潮速報及災情掌控有實際之助益。
關鍵詞：孟加拉灣氣旋、風暴潮、COMCOT 模式、溢淹、參數化風場

以影響強度法分析與重建 1845 雲林口湖風暴潮事件

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摘　要

　　西元 1845 年雲林口湖發生嚴重之風暴潮事件，造成萬人喪生，為台灣歷史上最嚴重之風暴潮事件。為重建 1845 口湖風暴潮事件，本文發展風暴潮影響強度分析法(SSIIA)。該法以現行於中央氣象局之 COMCOT 風暴潮模式為基礎，進行大量單元颱風之風暴潮模擬，以建立颱風位置對風暴潮與溢淹高程之 SSIIA 敏感關係圖。本研究為重建颱風路徑，發展颱風路徑對風暴潮影響分析法。該法透過 SSIIA 之分析結果，進行風暴潮潮高、溢淹高程與溢淹範圍之綜合評分，以求得可能之颱風路徑組合，並考慮颱風移動速度之差異性，得出最嚴重影響移動速度之路徑，並由該結果建立 1845 年事件之可能情境。透過上述之分析結果，本研究提出對雲林口湖風暴潮生成之颱風情境，以及該路徑所造成之風暴潮和溢淹範圍。本研究所建立之分析方法，可系統性分析沿海低窪地區之風暴潮溢淹潛在災情，有助於進行風暴潮風險評估及災防規劃。

　　關鍵詞：風暴潮影響強度分析法 SSIIA、颱風路徑、移動速度、口湖風暴潮、COMCOT 風暴潮模式、風暴潮重建

GNSS 反射計風速反演算法優化及品質評估

GNSS-R wind speed retrieving algorithm optimization

and performance assessment

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摘要

全球定位系統（GNSS）在海洋表面散射訊號受海表粗糙度影響，海表粗糙度與風速相關，海表 GNSS 反射訊號進而可被用於反演海表風速。參考 CYGNSS 技術報告自主開發的 GNSS 反射計 Level 1b 及 Level 2 風速反演系統第二版（Version 2.0, V2.0） 已經被建置，Level 1 系統產品為表徵海表發射率之參數 Normalized bistatic radar cross section (NBRCS)矩陣以及 DDM observable (DDMO)， Level2 產品為風速與海表反射率關聯性之函數 Geophysical Model Function (GMF)以及風速。

由兩種 DDMO 反演並融合之風速產品（V2.0）誤差 RMSE 約為 3.2m/s。衛星遙測風速產品誤差為 1.67m/s。故尋找現有反演系統誤差來源，逐步評估副產品品質，並提出相應因應策略，以減少誤差累計，提升產品品質成為當務之急。

反演系統分為 Level 1b 和 Level 2 兩個層級。 Level 1b 可能的誤差來源為：因採用 WGS84 地球模型未考慮平均海面高程導致的 Path delay 誤差；在校正 (calibration) power analog 過程中因硬體技術未能準確估計 transmitting power，receiving antenna gain, transmitting antenna gain 等參數，導致正規化過程中引入誤差；在採用 glistening zone 散射面積校正 ambiguity 效應過程中，對 Effective scattering area（ESA）採用的計算方法可能引入誤差；在獲得 NBRCS 後，未能做詳盡統計分析以管理數據品質等原因。 Level 2 可能的誤差來源為：因採用 ECMWF-ERA5 作為風速 Ground truth 建立 GMF，可能因 ECMWF-ERA5 dataset 本身與真值之偏差導致引入誤差；因計算效能所限，僅採用 1 日之資料建立 GMF 並應用於風速反演；因中低風速與高風速與發射率因影響物理機制不同，均有各自對應的方程（FDS-GMF & YSLF-GMF），然而在中風速（12~30 m/s ）區間兩種 GMF 若有重疊將導致一個發射率值對應兩種風速的現象出現等。

根據誤差來源，相應的因應策略有： 引入 DTU10 Mean Sea Surface Height model 以更新地表反射點位置計算及 Level1 後續產品計算；以卷積之角度更新 ESA 計算方法；以統計分析方式管理 Level 1 產品品質；整合更多可獲得的衛星，浮標風速資料作為風速 Ground truth，並考慮 mean square slope 及波浪參數之影響。

關鍵字: GNSS-R, 風速反演系統, 誤差來源分析, 算法改進

利用移動載具進行沿岸流場之最佳測繪研究

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摘　要

傳統海洋聲層析（Ocean acoustic tomography; OAT）將感測器置於觀測域外圍，僅能提供螺線向量場之資訊。鑑此，本研究提出移動載具聲層析術（Moving vehicle tomography; MVT），以基隆望海巷海灣為研究場址進行沿岸海流之測繪。MVT除了可藉由載具的移動以獲得不同角度的聲線提升測繪解析度外，隨著載具航行至觀測域內採樣，更可獲得非旋性向量場之訊息。採用開放邊界模態分析法（Open-boundary modal analysis; OMA）求解滿足研究海域的海岸線及開放邊界條件的特徵值問題，以獲得當地流場中不可壓縮流、非旋流與邊界流的特徵模態，來表示流場。為驗證方法之有效性，首先，基於海洋模式流場之數值模擬結果顯示，利用理想的來回走時差重建24小時的流場變化，傅立葉表示法之平均誤差為41.6%，而OMA表示法則降至9%；另，利用BELLHOP聲傳模組模擬近乎真實的來回走時差重建24小時的流場，傅立葉表示法之平均誤差為48.2%，而OMA表示法降至13.1%。再者，應用OMA表示法於2017年望海巷海灣現場實驗所得之來回走時差進行流場測繪；結果顯示，灣內環流流場與灣外東南向均勻流之不確定性均降低。最後，更結合了ADCP資料進行測繪，以提升流場重建準確度。

Impact of the Intra-seasonal Anomalous Circulation on an Intense Anti-cyclonic Eddy off the Southwest of Taiwan

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Abstract

In this study, the mesoscale eddy activity off southwest of Taiwan (SWTW) during winters from 2013 to 2019 are summarized by three independent data sets. The Taiwan Ocean Radar Observing System (TOROS) data with high temporal and spatial resolutions is useful to analyze the surface currents' hourly variation and define eddy centers. The results indicate that about two thirds of the total eddy activity should be anti-cyclonic and cyclonic eddies (ACEs and CEs) during past seven winters. The winter of 2016/2017 shows the strongest ACE from the TOROS-detected current, and both of drifter routes and satellite-detected sea surface height confirm the special event.

In order to further analyze the 2016 winter case, the EOF mode 1 and 2 of surface current firstly explain that a CE exists ahead of the westward-moving ACE to block its propagation for more than one month. Moreover, the vorticity budget equation depicts that the horizontal vorticity advection should be the key factor to maintain the evolution of such a strong ACE from consequently larger non-linear term driven by upstream Kuroshio. The total kinetic energy of upstream Kuroshio leads about 2.5 weeks ahead of ACE spin-up with 78.4% correlation.

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Asymmetries in Mesoscale Eddy Propagation on a Beta-Plane: Perspective from Shallow-Water Simulations

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Abstract

A reduced-gravity shallow-water model is implemented to study the propagation of mesoscale eddies on a beta-plane. Prior theoretical analyses of Davey and Killworth (1984) showed that eddy's westward drift approximately follows the long Rossby wave speed (βL_d^2), with anticyclones (AC) / cyclones (C) being faster / slower. The propagation features can be understood in terms of force balance between the beta-induced driving force (F_B) and the background Coriolis force acting on the translating eddy mass anomaly (F_C). F_B arises from the north-south variations of Coriolis acceleration associated with eddy's rotational velocity and is pointed southward and northward for AC and C, respectively. Eddy's mass anomaly is also of opposite sign, thereby requiring a westward drift for both AC and C.

It is shown that, qualitatively, eddy's zonal propagation speed derived from the numerical experiments is consistent with the theory described above. Quantitatively, AC's zonal propagation speed is well represented by the theory, but large discrepancy is found for C. Further analysis reveals that the greater zonal propagation speed than βL_d^2 for AC is mainly due to the positive correlations of eddy's height anomaly and the geostrophic rotational velocity, which reinforces F_B. The speed deviation from βL_d^2 thus increases with a dimensionless parameter characterizing the height anomaly relative to eddy's mean thickness. For cyclones, on the other hand, the theory significantly overestimates the zonal propagation speed, and the speed deviation shows no dependence on height anomaly. A large fraction of mass leakage and radiation of Rossby wave are found along the trails of cyclones, which may lead to significant energy loss and thus slow-down of cyclone's speed.

台灣島嶼陷流之研究

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摘　要

　　由於衛星遙測存在著近岸流場觀測的限制，而沿岸實測資料又僅能提供片段的觀測數據，使得臺灣周遭的近岸流場研究相對中大尺度海洋現象之研究要少許多。研究中發現 9 顆漂流浮球沿台灣西南側環繞至東北側的軌跡結果，這些浮球如同受到陷在台灣沿岸流場而移動，漂流軌跡甚至可長達半個台灣以上，此處將該現象定義為島嶼陷流。為了確認島嶼陷流的動力機制，本研究使用 Regional Ocean Modeling System (ROMS)海洋模式模擬台灣海峽流場並以模式浮子的軌跡機率分布來探討島嶼陷流與沿岸距離、潮汐、風場等因素的關係。結果顯示離岸越遠島嶼陷流的發生機率越低，從漂流浮球的移動速度也發現島嶼陷流與海峽主流有明顯的流速差異。而漲退潮在台灣西北側的往返現象會降低島嶼陷流到達台灣東北側的機率，相對在無潮汐影響下卻可以更完整的環繞台灣，且影響深度可以達約 30 公尺深。有趣的是西南風造成的艾克曼效應並不會增加島嶼陷流完整環繞台灣的機率，過強的風速反而抑制陷流的形成。在夏季經過台灣海峽的漂流浮球大多數會直接北漂至東中國海，然而沿台灣西岸漂流的浮球卻可能受到島嶼陷流影響而漂至台灣東北側。本研究希望經由對島嶼陷流的進一步認識，可以為臺灣西部沿岸的漂流物追蹤提供多一個可能路徑的參考。

南海北部^{13}C及^{14}C培養法之基礎生產力差異探討

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摘　要

　　海洋基礎生產力（Primary Productivity, PP）是海洋生態系中不可或缺的基礎能量及源頭，因此，能準確量測並計算海洋 PP 的方法是非常重要的。現今，主要實際測量海洋PP 的方法是以甲板培養法為主，而本實驗是使用更貼近海洋真實自然狀況的現場培養法。大部分 PP 的實驗中都會使用^{14}C作為示蹤劑，但是因為^{14}C為放射性元素，因此，無論是在自然環境中的實測或是實驗室中的培養工作，都會受到不同程度 上的限制。使用穩定同位素^{13}C當作是 PP 量測的示蹤劑，是另一種量化 PP 的替代方式。前人文獻中，有些使用 ^{13}C 量 PP的研究僅是透過測量表層海水的 PP，無法進一步了解整個透光層中PP的變化。本研究希望透過 ^{13}C 及 ^{14}C 現場和甲板培養法了解兩個問題：其一，現場與甲板培養法，對於PP量測的差異為何；再者，以^{13}C量測 PP 的數值，是否在低緯度海域，能與^{14}C的PP量測結果，呈現顯著的相互關係。在南海北部初步的研究結果顯示，使用13C與14C所量測出的 PP 數據中有顯著且正向的 線性關係（^{13}C-PP = 0.8014C-PP + 0.25, r = 0.93, n = 7, p < 0.01）。如蒙委員審查核予通 過執行，本計畫將以既定的航次規劃，在南海北部於不同季節配合研究船出海採樣進行研究，利用^{13}C和^{14}C不同標定法量測 PP，並進一步對其差異相互比對，進而了解 在南海北部使用^{13}現場培養法亦是一種貼近海洋真實面貌的 PP 測量。

海水中硝酸鹽測定新技術:釩還原偶氮法

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摘　要

　　海水中的硝酸鹽濃度一直是海洋化學的重要指標，但其測定卻是非常不容易的工作，目前普遍使用的方法是利用鎘銅還原管將其還原成亞硝酸鹽後再用粉紅偶氮法測定，這種方式既繁瑣、具毒性又不穩定。本文採用氯化釩作為還原劑，過程中樣水只需加入一次混合試劑，經過適當溫度處理，樣水中的硝酸鹽即可被有效的還原成亞硝酸(表觀還原率為100%)。在此條件下,硝酸鹽及亞硝酸鹽均會得到等量的粉紅偶氮化合物，即完全相等的莫爾吸光係數(equal molar absorptivity) 其值為50,000M^{-1}cm^{-1}，此法濃度範圍可至50 μM，偵測極限為0.2 μM，沒有顯著的鹽度效應及褪色反應，可用於測定各種環境水體的硝酸鹽。發展此法最大的意義是:未來可能全面取代多年來令人困擾的舊式鎘銅還原法，為海洋科學研究提供更穩定更準確的數據。

以陰離子交換樹脂分析自然水中溶解態銀物種的可能性

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摘要

　　銀為水中的微量元素，濃度約為 pM 左右，在測量前通常需先經過預濃縮才能有較高的解析度。前人文獻中提到，在海水中的銀物種主要有氯化銀複合物、有機銀複合物和硫化銀，淡水環境則以銀離子、有機銀複合物和硫化銀為主，並會受到鹽度、pH、溶氧等其他參數影響物種的分布。為了能更進一步了解銀的生地化循環，需要有一方法針對銀的物種做量測，而目前銀的預濃縮方法主要有兩種，溶劑萃取法和陰離子交換樹脂法，但是還沒有明確針對不同的銀物種分離的技術。因此希望可以利用陳威翰在 2011 年提出的有機複合─酸萃取法，結合上述兩種方法的原理，配合前處理方法的不同來分離銀之物種。

　　有機複合─酸萃取法中，在樣品中添加人工合成的有機螯合劑可以使水中的銀和螯合劑形成帶負電的螯合物，進而被滯留在陰離子交換樹脂上。根據穩定常數，此方法可能只適用於穩定常數較低的氯化銀和有機銀複合物，穩定常數較高的硫化銀可能無法透過加入螯合劑來測得，所以除了無法分離物種之外，還可能造成銀濃度的低估。為了回收水中的硫化銀複合物，實驗中試著把水樣酸化和經過紫外光消化，而經過消化的樣品相較之下有較高的回收率。因此為了達到分離銀物種的目的，預期可以藉由添加螯合劑和紫外光消化的前處理方法不同，能將水樣中的不同銀物種做區分。

Aeroplysinin-1 anti-cancer effect by inducing apoptosis via oxidative stress and regulating the expression of EMT-related proteins

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.

Abstract

Aeroplysinin-1 (Apl-1), an alkaloid of brominated isoxazoline secondary metabolite. This compound plays an important role in the chemical defense mechanism of sponges and its functions include antibacterial, antiviral, antiangiogenesis, antitumor, and anti-inflammatory effects. Apl-1 exhibited cytotoxic activity of leukemia cancer cells Molt 4 and K562, and prostate cancer cells PC-3 and Du145. However, for human non-malignant CCD-966SK cells and normal rat macrophage NR8383 cells were only weak cytotoxicity. Therefore the Apl-1 shown to cytotoxicity more selective and specific. To fully understand the mechanism of Apl-1, we further explored the precise molecular targets in leukemia and prostate cells. We found that the use of Apl-1 increased apoptosis and caused disruption of mitochondrial membrane potential (MMP) in a dose-dependent manner, as demonstrated by annexin-V/PI and Rhodamine 123 staining assays, respectively. Moreover, our discoveries indicated that the pretreatment of leukemia and prostate cancer cells with N-acetyl-L-cysteine (NAC), a reactive oxygen species (ROS) scavenger, diminished MMP disruption and apoptosis induced by Apl-1, suggesting that ROS overproduction plays a crucial role in the cytotoxic activity of Apl-1. On the protein level, the expression of inhibited anti-apoptotic proteins and upregulated pro-apoptotic protein by using Apl-1. And affect the expression of EMT protein related to cancer metastasis. Taken together, our results suggested that the anticancer effect of Apl-1 was ROS-mediated mitochondrial apoptosis and involved with regulating the expression of the EMT-related proteins.

Dynamic Speciation and Reactivity of Cobalt in a Macro-Tidal Urban Estuary

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Cobalt (Co) is an essential trace element for most of marine plankton, exhibit a complicate biogeochemical cycle in the aquatic environments. Co is mainly transported to the ocean *via* estuaries with various input sources (i.e., atmospheric input, industrial and municipal effluents, remobilization from benthic and re-suspended sediments), complex processes also occurred within estuarine mixing zone, where river water meet seawater. Earlier studies suggested that estuarine transport of Co controlled by the reactive partitioning between dissolved and particulate phases, and it may be modified by several factors, such as pH, ionic strength, redox condition. However, there are very few studies on the cycling of this trace metal in the estuary environment, while the Co budget to the ocean is now being focused. The main objective of this study is to uncover the main factors governing the distribution, chemical affinities and transformation of truly dissolved (<1kDa), dissolved (<0.45µm), colloidal (1kDa ~ 0.45µm) and particulate Co (>0.45µm) during river-sea mixing, and the effect of turbidity maximum and sediment remobilization. Samples were collected multiple times from Danshuei River estuary in various years (2001~2003, 2007, 2010, 2017) along the salinity gradient. The concentrations of dissolved and particulate Co showed complicated and elaborated non-conservative mixing behavior, fractionation of dissolved phase and particle phase were mediated by the nature colloidal materials, with significant benthic inputs induced by sediment re-suspension events. Results showed that benthic remobilization and desorption of Co from suspended particles induced by ligand competitions, appears to be the major mechanisms responsible for the non-conservative behavior and transformation of Co observed.

淡水河河口及其近海的甲烷濃度季節性變化

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摘　要

　　從1750年第一次工業革命到現今，大氣中的甲烷濃度從1750年的722ppb上升至2020年的1877ppb，而甲烷的全球變暖潛勢(Global warming potential, GWP_{20}) 在20年的時間尺度下是二氧化碳的84倍，甲烷在大氣當中的滯留時間約12年，若能了解甲烷濃度的分佈及釋放來源，並有效進行減排，則能在較短時間內看見甲烷減量的效果，目前文獻上甲烷在副熱帶河口區域的相關研究較少，因此本研究區域設置在淡水河河口及其外海，以了解甲烷在水體中的濃度分布，淡水河為副熱帶的城市河川，約710萬人口(1/3台灣總人口數)居住在淡水河流域上，此研究在河口及其近海共設置27個測站，分別在2019/11(秋季)、2020/5(春季)、2020/8(夏季)及2021/1(冬季)進行採樣，以了解甲烷濃度在淡水河河口至近海的季節性及空間性變化，研究結果指出甲烷表水濃度從河口向外海遞減，而外海表水甲烷平均濃度分別為秋季13.7nM、春季30.6nM、夏季22.3nM及冬季27.0nM，在春季時表水平均甲烷濃度呈現最高值。

不同年間雲彰隆起海域海洋環境與基礎生產力季節性變化與差異

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摘　要

　　近年來，我國政府不斷地積極開發離岸風電場，而離岸風電場的安裝與運作期間中，是否會對海洋環境與生態造成潛在影響，成為了備受矚目的議題。而海洋基礎生產者不僅具備調節氣候的能力，同時也是運轉海洋生態鏈的基石，但其除了會受到人為活動的影響外，也會因海洋環境的改變而有所變化。臺灣雲彰隆起海域為我國離岸風力發電最具開發潛力之場址，為建立評估離岸風電場開發及運轉對當地海域海洋生態之間的影響，根據 Tseng et al（2020）指出該海域於 2017 年平均基礎生產力之四季變化於時間軸上呈現類似常態分佈曲線，最高值出現在夏季，最低值則出現在冬季。然而該海域因位處北迴歸線上，於冬季之外的季節，影響其基礎生產力變動最關鍵的水體動力與可利用光等因素，於同一季節裡有相當激烈的變動，因此應累積不同年間下於相同季節的現場觀測數據，才能全盤掌握該海域基礎生產力的季節性變化。本報告分析了 2018 年利用海研二號再度於雲彰隆起海域取得之現場觀測數據，並與 2017 年相同季節進行對比。發現於 2018 年研究海域四季平均基礎生產力分別為 103±39 mgC m^{-2} d^{-1}（冬季）、747±146 mgC m^{-2} d^{-1}（春季）、994±395 mgC m^{-2} d^{-1} 與 1012±261 mgC m^{-2} d^{-1}（夏季）、368±278 mgC m^{-2} d^{-1}（秋季），與 2017 年相比之下，除了春季之平均基礎生產力存在顯著差異，其餘季節並無顯著差異。推測造成 2018 年春季之平均基礎生產力高於 2017 年春季的原因為：風場相異（2018 年為季風間歇期；2017 年為東北季風期）以及水體可利用光強度不同（2018 年日照光強度為 75.2 Einstein m^{-2} d^{-1}，明顯高於 2017 年 1.2 倍），上述兩種因子皆會影響水體穩定度與基礎生產者對光的利用度；冬季與夏季期間，影響該海域基礎生產力之物理及化學因子則無明顯改變，故基礎生產力無顯著差異；秋季之海洋環境雖有變化（2018 年水體可利用光強度與水體穩定性皆比 2017 年低；2018 年營養鹽供應量稍比 2017 年高），但平均基礎生產力無顯著差異。

夏季北南海與西太平洋間表層水總鹼度之關聯性

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　　總鹼度(Total Alkalinity)是碳循環以及碳酸鹽系統重要參數之一，然而北南海表層水分布在大陸棚、台灣海峽以及黑潮之間，其中總鹼度的分布如何受到西太平洋赤道表層水總鹼度之影響目前仍不清楚。因此本研究使用 2016、2019 以及 2020 年夏季共四次航次，採集 412 個北南海表層水樣品。結果顯示夏季北南海表層(小於 5 公尺)總鹼度為 2230.4±10.2μmol/kg，總鹼度大致隨深度增加而增加，直到深度大於 1500 米後鹼度穩定至 2416.5±5.5μmol/kg。此外，鹽度(Salinity)對深度關係圖顯示此處海水之鹽度極大值約略在 125 公尺深。而總鹼度對鹽度的關係顯示非線性之關係。為了移除海水總鹼度受到蒸發降雨之影響，我們計算 NTA(Normalized Total Alkalinity)將鹽度標準化至鹽度 35。發現 NTA 在 Sigmaθ 介於 20.5~25 時的 NTA 沒有顯著的變化，平均為 NTA=2302.7±10.9 μmol/kg，與太平洋赤道地區 NTA=2301±9 μmol/kg 的數值沒有顯著誤差，因此我們推測南海北部表層水(125 公尺)與西太平洋(150 米公尺)有非常相似的總鹼度來源。

海水酸鹼度分光法測量系統開發

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摘 要

自工業革命至今，海洋吸收了人為排放二氧化碳(CO_2)總量的三分之一，海水酸鹼度(pH 值)也隨之下降了約 0.1。為了準確評估海洋酸化，海水酸化觀測組織 GOA-ON (Global Ocean Acidification Observing Network)根據專家的經驗提出了兩個量測 pH 的準確度標準，分別是 weather goal: ±0.020 (量測生地化反應需要的準確度標準)和 climate goal: ±0.003 (量測人為造成的長期海水 pH 變化)。pH 分光光度法自 1993 年確立以來，一直被視為準確測量海水 pH 的方法，近年來自動化分光法測量的發展，讓分光法 pH 的操作更加容易、應用範圍也更廣。然而，目前高精準度的自動化測量方式大多是使用附帶光源的分光儀或是大體積(>25ml)的流動式光槽。

本研究使用商業化的微型光譜儀(Ocean Optics FLMS 12850)和光源，建立了一個半自動化微流體的分光法 pH 測量系統，減少量測時使用的樣品體積，並維持高精準度。本研究將儀器硬體設備對 pH 精確度的影響分為三個部分：光源穩定度、儀器溫度、染劑加入量誤差。光源受儀器溫度和藍光 LED 燈影響，開啟後約 30 分鐘能達到穩定狀態；儀器溫度在光源穩定後，能控制在 ± 0.15°C 以內；染劑加入量誤差的影響則是透過加入過量染劑的方式，推算使用注射式幫補加入染劑可能會造成 ± 0.00066 的精確度誤差。整體測量值的精準度為 ± 0.002。在 pH 7.600 ~ 8.450 的範圍內，此儀器(吸光值解析度：± 0.0012) 與 Cary50 分光儀(吸光值解析度：±0.0005) 的 pH 測量值差異為 ＋0.0013 (±0.0019)，小於兩台儀器的量測精確度總和(0.004)。量測 Tris buffer 的準確度誤差大約為 0.006 (Tris buffer 的配置誤差：0.005)，符合 GOA-ON 提出的 weather goal，略高於 climate goal，可用於精準的量測短時間尺度由生地化反應造成的 pH 值變化。此儀器以模組化的方式連接設備(光源、分光儀)，相較於市售的分光光度計，更方便使用者維修或更換零件。

台灣西部沿海牡蠣
對持久性有機污染物環境調查及生物累積

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摘　要

　　持久性有機污染物(Persistent organic pollutants,POP)化學結構穩定，不易分解，經常存留於環境中，並具有生物累積性及毒性，經由食物鏈累積在海洋生物體中，造成海洋生物之危害，更威脅海洋生態環境及人類健康。牡蠣生長於潮間帶及淺海的岩礁海底，為濾食性生物，蓄積污染物的能力強，直接累積紀錄當地環境污染物，極適合當成環境指標生物。本研究針對台灣西部沿海牡蠣進行PAHs的檢測，探討西部沿海(王功、台西、東石、七股)PAHs在牡蠣體內累積的含量並評估食用後之風險。初步結果顯示，野生牡蠣累積PAH (89.33~589.27 ng/g dw)略高於養殖牡蠣(73.30~328.72 ng/g dw)，以東石之野生牡蠣累積PAH量最高。致癌風險評估方面，US EPA將風險值ILCR(癌症風險指數)≤10^{-5}為最大可接受的致癌風險，目前資料顯示，各個測站均處於安全範圍。

高時間解析度之表水二氧化碳分壓自動量測浮標

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摘　要

碳循環跨越生物、土壤、海洋與大氣，其中內陸水體如湖泊及河川對全球碳循環之影響力不可忽視。高頻率二氧化碳分壓(partial pressure of carbon dioxide, pCO$_2$)連續資料有助於解釋內陸水體碳酸鹽系統的變化機制。即使目前有多種儀器可量測海水中pCO$_2$，但目前仍缺乏針對內陸水體高pCO$_2$及高變異的量測儀器。為了能滿足高時間解析度與近岸水體內的pCO$_2$量測能力，本研究設計一浮標系統以及水氣平衡器，其中電子系統使用ATmega2560單板微控器，pCO$_2$感測器為使用非分散性紅外線(NDIR)之紅外線氣體分析儀(Senseair，K30)。本研究系統性地驗證該感測器在五種溫度(20、25、35、45及55℃)下的校正曲線，及計算不同分壓梯度下之指數遞減時間(*e*-folding time)。本pCO$_2$浮標系統還跟高解析度之pCO$_2$走航分析儀(Apollo，AS-P2)比較，結果顯示兩者之間有良好關係性。此外，此系統已在實驗室、養殖池、潟湖、以及海況平穩的潮間帶成功佈放。以台南海寮紅樹林水域為例，在量測時間頻率為每10秒一筆數據下，本系統已成功取得至少70小時之連續資料。未來可望應用在pCO$_2$小於10000ppm之平穩水體中。透過以上驗證，本系統(解析度±30 ppm)與商用走航式pCO$_2$系統反應速度有良好之一致性，並具備了較佳之功耗表現及體積小之優勢，可應用於近岸水體之高時間解析度連續量測。

南海北部之季節性顆粒態有機碳通量變化

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摘　要

　　海洋中向下傳輸之顆粒態有機碳通量是控制全球氣候的重要途徑，碳通量可以透過衛星觀測之推算、佈放沉積物收集器、釷鈾不平衡法……等多種方式進行估算。前人研究指出，因現場量測資料少且無法有效約束估算的碳通量變異性，使得在計算每年全球海洋平均碳輸出量從3-17Gt都有，故如何有效約束海洋碳輸出通量儼然是重要的議題。全球邊緣海僅占海洋表面積約8%，但基礎生產力卻貢獻了整個海洋約30%之多，碳埋藏速率也較大洋來的快，因此研究邊緣海對於瞭解全球碳循環與生地化作用是非常重要的。南海是全球最大的邊緣海之一，冬季受東北季風的影響、夏季受西南季風影響、其他時間則為季節轉換期。本研究從 2017 至 2021 (7個航次包含春、夏、秋、冬)固定在南海北部深水海域，佈放沉積物實測顆粒態通量，結果顯示春季顆粒態有機碳通量為73±19 mg-C m^{-2}d^{-1}、夏季為57±20 mg-C m^{-2}d^{-1}、秋季為64±8 mg-C m^{-2}d^{-1}、冬季為64±10 mg-C m^{-2}d^{-1}。這結果呈現碳輸出通量僅有些微的季節變化，冬季因作業困難，數據較少，希望可以在新海三正式維運後，可以取得多一些冬天的數據。最後，也比較衛星估算與釷鈾不平衡法推估之碳通量，希望能夠找出不同估算方法之間的關係且更有效的約束碳通量。

臺灣近岸區域水文化學參數與溶解態重金屬的時空變化趨勢

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摘要

陸地人為活動將民生、農工業廢水排放進入河川，透過河川逕流將陸地物質輸入至海洋。欲了解兩系統交互作用對海洋生態環境的影響，近岸區域生地化學與水文參數尤為重要。近岸區域介於河川與大洋的交界，也代表著河口的延伸，顯示了陸地河川與海洋混合的訊號。此研究利用 2004 年至 2018 年總共 19 個航次，於臺灣近岸區域採集的表水樣品，分析營養鹽、總懸浮固體、溶解態金屬等資料，探討近岸區域接收陸地物質的訊號強度與時空變異。為去除近岸物質濃度受到河海水混合造成的稀釋效應，使用相關文獻中的大洋資料作為無人為、陸地影響的背景值，以外推方法估算鹽度為 0 時的物質濃度(河川終點端濃度) (C_0)，用來比較不同河川系統輸出至近岸區域的物質強度；除此之外，彙整水利署主要河川的流量資料，估算各採樣時間河川輸入至近岸的流量(Q)，計算輸入至近岸區域地物質通量(F)。整體而言，臺灣東西岸物質濃度皆有顯著的空間差異；氣候變化改變河川流量以及隨逕流輸入至近岸區域的物質濃度，假設陸地輸入源的通量固定(F)，則河川流量與物質濃度關係應為: $F = C_0 * Q$，物質濃度(C_0)會受到河川流量(Q)的增加而有稀釋作用的現象。分析結果發現，當流量增加時，矽酸鹽與懸浮顆粒濃度增加，反映出氣候變化改變了陸地風化速率與河川流量，因此矽酸鹽與懸浮顆粒是陸地風化作用的結果；磷酸鹽、硝酸鹽類以及溶解態金屬受到區域人為活動影響，物質濃度不隨流量變化而改變，表示陸地輸入源不固定，物質濃度呈現時間差異。

Immunosuppression of Pacific White Shrimps under Future Ocean Acidification

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Abstract

Atmospheric partial pressure of carbon dioxide (pCO$_2$) has been increasing dramatically after the Industrial Revolution. About 30% of anthropogenic CO$_2$ has been absorbed by the ocean, resulting in a drop of global ocean pH by 0.1 units during the past 60 years which is termed ocean acidification (OA). Predicted pCO$_2$ at the end of the 21st and 23rd centuries will be 900 μatm and 1900 μatm, lowering surface ocean pH by 0.4 and 0.5 units, respectively. Several studies have been conducted to understand the impacts of the OA on marine invertebrates, yet little attention has been paid to investigate the impacts of OA on the immune functions of crustaceans. Here, Pacific white shrimps were exposed to predicted future seawater pH conditions (7.88 ± 0.04 and 7.58 ± 0.06) and ambient seawater pH condition (8.04 ± 0.06) for 3 months. Carbonate chemistry parameters namely pH$_{NBS}$ and dissolved inorganic carbon were measured in each tank at weekly intervals throughout the experiments while immune system parameters such as Total hemocytes count (THC), phenoloxidase activity (PO), phagocytosis (PGT) and superoxide production (SOP) were analyzed at the end of the experiment. THC, PO and PGT were significantly lower while SOP was significantly higher in shrimp hemolymph under decreased pH conditions compared to that of ambient pH conditions. These findings indicate that future OA may lead to immunosuppression in Pacific white shrimps which will make them more susceptible to pathogenic diseases.

Keywords: Ocean acidification, Carbon dioxide partial pressure, pH, Pacific white shrimps, Immune functions

Evidence of microplastics in marine dried fish

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Abstract

In recent past marine microplastic pollution has gained extensive attention in the world. After small plastic particles enter the marine environments, the primary risk associated with them is their suspected bioavailability for marine organisms. The ingestion of plastics has been reported in various groups of organisms such as marine invertebrates, fish, seabirds, turtles, mammals and importantly some of these organisms are human consumables as seafood. However, it is seldom reported the occurrence of microplastics in dried fish products used for direct human consumption. This study investigated the potential presence of microplastics in dried marine fish from different countries according to their types and chemical composition which determined using microscopy and micro-Raman spectroscopy. Digesting fish samples using potassium hydroxide followed by floatation in sodium iodide solution was the method used to isolate the microplastics. Multiple types of microplastics, including fibers, fragments, and films were observed in dried fish samples. Fibers were the most common type of microplastic and consisted of more than three-fourths (79.82%) of total microplastics count in analyzed dried fish. Dominant types of polymers identified by Raman spectrometer were Polyethylene, Polyethylene terephthalate, Polystyrene, Polyvinyl chloride and Polypropylene. The highest average count of microplastic items was found in the dried fish from Japan. Our observations confirmed that microplastics have intruded the marine ecosystem thereby may enter into humans through seafood. Further investigations are required to test the sources of these microplastics and their health hazard to humans.

Keywords: Microplastics, Marine Dried fish, Polymers, Human exposure

Carbon uptake by seagrasses from Dongsha Atoll

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(R.O.C.)

Abstract

Seagrass, the only marine angiosperm is spread in coastal zone up to depth in 90m which is limited by irradiance. Even though seagrass represent 0.1-0.2% of global ocean, it plays a key role in coastal ecosystem by organic carbon production and export as its main ecological importance. It has been estimated that total net primary productivity of seagrass is 490 Tg C yr^{-1}, resulted in 120 Tg C yr^{-1}(24 %) of total export carbon. The main export components of seagrass beds are dissolved organic carbon (DOC) and particulate organic carbon (POC). In this study, we examine the carbon uptake by seagrass and measure their POC and DOC productions. Seagrass were taken from Dongsha Atoll region and planted in outdoor tanks with loose coral sand substrate along with continue nutrient effluent input and regularly monitored. DOC production rate by seagrasses and oxygen consumption rate by fallen seagrasses were monitored from late fall 2020. The preliminary result shows that 0.63 Cg m^{-3}day^{-1} of DOC was produced by 1g of seagrass and the rate of oxygen consumption was approximate 2.19 O$_2$ g m^{-3} day^{-1}. Thus, seagrass conservation and restoration is a necessary act to elevate the blue carbon strategies as a mitigation of climate changes.

Key words – Seagrass, Dissolved Organic Carbon (DOC), Oxygen consumption

以現代質譜技術分析台灣產葉型軟珊瑚之代謝體

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摘　要

　　軟珊瑚在珊瑚礁生態系中扮演著多重不同的重要角色，一方面軟珊瑚的共生藻能將光能轉換成化學能，近一步合成醣類、蛋白質等物質在食物鏈中傳遞，另一方面，軟珊瑚的枝狀或片狀結構可提供海洋生物的棲息。此外，軟珊瑚會產生不同類型的次級代謝物抵抗其他生物的捕食與競爭生存空間。隨著台灣產軟珊瑚的天然物研究資料的建立，初步分析發現軟珊瑚的次級代謝物成分似乎會隨著生長環境與地點，而有產生不同的類型差異。這是因研究人員常規的分析方法的遺漏，抑或是海洋生物物種因受生長環境刺激的表觀遺傳改變？

近年來，質譜分析技術快速進步，如基質輔助雷射脫附電離質譜照影技術(MALDI IMS) 兼具了質譜儀和顯微鏡的優點，藉由分子空間分佈的影像以觀察次級代謝物與其生理上或病理上的關連性。同時，利用質譜分子網絡分析可以了解該生物次級代謝物的化學多樣性。本研究以採集自台灣周遭海域的軟珊瑚 *Lobophytum* spp 為對象，利用現代質譜技術建立此物種次級代謝產物在生物體內空間上分布狀態，同時，分析其次級代謝物之化學多樣性。目前結果顯示軟珊瑚 *Lobophytum* spp 的次級代謝物類型與其分布組織(位置)具有特定關聯，如steroid 高度集中於觸手端，而其它 cembrane 類代謝物則顯示在於 coenosarc 端（結締組織）。此外，這些軟珊瑚所生產之次級代謝物類型，會因其生長環境產生顯著的差異性。

藉由上述技術，我們希望建立正常軟珊瑚與白化軟珊瑚的代謝體資料，進而找出評估軟珊瑚的健康指標模式，同時了解軟珊瑚次級代謝物在生態上的作用。

1. Antitumor Activity of 13-Acetoxysarcocrassolide, a Potent Dual Inhibitor of Hsp 90 and Topoisomerase II α via Oxidative Stress

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Abstract

3-Acetyloxysarcocrassolide (13-AC) is a marine cembrinoid derived from aquaculture soft coral *Lobophytum crissum* and possesses potent anticancer activity against bladder and oral cancer, gastric carcinoma with antiproliferation, antimetastasis and apoptotic induction. Additionally, the cytotoxic effect of 13-AC has also been observed against a panel of leukemia cells in our previous study, but the underlying mechanisms are still unexplored. MTT, flow cytometry and western blotting were determined the effect of 13-AC on apoptosis induction and expression of apoptosis-related protein in this study. The cytotoxic effect of 13-AC indeed induced apoptosis in Molt4 cells evidenced by cleavages of PARP and caspases, phosphatidylserine externalization as well as reduction of mitochondria membrane potential. Specifically, the blockade of apoptosis by the ROS scavenger, NAC, attenuated cytotoxicity induced with 13-AC. Further, molecular docking and immunofluorescent assay was clarified the anti-cancer activity of 13-AC involved with inhibition of Hsp 90 activity by eliciting the level of Hsp 70 and suppressing the level of its client proteins and Topoisomerase IIα in oral cancer Ca9-22 cells and leukemia Molt4 cells. Remarkably, 13-AC possessed potential antitumor activity with reduction of tumor volume (41.4%) and weight (72.5%) in *in vivo* Molt4 xenograft animal model, respectively. Collectively, we identified marine cembrinoid, 13-AC, as dual inhibitor of Hsp 90 and Topoisomerase II against several cancer cells, exerting more potent cytotoxicity to provoke apoptosis of cancer cells via enhancement of ROS generation. Thus, the present investigation could provide a new insight for the cancer therapies of marine natural product, 13-AC.

A possible underestimation of the dilution technique for measuring the growth of picophytoplankton during 24-hour incubation

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Abstract

In oceanic communities, picophytoplankton often dominates phytoplankton biomass and productivity. Diel variations in picophytoplankton abundance and growth have been well documented. Therefore, considering these variations, estimating the picophytoplankton in growth rate for 24 h incubation would result in a possible underestimation, due to longer incubation times over their growth phase. Besides, these studies may not have been able to assess the maximal growth rate within a diel cycle. In this study, the growth rates of picoeukaryotes were 0.21 and 0.06 h^{-1}, and those of *Synechococcus* spp. were 0.15 and 0.06 h^{-1} for daytime and 24 h incubation, respectively, and the values were higher at significant levels in the daytime than that for 24 h incubation. This finding suggests that estimates based on 24 h sampling may not accurately reflect the true growth rate of these populations on ecologically relevant time scales.

Using Microsatellite Markers to Study the Population Structure and Dynamics of Cutlassfish Trichiurus japonicus) in the Northwest Pacific

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Abstract

Cutlassfish is one of the important fishery resources in the tropical coasts of the Northwest Pacific Ocean, accounting for 80% of the global production. *Trichiurus japonicus* was considered to be a subspecies of *T. lepturus*, but it has recently been regarded as an independent species. It is the most common species of cutlassfish caught along the coast of this area. Despite being an important fish resource in Taiwan, there are only limited genetic studies about it. In recent years, the catch of cutlassfish in Taiwan has dropped sharply, so it is urgent to manage its fisheries. In this study, 10 novel microsatellite markers were developed from transcriptome and used to infer the population structure of T. japonicus. A total of 150 samples were collected from five locations along the coast of the Northwest Pacific. The average number of alleles in each microsatellite locus was between 12 and 25, and the observed heterozygosity was between 0.37037 and 0.86667, indicating high level of genetic diversity on most microsatellite loci. STRUCTURE analysis revealed K=4 indicating four possible clusters in these areas. However, AMOVA showed that there was no significant genetic differentiation among the five locations, suggesting population variation was unrelated to geographic locations.

Larval fish composition and vertical distribution over a seamount along the Kuroshio

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Abstract

Seamounts in oligotrophic areas, such the Kuroshio, have long been documented as biological hotspots, particularly, by commercial fisheries which recognized massive aggregations of nektonic stocks. Such productivity has not been fully explored due to the difficulty and lack of explorations of varying conditions on different kinds of seamounts. This study aimed at identifying biophysical conditions using CTD profilers, echosounder, and water sampling for chemical analysis, flow cytometry, and zooplankton collection at 3 discrete depths. Kelvin-Helmholtz billows observed during a time-series survey on the summit was coupled by a huge spike in the heterotrophic bacterial density across all depths. Overall, zooplankton biomass was 50% more abundant near the surface (43.4 ml m^{-3}) than the mean of the deeper layers on the summit. However, larval fish showed a contrasting pattern by doubling the near-surface density in deeper waters (5.7 larvae m^{-3}), and was comprised mostly by unidentified yolk-sac larvae. Mesopelagic fish, i.e. Myctophidae and Gonostomatidae, dominated the overall larval composition and showing a diel variation in density. Neritic taxa, including some epipelagic and reef-associated families were abundant on the flanks of the seamount. This study revealed that seamounts provide an isolated setting for spawning, highlighting its role as a source of fish recruits.

Keywords: Ichthyoplankton; Kelvin-Helmholtz billows; Nutrient; Seamount; the Kuroshio

Stable isotope composition utilization: the activity radius and foraging resource analysis on finless porpoise in the Taiwan strait

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Abstract

As cetaceans are the apex predators, a strong interplay would be occurred between the population size, habits of cetaceans, and marine ecological structure. The numbers of stranded finless porpoise *N. asiaeorientalis sunameri* in Taiwan strait area have been increasing in recent years, especially recorded nearby the Matsu island. The study aims to investigate whether their activity and foraging radius is related to the increased stranded numbers. Stable isotopes of carbon (δ^{13}C) and nitrogen (δ^{15}N) compositions in the tooth, muscle, and stomach contents of finless porpoises were measured to estimate their activity radius and foraging resource. On the one hand, according to the δ^{13}C profiling in different dentine growth layer groups (GLGs), we inferred that their activity radius is close to estuarine and nearshore regions. On the other hand, the δ^{13}C features in stomach contents infer that this finless porpoise might forage away from their regular habitats. Besides, the δ^{15}N compositions in stomach contents could denote the trophic level of Taiwan population is higher than that of Matsu counterpart. This study is expected to understand the possible reason for increased stranded records and provide feasible conservation information for this threatened species reported in the IUCN red list.

Keywords: δ^{13}C, δ^{15}N, finless porpoise, life history

Effects of ocean acidification on visual performance and neurotransmitter characteristics underlying the behavioral patterns of Indian medaka (*Oryzias melastigma*)

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Abstract

The partial pressure of CO_2 level in the ocean has increased from 280 μatm to approximately 410 μatm after the second industrial revolution, thus causes ocean acidification (OA). Previous studies denoted that the high level of CO_2 would affect the behavior of marine organisms. However, the related mechanisms regarding this effect are fragmentary. Fish rely on visual performance to obtain accurate information during movement. Therefore, any impairment of the visual system could have a significant impact on fish behavior. Besides, the linkage between neurotransmitters (e.g. serotonin, dopamine and GABA) and the anxiety-related behavioral responses have been extensively studied in model teleosts. Therefore, the present study aims to investigate whether those physiological responses in terms of visual performance and neurotransmitter characteristics under CO_2 treatment would affect behavior patterns in marine fish, Indian medaka (*Oryzias melastigma*).

Indian medaka were transgenerational reared in the normal (control group; pH= 8.1) and acidified (OA group; pH= 7.6) SW. The OA strain showed anxiety-like behavioral patterns under the novel tank diving test. By electroretinogram (ERG) measurement with green light (505nm) stimulation, significant variances in the vision ability between OA and control group were not observed. The transcript expressions of the optic-responsive gene, *opn1MW*, in OA strain eyes were higher than control ones. Based on the whole brain's transcriptomic profiling, the genes related to the re-uptake system in the serotonin pathway showed differential expression patterns between control and OA strain. Consequently, our study could infer that not the visual impairment but the serotonin pathway's irregular function may primarily associate with the anxiety-like behavior pattern in Indian medaka.

The adaptive significance of crustacean hyperglycemic hormone (CHH) in *Xenograpsus testudinatus* under ambient perturbations
環境擾動下烏龜怪方蟹甲殼類升血糖賀爾蒙之研究

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The shallow-water hydrothermal vent in the northeast of the Kueishan Island was characterized as an acidic and sulfur-rich environment (pH: 6.4~7.7; [H_2S]: 0~3840 μM), thus potentially stressful to general organisms. Since *Xenograpsus testudinatus* is the endemic and dominant metazoan in this system, the present study aims to explore the stress-related neuropeptides and metabolites in terms of adaptive mechanisms in *X. testudinatus*. This study applied simulated acidic (pH 6.5; [H_2S]~0 μM) and sulfide-rich (pH 8.1; [H_2S]~500 μM) treatment, respectively, to *in situ* estimate the pH value, glucose and lactate contents in the hemolymph of *Xenograpsus testudinatus*. Besides, the essential neuropeptides expressed in the eyestalk, crustacean hyperglycemic hormone (CHH) and molt-inhibiting hormone (MIH), were both examined to verify the physiological responses. UMAP and ANOVA analysis were further applied to evaluate the effects by acidic- the sulfidic-treatments. Under the acidic treatment for 3 hrs, expressions of metabolites and neuropeptides were decreased. After long-term treatment for 168 hrs, glucose content kept decreased, whereas pH value and lactate content were compensated. Neuropeptides expressions were similar to the control group. Under the sulfidic treatment, lactate content and neuropeptide expressions gradually decreased, whereas the glucose content kept stable. Consequently, the intrinsic adaptive significance underlying the reduction and consistent physiological features of *X. testudinatus* seems different from the other crustaceans that would elevate respective metabolism and responsive neuropeptides under environmental stress.

Key words: hydrothermal vent crab, acidic, sulfur-rich, artificial treatment, neuropeptides, metabolites

Long-term biogeographic changes in jellyfish hazards mirror the human imprint in the World Ocean

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Abstract

Global anthropogenic changes have transformed marine ecosystem dynamics, affecting ecosystem functioning and the services they provide to human wellbeing. These changes have promoted the proliferation of potentially harmful, opportunistic populations, such as jellyfish, which may have wide ecological and economic implications. Here, we compiled a comprehensive dataset accounting for jellyfish-related socio-economic records in Large Marine Ecosystems (LMEs) over the period 1884 – 2019. We assess the long-term, large-scale trends of the main negative jellyfish impacts on human welfare: envenomation (fatal, stinging), industrial fisheries, and powerplant operation disturbances. We used multi-scale approaches to track the jellyfish hazards dynamics and their link with the anthropogenic imprint on health of marine ecosystems. Our results unveil conspicuous changes in jellyfish hazards marked biogeographic expansion since the early 1990s after a shift in their temporal dynamics. These findings have been concurrent with the state of ocean health in the last decades. The long-term large scale pattern of jellyfish hazards stresses implied the prominent role of jellyfish as valuable indicators of the human imprint in the World Ocean.

比較塑膠微纖維及天然微纖維攝入在中南美白對蝦之累積及亞致死效應

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摘要

　　微塑膠是海洋環境中最豐富和持久的污染物之一，普遍地被多種海洋生物所攝入，其中又以纖維型態最為常見。但生物所攝入的微纖維不全然是塑膠所製成的，普遍存在環境中的天然纖維也是相當容易被生物所攝入。但在探討纖維對於海洋環境污染時往往會忽略天然纖維所造成的風險，對於比較微塑膠纖維及天然微纖維對海洋生物的影響的文獻更是相當缺乏的。本實驗使用海洋環境中最為常見的聚酯纖維以及天然棉纖維作為材料，以全球廣泛養殖物種且居住於沿海塑膠污染熱點地區的中南美白對蝦（白蝦，*Litopenaeus vannamei*)做為實驗物種，比較塑膠微纖維及天然微纖維對蝦類生理及行為的影響。本研究評估(1)白蝦暴露於塑膠及天然微纖維後於各部位的累積量、腸道內排空情形 (2)長期暴露下動物是否對於判斷難以消化的纖維與食物具有學習能力(3)長期暴露下對於泳動行為的影響。目前結果表明，白蝦攝入天然纖維數量與體重間具有正相關性，塑膠纖維則無趨勢。連續收集白蝦排遺中纖維 12 小時後，純棉纖維排出率顯著高於塑膠纖維，36 小時內兩者纖維排出率皆高達 98%以上。其餘實驗結果將在本次研討會中發表。本研究結果能首次呈現海洋甲殼類生物攝入塑膠及天然微纖維後對生理及行為影響的比較。

在實驗室培養皿中培養珊瑚:

開發研究石珊瑚生理與生態毒理學有效的實驗平台

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摘要

珊瑚礁生態系是地球上重要的生態系之一，在全球環境變遷、海洋污染等原因下，珊瑚礁正在慢慢地減少。石珊瑚為形成珊瑚礁的重要生物，預先瞭解石珊瑚的生理過程，有助於預測當海洋環境發生改變時對珊瑚的影響。然而在研究珊瑚生理反應時，需花費人力、金錢與時間建立珊瑚實驗系統缸，此方法不易觀察到珊瑚的生理狀態與即時反應。因此我們提出建立一個實驗平台，在培養皿中培養珊瑚，使用簡單的設備進行培養，在顯微鏡下能直接觀察珊瑚的狀態，瞭解珊瑚的生理學並應用於生態毒理測試，如：塑膠微粒、防曬乳、除草劑等的相關研究。本次研究使用細枝鹿角珊瑚(*Pocillopora damicornis*)作為實驗物種，從珊瑚群體剪下約 3 mm x 3 mm 的片段置於培養皿中，加入過濾的人工海水在培養箱中培養 28 天，為了找到適合的培養條件，進行餌料的餵食、不同 LED 燈及光譜、不同光照強度及比較珊瑚群體頂端及側面的珊瑚片段培養難易度，在培養的過程中觀察珊瑚是否能維持其生理及生物特徵，也確認此平台是否能培養其他珊瑚物種及測試平台應用的可能性。由結果可知將細枝鹿角珊瑚的頂端片段培養在 Illumagic 的光譜下，光照強度為 21~40μmol/m2/s，並每週餵食豐年蝦 2 次，其片段存活率高、有明顯成長及珊瑚蟲數量增加，且培養期間未出現白化或組織剝落等現象，在此培養條件下，也觀察到珊瑚片段仍進行無性生殖、形成骨骼、與共生藻共生、攝食與消化及珊瑚蟲遇到刺激有收縮的反應等生物特徵。此平台和培養條件可以培養包括細枝鹿角珊瑚等 6 種珊瑚 3 個月以上，皆有超過 50% 的存活率。在此平台中使用薄荷醇能成功誘導珊瑚白化，可知此平台能探討珊瑚與共生藻的共生和白化關係。本研究室成功建立以培養皿培養珊瑚的平台，許多實驗可以在實驗室進行，除了能減少珊瑚活體使用的數量、實驗及人力成本，也能研究珊瑚的生理學，未來也將進行生態毒理的相關測試，加速瞭解石珊瑚在面對環境改變時的生理過程。

台灣西南海域天然氣水合物富集區甲基類化合物微生物降解模式

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摘　要

　　海洋沉積物是全球最大的碳儲存庫，透過不同的微生物活動可將沉積物中有機物質逐步降解最終形成二氧化碳再次釋放回環境中，因此微生物活動為海洋元素循環中不可缺少的過程。自然環境中甲烷的生成來源包含微生物厭氧呼吸作用以及熱裂解作用兩大類別，前者因需有機物質供應，因此大多發生於地層淺處，而後者一般發生在地層深部高溫處，透過非生物作用分解地層中有機物質，再透過地層中裂隙傳送至淺層。台灣西南海域天然氣水合物富集區包含了主動大陸邊緣及被動大陸邊緣兩種穩定程度不同的地體結構。依地體構造不同，我們推論主動大陸邊緣淺層沉積物中的甲烷主要是由熱裂解作用形成，再透過裂隙移動至淺層。相較之下，被動大陸邊緣地層穩定且裂隙數量較少，缺乏逸散通道，熱裂解作用所產生的甲烷不易逸散至淺層，因此我們假定微生物作用可能為該區甲烷的主要來源。為了驗證地體構造是否為影響天然氣水合物富集區內甲烷來源的主要因素，我們使用了採集自主動大陸邊緣的四方圈合海脊及被動大陸邊緣的福爾摩沙海脊沉積物與甲醇和甲胺兩類甲烷前驅化合物混合培養進行驗證，並解析厭氧狀態下小分子有機化合物代謝途徑。結果顯示甲基類化合物降解途徑隨地點與深度有所差異，甲烷產生作用主要發生在淺層沉積物中，且甲烷濃度也隨培養時間、地點及深度而改變；經由 99 天的培養過後，我們所提供的甲醇及甲胺有 30%–80%皆轉換成甲烷，同時只有 2%–8%透過礦化作用轉換成二氧化碳。而微生物族群結構在甲醇及甲胺培養下雖有些微差異，但仍以地域性差異為主要控制因子，且在福爾摩沙海脊及四方圈合海脊中會隨時間改變誘導出不同族群增生。

The underlying mechanism of sulfidic-adaptation in vent crab (*Xenograpsus testudinatus*)

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Abstract

A cluster of shallow-water hydrothermal vents was detectable off the southeastern tip of Kueishan Island. Except for *Xenograpsus testudinatus*, a dominant species in this particular ecosystem, living organisms were rarely recorded due to the sulfur-rich significance. According to previous studies, deep-sea hydrothermal organisms rely on symbiotic bacteria to drive the chemosynthetic metabolism and transfer the inorganic/organic compound as nutrients. Whether the shallow-water hydrothermal *X. testudinatus* convergently host symbiotic bacteria that can capture chemical energy and yield a constant food source, thus affect respective distribution was investigated. The binary-choice experiment and 16S rRNA gene amplicon sequencing were performed. Although *Xenograpsus testudinatus* did not show apparent environmental preferences toward sulfidic- and regular-seawater based on the novel tank test. The metagenomics profiling showed that *Epsilonproteobacteria* and *Gammaproteobacteria* were found to be the dominant classes in the gill tissue and carapace surface of *Xenograpsus testudinatus* directly sampled in their hydrothermal vent habitat. Moreover, as for oxidation of reduced sulfur compounds, *Sulfurovum*, *Sulfurimonas*, and *Thiomicrorhabdus* were abundantly detected genus in gills. These bacteria significances in *Xenograpsus testudinatus* inferred that these symbionts require a source of sulfide as electron donors, thus reducing animal's cellular toxicity. This holobiont associated with the vents has developed behavioral-independent as well as physiological and symbiosis adaptations in this sulfidic-environment.

美麗海葵(Exaiptasia pallida)接種同源及異源共生藻

後之生長、共生藻密度及基因表現變化的研究

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摘　要

　　珊瑚與渦鞭毛藻(共生藻屬)間的胞內共生現象是維繫珊瑚礁健康的基礎。而自然界珊瑚會透過不同共生藻配對的共存性以增加其對於環境的適應力，並影響本身生理反應。為探究胞內共生現象建立的機轉及其背後的細胞與分子調控機轉，本研究以模式生物美麗海葵(*Exaiptasia pallida*)分別接種5種同源或異源共生藻(包括clade A, B, C, D, E)，並觀察共生藻進入海葵體內後，對於海葵生長的影響及共生藻密度與分佈的時序變化，同時萃取接種後0小時, 12小時, 48小時, 96小時, 7日, 14日的海葵總RNA，進行26種標的基因的qPCR反應(quantitative polymerase chain reaction)，藉以驗證標的基因在海葵與同源或異源共生藻建立胞內共生過程中的表現差異，以瞭解該基因在建立胞內共生過程中所扮演的角色。結果顯示，在本實驗的14天期間，無論是同源或異源共生藻均能進入海葵體內，但接種同源、異源共生藻及未接種對照組的海葵生長大小均無顯著差異，且僅有clade B(同源), C(異源)與D(異源)共生藻能在海葵體內存活並增殖，其中同源共生藻(clade B)在海葵體內的細胞密度最高，其次依序為clade D及clade C。依據NGS(next generation sequencing)分析的數據，共生建立初期(12小時, 48小時)表現大幅變化的基因數目大於後期(96小時, 7日, 14日)，顯示初期共生藻進入海葵細胞內會引起宿主基因表現的劇烈變動。本研究將這些表現量與未接種之對照組(0小時)差異達10倍以上的基因進行功能分類，將其分為細胞複製周期(cell cycle)、細胞骨架(cytoskeleton)、細胞外基質(extracellular matrix)、代謝(metabolism)、緊迫反應(stress responses)與物質運送(transporter)等，並從中挑選出26種海葵標的基因，進行qPCR反應。結果顯示，在接種同源共生藻的海葵體內，各標的基因qPCR數據顯著變動的時期與NGS的數據近似，不僅相互驗證也呈現NGS數據的高準確性。此外亦發現海葵接種不同共生藻時，基因表現不同，顯示海葵與不同共生藻間存在特定的交互作用。整體而言，本研究驗證及篩選出參與胞內共生的相關基因，並提供分子證據以支持海葵與渦鞭毛藻建立共生的過程可分為適應期、共生藻細胞轉移期、細胞辨識時期、共生體快速複製時期及代謝調控時期等，作為未來研究珊瑚胞內共生的基礎。

Nickel superoxide dismutase relieving photoinhibition and protecting nitrogen fixation in *Trichodesmium*

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Abstract

Trichodesmium, a major diazotroph in the tropical and subtropical ocean, provides significant amount of bioavailable nitrogen in the oceanic regions and plays an important role in driving carbon dioxide uptake into the ocean. Remarkably, the diazotroph carries out photosynthesis and nitrogen fixation simultaneously in the surface waters where light intensity can be extremely high during daytime. We found that the expression of nickel superoxide dismutase (NiSOD) is positively and reasonably correlated with total SOD activities, nitrogen fixation rates, the expression of representative photosynthetic proteins only under high light conditions. The close correlation supports that NiSOD is essential for *Trichodesmium* to cope with photoinhibition and protect nitrogen fixation. High SOD activities and Ni quotas observed in the surface water suggest high NiSOD demand in *Trichodesmium*. The capability of high NiSOD expression may explain the advantage of *Trichodesmium* in surviving and blooming in the highly stressful environment.

台灣周遭海域深海廢棄物的組成與分布

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摘　要

　　由於海洋廢棄物可能潛藏生態問題，其議題逐漸受到重視，聯合國永續發展目標 (SDGs) 更訂定2025年以前海洋汙染減量的目標，引起各國投入研究。由於廢棄物多來自陸地，因此河口、港口及大陸沿岸被認為是廢棄物堆積的熱點，受到高度重視，台灣政府與環保公民團體亦成立海洋廢棄物治理平台，著重全台近岸的廢棄物汙染監測，對深海廢棄物的了解相對有限，台灣周遭海域亦尚未有完整的深海廢棄物研究。然而，近年來的研究顯示：深海是人造廢棄物的潛在熱點，可能存在比淺海更多的人造廢棄物 (A.A. Keller et al., 2010)。本研究期建立底拖網的監測標準程序，提供政府機構規劃海洋政策之參考。

　　本研究自2019年至2021年，在台灣周遭海域共執行底拖網44次，深度介於32到3597公尺，為全球已知使用底拖網研究深海廢棄物的研究中最深的一處。全部拖網中，平均每平方公里便有5282.5個廢棄物，其重量達到每平方公里1167.4公斤；塑膠類佔總個數的95.3%，平均重量則為每平方公里11.0公斤。對比中國沿岸進行之研究 (C. Zhou et al., 2016; F. Zhang et al., 2020)，無論是全部廢棄物的平均密度，抑或塑膠類的平均重量，台灣皆較高。另一方面，深度159- 915公尺與915- 3597公尺的深海皆得到比淺海 (<159公尺) 更重的廢棄物，足見深海研究的迫切性。

　　海洋廢棄物受到地質條件、海流方向影響，在不同地貌間可能存在差異。而台灣位處弧陸碰撞區，擁有多樣地形。本次研究比較海底山、海盆、陸棚與大陸斜坡，發現各地形的廢棄物平均重量並不相同。值得注意的是，塑膠類平均重量在深度、棲地中無明顯差異，其平均個數卻會隨著深度與棲地有所變化，顯示進一步了解廢棄物搬運機制的需要。

臺灣西南海域漁業資源結構與生態系統模式建構之研究

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摘　要

　　臺灣西南海域因海底地形複雜多變，又有隨季節而變化的海流匯合，使此區形成營養鹽豐富的海域，具有生物多樣性高且生態結構複雜之特性。本研究將透過生態模型可用於計算生態指標同時解析營養位階結構特性，蒐集 2011~2016 年之臺灣西南海域各漁法之漁獲資料及港口查報員資料，分析漁業資源結構，並根據各營養階層之物種組成計算其生態系統參數如生物量、單位生物消耗量等，建置質量平衡模型並探討生態系統結構特性。透過利用 Ecopath with Ecosim 所建構之質量平衡模型結果顯示，各營養階層主要優勢物種包含烏魚、花腹鯖、鯵科與小鱗脂眼鯡等，而頂端掠食者則包含立翅旗魚和圓花鰹等優勢物種。從捕撈的平均營養位階為 3.2，看出所捕撈的物種大多屬於中高營養位階，而透過綜合生態影響力分析(Mixed Trophic Level)解析此系統內各種群或捕撈之交互關係，可以發現捕撈對較高營養階層物種對研究海域生態系都呈現負面影響，而較低營養階層物種對大部分物種呈現正面影響。另外對本研究進一步針對生態系統進行網絡分析(Network Analyze)，臺灣西南海域之系統連接指數為 0.267，平均能量路徑長為 6.12，路徑總數為 2214，後續將透過比較前述指數比較研究海域生態系統之年季別變動之規模與特性。

關鍵字：臺灣西南海域、質量平衡營養模型、生態系統結構

年代氣候變異指數對跨洋區黃鰭鮪釣獲率時空間分佈之影響

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摘　要

　　氣候變遷影響海洋生態系統為當今被重視的議題之一，又黃鰭鮪為經濟性鮪類、具高度洄游之特性且易受到海洋環境變動而改變其時空間分佈，因此本研究主要探討長時間尺度氣候變異因子對黃鰭鮪釣獲率之影響。本研究整合 1971~2010 年各區域性漁業管理組織黃鰭鮪漁獲資料並結合氣候變異因子數據，探討大西洋多年代際振盪(AMO)、太平洋十年振盪(PDO)以及北太平洋環流振盪(NPGO)對黃鰭鮪跨洋區釣獲率與分佈之影響。分析結果顯示 AMO 與大西洋、東太平洋以及西太平洋釣獲率有顯著相關；此外，西太平洋釣獲率與 PDO 及 NPGO 顯著相關且有 1~5 年的時間延遲效應。小波分析也顯示 AMO、PDO 及 NPGO 於 1971-2010 年各洋區黃鰭鮪釣獲率有 8 到 16 年的變動週期。進一步比較空間分布差異，結果顯示於 PDO 正相位年代，黃鰭鮪之釣獲率有上升之趨勢，PDO 負相位年則呈現較低值。未來本研究擬加入 AMO 及 NPGO 之相位變化，分析各區域黃鰭鮪在不同氣候變遷事件下之時空間分佈變化。

Genetic population structure of the mangrove mud sleeper

Butis koilomatodon (Perciformes:Eleotridae) in East Asia

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Abstract

Although lack of physical barriers in the ocean may result in genetic homogeneity in a variety of marine species, many other factors may contribute to the formation of genetic structures, such as pelagic larval duration, type of egg, and larval behavior etc.. *Butis koilomatodon*, a peripheral freshwater sleeper, is widely distributed in the Indo-Pacific Ocean. In the East Asia, it mainly inhabits mangrove and estuary of coastal areas. Sticky egg produced by *B. koilomatodon* may reduce the chances of its spreading with ocean currents, and discontinuous mangrove habitat may also contribute to the formation of population genetic structure. The aim of the present study is to test whether the population genetic structure is present in *B. koilomatodan* in East Asia. Fragments of cytochrome C Oxidase Subunit I (COI) and Displacement Loop (D-loop) were sequenced for molecular analyses. A total of 74 specimens were collected from 11 localities in East Asia, including eight localities from Jinshan to Zhanjiang in China (n=61), Rhan Rang and Tac Cau in Vietnam (n=10), and Tainan in Taiwan (n=3). The phylogenetic analysis revealed lack of genetic structure in COI, but two major lineages were shown in the tree based on d-loop sequences, viz. (1) all samples in Vietnam and two individuals from Tainan; (2) samples in other regions and one individual from Tainan. The mean haplotype and nucleotide diversities for all samples were 0.953 and 0.010. Bayesian skyline reveal population expansion 0.2-0.3 Mya ago (Late-Pleistocene). The historical population expansion also supported by the unimodal mismatch distribution, a significantly negative Fu's *Fs* value (-22.7; $p < 0.001$) and Tajima's *D* test (-0.7; $p = 0.249$) based on d-loop gene. The population genetic structure of *B. koilomatodon* may attribute to isolated populations during glacial period, following by rapid population expansion after the raise of sea surface level during the interglacial period.

臺灣北方海域海床構造的成因初探

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摘要

臺灣北方海域西、北側是平坦的東海陸棚，東南側與南沖繩海槽相鄰。過去研究指出，在大地構造上，此區域地質主要受到臺灣造山帶的後造山垮塌以及沖繩海槽的弧後擴張之影響，但其地形特徵與地體構造之間的關連性少有討論。本研究利用多音束水深資料與多頻道反射震測資料，進行地形與震測相特徵分析，以探討海床下的構造型態，嘗試了解不同海床構造的分布特徵與形成機制。

我們將研究區域分為北方三島區、基隆外陸棚區與基隆內陸棚區三個區域。根據多音束水深資料，海床構造特徵主要有線型與環狀兩種。最主要的線型特徵為東北-西南走向，延伸長度可至 10 公里以上。而北方三島區、基隆內陸棚區則另有西北-東南等不同走向的線型特徵，但延伸長度大多在 10 公里以下。環狀特徵則是在北方三島、基隆內陸棚區內分布數量較多，且高程差(35-66 公尺)較線型特徵為大(15-47 公尺)。根據多頻道反射震測剖面，除了上新世的半地塹盆地與斷塊廣泛可見，在淺部地層中也有許多切穿海床的正斷層分布，顯示應皆為活動構造。在基隆內、外陸棚區，地層中有多處分布在斷層周圍且具有強振幅、混亂相的訊號特徵，推測應為岩漿沿著斷層侵入而形成的岩床、岩脈等構造。在北方三島區的剖面中，有部分區域深部地層為淺部地層訊號所遮蔽；在與火山構造之分布比對後，我們推測應為熔岩流覆蓋海床所造成，表示臺灣北方海域的海床及地層可能也受到火成作用影響。基於本研究之多音束水深以及多頻道反射震測剖面，我們推測線型特徵主要反應切穿海床的斷層構造，不同走向與長度則可能是雁型排列的斷層面延伸後相互接續所形成的結果；而環狀特徵可能與崩塌有關，推測可能為破火山口或是斷層錯動而導致的崩塌地形。

上新世晚期以來，臺灣北部進入後造山垮塌階段，原先造山作用形成之逆斷層再活化為以東北-西南走向為主的正斷層。隨後後造山的岩漿活動隨著斷層上升，出露在海床形成火山、破火口地形。一系列東北-西南走向的斷層面持續延伸並相互接續，形成西北-東南等走向的次要斷層與破碎帶，而岩漿亦更容易上升侵入並噴發出海床，而在北方三島區內分布了崎嶇且有許多丘狀起伏的海床形貌。

關鍵字: 臺灣北方海域、海床形貌、多音束聲納、多頻道反射震測

由海底地震儀資料探討南沖繩海槽之熱液活動特性

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摘要

　　沖繩海槽是琉球弧溝系統作用所造成的弧後擴張盆地，在這樣張裂性的地質作用區域內常有活躍的火成和熱液活動。在過去的研究中，利用地球物理(震測、重力和磁力)、地質(岩石採樣)和實際水下觀測方法，也在南沖繩海槽內發現許多有潛力的熱液活動場址，包含火龍火山 1、火龍火山 2、石林隆堆、蓬萊斷層帶及第四與那國海丘場址等。但這些方法對於熱液相關活動分析所能涵蓋區域通常較小或是無法長期持續觀測。海底地震儀，具備一個水聽器及三分量的地動儀，可以用來持續監測天然地震及各種地動訊號，本研究即希望利用海底地震儀資料分析，來對於這些熱液活動資訊有更進一步了解。本研究分析了 2017 年 OR2-2231 航次於南沖繩海槽佈放的 6 個海底地震儀資料，記錄時間從 2017 年 4 月 7 日至 4 月 18 日，共 12 天。資料時頻分析顯示其中 3 個海底地震儀有記錄到諧波震顫(harmonic tremor)，一種常被認為與流體在火山內部的共振或火山氣體的排放有關的訊號。在測站距離小於 4 公里的情況下，諧波震顫只被單一個海底地震儀記錄，推測諧波震顫應該是由局部的活動造成。為了瞭解諧波震顫的震源特性，本研究也透過火山震顫模擬測試不同物理參數下產生的不同火山震顫，結果顯示諧波震顫在火山氣體週期性供應時才會產生。透過訊號來源定位分析搭配前人研究南沖繩海槽內部的噴氣構造位置，發現諧波震顫訊號來源與海槽內噴氣構造及海底火山的位置對應良好，且相同時段發生的諧波震顫不一定來自同一個方向，可能是熱液系統內流體遷移造成的結果。

臺灣東北海域棉花峽谷之地形與地層特徵研究

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摘　要

海底峽谷為大陸邊緣常見的地形特徵，其形成原因主要為濁流侵蝕或海底山崩所造成。棉花峽谷為臺灣東北外海一個西北-東南向的海底峽谷，連接了東海陸棚與沖繩海槽，其上游有東西兩支流，在峽谷中段匯合為一主流。過去因資料類型與品質限制，對於棉花峽谷的地形與地層特徵、相關構造與峽谷的演化過程仍未完全瞭解。本研究藉 100 與 20 公尺解析度的多音束水深資料以及多頻道反射震測資料，檢視棉花峽谷的流徑、地形及地形特徵，並討論其上游至下游的地形變化與沉積作用及構造活動間的關聯。水深分析結果顯示，峽谷全長約 136 公里，始於陸棚邊緣向陸約 22 公里處，止於陸坡底部水深約 1400 公尺處，峽谷出口後接棉花海底扇。東西兩支流形貌差異甚大：東支流長約 22 公里，由水深 600 公尺處發育，寬約 1.2 至 5 公里，下切深度約 120 至 380 公尺，頭部主要有三個小分支，皆從一崖狀地形發育，屬於陸坡限制型（slope-confined）峽谷；西支流長約 86 公里，由水深 200 公尺處發育，寬約 0.6 至 4 公里，下切深度僅 35 至 207 公尺，是一下切極淺的水道，流徑蜿蜒，有多次轉彎，屬於陸棚嵌入型（shelf-indenting）峽谷。震測分析結果顯示：東支流水道軸部有少量沉積物堆積，谷壁兩側的地層多被截切；西支流海床較無沉積物堆積，但因海床堅硬，訊號難以穿透至下部地層；主流則有多期的自然堤沉積物堆積在兩側。此外，在東支流兩側皆發現被掩埋的古峽谷分布，水道內的填充物有相似的震測特徵：水道底部為反白且混亂的特徵，中間為局部的強反射，上層則為半透明的傾斜反射。結合地形及地層分析結果，本研究進一步釐清現生棉花峽谷的範圍與流徑，及峽谷的沉積形貌：東支流目前仍活躍，其下段有小型曲流、數個半月型崩面以及階地的分布，水道內則因侵蝕旺盛，沉積物堆積的較少；西支流上段水道下切淺且地勢起伏小，可能與海床熔岩流的堅硬岩性有關，目前呈非活躍狀態，下段有小分支以及溝壑分布，顯示西支流下段有較活躍的侵蝕作用；主流水道兩側的數個階地分布、水道中崩移塊體的堆積，以及兩側的厚層自然堤沉積物皆顯示目前主流以堆積作用為主。此外，兩支流交匯處發展出較大規模的峽谷與東支流頭部的數個小分支，可能皆與下方的斷層觸發塊體運動相關，西支流則可能是沿出露在海床的火成岩體所造成的局部起伏而形成。東支流兩側被掩埋的古峽谷，其內部震測特徵、下切深度皆相似，可能為同個時期且相同作用所形成，雖然目前對其形成機制還不瞭解，但可知道古峽谷的分佈與現今的峽谷範圍並不相同。

Reconstructing the latitudinal variation of upper ocean temperature in the Okinawa Trough since the Last Glacial Maximum by using a multi-proxy approach

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Abstract

Glacial-interglacial seawater temperature evolution in the Okinawa Trough (OT) is thought to be influenced by changes in Kuroshio Current and the strength of East Asian Monsoon system. Geochemical proxies, such as $U^{K'}_{37}$, TEX_{86} and planktonic foraminifera Mg/Ca, are commonly used to reconstruct past seawater temperatures in the OT. However, different habitat depths and seasonal abundances of the source organism may result in proxy discrepancy that complicates data interpretation. Notably, TEX_{86} has been interpreted as reflecting either mixed layer or thermocline, which can be constrained by a multi-proxy approach. However, there is still a dearth of thermocline temperature and multi-proxy records along the latitude in the OT. Furthermore, previously published proxy records are based on different calibrations, making a direct and systematic comparison difficult. Here we present new multiproxy seawater temperature records from three sites (MD01-2404, GH11-2017 and GH08-2004) and recalibrate previously published records in order to generate a systematic multi-site, multi-proxy assessment of upper ocean temperature evolution in the OT since the Last Glacial Maximum (LGM). Our new records show that in the central OT, the temporal pattern and absolute values of TEX_{86}, Mg/Ca and $U^{K'}_{37}$ are in agreement, while the trend of Mg/Ca-derived thermocline temperature records is anti-correlated to its sea surface counterpart. In contrast, TEX_{86}-derived temperature time series in the northern OT are not consistent with sea surface temperature records, and the magnitude of glacial cooling derived from TEX_{86} (12.5℃) is larger than that in the central OT (4℃). According to multi-proxy records along the latitude, $U^{K'}_{37}$ and TEX_{86}-derived temperatures decrease with latitude while Mg/Ca-derived temperatures at the mixed layer and thermocline do not follow this latitudinal pattern, implying foraminifera may register different seasonal conditions at different latitudes. Our data suggest that a better understanding of the representative season and depth of proxy's source organism in the OT is essential to improve the robustness of regional upper ocean temperature reconstruction along the latitude.

運用全像儀區分水中絮凝及生物顆粒之特性:以高屏溪河口為例

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摘　要

　　懸浮顆粒的主要來源是透過河川輸送進入海洋，並於近岸河口地區扮演著重要角色，如：成為生地化訊號之載具，因此懸浮顆粒之特性在海洋生物地球化學的研究上具有一定重要性。懸浮顆粒可分為生物源、陸源以及人為顆粒三大類。其中，陸源顆粒透過物理化學作用力以及生物分泌物的膠結作用，會由粒徑較小的初級顆粒（如：黏土礦物）膠結形成粒徑較大的絮凝顆粒，其過程稱為絮凝作用。而研究懸浮顆粒的傳統採樣手法之中，除了無法從聲學、光學儀器中區分出生物顆粒以及絮凝顆粒外，實體樣本亦受限於絮凝顆粒本身容易破碎之特性，挑戰性高。因此，為了解決前述之問題，本研究運用了水下數位全像儀（LISST-Holo）並搭配傳統的現場觀測方法於高屏溪河口進行定點觀測，欲了解水體中絮凝顆粒及生物性顆粒之特性差異。

　　現場實驗於 2019 年 9 月 25 日至 27 日，利用小漁船於高屏溪河口外，水深約 11 米深的位置進行定點觀測。觀測期間，在離船 250 米處放置一浮動式平台，其上搭載自記式溫鹽深儀、都普勒流速剖面儀、現場雷射粒徑分析儀以及水下數位全像儀，以紀錄表層海水水文以及顆粒物理特性的時間序列資料。本研究團隊於船上，同時進行每半小時之水文剖面量測，以及每兩小時一次的水樣採集及現場過濾。樣本後續則進行了葉綠素、營養鹽、不同粒徑群組懸砂濃度之分析。

　　根據水文觀測，站位點於實驗期間之各種參數主要受到潮流的調控，可以觀測到兩種水團之週期性影響，分別是表層的低鹽之沖淡水，以及底層的低溫高鹽之峽谷水。退潮時，沖淡水被潮流驅動至站位點，攜帶了大量沉積物，進而產生高濁度的訊號。沖淡水所造成觀測的顆粒物理特性改變為，表層水中的顆粒質量濃度以<10 μm 的顆粒作主導；體積濃度則是以>63 μm 的顆粒作主導，而導致顆粒容積密度變低。根據全像儀觀測之統計結果，於觀測期間皆有發現生物性顆粒以及絮凝顆粒，尤其為沖淡水出現時，絮凝顆粒的數量比例會上升，甚至大於生物性顆粒之比例。根據量測之生地化參數，沖淡水內具有高營養鹽濃度及顆粒態有機碳、氮濃度，但基礎生產者的生長受限於高濁度之影響，葉綠素並無上升。顆粒態有機碳來源則推測為浮游動物以及透過生物分泌物而產生的絮凝顆粒。綜合上述，高屏溪河口表層水受潮汐的調控而被沖淡水影響，導致水體中會存在著低容積密度的顆粒。而這些顆粒大多數是以絮凝顆粒之形式存在，少數由浮游動物貢獻。

九龍江外海至台灣海峽西部海域之沉積物「從源到匯」研究

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摘　要

「宿命」(FATES)團隊於 2005 年至 2015 年，8 個不同航次，於九龍江口共採集四支重力岩心 MK1、KM4、KM6、KM7 以及於台灣海峽採集總共 151 個表層沉積物，按照本系「海岸地質及過程試驗室」之岩心分析標準程序(SOP)，藉由粒徑分析、反射色掃描、多重感應元岩心記錄儀(MSCL)、放射性同位素($^{210}Pb_{ex}$、^{7}Be、^{137}Cs)分析、以及黏土礦物分析等多重代理參數(multi-proxy)，來探討九龍江口-台灣海峽海床沉積物的沉積過程和相關的源-匯響應。

由岩心中之 $^{210}Pb_{ex}$ 剖面結果得知，除 KM6 受到擾動，其餘 MK1、KM4 及 KM7 為穩定沉降，其沉積速率依序為：0.09、0.20、0.17 及 0.24 cm/yr，以及 $^{7}Be/^{210}Pb_{ex}$ 比值表示九龍江向外輸出新鮮陸源沉積物。平均粒徑及粒徑組成百分比中，MK1、KM4 主要以黏土、粉砂為主，KM6、KM7 則以砂為主。而 MSCL 資料中發現，於近岸側的 MK1 及 KM4 磁感應率較高，靠台海外側的 KM6 及 KM7 較低，表示這些由花崗岩風化所組成的沉積物，向外輸出至台灣海峽時，被其他水團所帶來的沉積物稀釋。結合岩心反射色、磁感應率、$^{210}Pb_{ex}$ 剖面、粒徑組成於空間上的分布，九龍江外的沉積物組成似乎有其他來源的輸入，且於 KM4 及 KM6 站位點間分界，為了更進一步了解台灣海峽中沉積物的傳輸途徑及可能的來源，本研究使用沉積物傳輸模式分析 Gao & Collins Model(Gao & Collins, 1992)，利用 3 種粒徑統計參數：平均粒徑(Mean)、淘選度(Sorting)及歪度(Skewness)，找出是否有傳輸趨勢成立，以及將「宿命」(FATES)團隊成員所提供之黏土礦物資料(Xu et al., 2013)、磁感應率資料(Horng &Huh, 2011)、生物指標參數以及 151 個表層沉積物之粒徑參數進行經驗正交函數分析(EOF)，找出此分界是否存在於台灣海峽西部。

由 Gao & Collins Model 分析得出，台灣海峽表層沉積物有兩組傳輸趨勢：1.由中國大陸東南沿岸河川所輸出的沉積物，向東傳輸進入台灣海峽；2.由台灣西部河川所輸出的沉積物，並且於等深線 50m 處輻合。而 EOF 分析結果中，前三個特徵模式解釋百分比為 Mode1:61.14%、Mode2:24.28%、Mode3:9.33%；其中 Mode1 解析出以中國大陸東南沿岸河川所輸入之陸源沉積物以及由台灣海峽所輸入之非陸源沉積物的交界，並通過 KM4 與 KM6 間，與岩心結果符合，而將趨勢分析結合，此界線與趨勢分析之輻合位置穩合，表示界線確實存在，但本研究缺乏台灣海峽南邊資料，未來預計新增台灣海峽南部之資料，進行探討。

高磁力異常向宜蘭外海延伸的初探及對宜蘭熱構造隱含意義

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摘要

開發再生能源是人類追求永續發展重要的一環，地熱為穩定性高的再生能源，可作為電力基載。宜蘭平原的清水地熱於 1980 年代曾設立商轉的地熱電廠，宜蘭平原可能具有地熱發電的潛能，其地下熱源的分佈值得進一步探討。前人的研究大多將宜蘭平原區視為南沖繩海槽構造的延續，並認為南沖繩海槽目前處於弧後張裂盆地到海洋地殼擴張的過渡階段，因此宜蘭平原地下熱源可能跟弧後擴張引起的熱入侵有關。本研究擬從龜山島東側至宜蘭海脊南北嘴的磁力及熱流資料，輔以多頻道反射震測資料，探討宜蘭平原區與海域構造的連慣性。初步結果顯示蘭陽溪出海口至宜蘭海脊北嘴斷層有寬度約 5 公里的高磁力異常帶分布，多頻道反射震測剖面高磁力異常帶下方出現硬底質的訊號表現，可能為火成岩入侵岩體，熱流值也顯示宜蘭海脊北嘴斷層有偏高現象(最高為 $127mW/m^2$)。本研究未來將結合熱流的分佈，探討整個構造帶上地下流體的熱對流情形，希望能對構造帶上熱源的分佈提出合理的解釋。

關鍵字：南沖繩海槽、宜蘭海脊、磁力異常、反射震測、地熱

臺灣主要地層之熱導係數研究

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摘要

　　前人的研究認為臺灣擁有相當高的地熱潛能，地層的熱導係數為評估地熱潛能的重要參數之一，本研究將有系統性的測量臺灣地層的熱導係數，過去一年來總計費時 21 天，於西部麓山帶、雪山山脈、脊樑山脈、海岸山脈、恆春半島等地質區的主要地層露頭，鑽取直徑 6 公分、長 10~30 公分的岩心或採集岩石樣本，共計於 40 個地層中採了 105 個樣本，樣本經磨平處理後，以 ISOMET 熱導係數儀測量其熱導係數。測量結果發現，熱導係數最大值(~4.77 $Wm^{-1}K^{-1}$)為雪山山脈始新世時期的四稜砂岩，最小值(~1.14 $Wm^{-1}K^{-1}$)為西部麓山帶中新世時期的南莊層，推測雪山山脈的四稜砂岩由於其礦物組成多為導熱程度高的石英組成，因此熱導係數偏高，西部麓山帶的南莊層可能因孔隙率高，因此熱導係數偏低。另外，海岸山脈地質區整體的熱導係數是所有地質區當中最低的(~1.49 $Wm^{-1}K^{-1}$)，推測其岩石多為海洋性沉積物組成，膠結性差。若是以地理上做分類，會發現臺灣中央山脈的熱導係數皆大於海岸山脈，推測中央山脈的主要岩石多為石英含量高的沉積岩和變質岩，而海岸山脈的岩石多為雲母、黏土礦物這些導熱程度低的礦物組成。本研究所展示這些系統性的熱導係數量測結果，可提供未來研究臺灣熱流估算的參考。

關鍵字：熱導係數、地熱探勘、熱流、岩石熱傳導

Variations of Western Pacific Deep and Intermediate Water during Last Glacial Period

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Abstract

Deep water circulations are important as they regulate the global carbon storage and climate systems. During glacial periods, deep water was less ventilated than interglacial periods because of a weakened deep water circulation that affected by sea-ice coverage in source regions. Meanwhile, an enhanced forming of intermediate water was observed in the North Pacific during last glacial period down to the depth around 2000 m, so called Glacial North Pacific Intermediate Water (GNPIW). The GNPIW has great influence on atmospheric CO_2 storage/release and cause to the lower atmosphere CO_2 concentration during glacial period. However, the long-term variations of GNPIW are still lack of comprehensive discussions. In this study, a sedimentary core YK15-01 PC13, which retrieved from the Ryukyu Arc with the water depth of 2520 m, was used for investigate the long-term variations of intermediate water of the western North Pacific region. Based on radiocarbon-based ages accompanied with a volcanic eruption event, the preliminary age model revealed that the core can cover at least the last 160 ka. Proxies including redox-sensitive elements derived from XRF scanner, TC and TOC of bulk sediments and paired benthic-planktonic ^{14}C ages were used to identify the paleohydrology. The results of this study might be helpful to understand the deep water hydrology during glacial periods and identify the GNPIW distribution in the low-latitude western North Pacific.

臺灣東北部海域棉花火山熱液循環系統流體移棲模擬

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摘要

台灣東北部海弧後張裂區域已發現多處活躍的熱液場址，由正斷層或岩漿侵入活動引發的熱液流體循環作用，易於海床附近產生礦化現象，熱液流體的移棲模式有助於我們了解成礦機制。本研究以南沖繩海槽的棉花火山為研究區域，使用有限元素法三維熱模型來模擬海床下熱液的流動情形及溫度場變化。以 200 公尺解析度水深資料建立海床地形，並根據反射震測影像建構海床下熱液流體通道的幾何形貌。本模型使用多孔介質熱傳公式以及達西-布林克曼公式作為控制方程，並模擬一高滲透率的流體通道驅使的熱對流其 0.1 個百萬年的暫態模型。初步結果顯示，通道流體的上湧速度在每年 70 至 0.7 公分時，模型高熱流值與現地熱流觀測值(1.69W/m^2)相符，這個速度跟以往的研究相對較低。在參數敏感度測試中，可以發現流體通道深度及流體速度兩大變因有線性關係，而滲透率和流體速度成反比且為熱液循環中最為敏感的參數。本研究初步建立棉花火山熱液循環場址下之熱模型以期能提供探討成礦模式所需之基礎溫度資訊。

關鍵字: 熱液流體、熱模擬、地溫梯度、南沖繩海槽、有限元素法

辨認卑南溪沉積物的有機地化特徵

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摘 要

臺灣位於歐亞板塊與菲律賓海板塊的碰撞邊界上，活躍的造山運動造就許多高聳的山脈，也造成臺灣地震的發生頻率較高及地質條件較為破碎。而在東亞季風及颱風的影響下，臺灣的降雨量相對豐沛。由於臺灣的河川具有坡度陡、從上游至出海口的距離短以及流域面積小的特徵，常被稱為山溪型河川。在強降雨或颱風事件下，大量的泥沙藉由河流往下游及外海輸送，在海洋沉積物中形成所謂的快速沉積層(即事件層)。由於事件層比一般沉積層有更多來自陸源輸入的物質，所以了解陸源沉積物的特徵是相當重要的。本篇研究的區域位於卑南溪，卑南溪與花蓮溪、秀姑巒溪並稱東部三大水系，是東部重要的河川之一。並且於外海銜接了臺東海底峽谷，是陸源沉積物從陸地傳輸至深海平原的重要通道。為了釐清這些經由河川攜帶至深海埋藏的沉積物特性，我們使用多項有機碳代用指標，包含碳氮比、穩定有機碳同位素以及生物指標中的木質素。由於木質素普遍存在於維管束植物當中，加上結構穩定，較不易被生物降解，在前人研究中能夠作為植物有機碳來源的示蹤劑使用。研究中並以河床沉積物、懸浮沉積物以及土壤為分析標本，辨認沉積物中的有機地化特徵。在分析結果方面，從穩定有機碳同位素約-22‰至-30‰的偏負數值，可以推估有機碳有高比例來自浮游植物及 C3 植物的貢獻。並且在木質素用於判斷植物貢獻的 S/V 比和 C/V 比的結果上，主要是來自於被子植物的葉子貢獻。而利用木質素酸醛比的資料，可進一步推斷木質素受成岩作用的影響狀況。結果發現土壤標本比起河床沉積物具有更高的酸醛比值，顯示降雨過後沖刷土壤所帶至河川的有機質中，具有較多的降解成熟的木質素，可能為岩石風化所產生及土壤中微生物活動所影響。而河床沉積物中的木質素，則有較高比例來自於集水區內現生的植物碎屑，受到成岩作用的影響較低。結合各項指標結果的討論，有助於釐清木質素是否能做為指示深海沉積物事件層成因的有效指標，並為後續研究海洋沉積事件層的重要依據資料。

Retrieving the Hidden Wave Signals from Oceanic Ambient Noise

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Abstract

Ambient noise seismic interferometry involving the cross-correlation of continuous signals at different receivers has been widely used to retrieve the Green's functions between any pair of stations. Although many promising results have been demonstrated in recent years, there is no study has been devoted to assess the possibility for retrieval of ocean waves. The main object of this work is to answer this question whether the technique can be used to obtain the Green's function of the ocean signals. We exploit the ambient noise seismic interferometry to obtain the Green's functions of ocean waves propagating from deep-sea pressure gauges to tide gauge stations deployed in the eastern Taiwan. The preliminary results show that the obtained Green's functions do follow the shallow water equation and can be used to estimate the arrival time of the tsunami propagating from the pressure gauge to the tide stations. The comparison of the Green's function between different stacked periods can provide the potential seasonal variations of the ocean current along any pair of stations.

Binning and Regularization in 2D Seismic Data

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Abstract

Regularly-distributed traces without any missing instances are the basic prerequisites for proper pre-stack depth migration (PreSDM). As such, regularization is a commonly-adopted processing step in 3D seismic data processing. It transforms the irregularly-distributed seismic traces into the center of regular bins, and interpolates missing traces during the process. In a 2D survey, however, regularization is not as straightforward due to the low fold number in most places other than the center of the sail line. In this study, we develop a workflow for 2D regularization. We carry out the test on line MGL0908-1A, a 2D transect acquired in offshore southwestern Taiwan during the TAIGER project. This workflow first defines a 3D geometry with the sublines parallel to the sail line direction. It then selects the subline that is closest to main data distribution, and chooses the traces closest to the center of the CMP (common midpoint) bins along this subline. After binning, missing traces are interpolated iteratively in the common-offset domain and in the CMP domain. Finally, the CMP gathers are regularized to offsets with equal intervals via Fourier-domain interpolation. After 2D binning and regularization, the gathers show better event continuity and less spatial aliasing both in common offset domain and in CMP domain, which facilitates better CMP-domain multiple attenuation and event picking during the velocity model building that follows.

Deeping of Mixed Layer Depth during the Active Phase of Madden-Julian Oscillations (MJOs) in 2018

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Abstract

During the boreal winter, MJOs as organized deep convections and intra-seasonal weather systems propagate eastward along the equator of the Indian Ocean. The associated strong westerly wind during the passage of MJOs (often termed active phase) can enhance turbulence mixing via shear instability, and thereby the cooling of sea surface temperature (SST). Because the heat and moisture fluxes at the air-sea interface can be modulated by the SST variations, exploring the evolution of upper ocean structure during the MJO, i.e., the deepening of surface mixed layer depth (MLD), can improve the model forecast on the weather systems. ALAMO floats as autonomous vehicles can profile the temperature and salinity in the upper 300 m. Two floats deployed in the eastern Indian Ocean at the end of November 2018 profile the upper ocean during an MJO around the middle of December 2018. The passage of the MJO results in the rapid deepening of MLD from 20m to 50m, and the cooling of SST from 28.1°C to 27°C in five days. Because the SST cooling and wind increased to 9 m/s-1, the latent (LH) plus sensible heat flux (SH) increase from 100 to 400 W m-2. Future work will focus on reproducing the evolution of upper ocean structure in the numerical models. The results can benefit future model forecasts on the MJOs.

鵝鑾鼻背流側次中尺度渦旋之研究

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摘　要

　　為研究研究鵝鑾鼻背流側次中尺度渦旋現象，本研究分析於2020年9月使用新海研1號於該海域實驗之觀測資料，結果顯示渦旋的生成具有週期性變化，主要受到半日潮週期影響，當臺灣東南海域正值大潮期間，潮位主要是半日潮主宰，渦旋便會在漲潮期間開始形成，脫離迴流區後持續朝著下游移動，大約每間隔12小時，便會有新的渦旋接二連三地誕生，這些渦旋攜帶著低溫、高鹽、高葉綠素濃度的水，為水平空間尺度約10-20公里的氣旋式渦旋，以0.5-0.6 ms⁻¹的速度向北前進，這些渦旋特徵都與先前結合模式及遙測的研究結果(Cheng et al.(2020))相近。然而。現場實測進一步指出，次中尺度渦旋可影響的垂直深度範圍約為100-150公尺，當渦旋形成時，原本位於水深100公尺以下的低溫海水被往上抬升至約混合層深度(80公尺)，海表上層溫度同時也跟著降低，水層的等溫線被擠壓形成有如拱門般向上凸起的弧狀，渦旋向北移動後，冷水又下降回原始深度，在鹽度分布也觀察到類似的抬升變化。冷水被抬升的動力機制尚待討論，根據目前實測資料，渦旋通過觀測海域時，水層內量測到較大的紊流動能消散率($\varepsilon \sim 10^{-6}$)，有別於分層穩定大洋的紊流動能消散率($\varepsilon \sim 10^{-9}$)，推斷當渦旋通過時，產生垂直混合作用將深海的高鹽冷水提攜至海表面，由此形成了高鹽低溫的冷心渦旋。

Global Mean Sea Level Variation on Interannual-Decadal Timescales: The Climatic Connections

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Abstract

We investigate the impacts of the interannual climate oscillations on the global mean sea level (GMSL) with data derived from satellite radar altimeter observations since 1992. After removing numerically the long-term trend and seasonal variation, we conduct the cross-correlation and coherent spectrum analyses of GMSL with several climate oscillations represented by their respective meteorological indices, including El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), Atlantic multidecadal oscillation (AMO), Arctic Oscillation (AO), Antarctic Oscillation (AAO). We find: (i) High correlation between GMSL and ENSO on timescales longer than 1.5 years, especially w.r.t. the Central-Pacific type of El Niño. The reasons might be related to changes in dynamics of the ocean mixed layer and in land-sea distribution of precipitation. (ii) Moderate correlations of MSL with PDO and AMO, respectively on timescales of over 4 years and 2-10 years, and AMO's peak correlation is 8 months earlier in phase than GMSL. (iii) Weak correlation of GMSL with AO even though the altimetry data do not include Arctic sea, implying exchanges of the Arctic water with other oceans. (iv) Practically no correlation between GMSL and AAO. Finally, we least-squares fit the above five indexes to GMSL to assess the relative contribution of each oscillation in causing the interannual GMSL variations, which would lead to a better understanding of the GMSL under the on-going climate changes.

微型資料浮標的測風原理及其應用

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摘要

目前使用於海洋科學測量的浮標體積都過於龐大，並且需要大型研究船進行運送，造成人力成本過於高昂，為解決此問題，國立中央大學團隊便開發低成本、高準確性的微型資料浮標，其特點除了體積小、可準確測量一般浮標測量之波浪參數之外，也可以透過內部的微機電陀螺儀與加速度計來計算海面的傾斜度，進而計算出海面平均坡度(mean square slope, MSS)，一般而言，MSS分為順風與側風的兩個分量，且不考慮風向，與風速呈現近乎線性的變化。本研究利用海面平均坡度作為海面幾何起伏程度指標，並以岸基風速計作為比對的依據，探討海面幾何起伏程度與空氣動力觀點上的粗糙度之相關性，再根據演算的結果實際將微型資料浮標以自由漂流的形式在大洋中進行觀測。

本研究分為兩個測站，其一為永安臨海觀測站，觀測時間為颱風盛行時期:2019年8月1日至2019年8月11日共10日，此測站主要觀測項目是以WINDCUBE v2來推算在10公尺高度下的風速與特定之海表波浪參數，並且與鄰近氣象站比較，光達測出之風速與氣象站之風速的相關係數為0.69，誤差為1.2(m/s)，同時將鄰近之微型資料浮標測得的MSS做比較，來探討MSS與風速的回歸關係，分為海風方向與全部風向做比較，取得之回歸線將與白沙灣測站用於實際大洋進行觀測。

其二，將微型浮標佈放在新北市石門區白沙灣海水浴場，其地形為開口向北北西的半封閉海灣。佈放方式及永安臨海觀測站的方式一致，以水深的1.5倍長度的浮力繩連接水面的微型浮標與底床上的重塊，提供浮標隨水面自由波動空間的同時還可以確保浮標全程都在白沙灣範圍內進行觀測，避免被海流帶至外海。同步觀測分別有用於比對的風速風向資料其來自白沙灣岸邊定點觀測的氣象站，距離錨繫的微型浮標約500 m，以及中央氣象局的富貴角浮標風速測站。同步觀測時間為2020年1月19日至4月30日，共113天，並且與永安觀測站做出之回歸線同時比較後，用於實際大洋使用。

關鍵字: 微型資料浮標、風速、Mean Square Slope

利用直方圖均衡化改善微波雷達測流方法及驗證

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摘要

　　X-Band 微波雷達便於岸邊架設且具備一次性大範圍調查的優勢，對於海流的測量有其應用的價值。本文旨在降低微波雷達量測波浪時回波訊號對距離和方向的依賴性，以及如何以所得之波浪訊號反演出海流的方法。

　　本研究使用中央氣象局白沙灣近岸海象微波雷達及移動式海岸環境監測雷達於 2020 年一月底於北海岸白沙灣近海實驗所測量之海上波浪資料，藉由對比度受限自適應直方圖均衡化(Contrast Limited Adaptive Histogram Equalization, CLAHE)對雷達影像進行預處理，將若干小視窗分別強化波紋特徵，消除訊號隨距離逐漸衰弱此現象在頻率域上造成的低頻訊號以後，利用傅立葉轉換求取二維空間中一維雷達徑向上的頻率及波數，再經方向波譜得波向與雷達徑向間的夾角大小校正波長，最後以擬合受海流影響之分散關係式求得流場，並以流剖儀(ADCP)實測資料對流剖儀所在之處之雷達流速擬合結果進行驗證。

　　由於擬合法的應用頻率範圍與權重比例改變皆會影響擬合結果，根據目前所採用擬合所得之結果，比對後可以發現由雷達獲取的流速波動幅度較流剖儀來得大，但經過時間上的移動平均後，明顯可看出在雷達徑向上兩者的流速，隨潮汐變化之流速流向在趨勢上具有一致性。

關鍵字：微波雷達、直方圖均衡化、分散關係式、方向波譜

當黑潮流經海底山— 背向波、切變不穩定與紊流混合

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摘　要

為了研究綠島北方海底山周遭的小尺度海洋現象，我們於 2020 年 9 月使用新海研 1 號進行現場觀測實驗，沿著一條東北-西南向的測線做流場的掃測並同步利用紊流儀收集水文資料及紊流動能消散率(ε)。當黑潮流經此約 200 公尺深的海底山時，在科學魚探儀的回聲強度影像中，可以觀察到海底山背流側有著多樣的小尺度流體運動特徵，包括背向波(lee waves)和切變不穩定波(shear instability)等。紊流儀的觀測結果顯示，這些小尺度運動造成強烈紊流，海底山背流側的 ε 約可達 $O(10^{-5}$ W kg^{-1})，較上游處大了 2 個數量級；除了空間上的變異外，ε 的量值也隨著時間變化，目前的分析結果顯示此時間變異與鄰近的成功潮位站之水位變化有相關性。藉由分析無因次參數理查遜數(Richardson number，Ri)，我們得知在海底山周遭有多處 Ri < 0.25，即滿足切變不穩定發生的條件，且該區域的 Ri 值的機率分佈峰值大致落在 0.25 附近，此狀況符合臨界不穩定(marginal instability)的特徵。本研究也嘗試找出 Ri 與紊流擴散係數(κ_ρ)的對應關係，並與前人所得之經驗公式做比較，希望能對此區域的紊流混合提供一個較簡單的參數化方法。此外，當黑潮流經海底山，山頭後會出現近似停滯的背向波，使得背流側的水文和流場垂直結構和上游處略有不同，透過線性穩定分析，我們得到當背向波存在時，切變不穩定的成長率可以較上游處大 1.5 至 3 倍。

極度降溫對颱風強度發展之影響

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摘　要

　　長期以來，海表面溫度(Sea surface temperature, SST)響應對於熱帶氣旋的強度發展至關重要。然而，除了常規的響應外，一些颱風還可能引起海表的極度降溫(Extreme drop, ED)，預計將對於颱風強度帶來更直接的影響。本研究收集並處理北太平洋西部2001年至2018年颱風盛行期間所有颱風數據及Remote sensing system(REMSS)的海溫資料，針對極度降溫的分布特性進行統計分析，並檢驗極度降溫對颱風強度(Tropical cyclone intensity, TCI)變化的影響敏感程度，並嘗試歸納極度降溫的產生與背景環境因素(機制)之間的關係。最後，我們透過區域海洋模式(Regional ocean modeling system, ROMS)重建三個極度降溫颱風案例對應之背景環境，嘗試解析這些極度降溫範例發生之原因。透過上述研究，我們可以對極度降溫的生成機制有進一步的認識，透過統計顯示降溫與颱風強度變化之連結，整體而言，能夠用來輔助改善對於颱風強度演變之理解。

南海北部微型浮游植物生物量及藻屬之時間變化

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摘要

南海為貧脊營養鹽的開放性大洋，因此裡面的浮游生物容易受到營養鹽因子所影響，本研究透過長時間採集 SEATS (South East Asia Time-series Study，SEATS) 測站中，7 個深度 (5m、25m、50m、75m、100m、125m、150m) 的海水樣本，運用光學顯微鏡觀察此測站內藻類於各深度的分佈狀況，探討其中浮游植物的生長環境、數量多寡和生長大小之間的關係，並比對不同季節、不同時間所產生的變化，推斷南海近年來受到外在環境影響所造成海底內生態的改變。

冬季南海北部海流變化

董欣維

海軍軍官學校

摘要

　　此次我們將探討北極振盪對冬季南中國海北部海流的影 響，以及溫度是否影響海流流速，我們將以 2018 年為對 照，比對今年 1 月份出海紀錄，且今年有遇到北極振盪， 並且海流流速及流向與之前相比有所差異，所以我們打 算探討這一切原因是否和今年 1 月份北極振盪所造成的寒 流有所影響，並附上浮標軌跡圖。

海洋表層遙測與實測葉綠素之時空變化比較

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摘　要

　　植物性浮游生物量以葉綠素 a 為指標，許多研究利用葉綠素的高低來判定生物量的多寡及海洋生產力的高低，然而，海洋表層葉綠素實測與遙測值會因季節及海域不同而有所差異，因此只利用遙測的表層葉綠素作為探討海洋生地化反應的唯一指標會造成誤差。因此本研究透過 2013 年 2 月至 2019 年 11 月航次，於南海北部執行 10 次大範圍的表水樣品採集航次，以分析實測與遙測海洋表層葉綠素的時空變化。時間上春、夏、秋、冬各季節實測與遙測值依序為 0.12/0.18、0.22/0.14、0.12/0.11、0.28/0.38 (mg m-3)由此看出海洋表層葉綠素實測值於夏、冬季高於春、秋季；衛星遙測值則是春、冬季高於夏、秋季。由實測值的變化推斷，表層葉綠素濃度在冬、夏季可能是由於盛行東北季風及偶發極端天氣事件影響(如颱風、內波)，衛星的遙測數據可能因遮蔽效應(如雲層、海浪)影響，無法完全反映真實狀況。實測與遙測葉綠素值在陸棚、陸坡及海盆區分別為 0.26/0.22、0.23/0.20、0.18/0.18 (mg m-3)，結果顯示實測與遙測值的水平變化趨勢相同，但是就實測與遙測值的誤差而言，在陸棚區的誤差較顯著，造成此差異的原因可能為陸棚區水深較淺，受到再懸浮、溶解態有機物質等因素的影響較為顯著。由我們初步的研究成果顯示，實測與衛星遙測海洋表層葉綠素值在南海北部的使用上，在時空條件的變異下，冬、夏季及陸棚、陸坡區的進一步修正是必要的。

關鍵字：葉綠素、衛星遙測、南海北部

Arsenic speciation in estuary mixing zone: influence of tidal resuspension

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Abstract

Arsenic (As), is a metalloid element receiving major concern due to its toxicity. It is one of the major contaminants in aquatic environments, existing mainly as four oxidation states in natural waters, the toxicity of arsenic species depends strongly on its molecular form and oxidation state. Of those arsenic species commonly found in water samples, arsenite (As(III)) is more toxic than arsenate (As(V)). Due to its chemical similarity to phosphates, inorganic arsenics enter the food chain and microbial loop through phytoplankton and bacterial transformations, produce methylated arsenics (i.e, monomethylarsonate (MMA) and dimethylarsinate (DMA)). In recent years, we had successfully reveal the existences and diurnal-concurrent variations of colloidal As together with organic phosphorus in marine waters. Our results highlight the production and assimilation of Arsenic compounds and colloidal mediation, signify their importance in marine As and P biogeochemical cycles (Lee et al., 2017, Wen et al., 2018; Lee & Wen, 2019). In rivers and estuaries, the arsenic contents are strongly affected by geological characteristics of the drainage area and by anthropogenic inputs. The adsorption of arsenic on precipitated hydrous iron oxides plays an important role in the removal of arsenic from estuarine waters. In this study, we identified and quantified the different forms of As based on molecular weights and oxidation states, and the impacts of tidal induced re-suspension processes.

Introduction

As earlier studies showed, arsenic can be removed to sediments in estuarine system. However, little is known about releasing arsenic due to resuspension. The purpose of this study is to investigate the distribution and transformation of dissolved and colloidal arsenic during river-sea mixing, and the effects of sediment resuspension. The behavior of As in estuary is complex and dynamic. Total dissolved fraction exhibited a non-conservative estuarine addition mixing pattern but truly dissolved fraction displayed a removal pattern. Moreover, the percentage of organic and colloidal As in total dissolved As concentration changed drastically with tidal condition, ranged from ~10 nM to ~21

nM. Dynamic changes in molecular weights and oxidation states, caused by remobilizations were found in both truly dissolved and colloidal fractions during resuspension, which were due to competition reactions of complex formations, desorption from re-suspended particulate matter, and colloidal pumping. As:P mole ratio in suspended particles increased steadily with salinity from ~4 to ~8 ×10^{-3}, while in dissolved and colloidal phase showed similar pattern, a phenomenon not been observed before. Arsenopyrite seems to play a significant role in speciation dynamics during tidal mixing. In conclusion, to accurately understand the fates of arsenic in shallow estuary, future studies should aim to validate these reactions and processes in order to exactly assessed by thermodynamic modellings.

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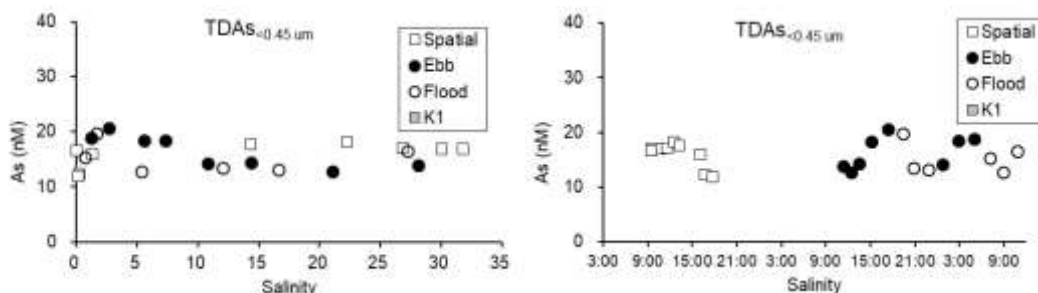Lee, C.-P., Cheng, C.-Y., and Wen, L.-S. (2017) *Limnology and Oceanography*, doi: 10.1002/lno.10560.

Figure 1. Variations of total dissolved Arsenic (<0.45 μm) in Danshuei estuary.
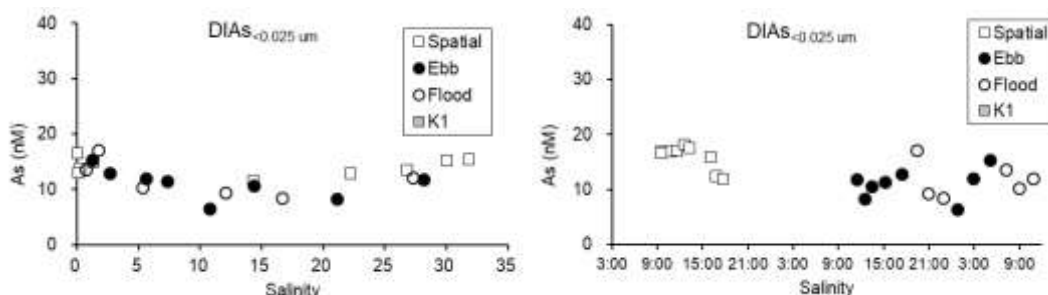

Figure 2. Variations of truly dissolved inorganic Arsenic (<0.025 μm) in Danshuei estuary.

The signals difference of ^{14}C and ^{236}U:

the perspective on the coral

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Abstract

Between 1946 and 1958, several nuclear weapon tests operated at the Marshall Islands, in the center of the Pacific Ocean. The tests released anthropogenic nuclides, such as ^{14}C, ^{137}Cs, ^{236}U, ^{239}Pu, into the environment. The nuclides were transported by the ocean currents, giving us chances to study paleo-ocean circulation. However, the nuclides formed differently and chemically distinct, possibly leading to different transport pathways. Coral skeletons can record the variation of the anthropogenic nuclides during calcification. Previous studies show that in the Caribbean Sea, the time of maximum ^{236}U is similar to the ^{14}C signal. However, the maximum of ^{236}U in the Japan Sea was about ten years earlier than the ^{14}C peak in Kenting. Despite differences in arrival times at different regions, the possible differences between the two nuclides' at the same site in the western Pacific was never evaluated. This study examines records of ^{236}U and ^{14}C nuclides during 1940s to 1970s in one *Porites* coral core, collected in Siaowan, Kenting, in 2006. Combined with the U-Th absolute dating techniques and oxygen stable isotope records, we have reliable arriving times of the ^{236}U and ^{14}C signals. Here, coral records show that the ^{236}U arrived at Siaowan before the arrival of the ^{14}C, with a lead-time of about 4-5 years. We aim to push our sampling frequency to a seasonal resolution to unravel possible mechanisms that lead to the arrival time difference. In addition to the nuclides formation process, chemical properties, and different transport pathways, we also consider that the ocean carbon reservoir could be a factor in the unsynchronized ^{236}U and ^{14}C signals.

鯨豚體內持久性有機汙染物的累積-藍鯨

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摘　要

　　本研究為台灣首次擱淺藍鯨累積持久性有機汙染物在鯨脂之含量分析。由全國鯨豚擱淺救援計畫報告指出，台灣鯨豚擱淺的數量呈現逐年增加趨勢，而造成鯨豚擱淺的原因尚未確定。環境汙染物累積(包括，持久性有機汙染物POPs, Persistent Organic Pollutants)被列為造成鯨豚擱淺的原因之一。持久性有機汙染物具有持久性、親脂性、生物累積性、及高毒性等特性，而鯨豚之獨特脂肪貯存器-鯨脂，造成有機汙染物容易累積，加諸鯨豚的壽命長，處於海洋食物鏈特殊的哺乳動物，因此了解鯨豚體內持久性有機汙染物的含量，將有助於了解海洋中持久性有機汙染物的汙染狀況及鯨豚受到持久性有機汙染物的危害程度。本研究結果顯示，本次擱淺藍鯨鯨脂脂肪含量為22.6%±0.4%，游離脂肪酸以單元不飽和脂肪酸含量最高(68.0%±1.5%)。在持久性有機汙染物含量上，以PCBs 和DDTs含量最高，分別為302.0±34.1 ng/g lw(脂肪重)和304.1±17.3 ng/g lw，其餘依序為PAHs(41.7±10.0 ng/g lw)、HCB (33.4±11.6 ng/g lw)和PBDE(7.2±1.2 ng/g lw)。其PCBs汙染量遠低於台灣其他擱淺鯨豚，與智利和挪威擱淺的藍鯨相當。危害分析結果顯示，此藍鯨PCBs的累積量不足以造成其生理上的危害。

Optimization of ^{236}U analysis:

UTEVA recovery and homemade reference materials.

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Abstract

Anthropogenic ^{236}U released in the late 1940s through 1950s during bomb tests is a powerful new ocean tracer to reconstruct the hydrological circulations in the past 80 years. With a breakthrough in the analytical technique, we can measure the ^{236}U/^{238}U in coral skeletons with femtogram of ^{236}U by the Multi-Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS) at the National Taiwan University (NTU). To ensure long-term analytical consistency and to improve an efficient sample preparation procedure, we prepared three new homogenized homemade reference materials, a ^{236}U-containing modern coral (Coral-M2), a ^{236}U-depleted fossil coral (Coral-F2), and a ^{236}U-free Marble (All-7). We optimized purification protocols, including uranium coprecipitation with iron hydroxide and the column separation of U from interfering elements. First, we adjusted the iron (Ⅲ) solution to generate a suitable amount of iron precipitates to increase the uranium coprecipitation efficiency. Second, we monitor the pH of the sample when adding ammonium hydroxide carefully. The final pH regulates the efficiency of coprecipitation of uranium onto the iron oxides. Currently, we were able to obtain a uranium recovery of 80% on average. The other part of the optimized protocol is chromatography. We will modify the eluent from pure HCl to added drops of HF and $H_2C_2O_4$. We anticipate increasing the uranium recovery further. Our next aim is to accomplish stabilized uranium recoveries to reduce errors from inexperienced operators. We will apply the modified protocol to process seawater samples.

Reference

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黑潮中微型塑膠濃度之空間分佈

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摘　要

　　目前全球每年生產超過3億噸的塑膠，每年約有800萬噸的塑膠廢棄物被排入海洋，且在物理及風化過程下形成微型塑膠(< 5.0 mm)。這些微型塑膠具有長程跨境傳輸及攜帶病菌或污染物的能力，對海洋生態造成負面衝擊。然而，臺灣附近海域之微型塑膠相關研究仍然欠缺。有鑒於此，本次研究於2019/9/23-2019/9/29期間利用330 μm網目之蝠網採集器調查臺灣東部海域的塑膠微粒濃度分佈情形。研究結果顯示，測站之濃度範圍為未檢出(N.D.)至0.15 items/m3，平均濃度為0.05 ± 0.02 items/m3。濃度分佈則呈現近岸較離岸高，且宜蘭南方澳之離岸高於花蓮及臺東富岡漁港外海。臺灣東北角之順時針海流則可能牽引西半部的水流並帶入塑膠廢棄物，致使宜蘭南方澳沿岸至外海出現較高微型塑膠濃度。此外，本研究利用黑潮具有較高溫高鹽環流之特性，以判斷採樣點位是否位於黑潮範圍中，進而評估微型塑膠進入黑潮環流之情形。從溫鹽數據可知於部分測站位於黑潮範圍，且有較高微型塑膠之濃度，由此可說明臺灣東部海域之微型塑膠不僅分佈於沿海區域，也存在於黑潮主軸中。該研究提供微型塑膠輸入海洋環境後，可進一步長程傳輸進入西北太平洋環流系統的證據。

2020 年台灣沿近海水 ^{134}Cs 及 ^{137}Cs 之分布

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摘要

來自大氣沉降以及 2011 年的福島事件，是在西太平洋上主要的人工放射性銫核種的來源，然而在黑潮以及台灣海峽中之放射性銫核種資料仍不足夠。本研究在 2020 年間，調查台灣鄰近海域中海水 ^{134}Cs (半衰期 2.06 年)以及 ^{137}Cs(半衰期 30.2 年)之活度濃度。調查結果顯示，所有海水 ^{134}Cs 皆低於偵測極限(0.5 Bq·m^{-3})。海水中 ^{137}Cs 之平均活度濃度在表層水(深度 0-5 公尺)為 1.2 Bq·m^{-3}，在深度為 50-150 公尺之間時，^{137}Cs 活度濃度則介於 1.2 至 1.5 Bq·m^{-3} 之間，深度深於 200 公尺海水中，則為 1.6 至 1.7 Bq·m^{-3}。

^{137}Cs 與σ_θ(位密度差、potential density anomaly)之間的關係顯示，海水中 ^{137}Cs 之極大值出現在σ_θ: 24.8 至 26.1 kg·m^{-3} 之密度層。該密度層與西太平洋亞熱帶典型水(subtropical mode water)以及中典型水團(central mode water)之特徵一致。這項主要結果與前兩年之結果一致。此外，即便表層水的 ^{137}Cs 平均值仍與前兩年之平均值相近，本年度在表層水中並未發現前兩年所發現之 ^{137}Cs 次高值。綜上，^{134}Cs 及 ^{137}Cs 在各深度之測量結果都低於原子能委員會之調查基準值(2000 Bq·m^{-3})。

以稀土元素組成特徵探究海洋氣膠中的汙染來源

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摘要

東海每年於冬春兩季接受大量東亞人為氣膠輸入，為研究人為氣膠傳輸對於海洋表層生地化影響的絕佳場域。 稀土元素（REEs）為系列具有相似性地化行為元素，（其中用於如：煉油製程、汽車排放觸媒），可成為分辨氣膠人為汙染來源的追蹤工具。 本研究於 2019 年九月至 2020 年八月期間在馬祖及彭佳嶼兩測站進行不同大小粒徑氣膠採樣，五種粒徑分別為 0.45-0.95，0.95-1.5，1.5-3.0，3.0-7.2 及大於 7.2 µm，並分析樣品中稀土元素及微量金屬濃度。 兩個測站總稀土濃度（ΣREE）大致上在秋、冬兩季呈現較高濃度，而春、夏季呈現相對低濃度。兩測站氣膠中總稀土濃度隨著粒徑增加而增加，主要來自於粗顆粒自然陸源的貢獻，但輕稀土/重稀土比值（LREE/HREE）則隨著粒徑增加而減低至陸源地殼比值（約 11.7），其中彭佳嶼測站粗粒徑樣品呈現高於地殼比值具輕稀土富集現象。兩測站粒徑小於 3.0 µm 氣膠中 La/Ce 及 La/Sm 比值（最高值分別為 1.2 及 30.3 於彭佳嶼）明顯高於陸源地殼比值（分別為 0.5 及 6.9），由於煉油製程觸媒富含 La 元素，經煉油製程排放或進入石化產品後燃燒排放導致比值升高，顯示其主要來源為煉油或是燃油排放顆粒。而兩測站粒徑大於 3.0 µm 氣膠中 La/Ce 及 La/Sm 比值接近陸源地殼值加上 La/V 及 Co/V 比值較高，顯示自然陸源顆粒影響外，極可能來自於燃煤飛灰影響。 由 REE 組成及其他金屬比值顯示，東海粒徑小於 1.5 µm 氣膠主要來源為如燃油電廠或船舶燃油排放，而粒徑大於 3.0 µm 氣膠來源除包含自然陸源輸入還含有燃煤飛灰排放顆粒。

使用硫摻雜的石墨氮化碳/溶菌酶澱粉樣原纖維去除水中的汞離子（II）

洪家豐、譚漢詩

摘 要

　　汞是重金屬之一，廣泛用於工業，醫療和農業。但是，汞離子（Hg^{2+}）甚至在低濃度下也顯示出高毒性和生物蓄積能力，這會引起環境和人類健康問題。因此，有必要從水性環境或臨床液體中鑑定並去除Hg^{2+}。目前，已研究了吸附，化學沉澱，脫鹽，電滲析，氧化/還原等服務方法對Hg^{2+}的吸收和去除。考慮到吸附效率，低成本和優異的修復效果，此處提供了一種很有前途的技術。在這項研究中，我們合成了一種含硫吸收劑，用於從水溶液中去除Hg^{2+}：硫摻雜的石墨氮化碳/溶菌酶澱粉樣原纖維（S-g-C_3N_4/LAF）。通過硫脲熱解合成S-g-C_3N_4。硫可以大大提高Hg^{2+}的吸附性能。LAF被引入吸收劑中，並增加了表面體積比。S-gC_3N_4/LAF的主要形態是通過能量色散X射線光譜（EDS）和掃描電子顯微鏡（SEM）確定的。使用ICP-MS用0.05g S-g-C_3N_4/LAF和1 ppm的初始Hg^{2+}濃度研究了pH（1-12）對汞的吸附效果。EDS結果表明，S-g-C_3N_4由元素C，N，O，S組成。SEM圖像表明，S-g-C_3N_4均勻分佈在LAF細絲上。隨著pH值的增加，汞的吸附量也增加了。對於即將進行的實驗，我們將使用X射線衍射（XRD）光譜表徵吸附劑的晶相。為了驗證Hg^{2+}的吸附，我們將使用X射線光電子能譜（XPS）。將研究g-C_3N_4，S-g-C_3N_4，S-g-C_3N_4/LAF的其他理化作用，例如pH，接觸時間和溫度。

Biological pumps of carbon, nitrogen and phosphorus in the northern South China Sea

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Abstract

This report presents the measured biological pumps (BPs) of carbon (C), nitrogen (N) and phosphorus (P) and their response to seasonal and event-driven oceanographic changes in the northern South China Sea (NSCS). The BP is defined as the sum of active and passive fluxes of biogenic carbon in the surface layer, which may be considered as the central part of marine carbon cycle. These active and passive fluxes of N and P were also considered to understand stoichiometric flux patterns and the roles of nutrients involved in the BP. The magnitudes of total C, N, and P fluxes were respectively estimated to be 71.9–347 (mean: 163) mg C m^{-2} d^{-1}, 13.0–30.5 (mean: 21.6) mg N m^{-2} d^{-1}, and 1.02–2.97 (mean: 1.94) mg P m^{-2} d^{-1}, which were higher than most previously reported BPs in open oceans, likely because a quarter of the BPs was contributed from active fluxes that were unaccounted for in BPs previously. Moreover, the passive fluxes dominated the BPs and were estimated as 65.3–255 (mean: 125) mg C m^{-2} d^{-1} (76.7% of total C flux), 11.9–23.2 (mean: 17.6) mg N m^{-2} d^{-1} (83.0% of total N flux), and 0.89–1.98 (mean: 1.44) mg P m^{-2} d^{-1} (74.2% of total P flux). Vertical fluxes of dissolved organic C, N, and P generally contributed to less than 5% of passive fluxes. The contrasting patterns of active and passive fluxes found between summer and winter could mainly be attributed to surface warming and stratification in summer and cooling and wind-induced turbulence for pumping nutrients into the euphotic zone in winter. In addition to seasonal variations, the impacts of anticyclonic eddies and internal-wave events on BP enhancement was apparent in the NSCS. Both active and passive fluxes were likely driven by nutrient availability within the euphotic zone, which was ultimately controlled by the changes in internal and external forcings. The nutrient availability also determined the inventory of chlorophyll a and new production, thereby allowing the prediction of active and passive fluxes for unmeasured events. To a first approximation, the SCS may effectively transfer 0.208 Gt C yr^{-1} into the ocean's interior, accounting for approximately 1.89% of the global C flux. The internal forcing and climatic conditions are likely critical factors in determining the seasonal and event-driven variability of BP in the NSCS.

歡迎光臨! 中央研究院 海洋生地化核心實驗室

Grand Opening! Marine Biogeochemistry Core Lab at Academia Sinica

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Abstract

Marine Biogeochemistry Core Lab was established at the RCEC of Academia Sinica in early 2021. The major objective of the Lab is to provide Taiwanese oceanographic community and Academia Sinica with a high quality service platform for biogeochemical core parameter measurement. Currently, the serving items include major nutrients (nitrate, nitrite, phosphate, and silicate), POC/PON, and phytoplankton pigments. Taking the advantage of this meeting, we shall introduce the application procedures, charges, related analytical methods, and data archive policy. Welcome to the new opened Marine Biogeochemical Core Lab at Academia Sinica.

摘　要

中央研究院海洋生物地球化學核心實驗室已於2021年初正式開放服務，服務對象為中央研究院及台灣海洋學界，實驗室成立目的為提供一個高效率、高品質的海洋生地化參數分析平台。　首先開放的服務項目為主要營養鹽、顆粒性有機碳/氮及浮游植物色素濃度三項參數，其他參數將陸續加入。　藉由海洋年會，我們在此介紹服務申請方法、收費方式、相關分析方法以及數據保存政策。

歡迎光臨! 中央研究院海洋生地化核心實驗室。

海洋生地化核心實驗室營養鹽測定的新日常

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摘　要

　　中央研究院海洋生物地球化學核心實驗室旨在提供學界高效率且高品質海洋生地化核心參數分析服務並進行相關分析方法優化。　針對海水硝酸鹽測定，目前的主流方法是以鎘銅還原法加Griess反應進行測定，但鎘為列管毒化物且其還原率易變動或衰退，進而影響分析品質；本實驗室經反覆測試釩(V)還原法，使用V-Griess預混試劑批次測定樣品，已完成方法建立，新方法除了測值穩定外，亦大幅減少測定時間。　針對其他營養鹽分析，本實驗室同時發展時序注入自動分析方法(Sequential Injection Analysis, SIA)，對樣品取樣、藥劑加入混和、檢量線製作、分光光度計測定及電腦數據記錄等過程均完全自動進行。由於SIA自動注射筒具備控制時間及體積的高度穩定性再加上相當低的稀釋效應，因此具備極高度的再現性及較佳的偵測極限。　本實驗室採用V-Griess預混試劑及SIA方法測定海水營養鹽有下列優勢：第一、當日可完成所有營養鹽測定，無需回水或再回融。　第二、採用V-Griess預混試劑，硝酸鹽樣本測定每日可達150個，為流動注入分析的5倍量。　歡迎體驗營養鹽測定的新日常!

分光光度法測量 pH 值的校正：指示劑的不純度與添加效應

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摘　要

在碳化學研究中準確地量測 pH 值，對於觀察海洋酸化並解釋其化學和生態影響至關重要。在近幾年文獻提到，市售的間甲酚紫指示劑(meta-cresol purple, mCP)大部分中都含有雜質，而純化過的 mCP 市面上並無販售。又因指示劑呈酸性，對 pH 的量測亦有影響。所以我們應用 Douglas and Byrne (2017)中的方法，排除雜質對 pH 值測量影響的效應結果去進行校正，並以#185 標準海水驗證經校正後的數值是否會更接近真值。此外，針對 mCP 添加的效應，則以兩倍 mCP 添加法來校正，我們測試了六個不同的 pH 的樣品(7.4、7.6、7.8、8.0、8.2、8.4)分別進行添加兩倍 mCP 及添加一次 mCP 分析測試進行校正，並以#185 標準海水驗證經校正數值的準確性。結果顯示，添加兩倍 mCP 校正相對於未純化 mCP 的校正來的更為準確。

東海顆粒態與溶解態基礎生產力初探

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摘　要

　　海洋基礎生產力在海洋佔有重要地位。它代表著植物性浮游生物將無機碳轉換為有機碳的能力。基礎生產力分為顆粒態基礎生產力 (Particulate Primary Production, PPP) 與溶解態基礎生產力 (Dissolved Primary Production, DPP)。顆粒態基礎生產力為生物光合作用後的有機生物體，其能量會隨食階向上傳遞；而生物光合作用的同時，會釋放有機碳到水體，其為微生物循環圈重要的能量來源，我們稱之為溶解態基礎生產力。DPP 作為微生物循環圈的重要能量來源，其研究卻為數不多。因此為了瞭解東海光合作用有機碳通量的空間分布，我們在 2019 年夏季對東海進行了大範圍顆粒態和溶解態基礎生產力的調查。結果顯示，長江沖淡水的注入主導了東海陸棚的生產力分布。高生產力出現在低鹽、高營養鹽的近岸區域；而靠近黑潮主流的大洋區域生產力則較低。詳細來說，PPP 介於 118.76 至 801.97 mgC m^{-2} d^{-1} 之間，平均為 299.64 ± 175.73 mgC m^{-2} d^{-1}；DPP 則是介於 176.76 至 1251.75 mgC m^{-2} d^{-1}，平均值為 432.24 ±318.52 xxx mgC m^{-2} d^{-1}。胞外釋放百分比(PER；定義為溶解態基礎生產力佔總基礎生產力的百分比)介於 35 % 與 81 % 之間，平均值為 57% ± 12 %，顯示在東海有超過一半以上的光合作用有機碳是以溶解態的型態作為異營性細菌的碳源。這樣的結果可能使我們必須調整過去微生物生態系以攝食食物網為主要架構的想法。

湧升強度對東海南部海域表層碳酸鹽系統之影響：初探

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摘　要

　　台灣東北外海的湧升是常年性發生的物理海洋現象，而表層所觀測到的冷水團主要是由黑潮次表水所貢獻，其強度主要受到黑潮與海底地形交互作用所控制，黑潮次表水在上湧過程中與鄰近海域水團進行複雜的生地化反應。然而，過去研究並沒有系統性的討論湧升強度對此海域碳酸鹽系統之影響。因此，本研究分別在2017年與2018年7月測量東海南部海域的總鹼度 (TA)與溶解無機碳 (DIC)，並且透過表水溫度差 (湧升邊界溫度[高溫]-湧升中心溫度[低溫])定義湧升強度。由2017年資料說明，因高溫高鹽的西太平洋海水由表層入侵至研究海域，使湧升強度減弱，觀測到表層海水中TA與DIC數值分別為1971與2261 $\mu mol\ kg^{-1}$。由2018年結果顯示，當湧升強度較強時，高DIC與TA的次表層海水 (75 m以深)可直接輸送至表層 (5 m以淺)，湧升後可直接增加表水中DIC與TA (表水TA數值與DIC濃度分別為1992與2268 $\mu mol\ kg^{-1}$)，進而影響表層碳酸鹽系統。湧升強度對東海南部海域表層碳酸鹽系統之影響仍需進一步分析。

Rapid Detection of Perfluorinated Sulfonic Acids (PFSs) Through Preconcentration by Bubble Bursting and Surface-Assisted Laser Desorption/Ionization (SALDI)

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Abstract

Perfluorinated Sulfonic Acids (PFSs) have been widely used in industry since the 1940s. The release of large amounts of PFAS in water systems was thought to cause many health concerns, such as cancer. There is critical need a rapid and efficient method for PFS analysis. In this study, we developed a bubble-based preconcentration that mimics the sea-spray aerosol enrichment in nature. The aerosol droplets contained enriched PFSs, which were generated through bubble bursting and collected. The droplets were subjected to PFS analysis of perfluorohexane sulfonic acid (PFHxS) and perfluorooctanesulfonic acid (PFOS) through SALDI mass spectrometry; silver nanoplates (AgNPts) were assisting materials. The method was highly efficient, with an approximately three-order magnitude enhancement (5×10^{-13} to 1×10^{-11} M). Ultralow PFS concentrations (0.5 ng/L of PFOS; 0.4 ng/L of PFHxS) were detected in preconcentrated tap water containing PFSs. Our method has potential for rapid real-world PFS detection in water.

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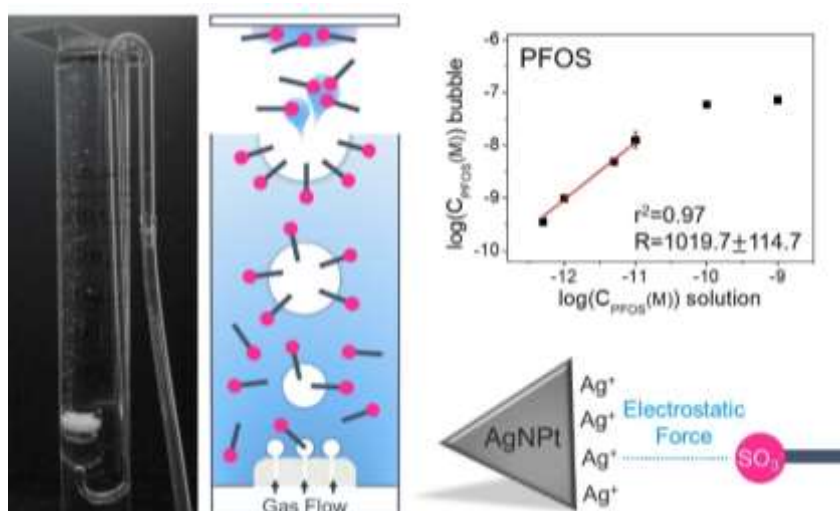
利用耳石形態判別臺灣沿近海帶魚屬物種之可行性研究

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摘要

　　帶魚為臺灣沿近海域重要的漁業資源之一，然在型態分類上較難有效判別，且各魚種生活史參數缺乏造成漁業管理政策尚難制定。過去研究顯示耳石形態可用來判別種類和系群，亦有作為環境指標的潛力。本研究比較臺灣帶魚漁獲物中常見的日本帶魚（*Trichiurus japonicus*）、南海帶魚（*Trichiurus nanhaiensis*）及白帶魚(*Trichiurus lepturus*)等三種帶魚之耳石型態差異，分析耳石樣本數分別為 422 顆、136 顆及 26 顆，總計分析樣本數為 584 顆。採樣時間為 108 年 11 月至 12 月及 109 年 3 月至 7 月。以帶魚魚體外觀及分子鑑種結果為依據，分析耳石之形質資料結合傅立葉分析所得輪廓參數，用以判別三種帶魚種類，結果由耳石形質參數配合傅立葉分析之交叉驗證判別正確率可達 92.6%，未來可作為判別三種帶魚魚種的方法之一。

關鍵字：帶魚、耳石形態、傅立葉分析

海生館救援海龜攝食選擇性分析與攝入廢棄物可能之健康影響

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摘要

　　本研究以國立海洋生物博物館收容海龜做為研究對象、結合活體排遺收集與死亡解剖、分子生物學、動物行為學、及獸醫學方法探討廢棄物攝入對海龜健康影響之研究。實驗一進行活體海龜行為分析，主要探討海生館收容海龜對於廢棄物與其食物之選擇性。實驗二進行救援海龜排遺中及屍檢腸胃道中海洋廢棄物長期監測，並探討海龜生物及非生物因子與廢棄物量之間的關係。實驗三以分子生物與獸醫學方法探討海龜攝入海洋廢棄物對其體內荷爾蒙濃度及海龜第五型疱疹病毒表現關係。

烏龜怪方蟹(*Xenograpsus testudinatus*)體內菌群 DNA 萃取方法的初步研究

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摘 要

烏龜怪方蟹(*Xenograpsus testudinatus*)生活在熱泉區極端環境，僅分布於龜山島東南方擁有熱泉湧出的地區，先前的研究指 *Thiotrichaceae* 科的微生物與熱泉環境中甲殼類有著特殊的共生關係，微生物可以幫助降低硫化物的毒性並提供部分營養。這一科別的微生物也同樣在烏龜怪方蟹身上被發現，這樣的共生關係有別於熱泉區外的其他甲殼十足目，此類型功能的微生物可能與怪方蟹的生存息息相關，然而目前沒有相關菌群微生物分析之深入研究報導。菌相族群的變化對於烏龜怪方蟹的生存可能較其他甲殼十足目更為敏感。然而目前海洋環境中，新興的污染物塑膠正對海洋生物產生各種的危害。攝入受汙染的食物(例如塑膠)可能直接或間接改變生物體內菌群。為了能確認攝入汙染物是否會改變怪方蟹的體內菌群，我們需要建立完整的海洋生物體中菌群 DNA 萃取方式，以便未來瞭解烏龜怪方蟹體內菌群變動的可能因子。目前海洋甲殼十足目的菌群研究仍沒有一套固定的操作方式，加上熱泉環境取得的樣本有許多的干擾因子，使得 DNA 萃取操作不易。為此我們嘗試多種不同的萃取與純化方法，並檢測不同方式取得的樣本中 DNA 濃度與污染物含量，最後使用聚合酶連鎖反應(PCR)，確認所取得的DNA 樣本中汙染物及干擾因子的去除狀況，以此歸納出最佳的體內菌群 DNA 萃取方法以利後續進行攝入受汙染的食物是否會改變其體內菌群的實驗，並替未來研究熱泉甲殼類生物與體內菌群提供一個參考的基礎。

珊瑚礁立體結構的量化分析

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摘　要

　　珊瑚礁的結構複雜度與其生態功能和生物多樣性息息相關，也是珊瑚礁健康狀態的代表性指標。然而，傳統方法很難客觀且有效率的對珊瑚礁的立體結構進行調查和評估；近年來興起的運動恢復結構(Structure from Motion, SfM)技術，是基於影像的低成本方法，能產生毫米等級的珊瑚礁三維模型。本研究旨在介紹運用 SfM 技術於水下調查的量化分析方法，結果能計算珊瑚覆蓋率的絕對面積，並追蹤個別群體的生長變化，搭配 GIS 軟體亦可計算其結構複雜度，能用於評估人為擾動的影響。利用水肺潛水或是無人機能拍攝不同尺度的礁體結構，產生的三維模型也可應用於各種展示和科普教育，未來隨著資料的累積與硬體的進步，在海洋環境調查、生態保育和監測上將有很大的發展潛力。

台灣海域的八放珊瑚新紀錄與新種

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摘　要

　　八放珊瑚屬於刺胞動物門(Cnidaria)的八放珊瑚綱(Octocorallia)，是珊瑚礁生態系主要的底棲生物。本研究描述台灣周遭海域發現 13 個新記錄種，包含桃園觀塘藻礁發現的 1 個新種。新紀錄種包括：紅花實穗軟珊瑚 *Stereonephthya rubrlflora* Utinomi, 1954、大間實穗軟珊瑚 *Stereonephthya osimaensis* Utinomi, 1954 採自北方三島(-10 m)；粗糙擬網柳珊瑚 *Paraplexaura asper* (Moroff, 1902)採自基隆潮境(-20 m)；球凸小枝軟珊瑚 *Cladiella spheroids* (Utinomi, 1953)採自新北龍洞(-5 m)；派氏羽柳珊瑚 *Pinnigorgia perroteti* (Stiasny, 1940)、棕櫚腔柳珊瑚 *Coelogorgia palmosa* Milne Edwards & Haime, 1857 採自綠島石朗(-15 m)；金髮羽柳珊瑚 *Pinnigorgia flava* (Nutting, 1910)採自恆春南灣(-20 m)；穗柳珊瑚未定種 *Nephthyigorgia* sp. 拖網採集自金門海域；變異冠形軟珊瑚 *Alcyonium variabile* (J.S. Thomson, 1921)、杜氏牛角軟珊瑚 *Eleutherobia dofleini* (Kükenthal, 1906)、條紋傘穗珊瑚 *Umbellulifera striata* (Thomson & Henderson, 1905)拖網採集自台灣西南海域(-50 m)；繁錦傘穗珊瑚 *Umbellulifera petasites* Thomson & Dean, 1931 拖網採自中洲海域(-40 m)。在桃園觀塘藻礁發現的新種 桃園無常軟珊瑚 *Inconstantia taoyuanensis* n. sp.，亦為台灣海域八放珊瑚的新記錄屬，其骨針形態與在南非發現的 *Inconstantia exigua* McFadden & van Ofwegen, 2012 近似，但珊瑚體形態和骨針大小有明顯差異。

Growth, reproduction, and distribution pattern of a coral barnacle *Galkinia equus* at Dongsha Atoll in the South China Sea

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Abstract

South China Sea has the largest internal waves (IWs) ever recorded. They originate from the Luzon Strait then propagate and steepen westward, eventually reach to the shallow water of Dongsha Plateau. The breaking of waves causes turbulence and strong vertical mixing. Previous studies have shown benefits of abundant nutrients and cooling effects brought by IWs to planktons and corals respectively. Though, how IWs affect the majority of marine organisms at Dongsha Atoll remained unknown. Here we observed the growth (basal diameter, basal depth, body wet weight), reproduction (percentage of egg-possessed individuals, egg volume), and distribution pattern on the host coral of barnacle *Galkinia equus* (Family Pyrgomatidae), which is sessile and symbiotic at the surface of large start coral *Favites abdita*; and further investigated the correlations of these biological parameters with annual sea surface temperature (SST), chlorophyll a (Chl-a), and nitrate which are oceanographic parameters in relation to IWs. As the results, both average SST and nitrate showed negative effects on most growth and reproduction parameters, in contrasting to Chl-a. Egg-possessed individuals were observed in all sampling months, April, June, and October, which overlap with the prevailing duration of IWs from March to November. In addition, individuals located at the east side of Dongsha Atoll where directly facing IWs have persistently high percentage of egg possession above 87.5%. Half of the distribution pattern of *G. equus* on coral host and individual orientation are random and not concordant with the direction of IWs. In conclusion, the IWs signatures of lower SST and higher Chl-a can have positive effects on the growth and reproduction of coral-symbiotic barnacles. And a comparison at a wider-spectrum of oceanographic conditions would help elucidate the relationships of IWs to coral reef dwellers.

Keywords: Internal waves, coral barnacles, Dongsha Atoll, coral reef ecosystem

DNA barcoding of the genus *Schismatogobius* in Taiwan

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Species of the genus *Schismatogobius* are small (<10cm) and scaleless amphidromous gobies. Several new species of *Schismatogobius* have been described recently from the Indo-West Pacific, and, according to an illustrated book, there are a few new recorded species in Taiwan, including *S. baitabag*, *S. mamoratus*, *S. ninja*, *S. sapoliensis*, *S.saurii*; however, there is no taxonomic study to confirm their identification in Taiwan. The purpose of this research is to investigate the diversity of *Schismatogobius* in Taiwan and verify the taxonomic status of species of *Schismatogobius*. Specimens of *Schismatogobius* were collected from downstream reach of creeks in southern and eastern Taiwan by hand nets. Because of the high intraspecific variation within this genus, molecular analyses are conducted to facilitate species identification. A fragment of cytochrome c oxidase subunit I (*COI*) was sequenced, and the results were blasted in the GenBank and BOLD online databases. The phylogenetic analysis showed there are four species of *Schismatogobius* in Taiwan, including *S. ampluvinculusi, S. mamoratus*, *S. sapoliensis* and *S. sauri* supported by high genetic distances. Sequences of *S. ninja* and *S. saurii* were nested in a clade*,* implying *S. ninja* a junior synonym of *S. saurii*. Further morphological examination will be conducted to confirm the molecular results of each species in Taiwan.

Body Size Composition of Deep-sea Benthos Along the Gaoping Submarine Canyon

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Abstract

Body size is correlated with respiration, second production, carbon flux, and trophic habit of living organisms, and is considered the master trait of ecosystem functioning. From 2014 to 2015, we collected surface sediment samples from a high-energy submarine canyon, Gaoping Submarine Canyon (GPSC), and the adjacent continental slope off southwestern Taiwan. The GPSC is known to subject to strong bottom currents, internal tides, and high terrestrial organic inputs from the Gaoping River. The total biomass and individual body size of macrobenthos and meiobenthos from the sediment samples were significantly lower within the canyon than on the slope at a comparable depth. Due to the relatively low biomass and abundance, the respiration and production of the canyon benthic assemblages were lower than the slope assemblages. The environmental factors related to physical disturbance substantially influence the body size composition of the canyon benthos, while food supply and sediment characters correlated closely with the slope communities. We presume that the extremely disturbing condition in the GPSC may have wiped out the local benthic assemblages and only the small resilient species could be conserved. The alterations of the canyon benthic community could be a reference to habitats under anthropogenic disturbances or global climate change.

Carbon Cycling in Benthic Food Web of the Gaoping Submarine Canyon

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Abstract

Submarine canyon directly links continental shelves with deep-sea plains through transporting sediments and organic matters (OM); as a result, it plays an important role in providing energy to the food-deprived deep-sea ecosystem. The Gaoping submarine canyon (GPSC) off southwestern Taiwan connects the Gaoping River to the deep South China Sea (SCS), carrying massive fluxes of 14-49 MT sediments every year (Hsu et al., 2014). While previous studies suggested that most organic carbon (OC) is exported down through GPSC and buried into SCS, this view completely ignores the biological function of sediment benthos.

In this study, three contrasting sites were selected: GC1, for upper canyon; GS1, for upper continental shelf, and S6, for upper continental slope. Sediments were sampled during the cruises from November 2014 to November 2020. We measured both of the standing stocks of living (i.e. biomass of benthos) and no non-living components (i.e. detritus OC) of the surface sediment. Also, sediment community oxygen consumption (SCOC) were measured by ship-board sediment incubation and microprofiling. Combining the estimated fluxes of particle organic carbon (POC) input and OC burial, we can construct benthic predator-prey relationships with carbon flows by linear inverse model (LIM). We expect that carbon cycling in the GPSC would be drastically different from other studied sites due to the high energy settings of GPSC (Liu et al., 2016) and peculiar biological conditions (Liao et al., 2017).

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大型人工海水水族館的微生物群落

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摘　要

　　養殖水中的細菌相組成，對養殖生物的健康有重要的影響。本研究對國立海洋生物博物館的白鯨池、大洋池和原水中的海水進行一年四季的細菌多樣性、水質(pH 值、溫度、濁度、營養鹽)與指標微生物(總菌數、弧菌與總大腸桿菌群)數量監測，此處原水為由外海所引進的海水，為海生館水族缸養殖用海水來源。

　　為暸解展示水缸中海水細菌群落之多樣性與季節變化，不同季節的三處海水樣本，分別經過濾後萃取其海水所含細菌基因體 DNA，以 PCR 擴增其 16S rDNA 片段，然後進行 Illumina 定序。吾人總共獲得 986,201 條 16S rDNA 序列片段，這些序列依其相似度(97%序列相似度)可分為 4159 個 OUT (operational taxonomic unit)。其中白鯨池 1816 個 OTUs、大洋池 2284 個 OTUs 和原水 2670 個 OTUs，三個池子共同擁有 675 個 OTUs。所有海水細菌群落總共包括 24 個細菌門，其中以變形菌門所佔比例最高(68.44%)，其次是未知分類菌(12.88%)，白鯨池和大洋池海水樣本中大部分以 Rhodobacteraceae 和 Erythrobacteraceae 較多，而原水則以未知分類菌與 Family 較多。一般來說，原水的細菌多樣性最大，大洋池次之，白鯨池最小。比較不同水缸在不同季節的細菌相組成，不同水缸的細菌組成差異大於季節性變化所帶來的影響。因為展示缸為室內半開放式循環水系統，所以白鯨池和大洋池的水質基本趨於穩定，而原水則是受到外在環境影響，因此推測其細菌相組成主要與溫度和營養鹽等環境因子有關。

Comparison of the suitable habitat predictability between bycatch and targeted data for Trichiurus spp. in the northern waters of Taiwan

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Understanding the species distribution is crucial for the decision-making in conserving the organisms and managing the harvesting. However, the prediction performance of species distribution models may vary by sampling methods. While using fishery-dependent data to predict the suitable habitat for species, the catchability and data property are likely to affect the species distribution estimation. To investigate if and how different sampling methods influence the species distribution estimation, we used logbook data of two fishing gears from the same fishing vessels to predict and compare the species distribution modeling performances for hairtail (*Trichiurus* spp.) in the northern waters of Taiwan. The two gears are the stick-held dip net and the pole-and-line fishing, the former incidentally catching the hairtails while the latter targeting the hairtails. We used the data reported from 52 fishing vessels from 2009 to 2018 to develop Maxent species distribution models (SDM) for September to November, when both fishing gears were used to catch hairtails. The effect of sample size was accounted for by randomly selecting the same number of records for the two gears. Our results show that using data from different gears may have similar performance in predicting the suitable habitats for September and November; however, using the data from the targeting fishery (pole-and-line) resulted in a worse prediction than using the bycatch data in October. The environmental variables have different contributions in the prediction when using different types of data for October and November. Such monthly-dependent sampling method effect may likely due to the difference in the fishing site and gear catchability, while further analysis is needed to clarify.

溫度的急遽上升對浮游植物的影響

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摘　要

　　某些海域海水密度在混合層與底層交界處會變化得非常快，海水分層的現象相當明顯。　如果分層的界面受到強列擾動，就可能產生海洋內波。當內波通過不同海域時，有些破碎的內波會造成海水垂直混合，其中，上升型內波會將底層冷水向上抬升，而下沉型內波會將上層暖水帶至下層，這些內波訊號可以透過 CTD 水文資料、ADCP 海流儀資料、潮汐週期、衛星影像等方法得知。根據近期的海上研究*(Li, et al., 2018)*,利用沉積物收集器 (sediment trap)收集沉降顆粒態有機碳通量(particle organic carbon, POC flux),發現內波通過前後有很高的 POC 通量產生。針對此現象作者提出了假設：因為內波通過，無論是上升型或是下沉型內波，在上下海水的強烈混合作用下，浮游植物因無法適應溫度快速的改變，可能出現 warm shock 或 cold shock 現象，也就是所謂的熱中暑或冷猝死，隨後殼體向下沉，導致碳通量高值的出現。本研究針對此假說設計藻類培養實驗，模擬浮游植物在不同升溫(溫差 1、3、5、7°C)條件下的存活情形，測定其染色培養及圖盤培養，初步結果顯示較大的溫變確實是會導致藻類死亡。

關鍵詞：內波、浮游植物、溫度改變、顆粒態有機碳、輸出通量

Benthic macroinfauna of the Gaoping shelf, southwest Taiwan

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Abstract

The benthic infauna communities serve key ecological functioning and service by enhancing nutrient cycling between sediment-water interface (SWI), contributing benthic-pelagic coupling, and transferring energy in the marine food web. However, the continental shelf ecosystem is less studied in the seawaters of Taiwan. This study examined the spatial and temporal patterns of the environmental variables and benthic infauna communities of the Gaoping shelf off SW Taiwan. Bottom water characteristics, sediment properties, benthic macrofauna assemblages, and oxygen flux between SWI were measured in March and October, 2019. PCA result suggests the environmental characteristics of the Gaoping shelf differed spatially and temporally. The benthic macrofaunal communities also demonstrated spatial and temporal variations. The mean macrofauna density collected in March was 10863.4 ± 4106.0 individuals m^{-2}; in contrast, the mean macrofauna density collected in October is 6011.7 ± 1753.9 individuals m^{-2}. Interestingly, the faunal mediated oxygen uptake (FOU) did not concur with macrofaunal density. Expect one of the stations, macrofaunal density was inversely related to FOU, with mean values of 10.5 μmol $m^{-2}d^{-1}$ in March and 16.3 μmol $m^{-2}d^{-1}$ in October. One of the possible causes of this finding might be related to macrofaunal size. Previous studies have pointed out that the size of macrofauna can have a disproportionate influence on ecological functioning (i.e., FOU). Another reason might be related to species identity. Species with different feeding modes and behaviors can have disproportionate influences on sediment bioturbation and bioirrigation, resulting in varying ecological functioning. In sum, the environmental and biotic descriptors of the Gaoping shelf system demonstrate spatial and temporal variations. Future work will focus on how biotic and abiotic factors shape the ecological functioning of the Gaoping shelf.

Can Fe relieve heat and light stress for endosymbiotic dinoflagellates?

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Abstract

The effects of global warming and rising sea surface temperatures have caused large scale global coral bleaching events. It has been proposed that accumulated cellular reactive oxygen species (ROS) concentrations under environmental stress is the major cause of coral bleaching. Our previous studies have demonstrated high Fe demand in endosymbiotic dinoflagellates (Rodriguez et al. 2016), particularly under high temperature condition (Reich et al. 2020). We thus hypothesize that Fe availability, mainly used for Fe superoxide dismutase expression, is essential to relieve the stress. Here, we have varied both light intensity and temperature to investigate whether Fe availability may relieve the stresses induced in a model endosymbiotic dinoflagellate, *Breviolum minutum*. We have measured cell growth rates, intracellular Fe quota, photosynthetic efficiency, and total cellular SOD concentrations of the cells through trace metal buffered laboratory cultures. In cultures grown at 31°C with medium light intensity, only cultures with high Fe availability treatments were able to reach exponential growth. By only lowering light intensity, the low Fe treatment was able to reach exponential growth. These results support that Fe availability is essential to alleviate the growth stress generated by high temperature and light intensities for the dinoflagellate. We are measuring FeSOD expression in the cells grown among the treatments to validate the hypothesis at molecular level.

Latitudinal gradient of marine bacteria community along the Kuroshio

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Abstract

Marine planktonic bacteria determine the biogeochemical cycling in a marine ecosystem, especially when the system is oligotrophic. The Kuroshio region is one of the major oligotrophic regions in the northwestern Pacific Ocean. Along the Kuroshio region from south Taiwan to the east coast of Honshu Japan (~22 to 35 °N), the planktonic bacteria diversity variation and species composition are still unclear. To investigate the bacteria community along this region, we collected samples from both surface and deep Chl-a maximum (DCM) layers and then applied high throuput sequencing techniques to obtain the 16s rDNA sequences. From those sequences, we estimated the diversity and composition of planktonic bacteria community. We found that most of the diversity indices did not show a significant latitudinal gradient. Only did the richness index in the surface layer increase with latitude. The latitudinal increment of evenness was best explained by the Chl-a concentration and species richness of heterotrophic nanoflagellates. This result suggests that system productivity and grazing pressures are both important in driving the latitudinal gradient of bacteria richness in the surface layer. On the other hand, species composition showed the latitudinal gradient more clearly. In the surface layer, the density of Bacteriodia significantly decreased toward higher latitude due to higher Chl-a and phosphate concentration. In the DCM layer, Alphaproteobacteria significantly increased, while Acidimicrobiia significantly decreased with latitude also due to higher Chl-a concentration. These results suggest that system productivity is the main driver of the species compositional change of planktonic bacteria along the latitudinal gradient. We argue that, in the Kuroshio region, planktonic bacteria community is predominantly subject to the impacts of system productivity. The effects of productivity are more clearly revealed by compositional changes rather than the differences of a composite diversity index.

海洋酸化對仔稚魚初期生長階段之影響-以三線磯鱸(*Parapristipoma trilineatum*)及銀鱗鯧(*Monodactylus argenteus*)為例

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摘 要

　　隨著全球二氧化碳排放的總量不斷增加，地球的大氣和海洋也因溫室效應而造成了氣候的變化，全球暖化及海洋酸化的現象日益嚴重。目前已有研究預估2100年時，大氣中的二氧化碳濃度將接近1000 ppm，海洋平均pH值也將從8.1下降至約7.8，同時，也有研究證實了酸化會對許多物種造成不同的負面影響。相關研究指出，仔稚魚飼養於酸化的環境中，可能會改變其耳石的尺寸，但各物種的結果可能會不相同。本研究利用中觀生態缸進行實驗，培養出銀鱗鯧(*Monodactylus argenteus*)及三線磯鱸(*Parapristipoma trilineatum*)仔稚魚，模擬在海水pH值約7.8的環境下，從卵孵化到孵化後第五天期間銀鱗鯧及三線磯鱸仔稚魚耳石(矢狀石)的變化情形。結果顯示，銀鱗鯧仔稚魚矢狀石的寬度顯著減少6%，方率顯著增加1%；三線磯鱸仔稚魚矢狀石的長度、寬度、周長、面積和方率都有顯著增加，分別增加了5%、5%、5%、11%及1%。但兩種仔稚魚的矢狀石對稱性則無顯著差異。

臺灣週邊水域康氏馬加鰆分布和漁獲率與海洋環境因子之關係

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摘 要

康氏馬加鰆俗稱土魠魚,是臺灣重要經濟性魚種,但目前臺灣對於該物種分佈及漁獲率與海洋環境因子關係的相關研究仍付之闕如。故本研究蒐集臺灣2011年到2016年康氏馬加鰆的漁獲資料,及透過衛星遙技術獲取海洋環境資料,解析該物種漁業利用情形與時空間之漁獲動態變化外。並利用泛加成模式(GAM)探究康氏馬加鰆漁獲量與海洋環境因子之關係。結果發現,臺灣週邊海域各漁法漁獲康氏馬加鰆之情形主要以刺網為主,占總漁獲量約為70%,且漁場呈現季節之變動趨勢,但高漁獲率海域主要都出現在臺灣西部海域,且隨時間推移,以澎湖群島週邊向西南方沿伸及收縮。另GAM分析結果顯示海表面水溫、海表面鹽度、海表面水色及海表面高度對康氏馬加鰆漁獲率有顯著之關係。

關鍵字:康氏馬加鰆、漁獲率、泛加成模式

花紋翻車魨垂直移動行為特徵與水溫之關係

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摘　要

　　花紋翻車魨 (*Mola alexandrini*)，屬於翻車魨科魚種，為大洋洄游性魚類，廣泛分布於熱帶與溫帶海域。花紋翻車魨的移動行為能力強，有長距離的水平移動行為。本研究於2019年4月於臺灣東部海域利用彈脫型衛星標識紀錄器 (pop-up satellite archival tag) 標放兩尾花紋翻車魨，並探討其垂直移動特徵與水溫變化之關係。一枚標識器結附於翻車魨身上178天後於日本九州附近海域彈脫，移動距離為1084公里，另一枚則在結附於魚體身上78天後於沖繩附近海域彈脫。花紋翻車魨有頻繁的垂直洄游行為。白天下潛至斜溫層下之深度範圍 (300公尺)，棲息水溫約攝氏15-20度。白天時，花紋車魨有時會移動至海水表面，推測因翻車魨長時間待在水溫較低之環境，需要移動至溫暖水域恢復其體溫。花紋翻車魨晚上則上升至混合層水域，棲息水溫範圍為攝氏20-23度，推測該日夜垂直移動行為可能其與深海散射層、周遭海水溫度有關。

Habitat preference and utilization distribution of swordfish (*Xiphias gladius*) in the northwestern Pacific Ocean determined with electronic tags

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Abstract

Swordfish (*Xiphias gladius*) is a cosmopolitan species found in tropical and temperate waters of all the oceans. They are distributed between ~50°N and 50°S. Mainly because of its evolved ability to withstand water temperature fluctuations from ~6 to 26°C, it is one of the mostly widely distributed pelagic species. The objective of this research is to use electronic tagging experiments to identify swordfish habitat preference and utilization distribution in northwestern Pacific Ocean. Three swordfish were tagged pop-up satellite archival tags (PSATs) and tags remain affixed from 14 and 229 days-at-liberty. From the tagging location in eastern Taiwan, pop-up locations ranged northwards to the East China Sea, southwest to the South China Sea and the other to the southeast off the Philippines. The total linear displacements were from 631 to 1,605 km from deployment to pop-up locations. Vertical movements extended to 915 m and ambient temperatures ranged from 4.5 to 32.9℃. The Delta T analysis indicated daytime and nighttime vertical movements were limited by temperature changes of $\leqq$18° and $\leqq$6°C, respectively. The percentage time spent at depth and temperature during daytime indicated swordfish tuna spent >50% of time at 400 to 500 m and spent >60% of time <200 m. Swordfish displayed characteristic W-shaped vertical movement patterns during daytime and nighttime. Distributions of time spent at depth were significantly different between daytime and nighttime where fish displayed a regular crepuscular pattern of ascending into the surface layer at dusk and remaining there until the following dawn where the fish descended past the mixed-layer depth.

Stomach content and stable isotope analysis of swordfish (*Xiphias gladius*) diet off eastern Taiwan

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Abstract

Swordfish (*Xiphias gladius*), is a commercially important species that is widely distributed throughout three oceans. This species inhabits oceanic waters with preferred environmental ranges and migrates vertically to the surface layer for feeding. The objective of this research is to use a combination of stomach contents analysis (SCA) and stable isotope analysis (SIA) to identify swordfish trophic dynamic in eastern Taiwan. In 50 swordfish stomach samples, six prey species were identified comprising four teleost species, two cephalopod species and one shrimp species. Mid-waters prey species were major food items for swordfish (e.g., Cephalopoda and Bramidae spp.). According to the %IRI, the most important prey items were unidentified fish (49.2%), followed by pomfret (Bramidae. spp) (23.3%), unidentified cephalopod (16.9%), diamond squid (*Thysanoteuthis rhombus*) (9.9%) and shrimp (0.6%). From the values of this index, cephalopods and fishes were main prey for the three size classes considered. And, 165 swordfish muscle samples (59-210 cm eye-orbit fork length, EFL) were examined for trophic position and population dynamics. $\delta^{15}N$ and $\delta^{13}C$ values for swordfish ranged from 7.9 to 14.3‰ and -18.9 to -15.4‰, respectively, and were all positively correlated with size. Swordfish can maintain their body temperature on an ephemeral basis below the thermocline because of its unique physiological and morphological adaptations (such as vascular counter current heat exchangers). This foraging adaptation allows them to mirror the diel migration of mesopelagic fishes and cephalopods to exploit them effectively as a resource as indicated by our SCAs and SIA results. Our initial study suggests that future SCA and SIA studies on swordfish are required to better understand size-specific trophic dynamics.

小琉球及蘭嶼海域光譜特性及珊瑚脂質成分分析

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摘　要

　　物種多樣色彩繽紛的珊瑚礁生態系，在氣候變遷的威脅下，近幾十年來世界上淺水域珊瑚礁已發生數次大白化事件，而在2020年台灣南部海域如墾丁、小琉球甚至蘭嶼都發生珊瑚大量白化現象；更有學者預測在2050年前世界上主要珊瑚礁90％珊瑚都將死亡，而在更深海域的珊瑚，如中光層珊瑚，被認為能提供淺水區珊瑚的庇護所，提供補充群以利珊瑚的回復。而珊瑚因具有與共生藻共生的特性，其細胞內的共生藻對於光線有一定程度的需求，才能進行有效的光合作用，得以提供養分給予珊瑚宿主。因此，本研究首先利用水下光譜儀測定小琉球及蘭嶼附近淺層及中光層海域15米、30米及45米，藉由光譜數據分析不同海域下，其不同深度的光譜分布。此外，利用技術潛水分別採集不同深度的水樣及珊瑚，分析其水域總有機碳，及珊瑚脂質成分。藉此進而了解中光層及淺層海域不同深度的光譜變化、碳氮分布，以及處於不同環境下珊瑚其脂質組成。

微型計量聲探模組設計開發

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摘　要

　　魚群探測系統為漁撈業之重要工具,係過聲音傳播和回波來確定物體距離、形狀等、並探測與識別水裡物體和輪廓,它可以讓使用者準確判斷魚群的數量和棲息的深度,但這類的產品多適合在較大且廣的開放水域作為使用。本研究透過Linux的單晶片電腦設計一微型計量聲探模組,並運用聲學原理及訊號處理技術於養殖水槽或陸上魚塭等水深較淺之有限空間進行魚群探測,透過接收並分析聲學訊號資料,了解其對魚群之相關資訊,包括魚隻大小、數量或魚群種類等進行估算及辨識之可行性研究。

關鍵字:樹莓派、水下聲探、背向散射、魚鰾共振

臺灣西南海域底棲漁業資源結構之年間與季節變化

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摘　要

　　為探討臺灣西南海域底棲性魚類資源動態，本研究蒐集104年1月至108年12月間臺南市、高雄市及屏東縣拖網漁業活動資料(含漁業署港口查報員記錄及標本船漁撈日誌)進行分析，期能完整掌握本海域底棲魚類種類組成及漁獲量之年間與季節變動情形，作為漁業資源評估、保育及管理之參考依據。結果顯示，臺南市10月至翌年1月之秋、冬期間為漁獲旺季，4-8月春、夏為淡季，淡、旺季間漁獲量差異大；高雄市漁獲量季節變化較小，以7-8月11-12月略高；屏東縣漁獲旺季存在明顯的年間差異，無固定的漁獲高峰期。108年臺南市查報資料記錄136個類別，前5優勢種(帶魚屬 *Trichiurus* spp.、刺鯧*Psenopsis anomala*、烏鯧*Parastromateus niger*、大頭白姑魚*Pennahia macrocephalus*、鎖管屬*Uroteuthis* spp.)佔總漁獲量38.0%，多樣性指數H'=2.57；高雄市記錄338個類別，前5優勢種(帶魚屬*Trichiurus* spp.、鎖管屬*Uroteuthis* spp.、長體蛇鯔*Saurida elongata*、刺鯧*Psenopsis anomala*、日本竹筴魚*Trachurus japonicus*)佔36.7%，多樣性指數H'=3.75；屏東縣記錄214個類別，前5優勢種(帶魚屬*Trichiurus* spp.、大棘大眼鯛*Priacanthus macracanthus*、黑鰔*Atrobucca nibe*、短棘鰏*Leiognathus equulus*、鎖管屬*Uroteuthis* spp.)佔39.0%，多樣性指數H'=3.8。利用多變量分析之集群分析法(Cluster analysis)及非計量多向度量尺法(Non-metric Multidimensional Scaling, NMDS)探討底棲魚類群聚結構之時間及空間分布，結果顯示各縣市間魚種組成有明顯的差異，臺南市及屏東縣的主要漁獲魚種相當富有季節性，臺南市魚種組成月份間差異性最為明顯，屏東縣次之；高雄市則相對穩定，月別魚種組成差異性小。各縣市漁場並不相同，漁獲相當具有地區性的特色，因此主要漁獲魚種組成及漁期亦呈現地區性之差異。

臺灣沿近海域冬季烏魚刺網漁業作業變動解析

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摘　要

　　烏魚(*Mugil cephalus*)在冬季時會隨著大陸沿岸流洄游至臺灣沿近海域產卵，然而長期過度捕撈、氣候變遷等諸多因素，導致漁獲量自1980年代全盛時期年均百萬尾持續下降，而近二十年來漁獲量大多維持數五十萬尾上下且呈現大幅震盪。烏魚漁業主要作業漁法包括刺網、巾著網或扒網等，而近十年已轉變以刺網為主，約佔總產量之八成，其中以流刺網為最主要作業方式。近十年主要漁獲位置有逐年北移的趨勢，以臺中外海為主，其次為新北、桃竹苗、宜蘭及基隆外海。尤臺中以北所佔比例，從2014年佔約72.4%，已逐年提升，在2018及2019年更佔全臺漁獲量的95%。顯示過去雲嘉以南的傳統烏魚漁場，在近年冬季烏魚汛期間幾乎已不易捕捉到來游烏魚。

關鍵字：烏魚(*Mugil cephalus*)、刺網、漁場

沖繩海槽浮游有孔蟲群集資料紀錄

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摘 要

　　沖繩海槽位於東海陸棚與琉球島弧之間，是半封閉式的半深海盆地，水深最深處超過 2000 公尺，主要接受來自東海陸棚的沉積物，並有世界主要西邊界流之一的黑潮流經。東海陸棚區的氣候與水文條件主要受到黑潮、東亞季風與長江沖淡水所影響，而沖繩海槽地區的水文環境另外可經由黑潮與西太平洋發生相互作用，因此此處沉積物能夠反映過去海洋和陸地環境及氣候條件的演化過程。黑潮流經沖繩海槽，主要有三個通道與西太平洋進行海水交換，沖繩海槽南邊的東臺灣通道、中部慶良間通道及北方的吐噶喇海峽。這三個通道除為沖繩海槽帶來開放大洋的信息外，也深刻影響著沖繩海槽的水文條件與生物族群。晚第四紀中冰期發生時，海平面大幅下降，大片淺海陸棚出露形成陸地，但沖繩海槽仍持續為海水覆蓋，因此其沉積物可以持續記錄海洋環境與氣候的變遷。探討古氣候演變的指標有許多種，如利用微體古生物如浮游有孔蟲結合碳氧同位素研究，可重建過去水文資料。另外，鑑定浮游有孔蟲種屬群集也是常用於建立海洋水文因子變化的重要指標。影響浮游有孔蟲群集的環境因子有：海水溫度、鹽度、營養鹽、日照及洋流等，本研究利用位於慶良間通道附近可紀錄過去四萬六千年氣候及環境變化訊息的沉積物岩心 GH11-2017，進行浮游有孔蟲化石群集鑑定及豐度分析，並結合前人所完成的碳十四定年與穩定碳氧同位素和鎂鈣建立的海表溫度資料，探討不同氣候時期及環境變化下，黑潮對沖繩海槽浮游有孔蟲群集的影響及慶良通道對於海槽內外水團交換所扮演的角色。此外，藉由浮游有孔蟲的群集資料，也可以與其他區域的岩心資料做對比，進一步討論調控西太平洋地區浮游有孔蟲種屬變化更深一層的機制。

Spatial-temporal patterns of proxy discrepancy in glacial cooling reconstruction

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Abstract

Geological data provide clues on the link between Earth's surface temperature and atmospheric CO_2 level, which will then help improve model projections of future climate in response to increasing greenhouse forcing. Last Glacial Maximum (LGM) is the period characterized by lower atmospheric CO_2 level and lower surface temperature on Earth. Geological data from this period, for instance in the form of LGM cooling maps, are often used to validate the climate models used for future projection. Due to the scarcity of proxy-based surface temperature estimates, all types of proxy are assumed to reflect the same environmental condition (e.g. annual mean sea surface) and combined to maximize the spatial coverage of the maps. This is despite the fact that the choice of calibration and proxy type alone may lead to different temperature estimates, which may in turn introduce artificial spatial heterogeneity in the reconstruction. To characterize the proxy-dependency of reconstruction and spatial-temporal patterns of proxy discrepancy, we built a network of sites from low-to-mid latitudes of the western Pacific, each site with multiple proxies (Mg/Ca, $U^{k'}_{37}$ and TEX_{86}) achieved by combining published and newly generated data. For comparison with the published records, we also recalculated temperature estimates by applying the most widely used calibration for each proxy based on ordinary least squares (OLS) regression, and new Bayesian statistics-based calibrations. Our analysis on published data based on author's choice of calibration shows that on average, the magnitude of TEX_{86}-inferred glacial cooling is the largest among these three proxies. The discrepancies are reduced when Bayesian calibrations are used, as it increases the magnitude of $U^{k'}_{37}$-derived cooling, bringing it closer to that of TEX_{86}. Bayesian calibrations also improve proxy agreement at half the sites. Comparison of temperature records based on OLS and Bayesian calibrations shows that the offsets between these two groups of temperature estimates vary in space but not with temperature.

For $U^{k'}{}_{37}$, the offsets vary as a function of temperature; Bayesian calibration-based estimates are lower than those based on OLS calibration at temperatures <26ºC, and vice versa at temperatures >26ºC. This explains why the application of Bayesian calibration leads to an overall stronger LGM cooling for UK'37. Future work will focus on including Mg/Ca data in the analysis, increasing the spatial coverage of our compilation, and generate the first-order spatial pattern of proxy discrepancy.

卑南溪流域河水之生物性碳流動與關鍵微生物族群組成

Riverine biotic carbon flow and crucial microbial composition in Beinan river system

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二氧化碳是重要的溫室氣體，因此探討碳循環中調控大氣二氧化碳濃度的機制是科學家們極為重視的議題之一。岩石風化和生物作用是影響大氣二氧化碳濃度變化的主要途徑，在陸域環境中，河川被視為收集風化產物傳輸到海洋的通道，但有許多證據顯示在河川中進行的生地化作用對大氣二氧化碳收支有重要貢獻，在全球碳循環中扮演不可被忽略的角色。河川中生物控制的碳流動 (biotic carbon flow) 包含自營作用 (autotrophy) 和異營作用 (heterotrophy)，此兩種代謝途徑分別消耗和釋出二氧化碳，因此河川對於大氣二氧化碳的影響取決於兩者間的收支情形。

本研究選擇於台灣東部擁有全台灣河川中最高沉積物輸出通量與高化學風化速率之卑南溪流域，由上至下游收集不同季節的河水樣本，進行穩定同位素添加培養實驗，在河水中添加標定 ^{13}C 同位素之無機碳與有機碳源，追蹤生物自營與異營作用造成的碳流動，並搭配營養鹽、葉綠素和分子生物分析，釐清相關控制因子和參與作用的微生物族群組成與表現。初步結果顯示，利用同位素標定培養實驗可確實偵測到河水樣品中生物對於無機碳和有機碳的合成作用，並估算速率，相較於河川上游，在卑南溪出海口有最高的自營和異營生物合成速率，其中，自營生物合成速率在濕季時較高，可達乾季時的 4 倍，與河水之硝酸鹽濃度呈顯著正相關；且全年異營代謝產生二氧化碳速率高於自營生物合成消耗的速率，推測卑南溪流域屬於異養河川系統。除此之外，在現地之微生物族群組成上也可看到明顯的區域性和季節性差異，顯示出參與作用之關鍵微生物物種有所不同。未來將進一步探討生物性碳的轉換速率和其他環境因子之間的關係，期望能結合地球化學與分子生物方面的分析結果，了解卑南溪流域完整的生物性碳流動過程，並藉由季節性之自營和異營生物合成速率的調查結果與河水流量資料，估算出卑南溪流域全年對於全球碳循環中大氣二氧化碳的貢獻。

關鍵字：生物性碳、自營作用、異營作用、^{13}C 同位素標定

Keywords: biotic carbon, autotrophy, heterotrophy, ^{13}C isotope labeling

台灣西南海域冷泉系統中甲烷氧化菌之族群結構與甲烷消耗之關係

The relationship between methanotrophs and methane consumption in cold seeps systems offshore southwestern Taiwan

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摘　要

甲烷是重要的溫室氣體之一，其所造成的溫室效應是二氧化碳的 23 倍，對全球氣候變遷與碳循環有重要影響。海洋沉積物中已被證實蘊藏大量甲烷，以游離氣體、溶解氣體及天然氣水合物的形式賦存於全球大陸邊緣。台灣西南海域位於歐亞大陸板塊與菲律賓海板塊交界處，大陸邊緣受到板塊擠壓形成斷層構造，提供深部地層中甲烷向上移棲的管道，使此區域的海洋沉積物呈現高甲烷濃度及通量。根據 IPCC 於 2007 年的報告，海洋向大氣釋放的甲烷僅占大氣中含量 1~5 % ，顯示海洋沉積物中甲烷在擴散至海水層的過程中，存在著顯著的甲烷消耗機制。而甲烷氧化菌 （methanotrophs） 扮演著控制海洋與大氣中甲烷通量的重要角色。本研究利用勵進研究船於台灣西南海域四方圈合海脊及 G96 逸氣通道，以水下無人載具對甲烷滲漏區進行目標性的探勘觀測，並針對碳酸鹽礁、管蟲、貽貝與菌叢等冷泉生態系採集岩心。

根據間隙水甲烷與硫酸鹽資料，沉積物硫酸鹽-甲烷轉換帶 （sulfate methane transition zone, SMTZ） 深度約介於 5~10 公分內，與過去研究相比顯示，此區域存在高甲烷通量且存在甲烷消耗機制。利用次世代定序技術，對上述岩心樣本中所有微生物之 16SrRNA 基因與針對好氧甲烷氧化菌之 pmoA 基因以 97% 相似度進行群集組成分析，得到分屬於 90 種菌門的 147195 個操作分類單元，顯示環境中的微生物組成複雜，並存在高豐度的好氧與厭氧的甲烷氧化菌，其中厭氧甲烷氧化菌群主要以 ANME-1b 菌科占多數， ANME-2a 為輔；透過及時定量聚合酶連鎖反應分析，近沉積物表層 1~8 公分處 pmoA 基因數量達峰值，而 ANME-1 與 ANME-2 的 16SrRNA 基因則隨沉積物深度增加，且與針對硫酸鹽還原菌之 dsrB 基因數量呈現正相關，並在約 SMTZ 處達到峰值。經由樣本群集間 beta 多樣性的非度量多維度分析，顯示站點間群集組成差異大於站點內不同深度（高甲烷與硫酸鹽梯度）的群集組成差異。綜合上述，結合地球化學與分子生物技術，冷泉環境中沉積物微生物群集組成十分複雜且多樣，其豐度與組成除了反映現地地球化學的梯度，得以快速的代謝甲烷、硫酸鹽、有機質，亦受控於海床的特徵或位置，後續工作將進一步探討組成間的連動性與甲烷消耗機制的控制因子為何。

Multiproxy-derived upper ocean temperature changes over the last glacial cycle in the Indo-Pacific Warm Pool

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Abstract

The Indo-Pacific Warm Pool (IPWP), with an annual average sea surface temperature (SST) higher than $28°C$, is the warmest water mass in the world. It serves as the heat engine of global climate and is closely linked to large-scale climate variability mode like El Niño Southern Oscillation, rendering it a hotspot for paleoclimate reconstruction. However, geochemical proxies used for past temperature reconstructions, such as $U^{K'}_{37}$, TEX_{86} and foraminiferal Mg/Ca, are associated with uncertainties. To better constrain past temperature changes, we present multiproxy-derived temperature records from site MD05-2928 near southern Papua New Guinea. To complement previously published $U^{K'}_{37}$-SST record at the site, we generate temperature estimates for the past 25 kyr using TEX_{86} and foraminiferal Mg/Ca; the latter on shallow dweller *G. ruber* and thermocline dwellers *P. obliquiloculata* and *N. dutertrei*. All SST records show expected glacial-interglacial swings, with lower glacial SST and higher Holocene SST. However, TEX_{86}-based temperatures are consistently higher than $U^{K'}_{37}$-based temperatures, with a glacial cooling ~1ºC stronger than that of $U^{K'}_{37}$. Mg/Ca-SSTs are ~4-5$°C$ lower than $U^{K'}_{37}$ and TEX_{86}-SSTs, and 2-3ºC lower than the Mg/Ca record from a nearby site MD05-2925. Notably, the Mg/Ca-inferred glacial cooling at these two sites are comparable (3–4ºC). The apparent cold bias in our Mg/Ca data could be related to the intensive cleaning method applied prior to trace element analyses. Our preliminary Mg/Ca-SST records show lower temperatures at the thermocline than at the surface ocean, suggesting that they may still reflect water column thermal structure despite the cold bias. Future work will focus on increasing the temporal coverage of our temperature records and further discussing the factors leading to proxy discrepancies.

Distribution of recent planktic foraminifera along land-sea transects off Sumatra and Java (Indonesia)

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Abstract

Planktic foraminifera are widely used in palaeoceanographic and paleoclimatic studies. The accuracy of such reconstructions depends on our understanding of the organisms' responses to environmental parameters (e.g., water temperature, salinity, and food availability). The marginal seas off Indonesian islands are climatically relevant, thus paleoceanographic reconstructions are abound. However, most of our knowledge of the environmental control on planktic foraminifera distribution is derived from indirect observations. To fill this gap, we present direct observations of planktic foraminiferal abundances (>150 μm) from 5 depth ranges between 0-500 m water depth at 38 sites off Sumatra and Java. The total planktic foraminiferal assemblage here comprises 28 morphospecies; 11 morphospecies, namely *G. bulloides, G. glutinata, G. calida, G. ruber, T. trilobus, G. menardii, N. dutertrei* and *G. hirsuta*, accounted for ~90% of the assemblage. In term of diversity our data is consistent with previous sediment trap data from the same season, but the dominance rank of species differs significantly. The standing stock and vertical distribution of planktic foraminifera differ in space, with absence or low abundance and stratified vertical distribution off Sumatra, while the abundance is higher and the vertical distribution less stratified off Java. Only *G. ruber* and *T. trilobus* deviate from this overall pattern as they show similar abundances off Sumatra and Java. The vertical succession of subsurface dwellers broadly agrees with that inferred from sediment trap samples, with the exception of *N. dutertrei* that seems to be inhabiting shallower levels. The overall latitudinal and vertical distribution patterns in planktic foraminiferal abundances reflect the oligotrophic and thinner mixed layer upper ocean conditions off Sumatra, in contrast to the eutrophic and a thicker mixed layer characterizing the upper ocean conditions off Java during austral winter. As the temporal coverage of our samples is limited to a few weeks, further study is needed to examine if and how the species-specific response to food availability and water column stratification varies in time.

Changes in thermal structure of the upper ocean off SW Sumatra during last glacial-interglacial cycle: Insights from clumped isotopes

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Abstract

The Indonesian region links the Indian and Pacific oceans and plays a key role regulating hydrography and climate in the tropical Indo-Pacific. The last glacial maximum (LGM; 19-21 ka), when temperatures were cooler and sea level stood lower, provides an opportunity to assess how surface ocean responded to such contrasting regime. Previous studies offshore SW Sumatra suggested a significant reorganization of the upper ocean structure during the last glacial-interglacial cycle (0-21 ka). Mg/Ca measured in surface and thermocline dwelling foraminifera showed a smaller surface to thermocline temperature gradient (ΔT_{s-t}) and a warmer thermocline during the LGM, which was interpreted as a less stratified water column and a deeper thermocline (Mohtadi et al., 2017). In contrast, organic paleothermometers $U^{K'}_{37}$ and TEX_{86} showed a larger ΔT_{s-t} with cooler subsurface temperatures during the LGM suggesting shoaling of the thermocline (Windler et al., 2019). To reduce discrepancy between these proxies and provide an independent assessment of the upper ocean thermal structure in this region during the last glacial, we analyzed foraminiferal species for clumped isotopes (Δ_{47}). The Δ_{47} method is a recently developed paleothermometer independent of seawater chemistry (unlike Mg/Ca proxy). Here, we used tests of surface (*G. ruber*, *G. sacculifer*) and thermocline (*N. dutertrei*, *G. menardii*) dwellers from core GeoB 10038-4 located off SW Sumatra. Our new records showed cooler temperatures in both the mixed layer and thermocline during the LGM. Thermocline dwellers showed a 2.1°C lower temperature in the thermocline, whereas surface dwellers recorded a larger cooling in the surface ocean of 2.6°C (*G. ruber*) and 6°C (*G. sacculifer*). This implies a smaller ΔT_{s-t} during the LGM, supporting deepening of the thermocline. In addition, magnitude of cooling in the thermocline indicated by foraminiferal Δ_{47} is smaller than that in TEX_{86} estimates. This might occur because of different depths at which both proxies record temperatures. Overall, our new data suggest more cooling in the surface ocean than in the thermocline and deepening of the thermocline offshore SW Sumatra during the LGM.

Key words: clumped isotopes, LGM, tropics, eastern Indian Ocean, multiproxy.

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Reconstructing past oceanographic changes off Northeastern Taiwan using multiple proxies

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Abstract

Due to the large spatial coverage of the ocean, upper ocean hydrographic change has a strong link with the global climate system. Therefore, knowledge of past hydrographic change can improve our understanding of the ocean-climate processes, and thus also the accuracy of future climate prediction. The Kuroshio Current is a strong western boundary current that brings an enormous amount of heat from the Equatorial Pacific to the middle latitudes of the western Pacific, thus it exerts a strong influence on the regional climate system here. Studying the long-term variations of Kuroshio Current will allow us to understand past climate change in the Northwestern Pacific. The Kuroshio Current bifurcates off northeastern Taiwan; the main branch enters the Okinawa Trough through the Yonaguni Depression while the other branch forms the Ryukyu Current flowing northward along the Ryukyu Arc. There have been several studies of the Kuroshio Current in the Okinawa Trough spanning the Last Glacial Maximum (LGM), but there is yet no study conducted at the bifurcation point off northeast Taiwan. Therefore, in this study, a ~22 m long sediment core (MD18-3523) collected during the EAGER cruise (2018) off northeastern Taiwan (24°07.40 N, 122°10.64 E) will be used to reconstruct the thermal structure of the upper water column. Stable oxygen isotopes of mixed layer- and thermocline-dwelling planktonic foraminifera, as well as biomarkers produced by algae and marine archaea, were used in this study to reconstruct past oceanographic changes. The age model of the sediment core was established by using radiocarbon dates of mixed planktonic foraminiferal shells. The age of the bottom of the core has been dated to be nearly 20 ka. The sedimentation rate is between 0.74 to 1.74 m/ka, with the lowest sedimentation rate occurring during the Holocene (5–10.5 ka), while the highest occurring during deglaciation (10.5–15 ka). Preliminary data suggest that the glacial cooling is in the range of 2–5.5 °C, depending on the temperature proxy. We will increase the temporal resolution of the geochemical records, and add another seawater temperature proxy (foraminiferal Mg/Ca) to improve the robustness of our reconstruction.

Multiple attenuation using the curvelet domain subtraction and Radon transform

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Abstract

Multiple attenuation is a critical step in marine seismic data preprocessing. Successful multiple attenuation can bring significant uplift in the quality of the final seismic stack. The SRME (surface related multiple elimination) method in combination with least-squares subtraction is the most widely-adopted approach. The assumption of orthogonality between the primaries and the multiples however constantly leads to over-attenuation. To account for this drawback, we propose to use curvelet domain multiple subtraction (Wu et al., 2013) to better discriminate the primaries from the multiples, as these two features are more separable in the multi-scale curvelet domain. When combined with CDP-domain residual multiple attenuation using Radon transform, we can efficiently suppress the multiples while preserving primaries in the deeper part. We apply this flow to the 2D seismic line MGL0905-8 and MGL0905-10 from the TAIGER dataset (2009) in offshore southwestern Taiwan. The results show a significant improvement compared to the conventional SRME method.

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高屏峽谷陸棚/斜坡區岩心之非破壞性分析紀錄所揭示該區域古海洋環境變遷

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摘　要

　　勵進研究船量身定做與法國研究船R/V *Marion Dufresne*高規格之巨型海洋岩心採樣設備與深海絞機系統，以提供國內學研界海洋地質相關研究領域、台灣鄰近海域海洋地質與災防調查、海底資源探勘所需。為瞭解並評估勵進研究船巨型活塞／重力岩心採樣能量，本研究以LGD-T31（108.12.10-12）與LGD-T32（109.01.14-16）兩測試航次期間，高屏海底峽谷南、北兩側之高屏陸棚/斜坡區進行同一站位多次採樣之8公尺巨型活塞／重力岩心作業。兩航次之巨型活塞岩心樣本回收率為25~28%；而巨型重力岩心樣本回收率達41%。海洋岩心非破壞性分析（多重感應元岩心記錄器、岩心反射色分析、岩心表面影像/X光影像）結果顯示，LGD-T32航次岩心記錄之拉張效應較LGD-T31航次來得劇烈，LGD-T32上部岩心出現15-30公分不同程度的拉張。推論這可能是由於岩心採樣過程導致海洋岩心內部發生擠壓，抑或是回收速度過快以致沉積物發生形變等。上述海洋岩心非破壞性分析結果提供了岩心QA/QC 的品質管控，亦可作為優化勵進研究船巨型海洋岩心採樣技術之參考，以利適時地滾動式修正，使海洋岩心之品質更能符合科學研究所需。再者，高屏陸棚區同站位重複採樣的活塞岩心LGD-T31-B-PC1/-PC2，透過非破壞性分析來解析岩心中所隱藏的環境變遷訊息。由於高屏溪流域陸源物質的剝蝕與傳輸至該海域，故兩岩心組成以陸源沉積物為主，除陸上植物屑、黑雲母外，亦可發現浮游有孔蟲與介形蟲等海洋微體化石。此外，根據兩岩心浮游有孔蟲的碳十四定年結果，岩心頂樣的年代約距今一千年前，我們認為岩心採樣過程可能是造成這上部沉積物缺損的主因之一，抑或是108年5月南部豪雨事件或8月白鹿颱風所移除。此外，兩岩心深度40~60公分處出現約20公分厚濁流沉積物，然後續仍需其他分析工作始能瞭解該事件層發生之因。

海洋中心長支距多頻道震測系統特性-空氣鎗震源系統

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摘　要

2015 年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 (Large-offset Multi-Channel Seismic，簡稱 LMCS) 系統，2018 年與勵進研究船磨合成功後，至今已經完成 4 個航次 (LGD1901、LGD1911、LGD2002、LGD2003)。海洋中心 LMCS 系統擁有 3 大特點：第 1 點為最長達 6 公里的受波器浮纜，包含 480 個頻道，可收集到來自深部地層的反射訊號；第 2 點則為導航系統伺服器，功能為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，以進行等距炸測，可克服臺灣附近海域多變的海況；第 3 點為能量集中的震源系統，能夠透過平行鎗簇的方式，提高 P/B (Peak to Bubble) 值，得到更清晰的沉積地層剖面。其中，震源系統包含兩大單元，第一項單元為 NCA 公司出產的空壓機，其充氣能力為 650 SCFM (18 m^3/min)，當工作壓力設定在 2000 psi 的狀況下，空氣鎗容積 2000 in^3 的充氣時間約 15 秒。若以船速 5 節估算，炸測間距約 39 公尺，亦可符合平常震測作業的 50 公尺炸測間距。第二項單元為 SECREL 公司出產的新型空氣鎗 G. Gun II，不僅方便維護與操作，能夠在甲板上更換空氣鎗容積配置，亦可利用混合鎗陣列的方式，得到更乾淨的震測訊號。以南海首航 LGD1901-02 測線的資料為例，從分析 4 串鎗簇近場 (Near Field) 之疊合訊號得知，其 P/B 值約介於 3.84-4.76 之間。進而，模擬遠場 (Far Field) 之直達波訊號，可發現其氣泡訊號幾乎消失，P/B 值約介於 21.99-32.63 之間。由此可知，此套震源系統所提供的訊號乾淨，並能夠有效去除氣泡影響。海洋中心震測團隊雖然已成功使用勵進研究船搭載 LMCS 系統蒐集資料，但未來仍希望持續發展與改善 LMCS 系統，以發揮其系統最大性能，並希望能夠配合學研界，積極投入台灣周遭海域能源與地質災害潛勢的調查研究中，為國家海洋地球物理探勘研究注入新能量。

勵進研究船深海型多音束聲納資料品質與作業效益-以台灣花蓮外海為例

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摘　要

勵進研究船(以下簡稱勵進)隸屬於國家實驗研究院台灣海洋科技研究中心,是目前台灣最大的科學研究船。勵進船底的GONDOLA配有淺海型與深海型多音束聲納。前者適用探測深度為600公尺內高解析海底地形,後者為11,000公尺內全海域地形測深。換言之,勵進可依任務需求執行海域的各式地形測繪調查工作。勵進深海型多音束聲納使用12 khz的作業頻率,於深海海域作業時能夠同時具備有穩定的資料品質與執行效率。

本研究使用LGD-T40航次期間於冬天東北季風盛行的花蓮外海執行深海型多音束聲納作業,作業區域位於花蓮海底峽谷與新城海脊之間,深度為250公尺至2500公尺。在風力6級以上、海流3-4節的海況條件下,透過良好的船隻操作與測線規畫,仍可收到聲納掃幅為水深的3倍以上且測深品質穩定之水深資料。經資料處理與品質分析的結果顯示,經過刪除壞點的資料在使用現地聲速剖面以及潮位修正後,資料品質符合國際海道測量組織IHO S-44精度標準,總傳播不確定度(TPU)也都符合IHO的規範要求。

勵進深海型多音束聲納資料品質不僅能符合IHO測量規範,在天候海況不佳的作業條件下,亦可透過駕駛台穩定操作與妥適測線規畫,收到品質優良的水深資料。

以數值實驗探討地下水於東沙環礁潟湖之擴散

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摘　要

　　東沙環礁位於南海北部大陸坡邊緣的開放大洋，遠離陸地形成獨立的生態系統。其礁臺包圍內部大潟湖，形成水深約一公尺之天然屏障，大潟湖水深最多約15公尺，屬於淺水環礁。在過往觀測資料中曾發現東沙環礁大潟湖在某些地方會有鹽度下降的情況，懷疑是地下水滲漏入海的訊號，且其強度似乎與大小潮有關係。本中心執行研究計畫，將在東沙環礁實地進行大潟湖的觀測採樣，以確認此鹽度下降的訊號是否為地下水滲漏。本研究為實地觀測的前期規劃研究，先以數值模式來進行地下水滲漏後擴散的實驗，以了解不同滲漏點以及各種外部驅動力（風、潮汐）作用情況下地下水影響的空間與時間範圍。研究方法採用ROMS區域海洋模式進行東沙環礁的物理環流模擬，用外部驅動力，包括風、潮汐、大洋環流，來驅動東沙環礁的水體流動。地下水滲漏則利用ROMS內建的河川徑流功能，設定只有底床具有流量的點源（point source）。有數個因素會影響滲流地下水的擴散情況，首先是地下水滲流流量，滲流流量越大，地下水擴散得越快。再來是滲出的地下水帶有與周圍海水不同的鹽度和溫度，因為鹽度低，地下水的密度通常小於海水的密度，故滲出的地下水會往水面擴散。外源的驅動力也很大程度地影響擴散。風驅動的垂直混合使得地下水訊號很快的擴散到整個垂直水層，因此地下水訊號在東沙環礁潟湖的分佈可視為水平空間和時間的函數，忽視垂直的變化。本研究設計不同的地下水滲流流量、鹽度與溫度，配合不同方向的風向進行數值實驗，試圖了解這些變數對地下水擴散的影響。特別是地下水對周圍海水鹽度的影響程度，此鹽度變化關係到儀器需距離滲出點多近才能觀測到地下水滲漏的訊號。

Ship-based Air-sea Flux & Exchange System (SAFE System)

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Abstract

Ship-based Air-Sea Flux & Exchange System (SAFE System) is designed for the exploration of the diurnal warm layer (DWL) in the upper ~20 meters of the ocean where solar heat can redistribute downward through advection and turbulent mixing. Therefore, the system is framed by a 45' floating buoy connected with a 20-m chain under the water. The acoustic Doppler current profiler (ADCP) and the Aquadopp Profiler (ADP), equipped in the buoy and on the chain, respectively, provide current velocity in the water column. The FP07microstructure thermistors, integrated into a MicroRider equipped on the chain, give an estimate of the thermal diffusivity. The intensive temperature sensors (SBE56temperature sensors and RBR loggers) distributed along the chain record the thermal variations in the upper 20 m at a vertical resolution of ~ 0.5 m. The SAFE system simultaneously measuring the currents, detailed thermal variations, and thermal diffusivity in the upper 20 meters of the ocean is expected to provide the necessary dataset to explain the dynamics of DWL. Recently, the development of the SAFE system is still ongoing and will be tested in the Kuroshio east of Taiwan.

Interannual changes of the circulations and hydrology in the East China Sea during summer using a numerical model

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Abstract

Interannual surface and subsurface variations of East China Sea are investigated using a 35-year ocean model simulation. A baroclinic mesoscale cold eddy is commonly observed in the subsurface to the south of Cheju during summer, which plays an important role in the subsurface water mixing. In the surface, the summer monsoon and Kuroshio Current are responsible for the first two dominant modes of variation, respectively. In the subsurface, the local wind dominates the interannual variations of the baroclinic cold eddy. Anomalous northeasterly wind induces southwestward pressure gradient due to the confinement of the land boundary. These anomalies propagate to the south through the topographic Rossby waves. In addition, the anomalous southwesterly at south trigger coastal upwelling around the Changjiang Estuary, favoring mixing of subsurface Kuroshio water and surface diluted water. These changes affect the structures and function of the marine ecosystem reported in many previous research.

Impacts of Distinct Ocean-atmosphere Coupling Processes

During the Winter Cold Surge in East Asia

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Abstract

Extreme weather condition appears more and more frequently in the future climate scenario. In the northern hemisphere, winter cold surge (CS) is the most influential weather phenomenon. In 2016 January, an unusual CS hit East Asia and caused devastating damages in many East Asia countries, potentially resulting mainly from the polar vortex ruptured under the influence of strong El Niño teleconnections. This study analyzes the associated ocean-atmosphere interaction (OAI) processes of the January 2016 CS using the reanalysis data and global coupled model experiments. Our results show that this CS event can be divided into two regimes in time: the first regime is dominated by the atmospheric forcing and the latter one is dominated by the oceanic forcing. For the atmospheric forcing-dominated regime, the strong winds and cold air associated with the CS forces the sea surface temperature change through the surface heat flux. On the other hand, for the oceanic forcing-dominated regime, the northward (southward) shift of the Kuroshio front causes an increase (decrease) in the regional sea surface temperature, which in turn dominates the surface heat flux change. Further comparing the CSs in different years, we can clarify them into fast-evolving and slow-evolving types in terms of different OAI. The fast-evolving CSs are initially dominated by the atmospheric forcing and then become dominated by the ocean, while the slow-evolving CSs are dominated by the ocean before becoming dominated by the atmosphere.

尼伯特颱風造成台灣東部近岸之海流及水位變化之探討

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摘　要

　　尼伯特颱風在經過台灣東部外海時，放置花東外海的三個ADCP有觀察到海表流速受到颱風影響而增強的情況。本研究將結合ADCP的流速資料、中央氣象局的水位及風速資料、Remote Sensing Systems的衛星遙測風速資料及普林斯頓大學海洋模式模擬的結果，來分析東部近岸之海流及水位在颱風經過後所產生的變化，並比較近岸與大洋的海水受到颱風擾動後的情況有何不同。

以誤差機率分布法發展台灣颱風暴潮系集預報系統

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摘　要

　　本研究所發展之暴潮系集預報模式，基於中央氣象局現有之COMCOT暴潮模式（COrnell Multi-Grid COupled Tsunami Model – Storm Surge）為基礎，以非線性淺水波方程式計算並分析風暴潮之生成、傳播以及近岸溯上等完整歷程，針對臺灣特有之地理環境建構網格計算，透過決定性預報路徑、強度及過往預報之誤差分布，計算機率密度分布曲線，產生多組假想颱風作為系集成員，並且發展相關機率預報產品。

　　研究中2016年至2018年之颱風案例進行系集預報之統整性分析，目前已知在理想颱風氣象場下，颱風中心位置越靠近測站位置將較有機會引起較高的暴潮水位，且颱風移動速度及近岸角度亦有可能受測站周圍地形影響而有較高的水位，以颱風強度而言，假想颱風之強度越強，則越容易對沿岸造成較高的水位，但與觀測資料比對時有機會過度預報；隨著系集成員數考量得越多，亦即考量越多颱風路徑偏移及前進速度變化的可能性，進而從系集預報中得到較高且延時較長的暴潮水位分布情形。以統計分析參數來看，現有之決定性預報有普遍較高的預兆得分，但對於防災的角度來說，決定性預報僅能包含部分的暴潮，對於大部分的情況下，利用決定性預報來考量台灣沿海的溢淹災害是不足的，因此在即時海岸災害預警方面，仍需要靠系集預報來進行補強。

臺灣北部海域流場季節變化

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摘　　要

　　本研究使用衛星遙測資料及數值模式輸出資料，探討臺灣北部海域在不同季風下流場變化。此區因地形、水文複雜，海洋動力過程一年中有著不同的面貌。為能綜觀性了解臺灣北部海域的流場，本研究將衛星測高儀、即時海水表面流動數據(Ocean Surface Currents Analyses-Real time, OSCAR)及混合座標海洋模式(Hybrid Coordinate Ocean Model, HYCOM)的海流資料區分為西南季風時期及東北季風時期並分別加以平均，結果發現在西南季風時期此海域主要受到臺灣海峽的海流及黑潮相互影響；而在吹拂東北季風時期，除了原先的臺灣海峽的海流及黑潮外，還有來自北方的中國沿岸流可能會加入。為進一步了解其變化因素，本研究亦將上述三種資料分別應用經驗正交函數(Empirical Orthogonal Function, EOF)進行時空分布。前三模態中，衛星測高儀海流及 OSCAR 海流的分析結果相似，皆可看出臺灣海峽的海流長年影響臺灣北部海域，而中國沿岸流在冬季會出現，但對此區影響較小。HYCOM 的結果則略為不同，從第三模態可看到來自北方的海流先向西南至臺灣西北方，再轉向東進入臺灣北部海域，此與漂流浮球軌跡較為吻合。會造成三種資料分析結果有差異的原因，可能是因為海流資料計算方法不同。

索羅門地區海嘯潛勢評估

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摘　要

　　索羅門群島位在太平洋板塊與印澳板塊之交界，長年大小地震與海嘯不斷。 因為當地居民大多住在沿海地帶，且房屋多為低矮之鐵皮屋或茅草屋，因此小規模 之海嘯即容易產生嚴重災害。為了解該地區之海嘯潛勢，本研究採用康乃爾大學所研發之多重網格海嘯模式(Cornell Multi-grid Coupled of Tsunami Model ,COMCOT），對 2007 年發生於索羅門西部群島以及 2013 年發生於 Santa Cruz 群島之兩場歷史海嘯進行模擬，並與現有資料比對進行模式驗證。模式驗證後使用影響強度分析法（Impact Intensity Analysis ,IIA）及海嘯到時分析法（Tsunami Arrival-Time Analysis ,TATA），配合海溝之位置及走向，針對索羅門群島之重要海岸城市，進行海嘯潛勢評估。並將索羅門群島南部的海溝劃分為六個孕震帶，設置情境參數，模擬地震發生時的海嘯災害。研究結果顯示， Gizo 及 Munda 為高海嘯潛勢都市，皆需注意來自 Ranongga Island 與 Vangunu Island 之海溝型海嘯威脅。而首都 Honiara 則因為位於群島內緣，要特別注意發生於 Vangunu Island 及 Guadalcanal Island 間之海溝型海嘯。

GNSS-R與海氣觀測資料關係建立

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摘　要

全球衛星導航系統反射接收儀(Global Navigation Satellite System-Reflectometry , GNSS-R)作為海洋遙測儀器,透過接收自地球表面反射的全球衛星導航系統(GNSS)訊號,取得觀測參數(observables)。接收自海表的反射訊號受到海況、風等影響,前人研究中並以此參數建立與海表參數、風速等的關係。

本研究目的以GNSS-R Normalized Bistatic Radar Cross Section(NBRCS)建立與海表觀測資料:海面平均傾度(Mean Square Slope, MMS)、風速(u10)與波浪參數之關係。

使用之GNSS-R NBRCS資料,由2018-2020年間NASA CYGNSS L1B Delay Doppler Map(DDM)以自開發算法而得,轉換DDM為Bistatic Radar Cross Section(BRCS),以再ESA正歸化得NBRCS,再選取反射點(SP point)周圍窗區計算DDMA NBRCS、LES觀測參數。海面平均傾度(Mean Square Slope, MMS)透過衛星觀測ESA SMOS選取南北緯40度間L2 Mean_Square_Slope及機載遙測NOAA WSRA L4 sea_surface_mean_square_slope資料;風速透過衛星遙測NOAA ASCAT METOP A/B/C選取南北緯40度間L2 Wind Speed、機載遙測NOAA/Hurricane Research Division's SFMR L2 Wind Speed等資料;波浪特性透過衛星遙測NOAA Jason-3等衛星測高計(Altimeter)、散射計(Scatterometer)選取南北緯40度間L2 SWH_C、SWH_KU波高資料。

尋找觀測期間同時間地點之CYGNSS NBRCS及CYGNSS入射角(incident angle)與海面觀測資料皆有數值的匹配點,針對不同incident angle繪製NBRCS對應若干觀測資料區間(bins),平均單一區間中NBRCS值後,得到海面觀測資料對NBRCS之散點圖並繪製趨勢線,建立GNSS-R NBRCS與海面觀測資料的關係,即Geometric Model Function(GMF)。

關鍵字:GNSS-R、MSS、u10 Wind Speed、Hs、GMF

海洋數值模式對鳳凰颱風(2008)引起近岸強烈降溫之研究

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摘要

2008 年鳳凰颱風侵襲臺灣期間,在臺灣東北近岸海域造成 12.5℃的海表降溫,如此強烈的降溫,大大吸引我們的關注,對其背後的形成機制極感興趣。此研究中,我們利用海洋數值模式（Regional Ocean Modelling System, ROMS）建立相關數值實驗,搭配有限的現場觀測資料以及衛星觀測資料做為佐證,嘗試解析造成該極端降溫背後之物理過程與機制。結果顯示,鳳凰颱風所造成的極端降溫是一個複雜交錯的過程,降溫前半段主要由東/東北風驅動的黑潮入侵引發強烈黑潮次層水抬升所造成,後續強烈地南風透過加強垂直混合搭配原本已經被抬升之次層冷水加強海面的降溫。最後,我們利用模擬的浮子軌跡監測這些冷水往下游移動之行為,發現這些強烈降溫可能沿著黑潮往下游一直延伸到日本島南端。

Exploring the Spread of Eddy Zonal Propagation Speed from Satellite Observation and Shallow-Water Simulations

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Abstract

We use a global meso-scale eddy tracking dataset to study the spread of eddy zonal propagation speed (C) relative to the local long Rossby wave speed (βL_d^2, where L_d is the deformation radius) and explore the effects of eddy-eddy interactions by using a shallow water model. Over 17000 eddies between 20° to 40° N in the Pacific are identified and tracked over a span of 26 years. The results show a widespread of normalized speed ($C/\beta L_d^2$), ranging between -5 to 5, with a mean of -1.08 and standard deviation of 1.18. The propagation speed approximating the long Rossby wave is well documented, but its spreading is not yet well understood. To explore the potential effects of eddy-eddy interactions, we re-calculate the statistics for eddies that are separated (between eddy's edge) by more than 0.5 to 5.5 L_d, with a 1 L_d interval. It is found that the spreads of normalized speed are similar among the tracked eddies separated by different distances. This suggests that short-range, direct influence of neighboring eddies is likely not the main cause of propagation speed spreading. To further quantify the effects of eddy-eddy interactions, a shallow water model is used to simulate two eddies separated by different distances and angles. Eddy properties resulted from two-eddy interactions and the potential influences of Rossby wave radiation will be presented.

全球氣候變遷下之台灣灘湧升流變化之初步探討

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摘 要

台灣灘是屬於太平洋的邊緣海，是南海及東海之間的過渡區域。台灣灘東西方的交界於中國大陸及台灣，南北方向為台灣海峽開放區域與東海及南海相連。根據歷史資料顯示，夏季時，來自台灣灘西南部的南海暖流脫離中國沿岸並沿著台灣灘東南邊大陸坡等值線流動，當到達東經 119.5 度時，一部分流向北流入澎湖群島的東西兩側進入台灣海峽，另一分支則向東南方流動，經過南灣後流入西太平洋。根據前人的研究，在夏季時台灣灘東南方的冷水湧升是相當顯著的，此現象可能與南海暖流流入台灣灘東南邊有關，當科氏力向南作用時，表層水將被推離陸坡，在此區域的表層來不及補充，進而造成底層的冷水湧升以補充表層水。此研究利用 MITgcm 數值模式來模式此現象，結果顯示在台灣灘的東南邊緣附近有一個類似香蕉形狀的湧升區，而海研三號於 2018 年 8 月 1 日至 3 日的航次也有觀測到同樣的結果。

臺灣周遭海域表層海流數據應用於
海難搜救漂流模擬之可靠度分析

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摘　要

臺灣位於亞太航運樞紐，海運交通繁忙，當有海難事故發生時，救援行動分秒必爭。我國海洋委員會海巡署為提升搜救成效，於105年引進美國海岸防衛隊的「搜救優選規劃系統」(Search and Rescue Optimal Planning System, SAROPS)，此系統能依海難發生初始位置、表面洋流與風向，計算遇險人船最有可能的漂流區域，規劃搜救任務，提升遇險者獲救率。目前該系統已導入美國之全球模式及臺灣在地化海氣象資料。本研究擬探討臺灣周遭海域表層海流資料之可靠度分析，提供海巡署SAROPS專責小組對於海流數據指南之參考。

本研究探討2016年3月至2017年2月一年中流經臺灣周遭海域全球漂流浮標計畫(Global Drifter Program, GDP)之漂流浮標，並利用美國海軍研究實驗室(United States Naval Research Laboratory, NRL)之HYCOM(The Hybrid Coordinate Ocean Model)數值模式海流、交通部中央氣象局(Central Weather Bureau, CWB)所提供的OCM(Ocean Circulation Model)數值模式海流以及台灣海洋科技研究中心(Taiwan Ocean Research Institute, TORI)所建立的TOROS(Taiwan Ocean Radar Observing System)高頻雷達海流資料。

本次使用之GDP漂流浮標為每6小時進行一次報位，將此資訊作為模擬之起點，並分別計算表層海流資料推估浮標0-6-12-18小時之漂流模擬軌跡，並藉由正規化拉格朗日追蹤技能得分(Skill Score)，探討上述資料在臺灣周遭海域海流數據之可靠度分析。此外本研究亦探討各海流資料在春夏秋冬四季及臺灣東西南北四個分區海域的模擬漂流浮標軌跡之情形，並計算其統計第95百分位漂流模擬推估位置差異（S95），以瞭解在模擬24小時後，漂流浮標實際位置與模擬軌跡之誤差情形，以瞭解不同海流資料所造成之誤差情形。

結果顯示，這三種海流資料由於近岸與大洋複雜的海洋環境系統中各自有不同的限制，其可靠度而有所不同，當模擬時間達24小時後，美國NRL HYCOM數值流場位置偏差可擴大至50~97公里，臺灣CWB OCM數值流場則可擴大至48~81公里，而臺灣TORI TOROS 10公里格網雷達測流則落在43~72公里間。且在本研究中亦提供臺灣周遭海域表層流場於四個季節及四個海域之可靠度。但必須特別強調，由於海象氣象資訊平台受到運作原理之物理限制、起始與邊界條件的準確度、海洋環境的複雜與紛紜等因素影響，且本研究僅以2016年3月至2017年2月間之海流數據及10個漂流浮標進行分析討論，漂流軌跡之時間與空間分布有限，尚不足以代表任依海洋環境數據之絕對優劣。

本研究以科學數據量化分析，說明了海洋的紛紜與複雜。當前表面海流流場數據因為水深地形、複雜海洋動力機制以及各數據服務平台之物理限制，而使得其產出流場各有其優劣，建議未來可透過資料整合、資料同化及深度學習技術，進一步提升可靠度分析方面。

波流遙測在金樽國際衝浪賽
Wave Monitoring by X-band Radar for Taiwan Open of Surfing at JinJun

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摘　要

　　近年來隨著政府大力推廣海洋運動，使得海洋運動發展如雨後春筍般蓬勃發展。然而這些海洋運動通常是透過海洋水體、環境或氣候因子產生行為，因此過去有許多研究已探討兩者之間的因果關係和相互影響情形。以衝浪活動為例，早在1974年時即有休閒衝浪參數(Recreational surf parameters)的概念被提出，並進而衍生出根據衝浪者的技術水準、能力分級與海洋波浪特性之關係。隨著行政院在2020年規劃推動「向海致敬」以來，一股「衝浪科學（The Science of Surfing Waves and Surfing Breaks）」之應用發展正在萌芽，期望發展「以人為本」的科學技術，透過開放式創新及結盟與合作希望向衝浪者和非衝浪的海岸規劃者、科學家和工程師傳達衝浪科學的基本知識。

　　在臺灣，海域遊憩活動除了釣魚、游泳，就以投入衝浪的人口最為蓬勃興盛，近10年間，更因臺東縣政府常年在東河鄉金樽漁港舉辦國際級衝浪賽事（Taiwan Open of Surfing），更將我國的衝浪風氣及國際知名度帶到新的境界。2020年衝浪賽於11月18日至22日舉辦，國家海洋研究院與臺東縣政府合作，於比賽期間在金樽海岸開設高解析X-Band波流遙測系統，並整合中央氣象局及國海院的海氣象數值預測資訊，以容易理解的圖表資訊展示介面，提供衝浪選手及主辦單位在衝浪競賽期間海域環境資訊。本文旨在報導海洋監測技術支援海域遊憩活動的創新服務試驗，為向海致敬中以「海域遊憩活動安全動態資訊系統建置」的前瞻基礎建設計畫拉開序幕，期望用科技拉近我們與海洋的距離。

關鍵字：衝浪、X-band、波浪、資料加值服務

基於深度學習之Sentinel-2多光譜影像土地使用/覆蓋分類法
Land use and land cover classification derived from Sentinel-2 multispectral imagery using a deep learning approach

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摘　要

臺灣海岸線長約一千五百公里，自民國106年2月《海岸管理法》公布施行後，相關單位都積極依照永續發展的理念，擬訂海岸管理相關辦法。然而，海岸地區的範圍除了平均高潮線向外海延伸至30公尺等深線之近岸海域外，還包含了濱海的陸地範圍，其定義乃以平均高潮線至第一條省道、濱海道路或山脊線之陸域為界。因此，海岸管理工作所牽涉的層面並不僅於海上，還有向陸域延伸的區域。而陸域環境的變化，無論是人為或是自然造成的影響，例如：人工建物開發、海岸防護設施破壞或海岸災害等，都需要掌握土地使用/覆蓋(Land Use/Land Cover; LULC)的資料。而獲取這些資料最有效率的方法，莫過於引進具備長時間與大範圍監測特性之衛星遙測影像。

歐洲太空總署之哨兵(Sentinel)系列之Sentinel-2衛星影像，具備12個可見光至短波紅外光之多光譜資訊與10公尺至60尺高空間解析度，每五天可對臺灣全島進行完整拍攝，且完全支持資料開放政策。換言之，每五天即可對臺灣海岸做一次全面性的LULC調查。本研究使用機器學習的深度學習方法，針對海岸地區的範圍，開發由Sentinel-2衛星影像產製LULC成果的技術。設定之目標為：雲、水、裸露地、植生、農田、人工建物等六類。並配合高空間分辨率之航空照片或無人飛行載具之空拍成果，率定分類成果之精度，以相關研究應用所需。

關鍵字：臺灣海域、海岸管理、永續發展、Sentinel-2 衛星、資料開放、土地使用/覆蓋、人工智慧、深度學習。

台灣東部沿岸小尺度渦漩之發生機制與特性
Mechanism and characteristics of small-scale eddies along the east coast of Taiwan

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摘　要

　　台灣東部沿岸屬於斷層海岸,高山與深海平行相鄰,海岸陡峭,沿海平原狹窄,經年又有黑潮通過,沿岸流速快,流場變化非常複雜。雖然從一般可見光範圍之衛星遙測影像上不易察覺其動態變化,但若使用海洋水色衛星影像之第二級產品,例如葉綠素-a或總懸浮物質含量,再適當調整資料呈現之區間範圍,就可以看到許多小尺度之渦漩。唯過去的觀測資料有限,不容易瞭解其發生機制與特性。拜資料開放政策之賜,歐洲太空總署(European Space Agency; ESA)的哨兵系列衛星中,Sentienl-2與Sentinel-3都有提供葉綠素-a與總懸浮物質含量的標準產品,不但涵蓋台灣東部沿岸地區,且時間可回溯至2016年。本研究嘗試開發一個基於時空模型之影像特徵萃取法,並應用來處理Sentienl-2與Sentinel-3時間序列影像,期能準確判定並追蹤台灣東部沿岸小尺度渦漩,並藉以探討其發生機制與特性。

關鍵字:台灣東部沿岸、小尺度渦漩、Sentienl-2、Sentinel-3、時空模型、特徵萃取。

海洋學門資料庫—物理海洋資料庫

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摘　要

　　物理海洋資料庫從1986年籌設資料庫以來，持續及穩定的收集臺灣周邊海域船測海流及水文資料等，主要是由國內三艘海洋研究船(新海研1號、2號、3號)配備的鹽溫深儀(Conductivity-Temperature-Depth Profiler，簡稱CTD) 及船載式都卜勒流剖儀(Shipboard Acoustic Doppler Current Profiler，簡稱SADCP) 所收集的物理參數所構成，計算出氣候場上的統計平均，藉助這些水文與海流分布圖可以初步了解臺灣周邊海域海水溫度、鹽度、流速之時空分布特徵。可將物理資料與其他領域資料整合做為環境資料因子，透過時空的統計分析，提供長期且完整、正確之海洋監測與觀測資料，協助政府在制定海洋相關決策時之佐證，並對維護我國海洋權益、規劃海洋資源之永續利用、降低天然災害之損失等等，期能發揮效益。

　　去年度資料更新狀況如下，船測鹽溫深儀及船碇式都卜勒流剖儀資料更新：新海研1號增加12個航次；新海研2號增加29個航次；新海研3號增加57個航次，以及過去海研一、二、三號歷史資料的統計也會一併展示。資料新增頻率為每月收集此三艘研究船執行計畫所採集到的電子資料，資料的點位規劃以各計畫主持人執行科技部計畫所擬訂的，透過現場實驗及觀測，累積海洋基礎而得。

　　配合學門資料庫內部橫向整合的分散式服務架構，運用JavaScript Object Notation (簡稱 JSON)作為資料交換格式，底圖套用內部同仁發布的網路地圖服務(Web Map Service, 以下簡稱WMS)的水深1000公尺網格圖層，作為展示CTD點位、SADCP軌跡及海流玫瑰圖的網頁服務，也繪製各式網格圖幅，可套疊在地圖上展示，提供不同深度及時間區間的統計參考。

生物海洋資料庫**Open API**應用於海洋群聚生態分析平台

翁其羽

臺灣大學海洋所/科技部海洋學門資料庫

摘　要

　　科技部海洋資料庫（ODB）所彙整臺灣周遭海域之海洋生物群聚資料，已具超過7萬筆浮游動物與5萬筆仔稚魚的生物豐度記錄。透過實作開放應用程式界面（Open API）得以分析其群聚之物種歧異度分布；並可調用國際海洋環境資料庫提供的環境因子，套疊於空間分布圖上或進行統計分析，用以探討在較大時空規模尺度下之群聚季節性分布模式，以及物種多樣性與海洋水文環境關聯性。並將之整合於 ODB 海洋生物地理空間生態資訊平台 bio.odb.ntu.edu.tw/query，使能與更多使用者互動，協助了解浮游動物與仔稚魚群聚之地理分布與組成，以期具體應用ODB生物資料庫於海洋生態科學、保育研究與科普推廣。

海洋學門資料庫

林姿吟

臺灣大學海洋所/科技部海洋學門資料庫

摘　要

　　海洋學門資料庫成立於1987年，當時是由行政院國家科學委員會資助(2014年3月3日更名為科技部)，委託國立台灣大學海洋研究所負責設置運作。成立的宗旨在於收集及保存我國海洋研究船探測所得的各種海洋資料，以提供學術研究和台灣四周海域海象統計分析之用。從資料庫建立之後，30多年來研究船所收集的海洋物理、化學、生物和地質、地物資料等，遍佈台灣四周海域以及東海和南海北部。這些資料經過資料庫同仁有系統的整理和分析之後,已經提供給學界使用多年，除此之外，相關的產品也提供給海洋工程、海難搜索救援和海洋教育等的應用。

台灣南部海域熱韌性尖枝鹿角珊瑚的生殖與培育

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摘要

　　全球珊瑚礁由於人為干擾和氣候變遷衝擊，已大量減少和快速衰退，並且可能在未來的數十年在野外消失。海洋熱浪是對珊瑚生存最嚴重的威脅，評選、培育和保存熱韌性珊瑚是珊瑚礁研究、保育和復育的關鍵任務之一。2020 年全台各地皆發生珊瑚大白化與大量死亡事件，台灣南部南灣第三核能發電廠出水口淺海(3 公尺)的水溫雖然高達 35.6℃，但數量豐富且族群正在擴張的尖枝鹿角珊瑚 (*Pocillopora acuta*)，約 50%的群體並未白化而仍然健康，並且正常生殖與釋放幼生，顯示具有熱韌性；其在流水式天然海水系統和再循環人工海水養殖系統中都能釋放幼生，餵食豐年蝦下，能夠維持至少 5 個月生殖，釋放幼生高峰的平均農曆日分別為 6、11、20 和 4，日期涵蓋月中的每一天。我們正在發展培育尖枝鹿角珊瑚在完全人工環境下，完成完整生活史的工廠化養殖系統原型，推動其作為研究珊瑚熱韌性的實驗模式物種，和標準化大量生產子代的種珊瑚 (broodstock)，以促進台灣珊瑚種原成為國內和國際優良的生物醫學研究材料和生態復育韌性物種。