International Conference on Marine Environment and Biodiversity Conservation in the South China Sea

南海海洋環境與生物多樣性保育國際研討會

Conference Proceeding

會議資料

National Sun Yat-sen University, Kaohsiung, Taiwan

台灣 • 高雄市 • 國立中山大學

2010.07.16~17

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Welcome Remarks and Acknowledgments from the Organizing Committee

The organizing committee would like to first extend its cordial welcome to scholars and experts from home and abroad, graduate students and the general public for attending the International Conference on Marine Environment and Biodiversity Conservation in the South China Sea. Thank you for coming to National Sun Yat-sen University (NSYSU), which is located in Sizihwan Bay, a beautiful scenic bay area in Kaohsiung. Assembled here in this conference is an impressive array of experts and scholars from home as well as China, Japan, the Philippines, Malaysia, Vietnam and the United States. The organizing committee would like to express its sincere welcome to every participant.

This conference aims at exploring a wide range of issues regarding marine environment and biodiversity conservation in the South China Sea from a macro perspective. It covers issues such as marine biodiversity, marine environmental changes, marine technology and environmental sustainability, the operation and management of marine protected area (MPA) and so on. This conference mainly addresses issues related to the South China Sea; however, other areas are also covered by conference presenters who explore common issues shared by all. It is hoped that this conference will explore and discuss issues regarding the environment and biodiversity conservation thoroughly.

This conference is organized by the College of Marine Sciences, NSYSU and Marine National Park Headquarters. It receives financial support from National Science Council, Taiwan Ocean Research Institute, National Applied Research Laboratories, Environmental Protection Administration and Ministry of Education. Special thanks will be extended to the sponsors as well as advisors who spent time and made efforts to make this conference possible.

It is hoped that this conference will generate fruitful results for future academic and governmental references for researching and policy-making. Finally, I wish this conference a great success.

Mo-Lin Yang
Director of Marine National Park Headquarters

Jin-Yuan Liu
Dean of College of Marine Sciences,
National Sun Yat-sen University

大會歡迎與致謝詞

首先歡迎來自國內外學者專家、研究生、社會大眾，來到位於高雄西子灣風景秀麗的國立中山大學，參加「南海海洋環境與生物多樣性國際研討會」。本研討會參與發表論文的專家學者，除國內諸多先進外，尚有南海周邊與附近的國家，包括中國、日本、菲律賓、馬來西亞、越南等，此外，並有美國著名學者，共襄盛舉。主辦單位在此以最誠摯的心情致上歡迎之意。

本研討會旨在以宏觀的角度，探討南海海洋環境與生物多樣性的議題，範圍十分廣泛，包括：海洋生物多樣性、海洋環境變遷、海洋科技與環境永續、海洋保護區經營與管理等。探索的區域雖以南海為主，惟因問題的共通性，所發表的論文主題，並不以南海為限。希望藉由本次研討會，深入探索海洋環境與生物多樣性保育的相關問題。

本研討會由國立中山大學海洋科學學院及海洋國家公園管理管理處主辦，並獲國家科學委員會、國家實驗研究院海洋科技研究中心、環境保護署、教育部等單位的經費支持，謹此致謝。籌備期間，承蒙諮詢委員們多方指導，籌備委員們費心費力，在此一併致上最誠摯的謝意。

最後，期待在這一次研討會能夠順利成功，並獲致豐碩的成果，所得的結論可以增進學術研究或作為政府施政的參考。

國家海洋公園管理處處長

楊模麟

國立中山大學海洋科學學院院長

劉金源

Welcome Remarks from the President of National Sun Yat-sen University

Distinguished guests from home and abroad, ladies and gentlemen, good morning!

I am delighted to see outstanding scholars and experts from home and abroad as well as friends caring about marine development attending this conference at National Sun Yat-sen University. On behalf of NSYSU, I would like to extend my cordial welcome to you all.

The topic of this conference concerns with marine environment and biodiversity conservation. This is a meaningful topic of our time when the earth is undergoing severe impacts due to people's continuous development. As we all know, because of global warming, the earth is experiencing dramatic environmental changes. Therefore, as we consume the resources of the earth, how to conserve and achieve sustainability is a pressing issue of today.

Oceans cover about 70% of the Earth's surface. The changes of marine environment can impact on the balance of the overall ecological environment. Marine biodiversity is the key to achieving dynamic equilibrium of all creatures on the earth. Taiwan is a typical island country with rather limited land resources. Therefore, the development and conservation of the ocean play crucial roles for Taiwan to achieve sustainable development.

NSYSU is Taiwan's only research university that has a college of marine sciences. Since its inception, NSYSU has been regarding marine development as one of its missions. In the past few years, NSYSU has received key financial support from Ministry of Education. A good amount of this budget was used to conduct marine research which has generated fair results. University of California, San Diego (UCSD) is the benchmark for NSYSU in that NSYSU strives to enhance its cooperation with Scripps Institution of Oceanography (SIO) so as to promote its academic performance in the filed of marine studies. I hereby call for participating leading experts from Taiwan and abroad to support NSYSU and offer your valuable suggestions to us.

Last but not least, I hope this two-day conference will be of a great success. And I wish you health and happiness.

Hung-Duen Yang
President of National Sun Yat-sen University

中山大學校長致詞

各位國內外貴賓、各位女士、各位先生，大家早安！

今天非常高興看到諸多國內外傑出學者專家以及關心海洋發展的朋友來到本校參加研討會，個人謹代表學校，致上誠摯歡迎之意。

本次研討會所探討的主題是有關海洋環境及生物多樣性保育的問題。這個議題在當今地球環境因為人類不斷的開發而受到嚴峻衝擊的關鍵時刻，相當具有時代的意義。眾所周知，此時此刻，我們的地球正因全球暖化而造成環境的巨變，因此，人類在使用地球資源的同時，如何保育以期永續，乃是當今相當迫切的問題。

海洋占地球表面積百分之七十以上，海洋環境的變遷關係著整個地球的生態環境的平衡，而海洋生物的多樣性更是地球生物動態平衡的關鍵。台灣是一個典型的海島國家，陸地資源十分有限，因此，發展與保育海洋，乃是台灣永續發展的命脈。

本校乃是台灣主要研究型大學中唯一設置有海洋科學學院的大學，自創校以來，海洋領域一直是本校發展的重點之一。尤其是過去幾年，本校藉由教育部重點經費的支援，投入了不少的經費於海洋研究，也獲致不錯的成果。現今，本校以UCSD（加州大學聖地牙哥校校區）作為標竿學習的學校，其中因素之一，也是希望加強本校與SIO（Scripps Institution of Oceanography）在海洋方面的合作，提升本校在海洋領域的學術水準。懇請在座國內外先進，能給予本校指導。

最後，預祝這兩天研討會順利成功，各位朋友身體健康、心想事成。

國立中山大學校長

楊弘敦

Welcome Remarks from the Director-General of the Construction and Planning Agency, Minstry of the Interior

Good morning, President of National Sun Yat-sen University, Dean of College of Marine Sciences, distinguished guests from abroad, Deputy Minister of Environmental Protection Administration, Deputy Minister of Research, Development and Evaluation Commission, ladies and gentlemen.

I'm honored to be here, on behalf of Construction and Planning Agency, Ministry of the Interior and Marine National Park Headquarters, to welcome every one of you to the conference.

South China Sea is a marginal sea connecting Indian Ocean and Pacific Ocean. Known for abundance in natural marine resources, South China Sea is an important hotspot of biodiversity and has long been a fishing ground. The world-renowned Coral Triangle encompasses an area from Indonesia, Malaysia, Philippines, Papua New Guinea, Solomon Islands, and Timor-Leste and nurtures more than 600 coral species, which is 1.5 times more than the number of coral species found in Great Barrier Reef, and about 2 times more than that in Kenting, Taiwan. And why is Dongsha atoll, which is in the area of South China Sea near Coral Triangle, not considered as part of the triangle? Last year, on a visit to Marine National Park Headquarters, coral reef scholars from Australia and the US indicated that Coral Triangle was defined by marine areas containing 500 or more species of reef-building corals and there was no sufficient evidence to show whether South China Sea had so many coral species. To explore the biodiversity in South China Sea and to make sure whether it is as biodiversified as Coral Triangle, more full-scale investigations are needed and it is also necessary to integrate the research projects in different countries.

The agency's subordinate Marine National Park Headquarters is the competent authority of Dongsha Atoll National Park, which is located in the north of South China Sea. As the managing body of the area, we've tried to figure out answers to the question by enhancing exchanges between the academic research and the real practice of management, and joining in the world's efforts in preservation.

The two-day "International Conference on Marine Environment and Biodiversity Conservation in the South China Sea" is co-organized by Marine National Park Headquarters and College of Marine Sciences, National Sun Yat-sen University, with the presence of local and international experts and scholars to share relevant research results on the environment of South China Sea. Under the premise of eco sustainable

development, we hope to achieve a feasible framework for international cooperation to delve into the resources in South China Sea. At the same time, the event is a chance for us to convey the results of scientific research and idea of preservation to the public, call to people's attention the valuable resources in South China Sea, and form a preservation consensus among the general public so as to encourage everyone to lead a greener life and bring the idea of marine preservation into practice.

Also part of our concern is the issue of the forming of trans-boundary marine protected area, which has become a focal point in global conservation efforts. Currently, up to 227 trans-boundary protected areas has been established worldwide. If the governments can put aside the political controversy of Nansha waters and establish a preservation-oriented trans-boundary marine protected area or a peace park, that will be beneficial to the neighboring countries and the marine lives in South China Sea.

Thank you for attending the conference despite your tight schedule and playing a role in the research of the marine environment of South China Sea and resources protection. We hope this event to be a starting point of international cooperation on the resource preservation of South China Sea. Thank you very much. And I hope this is going to be a successful event.

Shih-Wen Yeh
Director-General of Construction and Planning Agency,
Minstry of the Interior

署長致詞稿

中山大學楊校長（弘敦）、海洋科學院劉院長（金源）、與會的各國嘉賓、環保署邱副署長、研考會魏副主委，以及在座各位女士、先生，大家早安。

本人謹代表內政部營建署及海洋國家公園管理處誠摯歡迎各位嘉賓、先進蒞臨本研討會。

南海位於印度洋與太平洋的銜接帶，向來以豐富的海洋自然資源知名，被公認為生物多樣性熱點，自古即為重要的漁場。而世界知名的「珊瑚大三角（Coral Triangle）」涵蓋印尼、馬來西亞、菲律賓、巴布亞新幾內亞、所羅門群島、東帝汶之間的海域，珊瑚種類高達600種以上，是大堡礁的1.5倍，幾乎是台灣墾丁的2倍，而東沙環礁所處的南海就緊鄰此區域，「但為何南海沒能被劃入Coral Triangle的範圍?」，去（2009）年澳洲及美國珊瑚礁生態學者前來海洋國家公園管理處訪問時指出，納入Coral Triangle的一項要件是要有500種以上的造礁珊瑚，然而目前沒有充分數據證明南海有如此豐富的珊瑚物種。所以唯有更全面的研究調查，將各國獨立進行的研究計畫整合，才有機會了解南海生物多樣性是否如「珊瑚大三角」一樣豐富。

本署轄下之海洋國家公園管理處經營管理位於南海北端的東沙環礁國家公園，我們從這個區域經營管理者的角色試著去找出問題的答案，從加強學術研究與經營管理實務的交流，並參與國際合作共同保育的方向著手，應該是不錯的方法。

海洋國家公園管理處與中山大學海洋科學院共同舉辦為期兩天的『南海海洋環境與生物多樣性保育國際研討會』，集結台灣與南海周邊地區相關領域的專家學者，分享各項對於南海環境的研究成果，希望在生態與環境資源永續的前提下，型塑具體可行的國際合作架構

來了解南海資源。另一方面也希望藉由本研討會的舉辦將這些科學調查與保育概念傳遞給社會大眾，激起民眾對南海資源的重視，建立保育共識，更具體內化改變個人平日的生活習慣，以實際行動實踐對海洋環境與生物資源的保護。

另外，劃設跨界海洋保護區（transboundary marine protected area）也是我們所關心的議題。跨界保護已成為國際保育的重點，目前全球共有227座跨界保護區，未來若能促成各國擱置南沙海域爭議，轉而成立一座以保育研究為主的海洋跨界保護區或是和平公園，對於周邊國家及南海的海洋生物都將是一件美事。

各位於百忙中前來參加研討會，貢獻對南海海洋環境與資源保護的熱忱與關心，希望這個研討會能成為國際合作來保育南海海洋資源的第一步。最後，再次感謝大家熱心的參與本研討會，謹祝各位身體健康，萬事如意，也祝研討會順利成功。謝謝各位！

內政部營建署署長

葉世文

AGENDA 議程

July 16th 2010 (Friday) **2010 年 7 月 16 日（週五）**

Time	Activity 活動	Chairman 主持人
8:30~9:00	Registration 報到	Jin-Yuan Liu（劉金源） Mo-Lin Yang（楊模麟）
9:00~9:30	Plenary, VIP Keynote Address President Hung-Duen Yang（楊弘敦）, NSYSU; Director-General Shih-Wen Yeh（葉世文）, Construction and Planning Agency, Ministry of the Interior 開幕、貴賓致詞	
9:30~10:00	John W. McManus and Kwang-Tsao Shao（邵廣昭）, The Spratly Islands (Nansha): Networking Marine Protected Areas for Region-wide Benefits 1	Kwang-Tsao Shao （邵廣昭）
10:00~10:30	Coffee Break 茶敘時間	
10:30~11:00	Ting-Hsuan Huang and Chen-Tung Arthur Chen（黃婷萱、陳鎮東）, The Influence of Anthropogenic CO2 in the South China Sea..... 3	Kon-Kee Liu （劉康克）
11:00~11:30	Henrik Schmidt, Nested Autonomy with MOOS-IvP for Interactive Ocean Observatories..... 9	Jin-Yuan Liu （劉金源）
11:30~12:00	Wen-Yan Chiau（邱文彥）, Taiwan's Marine Environmental Policy in the South China Sea..... 19	Kun-Hsiung Chang （張崑雄）
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13:45~14:05	Shao, K.T., T.Y. Fan, L.S. Liu, H.J. Lin, I.J. Chen, D.J. Kuo（邵廣昭、樊同雲、劉小如、程一駿、林幸助、郭道仁）, Current Status and Perspective of Marine Biodiversity of Taiping Island in the Spratlys, South China Sea 23	Hwung-Hweng Hwung （黃煌煇）
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14:25~14:45	Kuo-Yen Wei, Tien-Nan Yang and Li-Ling Chen（魏國彥、楊天南、陳俐陵）, How many specimens should one count to obtain a reliable measurement of species diversity? Case studies of coccoliths using rarefaction analyses 27	Forng-Chen Chiu （邱逢琛）
14:45~15:10	Coffee Break 茶敘時間	

	Group Sessions 分組發表	
15:10~16:10	**Session A1 (Room 1106)**	**Session B1 (Room 1107)**
	Marine Environmental Change/ Science & Technology/Management	Marine Biodiversity
16:10~16:30	Coffee Break 茶敘時間	
16:30~17:30	**Session A2 (Room 1106)**	**Session B2 (Room 1107)**
	Marine Environmental Change/ Science & Technology/Management	Marine Biodiversity
18:00~21:00	Banquet 晚宴	

July 17th 2010 (Saturday) **2010 年 7 月 17 日（週六）**

Time	Activity 活動	Chairman 主持人
8:30~9:00	Registration 報到	
9:00~9:30	Minhan Dai（戴民漢）, Carbon Biogeochemistry of the South China Sea – current understanding and potential changes in the context of global change.....29	Tswen-Yung Tang （唐存勇）
9:30~10:00	Chong Ving Ching, Marine Biodiversity and Conservation in the South China Sea, with Emphasis on Ichthyofauna (Malaysia).....31	
10:00~10:30	Coffee Break 茶敘時間	
10:30~11:00	Edgardo D. Gomez, Enhancing Biodiversity in the South China Sea through Restoration and Restocking.....37	Chang Feng Dai （戴昌鳳）
11:00~11:30	Makoto Tsuchiya（土屋誠）, Landscape Diversity and Connectivity of Tropical Coastal Ecosystems 41	
11:30~12:00	Peter Gerstoft, Remote Sensing with Noise 45	Jin-Yuan Liu （劉金源）
12:00~13:30	Lunch 午餐	
13:30~13:50	Hideo Yamasaki（山崎秀雄）, Biological Impacts of Global Warming on Coral Reefs: Lessons from Coral Bleaching Studies.....49	Keryea Soong （宋克義） Chia-Hung Hung （洪嘉宏）
13:50~14:10	Rudolf Wu（胡紹燊）, Eutrophication and Hypoxia: Problems and Scientific Challenges 53	
14:10~14:30	Nguyen Van Quan, Coastal and Marine Ecosystem Services and Poverty Alleviation: A Case Study of Vietnam 55	
14:30~14:40	Break 休息	

	Group Sessions 分組發表	
14:40~15:40	**Session A3 (Room 1106)**	**Session B3 (Room 1107)**
	Marine Environmental Change/Science & Technology/ Management	Marine Biodiversity
15:40~16:00	Coffee Break 茶敘時間	
16:00~16:45	**Session B4 (Room 1106)**	**Session B5 (Room 1107)**
	Marine Biodiversity	Marine Biodiversity
16:50~17:20	Final Conclusions and Declaration of the Conference, Closing Ceremony 大會宣言、閉幕	

Session A1: Marine Environmental Change/ Science & Technology/ Management

Room 1106 **July 16th 2010 (Friday)**

Chairs: Cho-Teng Liu（劉倬騰）, Bang-Fuh Chen（陳邦富）

Session A2: Marine Environmental Change/ Science & Technology/ Management

Room 1106 **July 16th 2010 (Friday)**

Chairs: Ruo-Shan Tseng（曾若玄）, Fuh Kwo Shiah（夏復國）

Session A3: Marine Environmental Change/ Science & Technology/ Management

Room 1106 **July 17th 2010 (Saturday)**

Chairs: Yann-huei Song（宋燕輝）, Jia-Jang Hung（洪佳章）

Session B1: Marine Biodiversity

Room 1107 **July 16th 2010 (Friday)**

Chairs: Houng-Yung Chen（陳宏遠）, Tse-Min Lee（李澤民）

Session B2: Marine Biodiversity

Room 1107 **July 16th 2010 (Friday)**

Chairs: Hin-Kiu Mok（莫顯蕎）, Meng-Hsien Chen（陳孟仙）

Session B3: Marine Biodiversity

Room 1107 **July 17th 2010 (Saturday)**

Chairs: Wen-Tseng Lo（羅文增）, Chaolun A. Chen（陳昭倫）

Session B4: Marine Biodiversity

Room 1106 **July 17th 2010 (Saturday)**

Chairs: Chan-Shing Lin（林全信）

Session B5: Marine Biodiversity

Room 1107 **July 17th 2010 (Saturday)**

Chairs: I-Shiung Chen（陳義雄）

KEYNOTE SPEECH

主題演講

The Spratly Islands (Nansha): Networking Marine Protected Areas for Region-wide Benefits

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ABSTRACT

The Spratly Islands (Nansha) are contested in part or whole by six nations. Studies nearly two decades ago indicated that they may be important sources of larvae for maintaining heavily overfished coastal coral reefs throughout the region. It was suggested that an international marine park be established which would include in its charter a freeze on claims and claim-supportive activities. Over the last two decades, a number of Peace Parks have been established in other regions which exemplify this combination of conservation and tension-easing along disputed borders. The concept of establishing a Marine Peace Park in the area was supported in statements by former Philippine President Fidel Ramos, and more recently by former President Maa of Taiwan. However, there has been as yet no firm action towards the development of the appropriate agreements.

In addition to the larval supply issue, there are strong economic incentives to promote regional cooperation in these islands. The maintenance of military outposts in isolated regions has significant economic costs, such as transportation and maintenance of facilities, and social costs such as the difficulties in family life faced by the assigned personnel. The intrinsic high levels of biodiversity and tourism potential of the island group continue to raise the interests of regional countries in conducting research there. However, it currently takes several days of travel by ship for scientists from Taiwan and mainland China to reach the islands. Agreements on easing air travel restrictions could make visits more regular, and ship travel through ports in Malaysia, Brunei and the Philippines would make research vessel deployment much more practical.

An alternative to the establishment of a Peace Park in one step would be the gradual implementation of coordinated marine protection among marine reserves established individually by the claimant countries for areas they currently occupy. As national declarations are implemented, discussions could be initiated to ensure that regulations are complementary with respect to maintaining marine populations on larger scales. These discussions could potentially lead to increasing levels of research collaboration and to agreements to facilitate air and sea access. Bilateral and multilateral agreements could be set up for freezing claims and claim-supportive activities for particular subsets of the islands. In this manner, the Peace Park could potentially arise out of a series of small steps, rather than via a single ‘jump’.

南沙群島：為了全區利益來連結海生保護地區

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摘 要

六國爭相宣告部份或全部南沙群島的主權。近二十年前的研究顯示，為了保護這地區中已遭嚴重過度漁撈的海岸珊瑚礁，此區也許是海洋生物幼體的重要來源區。專家建議此區應建立一座國際海洋公園，並在憲章中列出先凍結所有宣示主權及支持主權的活動。過去二十年以來，其他地區已建立幾座和平公園，展現出在具爭議性的邊界上，這樣的公園既結合了保育功能，亦可以消弭緊張局勢。菲律賓總統羅慕斯(Fidel Ramos)，以及台灣馬英九總統最近也支持在此區建立海洋和平公園。不過各國還未有具體行動來擬定適當的協議。

除了可以補給海洋生物幼體，另有強烈經濟動機來推動這島區的區域合作。這些孤立地區光要維修軍事基地，就要花上大筆經費，如交通與設備維修，以及駐派人員犧牲家庭生活的社會成本。這島區擁有高水準的生物多樣性及觀光潛力，也吸引了本地區國家來此研究。不過目前來自中國大陸和台灣的科學家均需花幾天搭船抵達。若能寬鬆飛航限制，便能使往返更加頻繁，透過行經馬來西亞、汶萊、及菲律賓港口，可更方便研究專船在此進駐。

若不能一步建立和平公園，替代方案便是各國逐步一起合作，對於各自占領並宣告主權地區當中的海洋保育區，實施海洋保護。正當各國宣告主權時，各方可以開始討論以確保相關規定可互補，以大規模維護海洋生物。這些討論可以增加研究合作，並讓各國達成協議來促進彼此海空交通。各國也可以先簽署雙邊與多邊協定，以凍結特別島區之主權及支持主權活動。這樣一來，和平公園便不需要「一步到位」，可以逐步達成。

The Influence of Anthropogenic CO_2 in the South China Sea

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EXTENDED ABSTRACT

The atmospheric carbon dioxide has increased by about 39%, from the preindustrial value of 280 ppm to approximately 388 ppm in Jan. 2010 because of the fossil fuel combustion and deforestation. Nearly one third of the anthropogenic carbon added to the atmosphere has been absorbed by the oceans. As the oceanic CO_2 uptake causes the pH values to decline the concentration of carbonate ions decrease, hence affecting the carbonaceous species in the oceans.

The rates of ocean acidification at the Hawaii Ocean Time-Series (HOT) and the Bermuda Atlantic Time-series Study (BATS) Stations are, respectively, 0.0015 yr^{-1} and 0.0006 yr^{-1} (data from http://hahana.soest.hawaii.edu/hot/hot_jgofs.html, Fig.1 and http://bats.bios.edu/index.html, Fig. 2). The decrease of seawater pH, however, is higher at 0.0022 yr^{-1} at the South East Asia Time-Serious (SEATS) Station (Fig. 3). Why there are different degrees of acidification maybe be related to individual ecosystems. The atmospheric CO_2 input of about 1.8ppmv yr^{-1} should have reduced pH by 0.0016 yr^{-1} at HOT which is close to the calculated one from observation. This may be because the chlorophyll a concentrations at HOT has been steadier than at BATS and SEATS. Increases of chlorophyll a concentrations resulted in consumption of CO_2, hence weakened acidification at BATS. The larger than expected acidification at SEATS may be due to a reduction of chlorophyll a concentration.

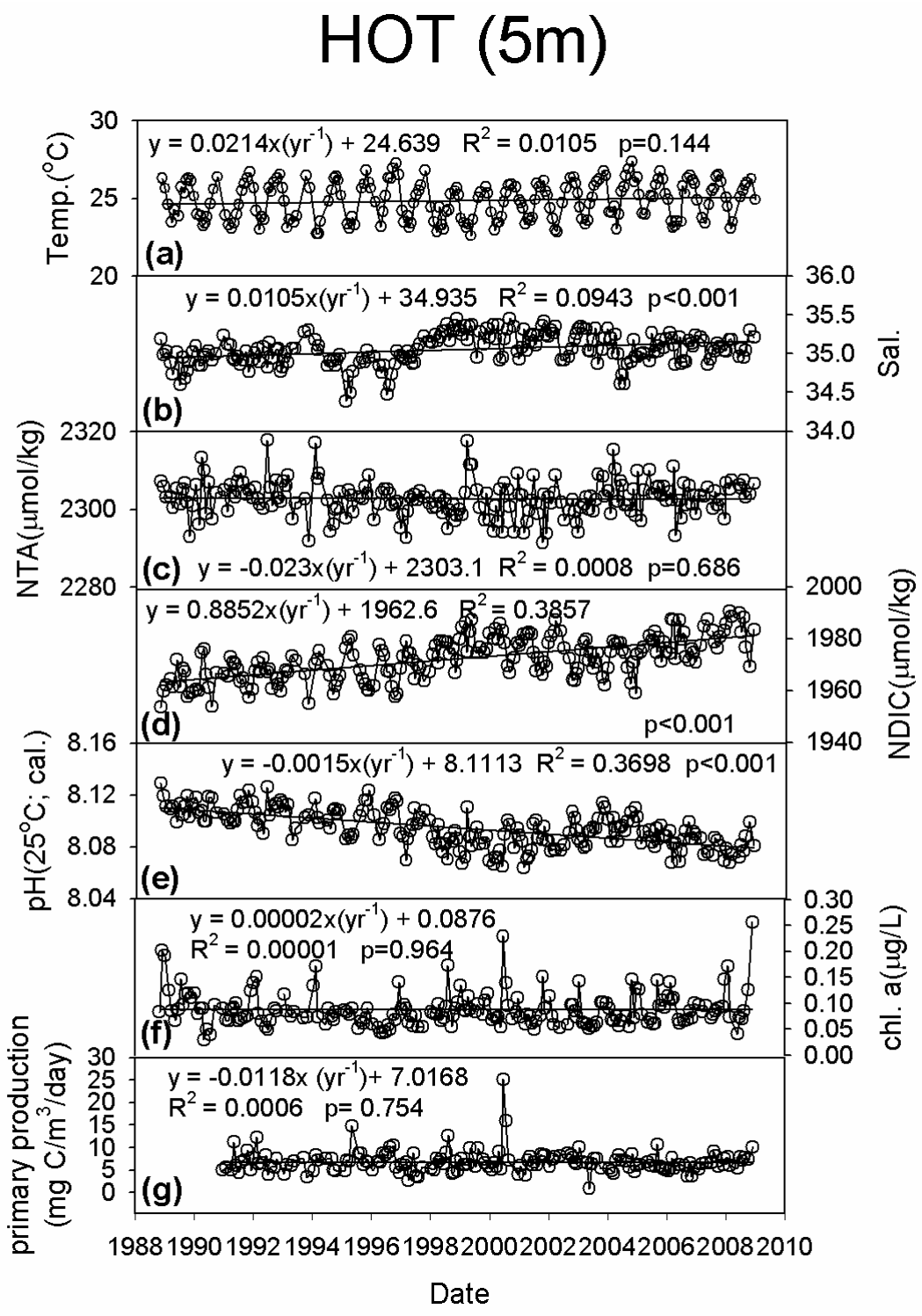

Fig. 1 The temporal trend of a) temperature, b) salinity, c) normalized total alkalinity (NTA=TA×35/S), d) normalized dissolved inorganic carbon (NDIC=DIC×35/S), e) pH (calculated from DIC and TA at 25°C), f) chlorophyll a and g) primary production at the HOT station.

這是在西太平洋夏威夷海域時間序列測站(HOT)的數值，依照時間順序，a) 溫度，b)鹽度，c) 正常化後總鹼度 (NTA=TA×35/S)，d) 正常化後已溶解的無機碳 (NDIC=DIC×35/S)，e) pH 值 (是由 25°C 時已溶解無機碳以及總鹼度的值。f) 葉綠素 以及 g) 基礎生產量。

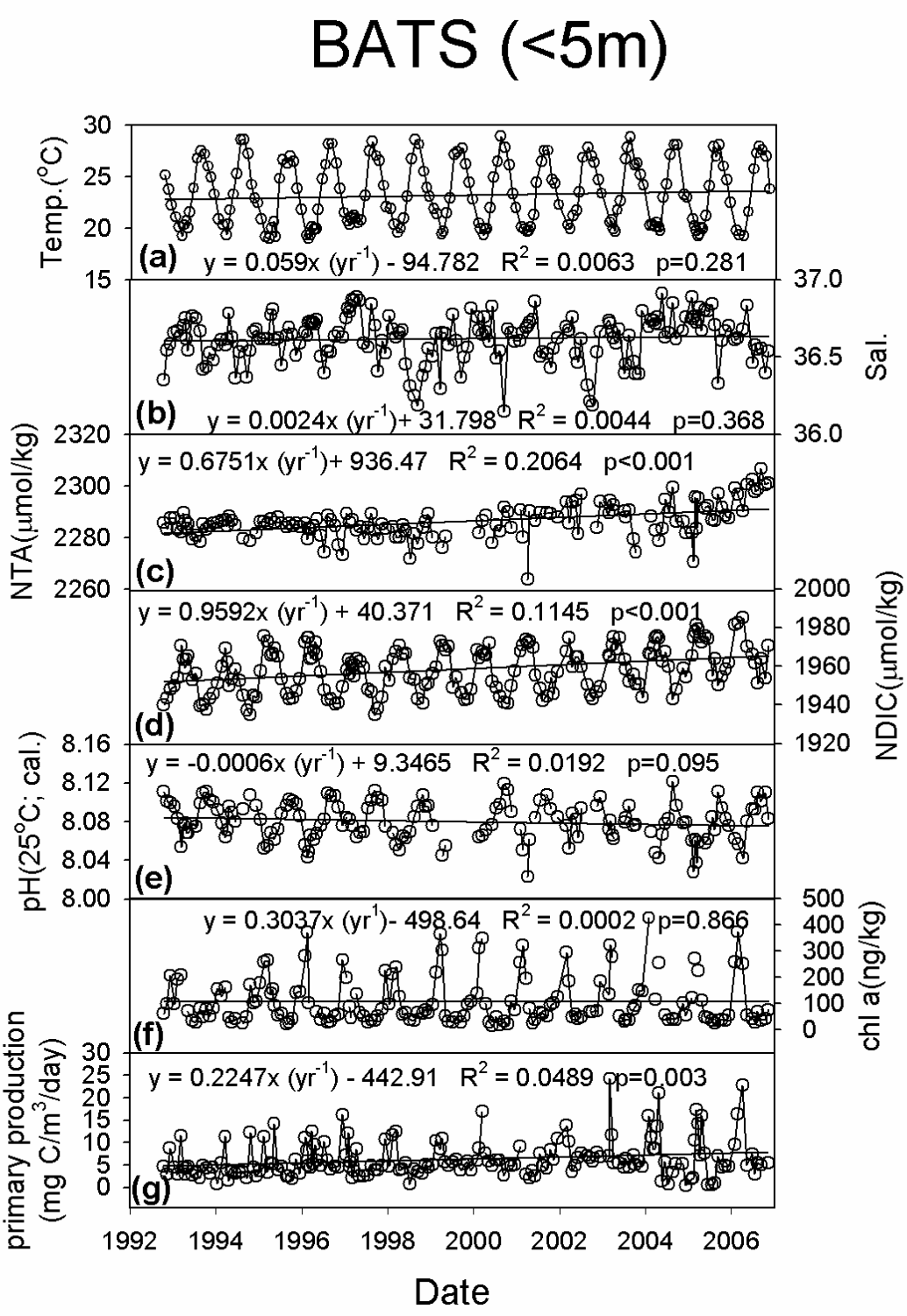

Fig. 2 The temporal trend of a) temperature, b) salinity, c) normalized total alkalinity (NTA=TA×35/S), d) normalized dissolved inorganic carbon (NDIC=DIC×35/S), e) pH (calculated from DIC and TA at 25°C), f) chlorophyll a and g) primary production at the BATS station.

這是在百慕達大西洋區時間序列測站(BATS)的數值，依照時間順序，a) 溫度，b) 鹽度，c) 正常化後總鹼度 (NTA=TA×35/S)，d) 正常化後已溶解的無機碳 (NDIC=DIC×35/S)，e) pH 值 (是由 25°C 時已溶解無機碳以及總鹼度的值。f) 葉綠素 以及 g) 基礎生產量。

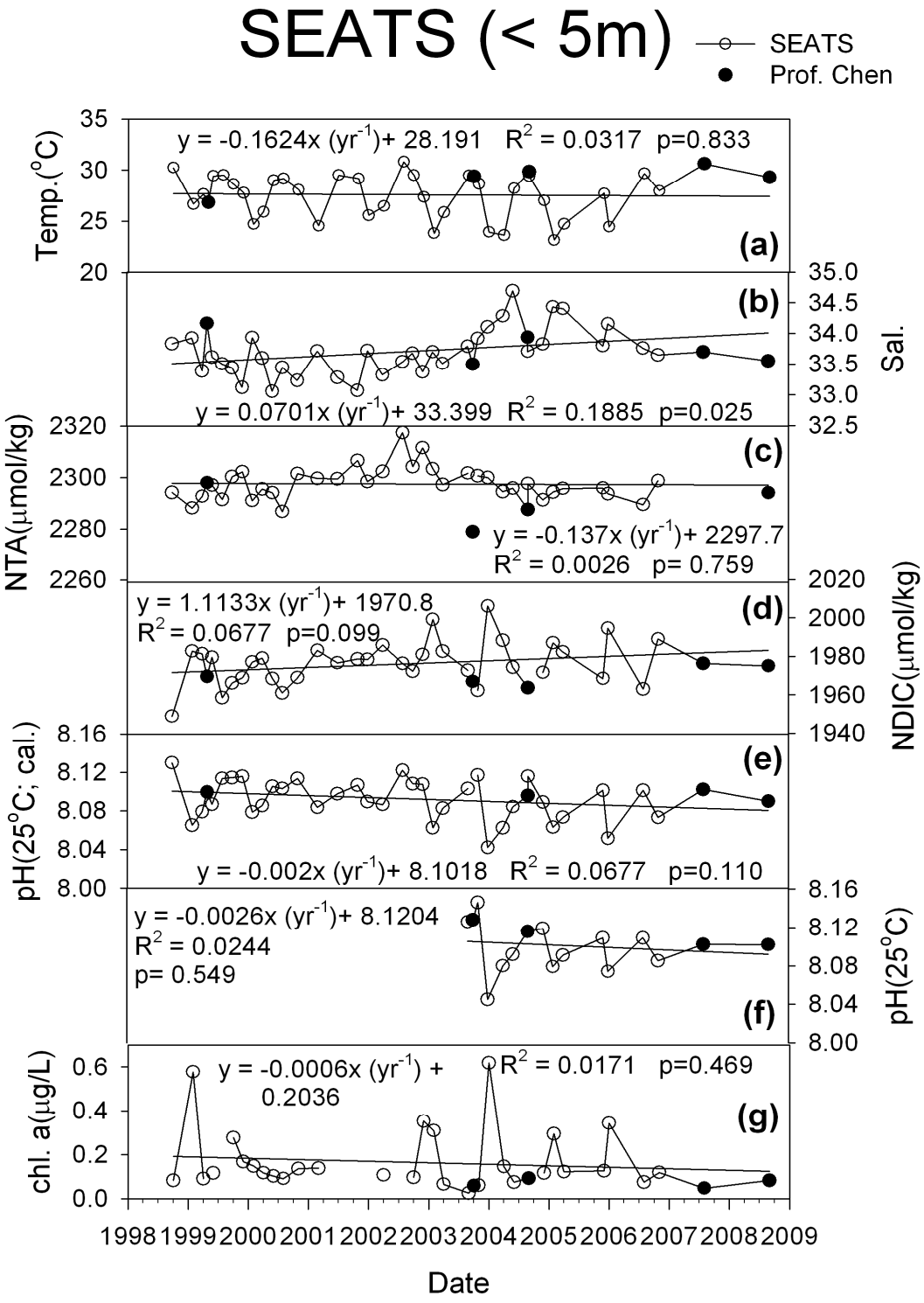

Fig. 3 The temporal trend of a) temperature, b) salinity, c) normalized total alkalinity (NTA=TA×35/S), d) normalized dissolved inorganic carbon (NDIC=DIC×35/S), e) pH (calculated from DIC and TA at 25°C), f) pH and g) chlorophyll a at the SEATS station.

這是在東南亞時間序列研究站(SEATS)的數值，依照時間順序，a) 溫度，b) 鹽度，c) 正常化後總鹼度 (NTA=TA×35/S)，d) 正常化後已溶解的無機碳 (NDIC=DIC×35/S)，e) pH 值 (是由 25°C 時已溶解無機碳以及總鹼度的值，f) pH 值以及 g) 葉綠素。

人為二氧化碳對南海之影響

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摘 要

因為燃燒石化燃料以及砍伐森林，大氣中二氧化碳含量，已經從工業革命前的 280 ppm（百萬分之一），上升到了 2010 年一月的 388 ppm，增加了百分之三十九。排到大氣中的人為二氧化碳有幾乎三分之一被海洋吸收。海洋吸收的二氧化碳，導致海水 ph 值下降，同時也降低碳酸粒子飽和度，因此影響海洋中的碳物種。

西太平洋夏威夷海域時間序列測站(HOT)與百慕達大西洋區時間序列測站(BATS)的海洋酸化速度，各自以 0.0015 yr^{-1} 以及 0.0006 yr^{-1} 進行。(資料來源：圖 1：http://hahana.soest.hawaii.edu/hot/hot_jgofs.html, 圖 2：http://bats.bios.edu/index.html)
不過在東南亞時間序列研究站（SEATS）（圖 3）海水 ph 值的降低速度卻較高，以 0.0022 yr^{-1} 的速度進行。酸化速度的不同可能與個別生態系統相關。在西太平洋夏威夷海域時間序列測站（HOT），由於大氣二氧化碳以 1.8 ppmv yr^{-1} 速度受到海洋吸收，pH 值原本應該減少 0.0016 yr^{-1}，才接近由觀測所計算出來的結果。這也許是因為在西太平洋夏威夷海域時間序列測站（HOT）的葉綠素 a 濃度比百慕達大西洋區時間序列測站（BATS）以及東南亞時間序列研究站(SEATS)還要更穩定。葉綠素 a 濃度增加導致消耗二氧化碳，也因此減輕百慕達大西洋區時間序列測站（BATS）的酸化現象。而在東南亞時間序列研究站（SEATS）的酸化現象比預期更嚴重也許是因為葉綠素 a 濃度降低。

Nested Autonomy with MOOS-IvP for Interactive Ocean Observatories

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EXTENDED ABSTRACT

The growing desire for autonomy in unmanned marine systems is driven by several trends, including increased complexity in mission objectives and duration, increased capability in on-board sensor processing and computing power, and an increase in the number of users and owners of unmanned vehicles. The MOOS-IvP project is an Open Source project designed and developed in this context. It is an implementation of an autonomous helm and substantial support applications that aims to provide a capable autonomy system out of the box. It also has an architecture, software policy, documentation, and support network that allows this newer generation of scientists, with newer vehicles and mission ambitions, to be nimble to build innovative autonomy algorithms to augment an existing set of capabilities. This paper describes the MOOS-IvP autonomy architecture and software structure, and describes how groups of vehicles, each with different sensors, processing power and communications capabilities, may be combined together to form a nested autonomy architecture with identical core autonomy software running on each platform.

MOOS-IvP is comprised of two distinct Open Source software projects. The Mission Oriented Operating Suite (MOOS) is a product of the Mobile Robotics Group at the University of Oxford, and provides core middleware capabilities in a publish-subscribe architecture, as well as several applications ubiquitous in unmanned marine robotic and land robotic applications using MOOS. Additional MOOS applications, including the IvP Helm, are available in the MOOS-IvP project. IvP stands for Interval Programming and refers to the multi-objective optimization method used by the IvP Helm for arbitrating between competing behaviors in its behavior-based architecture.

The MOOS-IvP software is available on the web via anonymous read-only access, [3]. It consists of more than 120,000 lines of C++, comprising about 30 distinct applications and over a dozen vehicle behaviors. It represents about 20 work years of effort or more from individual contributors. Autonomy configurations and missions in this environment have been tested in several thousands of hours of simulation and several hundred hours of in-water experiments, on platforms including the Bluefin 21-inch UUV, the Hydroid REMUS-100 and REMUS-600 UUVs, the Ocean Server Iver2 UUV, the Ocean Explorer 21-inch UUV, autonomous kayaks from Robotic Marine Systems and SARA Inc, and two larger USVs from the NATO Underwater Research Center in La Spezia Italy.

1.1 Trends in Unmanned Marine Vehicles Relating to Autonomy

The algorithms and software described in this paper have their genesis in unmanned underwater vehicles. Unlike unmanned sea-surface, ground and aerial vehicles, underwater vehicles cannot be remotely controlled; they must make decisions autonomously due to the low bandwidth in acoustic communications. Remote control, or teleoperation, in land, air, or surface vehicles may be viewed as a means to allow conservative, risk-averse operation with respect to the degree of autonomy afforded to the vehicle. In underwater vehicles, similar conservative tendencies are realized by scripting the vehicle missions to be as predictable as possible. Missions typical of early model UUVs were comprised of a pre-planned set of waypoints accompanied with depth and perhaps speed parameters. The on-board sensors merely collected data which was then analyzed after the vehicle was recovered from the water.

Advances in sensor technologies include greater capabilities, at lower cost, lower size and lower power consumption. The same is true for the on-board computing components needed to process sensor data. Increasingly underwater vehicles are able to see, hear and localize objects and other vehicles in their environment and quickly analyze an array of qualities in water samples taken while underway. Likewise, the available mission duration at-depth has grown longer due to improvements in inertial navigation systems, which have become cheaper, smaller and more accurate, and due to improvements in platform battery life. Each of these trends has contributed to making a UUV owner less satisfied with simply collecting the data and analyzing the results in a post-mission analysis phase. The information and analysis are available in-stride, in situ, why not act on that information in-stride to the advantage of the mission objectives? Enter adaptive autonomy.

The chart in Figure 1 below conveys a rough time-line and relationship between the evolution of UUV autonomy capabilities and the evolution of other critical UUV technologies. The notion of adaptive in adaptive autonomy is a sliding scale, and refers to the ability to allow increasing degrees of sensor information to affect in-stride autonomy decisions. On one end of the scale, even a vehicle that deterministically follows a set of waypoints may be adapting its heading decisions based on an INS or GPS sensor. However, sensors that are capable of perceiving qualities about the vehicle's environment, including water quality, bottom type, artifacts, and other moving vehicles, are able to alter the flow of autonomy decisions in a much more profound manner.

The notion of collaboration in collaborative autonomy may be viewed as a sliding scale as well. At one end of the spectrum are vehicles deployed alongside each other, executing a mission independently but each contributing to a joint mission. In this case, the collaboration occurs in the pre-deployment mission planning process. When at least periodic communication between deployed vehicles is feasible, a whole different kind of collaboration is possible, especially when each vehicle is able to adapt components of its mission to both its sensed environment and incoming communications from other vehicles. Advances in underwater acoustic communications (ACOMMS) in terms of reliability, range, flexibility in defining message sets, and bandwidth, have enabled the development of adaptive, collaborative autonomy [14, 15]. This trend also occurs in the context of declining cost and size of commercially available UUVs, making it possible for even medium-sized organizations to own and operate several vehicles.

The MOOS-IvP autonomy architecture has been developed and refined in this context of migration to adaptive, collaborative autonomy. Mission structure is less defined in terms of a sequence of tasks, but rather as a set of autonomy modes with conditions, events and field commands defining the transitions between modes. The modes correlate to a set of one or more active behaviors, where each behavior may be its own substantial autonomy sub-component. An autonomy system that includes the ability to adapt its mission to the environment, other collaborating vehicles, and periodic messages from within a field-control

hierarchy will inevitably need to balance competing objectives in a way that reflects a singular mission focus. This paper also discusses how multi-objective optimization is used at the behavior coordination level in the helm to achieve this design objective.

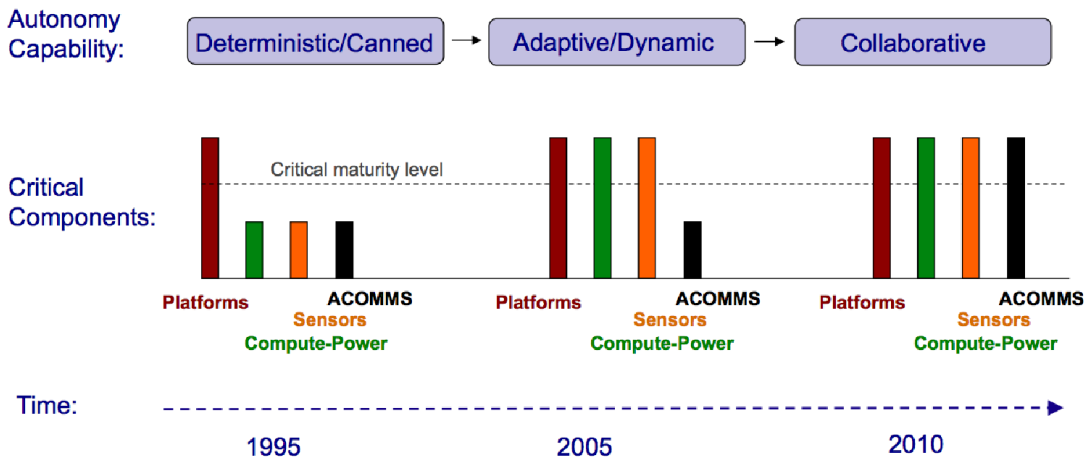

Figure 1. **UUV Technologies and Autonomy:** A rough time-line and relationship between UUV autonomy and other critical UUV technologies. Critical components include (a) the platform itself in terms of reliability, cost, and endurance, (b) on-board computing power and sensor processing, (c) on-board sensors in terms of resolution, size, and cost, and (d) acoustic communications (ACOMMS). Each of these maturing technology trends affects what is possible and desired from the on-board autonomy system. The corresponding trend in autonomy is from deterministic vehicles acting independently, toward adaptive vehicles acting in collaboration.

1.2 The Backseat Driver Design Philosophy

The main idea in the backseat driver paradigm is the separation between vehicle control and vehicle autonomy. The vehicle control system runs on a platform's main vehicle computer and the autonomy system runs on a separate payload computer. This separation is also referred to as the mission controller - vehicle controller interface. A primary benefit is the decoupling of the platform autonomy system from the actual vehicle hardware. The vehicle manufacturer provides a navigation and control system capable of streaming vehicle position and trajectory information to the payload computer, and accepting a stream of autonomy decisions such as heading, speed and depth in return. Exactly how the vehicle navigates and implements control is largely unspecified to the autonomy system running in the payload. The relationship is depicted in Figure 2.

The autonomy system on the payload computer consists of a set of distinct processes communicating through a publish-subscribe database called the MOOSDB (Mission Oriented Operating Suite - Database). One such process is an interface to the main vehicle computer, and another key process is the IvP Helm implementing the behavior-based autonomy system. The MOOS community is referred to as the "larger autonomy" system, or the "autonomy system as a whole" since MOOS itself is middleware, and actual autonomous decision making, sensor processing, contact management etc., are implemented as individual MOOS processes.

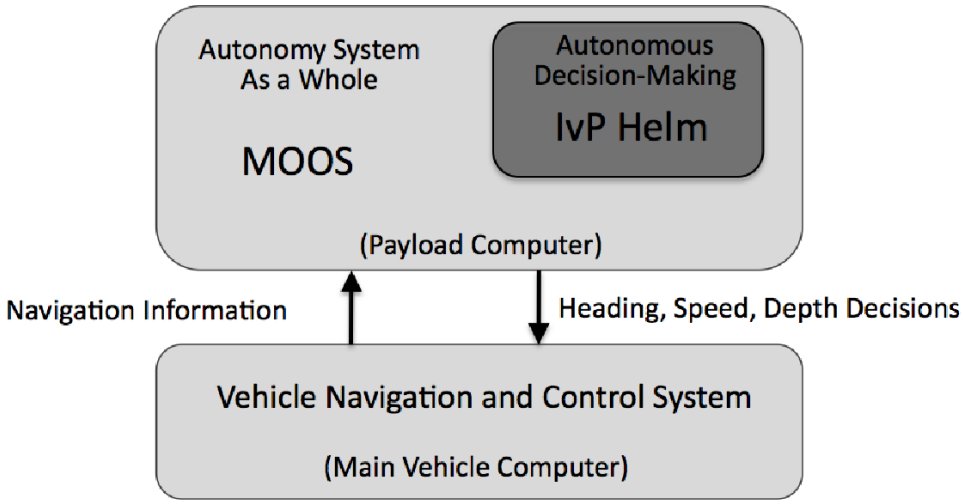

Figure 2. **The backseat driver paradigm:** The key idea is the separation of vehicle autonomy from vehicle control. The autonomy system provides heading, speed and depth commands to the vehicle control system. The vehicle control system executes the control and passes navigation information, e.g., position, heading and speed, to the autonomy system. The backseat paradigm is agnostic regarding how the autonomy system implemented, but in this figure the MOOS-IvP autonomy architecture is depicted.

1.3 The Publish-Subscribe Middleware Design Philosophy and MOOS

MOOS provides a middleware capability based on the publish-subscribe architecture and protocol. Each process communicates with each other through a single database process in a star topology (Figure 3). The interface of a particular process is described by what messages it produces (publications) and what messages it consumes (subscriptions). Each message is a simple variable-value pair where the values are limited to either string or numerical values such as (STATE, ‘‘DEPLOY’’), or (NAV_SPEED, 2.2). Limiting the message type reduces the compile dependencies between modules, and facilitates debugging since all messages are human readable.

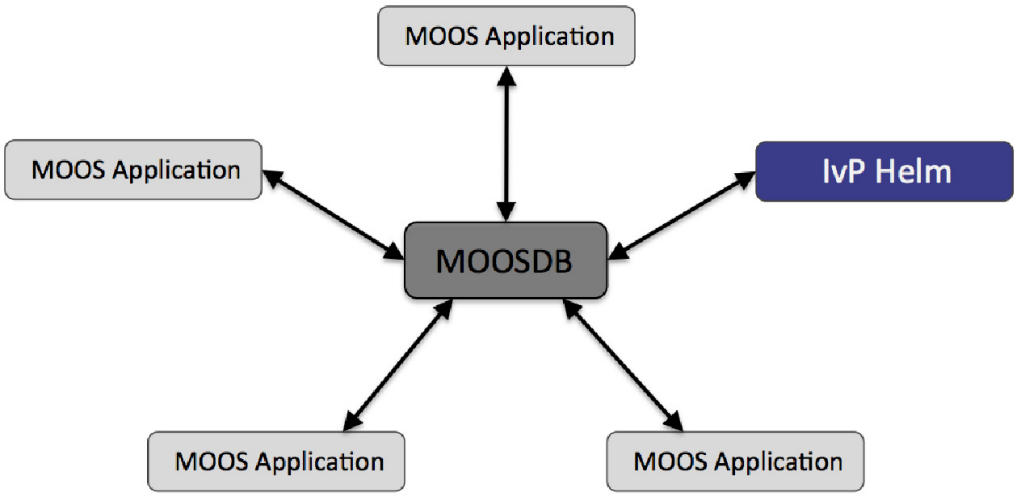

Figure 3: **A MOOS community:** is a collection of MOOS applications typically running on a single machine each with a separate process ID. Each process communicates through a single MOOS database process (the MOOSDB) in a publish-subscribe manner. Each process may be executing its inner-loop at a frequency independent from one another and set by the user. Processes may be all run on the same computer or distributed across a network.

The key idea with respect to facilitating code re-use is that applications are largely independent, defined only by their interface, and any application is easily replaceable with an improved version with a matching interface. Since MOOS Core and many common applications are publicly available along with source code under an Open Source GPL license, a user may develop an improved module by altering existing source code and introduce a new version under a different name. The term MOOS Core refers to (a) the MOOSDB application, and (b) the MOOS Application superclass that each individual MOOS application inherits from to allow connectivity to a running MOOSDB. Holding the MOOS Core part of the codebase constant between MOOS developers enables the plug-and-play nature of applications.

1.4 The Behavior-Based Control Design Philosophy and IvP Helm

The IvP Helm runs as a single MOOS application and uses a behavior-based architecture for implementing autonomy. Behaviors are distinct software modules that can be described as selfcontained mini expert systems dedicated to a particular aspect of overall vehicle autonomy. The helm implementation and each behavior implementation exposes an interface for configuration by the user for a particular set of missions. This configuration often contains particulars such as a certain set of waypoints, search area, vehicle speed, and so on. It also contains a specification of mission modes that determine which behaviors are active under what situations, and how states are transitioned. When multiple behaviors are active and competing for influence of the vehicle, the IvP solver is used to reconcile the behaviors (Figure 4).

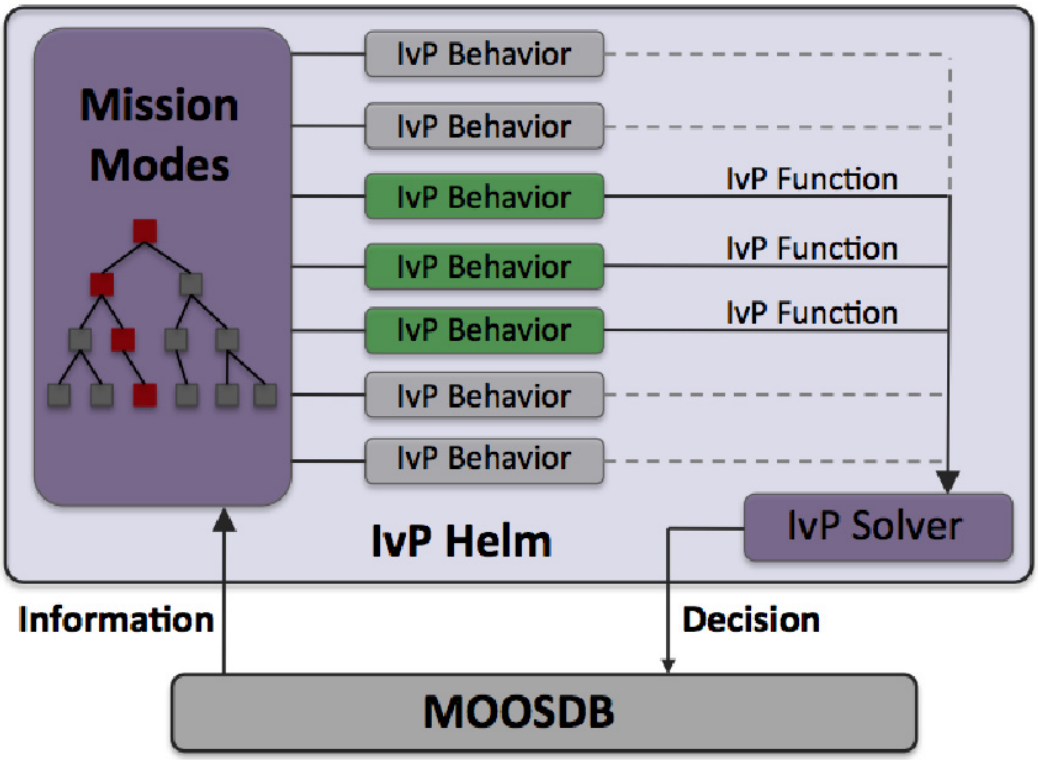

Figure 4: **The IvP Helm:** The helm is a single MOOS application running as the process pHelmIvP. It is a behaviorbased architecture where the primary output of a behavior on each iteration is an IvP objective function. The IvP solver performs multi-objective optimization on the set of functions to find the single best vehicle action, which is then published to the MOOSDB. The functions are built and the set is solved on each iteration of the helm – typically one to four times per second. Only a subset of behaviors are active at any given time depending on the vehicle situation, and the state space configuration provided by the user.

The solver performs this coordination by soliciting an objective function, i.e., utility function, from each behavior defined over the vehicle decision space, e.g., possible settings for heading, speed and depth. In the IvP Helm, the objective functions are of a certain type - piecewise linearly defined - and are called IvP Functions. The solver algorithms exploit this construct to find a rapid solution to the optimization problem comprised of the weighted sum of contributing functions.

The concept of a behavior-based architecture is often attributed to [5]. Since then various solutions to the issue of action selection, i.e., the issue of coordinating competing behaviors, have been put forth and implemented in physical systems. The simplest approach is to prioritize behaviors in a way that the highest priority behavior locks out all others as in the Subsumption Architecture in [5]. Another approach is referred to as the potential fields, or vector summation approach (See [1], [7]) which considers the average action between multiple behaviors to be a reasonable compromise. These action-selection approaches have been used with reasonable effectiveness on a variety of platforms, including indoor robots, e.g., [1], [2], [9], [11], land vehicles, e.g., [12], and marine vehicles, e.g., [4], [6], [8], [13], [16]. However, action-selection via the identification of a single highest priority behavior and via vector summation have well known shortcomings later described in [9], [11] and [12] in which the authors advocated for the use of multi-objective optimization as a more suitable, although more computationally expensive, method for action-selection. The IvP model is a method for implementing multi-objective function based action-selection that is computationally viable in the IvP Helm implementation.

1.5 The Nested Autonomy Paradigm

For large scale ocean monitoring and observation systems, no single unmanned platform has the ability in terms of sensing, endurance and communications to achieve large scale, long endurance system objectives. Even if multiple platforms are applied to the problem, effectiveness may be substantially diminished if limited to a single platform *type*. The *nested autonomy* paradigm, depicted in Figure 5, is an approach to implementing a system of unmanned platforms for large scale autonomous sensing applications. It is based in part on the objective of making seamless use of heterogeneous platform types using a uniform platform-independent autonomy architecture. It also assumes the platforms will have varying communications bandwidth, connectivity and latency.

The *vertical* connectivity allows information to pass from sensors to the on-board sensor processing and autonomy modules, or from each node to other nodes in the cluster, or up to the field operator, and thus forms the basis for the autonomous *adaptive control* which is a key to the capability in compensating for the smaller sensor apertures of the distributed nodes. Similarly, the *horizontal* connectivity forms the basis for *collaboration* between sensors on a node (sensor fusion) or between nodes (collaborative processing and control).

The three layers of horizontal communication have vastly different bandwidths, ranging from 100 byte/min for the inter-node acoustic modem communications (ACOMMS) to 100 Mbyte/sec for the on-board systems. Equally important, the layers of the vertical connectivity differ significantly in latency and intermittency, ranging from virtually instantaneous connectivity of the on-board sensors and control processes to latencies of 10-30 minutes for information flowing to and from the field control operators. This, in turn, has critical implication to the time scales of the adaptivity and collaborative sensing and control. Thus, adaptive control of the network assets with the operator in-the-loop is at best possible on hourly to daily basis, allowing the field operator to make tactical deployment decisions for the network assets based on e.g. environmental forecasts and reports of interfering shipping distributions, etc. Shorter time scale adaptivity, such as autonomously reacting to episodic environmental events or a node tracking a marine mammal acoustically must clearly be performed without operator intervention. On the other hand, the operator can still play a role

in cuing forward assets in the path of the dynamic phenomenon, using the limited communication capacity, taking advantage of his own operational experience and intuition. Therefore, as much as a centralized control paradigm is infeasible for such systems, it is also unlikely that a concept of operations based entirely on nodal autonomy is optimal. Instead, some combination will likely be optimal, but in view of the severe latency of the vertical communication channels, the *nested autonomy* concept of operations described is heavily tilted towards autonomy.

The MOOS-IvP autonomy implementation discussed in this paper is situated primary at the node level in the nested autonomy structure depicted in Figure 5. However, aspects of the MOOS-IvP architecture are relevant to the larger picture as well. A key enabling factor to the nested autonomy paradigm is the platform independence of the node level autonomy system. The backseat driver design allows the decoupling of the vehicle platform from the autonomy system to achieve platform independence. The MOOS middleware architecture and the IvP Helm behavior-based architecture also contribute to platform independence by allowing an autonomy system to be comprised of modules that are swappable across platform types. Furthermore, collaborative and nested autonomy between nodes is facilitated by the simple modal interface to the on-board autonomy missions to control behavior activations.

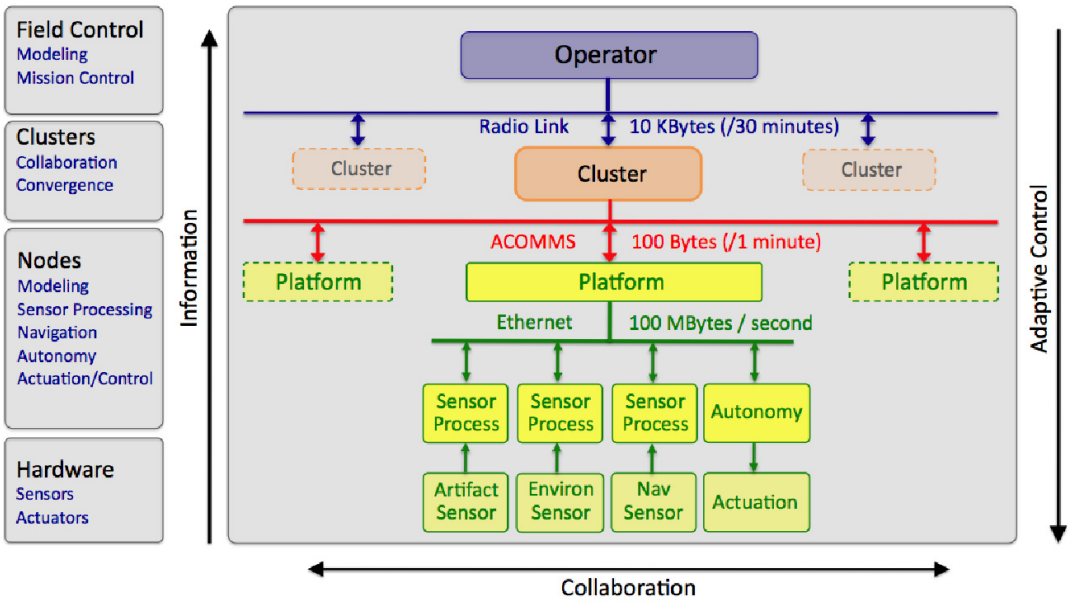

Figure 5: **The Nested Autonomy Paradigm:** Field control operators receive intermittent information from field nodes as connectivity and bandwidth allow. Elements of clusters may serve a heterogeneous role as a gateway communications agent. Likewise, nodes receive intermittent commands and cues from field operators. Node autonomy compensates for and complements the sporadic connectivity to field control and other nodes in a cluster or network of clusters.

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「區間規劃模組-任務導向操作套件」在互動式海洋觀測中之鑲嵌連結式自主結構

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摘 要

許多趨勢造成對無人水上載具的自主性產生越來越多的需求，這包括任務目標與執行期間的複雜性提高、艙上感測器處理能力與運算效能的增強，以及無人載具使用者與擁有者的增加。「區間規劃模組-任務導向操作套件」計畫是一項因應這個需求所設計與開發的「開放源碼」專案。這是自主式模組與許多支援應用程式共同執行，以提供即時可用的自主系統。它所具備的結構、軟體授權、文件與支援架構，也能讓新一代的科學家以更新型的載具與任務企圖心，靈巧地建構創新的自主運算系統，以便提升現有的系統的功能性。本研究將說明「區間規劃模組-任務導向操作套件」的自主結構與軟體架構，以及敘述如何將配備不同感測器處理能力以及通訊性能的各種載具群組結合，建構一個在各自平台上執行核心自主軟體的鑲嵌連結式自主結構。

「區間規劃模組-任務導向操作套件」是由兩個不同的「開放源碼」軟體專案所組成的。「任務導向操作套件」是由 Mobile Robotics 集團在牛津大學所開發的產品，能使用發佈-訂閱架構來提供核心中介軟體的功能，而一般無人水上自動機具與陸上自動機具中常見的一些應用程式也都使用「任務導向操作套件」。「任務導向操作套件」的其它應用程式還包括「區間規劃模組-任務導向操作套件」專案中涵蓋的「區間規劃模組」。IvP 指的是「區間規劃」，是一種「區間規劃模組」所使用的多重目標最佳化方法，用來在行為式架構的競比行為之間執行協調。

「區間規劃模組-任務導向操作套件」軟體在網際網路上能透過匿名唯讀存取來找到[3]。它包含 120,000 列以上的 C++原始碼，包括 30 種以上的不同應用程式以及十多種載具行為。它代表許多個別贊助者，總計超過 20 年以上工作時數的成果。在這個環境下的自主組態與任務，都已經通過數千小時的模擬測試與數百小時的水中試驗，操作平台包括 Bluefin 公司的 21 吋無人水下載具、Hydroid 公司的 REMUS-100 與 REMUS-600 無人水下載具、Ocean Server 公司的 Iver2 無人水下載具、Ocean Explorer 公司的 21 吋無人水下載具、Robotic Marine 系統公司與 SARA 公司的無人輕艇，以及義大利拉斯佩齊亞的「北約組織水下研究中心」的兩部大型水面無人載具。

Taiwan's Marine Environmental Policy in the South China Sea

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EXTENDED ABSTRACT

The South China Sea includes the Pratas Islands, the Spratly Islands, the Paracel Islands, the Macclesfield Bank and the Scarborough Shoal. It is a part of the Pacific Ocean, encompassing an area of around 3,500,000 km² from Singapore to the Strait of Taiwan. It is also one of the largest sea bodies after the five oceans. The sea consists of hundreds of islands, atolls, cays, shoals, reefs, and sandbars, most of which have no indigenous people, many of which are naturally under water during high tide, and some of which are permanently submerged. Minerals, natural gas, and oil deposits can be found on the islands and their nearby seafloor. The sea and its mostly uninhabited islands are subject to competing claims of sovereignty by several countries. States and territories that border each other on the sea include the People's Republic of China, the Republic of China (Taiwan), the Philippines, Malaysia, Brunei, Indonesia, Singapore, and Vietnam. For economic, military, and transportation reasons, the control--especially of the Spratlys--has been under dispute among Taiwan, China and several Southeast Asian countries such as Vietnam from the mid-20th century onward.

Accompanying with the expanding scale and intensity of human activities and marine resources exploitation, the loss of environmental quality and biodiversity in the South China Sea has been increasing. For instance, oil discharged from vessels is often found in many parts of the Sea. Overfishing and/or destructive fishing are also problems in the region. Furthermore, many development activities such as the establishment of artificial structures (e.g., jetties, seawalls, ports, airport runways, military facilities) on the sensitive islands or reefs may significantly disturb the natural processes of coastal and marine environment. These issues have been the focus of numerous literatures as well as the themes of many regional forums. On the other hand, it is believed that numerous shipwrecks can be found in the Sea. The South China Sea is, therefore, recognized as one of the potentially richest underwater cultural heritage sites. In short, the South China Sea is an extremely important asset for the peoples in the region in terms of environment, ecology as well as cultural heritage.

For the past several decades, Taiwan has effectively been in control of the Pratas Islands (i.e., reef atoll and the Pratas Island) and the biggest island (i.e., Taiping Island or Itu-Aba Island) of the Spratly Islands. In response to the environmental degradation in the South China Sea, the government of Taiwan published two editions of its marine policies in 2001 and 2006. President Ma Ying-jeou further announced his marine policy in 2008 during his presidential campaign. In addition to the claim of its long-recognized territory, Taiwan pays much attention to the environmental protection and ecological conservation of the South China Sea. Therefore, this presentation will introduce and discuss the related strategies included in the above marine policies. Examples in the Ocean Policy White Paper of 2006 are: (1) to

establish the marine biodiversity protection network in the South China Sea, (2) to establish an international center for marine research on the Pratas Island, (3) to protect the coral reef system, (4) to control aviation and maritime transportation in the Pratas Islands, (5) to conduct natural and underwater archeological surveys, and (6) to promote the necessary conservation and restoration projects in the South China Sea. Base on the concept of "common heritage", the marine policy of President Ma also proposes to open Taiwan's Taiping Island for the establishment of an "international peace park" so that the surrounding countries can work hand-in-hand to protect the natural environment and marine biodiversity in the South China Sea. The Island can also serve as an important base for human rescue efforts when emergency incidents occur. Additionally, oil pollution prevention and control deserves policy priority to avoid a repeat of the recent oil-spill disaster in the Gulf of Mexico, in light of the intensive development of oil and gas exploration activities in the South China Sea. However, more consensuses should be reached in the region. More dialogues on the appropriate mechanisms and future cooperation with other countries are also essential.

台灣對於南海的海洋環境政策

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摘 要

南海包括東沙群島、南沙群島、西沙羣島、中沙群島與黃岩島。它是太平洋的一部份，涵蓋了從新加坡到台灣海峽，約 3,500,000 平方公里的面積。南海也是除了五大洋以外的最大海域之一。這部份海域包括數百座島嶼、環礁、沙洲、淺灘、礁脈與沙壩，這些地區大多數都沒有原住民，在漲潮時也都會自然覆蓋在水面下，有些則是永久沉沒在水下。這些島嶼和鄰近海床都有礦物、天然氣與石油的沉積床。南海與其大部分的無人島都面臨許多國家的主權爭議。在黃海互相交界的國家與地區，包括中國、中華民國(台灣)、菲律賓、馬來西亞、汶萊、印尼、新加坡與越南。基於經濟、軍事，與交通方面的因素，在台灣、中國以及如越南等的東南亞國家之間，從 20 世紀中葉起就一直存在著統治權的爭執，尤其是對南沙群島的主權爭議。

隨著人類活動與海洋資源開發規模與程度的擴張，南海環境品質與生物多樣性的程度不斷降低。舉例來說，南海許多海域經常可以發現輸油管石油滲漏的現象。過度捕撈與/或破壞性捕魚作業也是這個地區的問題。另外，在這些脆弱的島嶼或礁脈建造人工建築結構體(例如防波堤、海堤、港口、機場跑道、軍事設施)等的開發措施，也都嚴重干擾沿海與海洋環境的自然過程。這些議題都是無數文獻與眾多區域性論壇關注的焦點。另一方面，南海也可能存在為數眾多的沉船殘骸，因此被認為是水下文化遺產最豐富的地區之一。總之，在環境生態以及文化遺產方面，南海都是這個地區人民一項非常重要的資產。

過去數十年以來，台灣都一直有效控制著東沙群島(即環礁與東沙島)，以及南沙群島的最大島(即太平島或稱黃山馬礁)。為了回應南海環境劣化的問題，台灣政府分別在 2001 年與 2006 年頒布了兩個版本的海洋政策。馬英九總統更在 2008 年競選總統期間進一步宣示了他的海洋政策。台灣除了長期認定領土的主張之外，對於南海的環境保護與生態保育更付出極大關切。因此，這份報告要說明並探討上述海洋政策的一些相關策略。2006 年海洋政策白皮書中有一些實例，包括：(1)在南海建構海洋生物多樣性的保護網路、(2)在東沙島設置一座國際性的海洋研究中心、(3)保護珊瑚礁系、(4)控制東沙群島的空中與海上交通運輸、(5)進行自然與水下考古調查、(6)在南海推行必要的保育以及復育計畫。基於「共同遺產」的概念，馬總統的海洋政策也主張開放台灣的太平島來建立一座「國際和平公園」，使南海週邊的國家能攜手合作，共同保護南海的自然環境與海洋生物多樣性。太平島也可以在發生緊急意外事件時作為救援行動的基地。另外，基於南海石油與天然氣探勘作業的密集開發現況，石油汙染的防止與控制應該列為政策的優先項目，以防止重演最近的墨西哥灣漏油災難類似事件。然而，這個區域應該要能達成更多共識。關於適切的機制與將來的合作方面，也必須與其它國家展開更多的對話。

Current Status and Perspective of Marine Biodiversity of Taiping Island in the Spratlys, South China Sea

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ABSTRACT

Taiping Island is the largest island among the Spratlys. It is 1,289 m long, 366 m wide, and covers an area of approximately 0.49 km^2. Taiwan holds sovereignty over the island and the Coast Guard Administration has the main authority. In order to execute the "Assessment of the Feasibility of Establishing Taiping Island in Spratlys as Marine National Park Project," the authors conducted underwater surveys and HDV recordings in June 2009 and March 2010. Each expedition lasted two days.

After the on-site surveys, 13 bird species, 3 seagrass species, 19 algae species, 267 coral species (including literature reviews), and 310 fish species were recorded. Some of these species were newly recorded. Moreover, Taiping Island and Chung-Chou Cay, about 3.1 nm to the east of Taiping, are important reproduction habitats for sea turtles and sea birds, and most coral reefs there are still in pristine condition. The live coral coverage on the fringe reefs of Taiping's northern side even reached 100%, making the area highly valuable for research, education and conservation. However, the whole Spratly Islands are facing massive exploitation threats from neighboring countries from reef fish resource usage, mariculture, over-fishing, blast fishing and cyanide fishing. Hence, adequate management and conservation policies are urgently needed. We strongly recommend the government to take an active strategy to conserve and manage Taiping Island. It includes establishing research station, conducting intensive on-site survey, building database, and joining international collaboration and management projects of South China Sea. In addition, we recommend the Kaoshiung City Government to first set up Taiping Island as a No-Take area, just like Pratas Island previously. Then, the Ministry of the Interior can plan for the Nan-Sha Taiping Island Marine National Park. The Council of Agriculture can also consider designating Taiping Island as an important wildlife habitat for sea turtles, sea birds, and coral reef organisms. The long-term plan for the future will be to establish a Nan-Sha International Marine Peace Park.

南中國海南沙太平島海洋生物多樣性之現況及展望

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[5] 愛之海潛水站

摘 要

太平島是南沙群島最大島，全長 1289m，寬 366m，面積 0.49 km^2，目前屬於我國固有之領土，有海巡人員駐守。作者等為執行內政部所委託之「南沙太平島國家公園可行性評估」計畫，乃於 2009 年 6 月登島現勘，並於 2010 年 3 月進行海底高畫質攝錄影。在各一次兩天的調查期間，共記錄到鳥類 13 種，海草 3 種，固著性大型藻類 19 種，珊瑚 267 種(含文獻整理)，魚類 310 種，各類群都有不少新紀錄種。太平島及島東方 3.1 浬處之中州礁目前不但仍是海龜、海鳥的重要繁殖棲息地，且大部份珊瑚礁區之生態狀況仍保持相當原始狀態，太平島北方之礁緣斜坡處，珊瑚之覆蓋率甚至達百分百，不論在研究、教育與保育方面之價值均甚高。但太平島周遭海域目前仍面臨鄰國擬開發當地珊瑚礁魚類、淺海養殖，以及毒魚及炸魚的威脅，亟需擬定管理及保育之政策並付諸實施。故我們建議政府應對南沙太平島的保育及經營管理採取較積極之作為。包括設立研究站，積極進行調查研究，建立資料庫，並參與南海之國際合作研究及管理計畫。此外，建議高雄市政府可比照以往東沙島先將太平島劃設為禁漁區，再由內政部規劃成立南沙太平島海洋國家公園，農委會亦可研議劃設為海龜、海鳥及珊瑚礁生物之野生動物重要棲息地，未來則朝建立南沙海洋和平公園的目標來努力。

An Analysis on Biodiversity in Western Waters of the South China Sea

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ABSTRACT

The outputs regarding biodiversity of the sub-component on habitat degradation of the UNEP/GEF Project namely *"Reversing environmental degradation trends of the South China Sea and Gulf of Thailand"* are analyzed and synthesized to provided key features of marine ecosystems and species richness in western waters of the South China Sea.

Mangroves, coral reefs and seagrass beds are the most important tropical habitats in western waters of the South China Sea with their estimated areas respectively being 156,600; 110,000 and 18,500ha in Viet Nam; 72,350; 2,800 and 33,810ha in Cambodia; 62,620; 90,000 and 2,550ha in Thailand; and 3,500; 43,400 and 220ha in the east coast of Malaysian Peninsular. Habitat structures are quite diverse and different among latitudinal regions from north, central and south Viet Nam; Gulf of Thailand and Malaysian Peninsular.

The initial figure of richness of "habitat building" species indicates diversity variance among coastal waters bordering western coast of the South China Sea. The "true mangrove" species is most diverse in Mekong delta with 34 species, hermatypic corals are riches in south central Viet Nam with more than 350 species belonging to 71 genera. Meanwhile, 18 and 14 seagrass species were recorded in Malaysia and Viet Nam respectively. An inventory of species composition at the site level indicates the fact that studies on taxonomy of habitat – associated species have scarcely conducted in almost countries bordering western coast of the South China Sea.

Characteristics of marine biodiversity in western waters of the South China Sea are influenced by physical forcing, including *inter alia*: geological seabed history, monsoon current and circulation, latitudinal temperature variance, and river run-off.

Based on data on area scale and species richness, and analysis of physical forcing, the target areas for prioritization in regional cooperation are suggested, including: Mekong delta and north coast of Gulf of Thailand for mangroves; south central Viet Nam and east coast of Malaysian Peninsular for coral reefs; and east waters of Gulf of Thailand for seagrass beds. Besides, a point of view in conducting science based management is discussed aiming improvement of management effectiveness.

南海西岸海域的生物多樣性分析

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摘 要

研究目的是將關於聯合國環境規劃署/全球環境基金的棲地劣化研究專案中稱為「徹底轉變南海與暹羅灣的環境劣化趨勢」的子計畫研究結果，進行分析並加以綜合，以便提出南海西海域的海洋生態系與物種豐度的主要特性。

紅樹林、珊瑚礁，與海草床是南海西海域最重要的典型棲地，面積估計分別是，越南佔 156,600、110,000，18,500 公頃；柬埔寨 72,350、2,800 與 33,810 公頃；泰國有 62,620、90,000 與 2,550 公頃；以及馬來半島東岸的 3,500、43,400 與 220 公頃。從越南的北部、中部到南部的不同緯度地區，以及暹羅灣與馬來半島的各種棲地結構十分多樣，也都各不相同。

由「形成棲地」的物種豐度初步指數，可以顯示南海西岸週邊沿海海域中多樣性的變異。湄公河三角洲的「真正紅樹林」物種最具多樣性，總計有 34 種之多，造礁珊瑚在越南中南部沿海也很豐盛，共有 71 個屬，總計 350 種以上。同時，馬來西亞與越南也分別有 18 種與 14 種海草的記錄。以地區性所觀測到物種組成的種類數量顯示，南海西岸的所有週邊國家，幾乎都未進行過相關物種的棲地分類研究。

南海西海域中海洋生物多樣性的特性受物理外力的影響，尤其是海床地質的演變史、季風氣流與環流、緯度氣溫變化與河水逕流。

根據區域、物種豐度，以及物理外力分析資料的建議，區域合作優先目標地區包括：湄公河三角洲與暹羅灣北岸的紅樹林；越南中南部與馬來半島東岸的珊瑚礁；以及暹羅灣東海域的海草床。另外，為了要改善管理效率，科學化管理的概念也一併被討論。

How Many Specimens Should one Count to Obtain a Reliable Measurement of Species Diversity? Case Studies of Coccoliths Using Rarefaction Analyses

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ABSTRACT

In biodiversity study, species richness is a function of how many individuals were identified and counted. It has been a long-lasted issue on how many specimens should one count and how to set a protocol with which to compare species diversities among samples of different sample sizes.

This study developed an empirical method that permits one to compare species diversities among coccolith assemblages of different sample sizes. This technique provides also an independent evaluation whether an adequate sample size was approached for measuring the species diversity of a sample. We compared also this empirical technique with the conventional rarefaction method of Hurlbert (1971).

Individual coccoliths produces by unicellular haptophyte coccolithophores and coccoliths were filtered from 1 liter seawater at different water depths at three stations from the South China Sea and one Station in the East China Sea.

At the East China Sea station, both methods showed that species richness can be adequately measured if all the coccoliths from 320 view fields were counted at the magnification of 2000 X under a Scanning Electron Microscope (SEM). Trajectories of species diversities from the two methods are almost identical. We suggest that applying either empirical or rarefaction technique, one can evaluate whether a census has reached the saturation number of species diversity, and meanwhile, one can also choose a standard specimen abundance level at which to compare species diversities among samples. The result suggests that counting of 500 specimens can approach the true species diversities of 20 – 25 at different water levels at this station..

Due to the low abundance of coccolithophoirdes, counting of 320 views' of coccoliths could not get enough specimens to reach the saturation number of species diversity. Nevertheless, although only 9-15 species were encountered in different samples while 100 specimens were counted, the rarefraction curves are stable enough to compare the relative species diversities at different water levels and stations.

要計數多少個體數才能獲取可靠的物種多樣性測量？
——以稀薄化法分析鈣板片為例

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摘 要

在生物多樣性的研究中，每一標本中所鑑得的物種數往往與被鑑定與計數的個體數量有關。到底要計算多少個體？以及如何建立一套準則以比較不同的樣本量中的物種多樣性？一直是長久以來學者們廣為討論的課題。

本研究發展出一套經驗法可用於比較不同樣本的鈣板片集群中的物種數。這個方法也針對測量物種數時對一個標本中的個體計數量是否足夠提供了一個獨立的評估方式。我們將此經驗方法與傳統的 Hurlbert（1971）稀薄化(rarefaction)法相互比較。

我們選擇了三個南海以及一個東海站位，分別過濾了在不同水深所採取的一公升海水，濾得其中所含之單細胞鈣板藻球(coccolithophores)與脫落之鈣版片(coccoliths)標本。

對東海站位標本，我們利用掃瞄式電子顯微鏡，以 2000 倍率檢視了 320 個視野中的鈣板片，，所得到的物種數軌跡線和利用稀薄化法所推得的理論值曲線幾乎是一樣的，因此，這兩種方法皆可適宜地測得物種數。我們認為無論是經驗法或稀薄化法，皆可用來評估計數的個體數是否有達到標本中物種數的飽和值；同時，也可用來決定比較不同樣本中的物種數時所適用之標準個體計數水平。結果顯示在這個站位的各個水深中，計數 500 個鈣板藻可辨識出 20-25 個鈣板片種，得以進行不同水深的物種多樣性比較。

南海樣本中鈣板藻的豐度較低，經計數 320 個視野的個體後仍無法獲得足夠的個體以趨近物種數的飽和值。不過，雖然在不同標本中計數 100 個鈣板片而只辨識出 9-15 個種，各站位及水深標本利用稀釋法所測得的曲線仍具有相當穩定性，足以用來比較各標本的相對物種多樣性。

Carbon Biogeochemistry of the South China Sea – Current Understanding and Potential Changes in the Context of Global Change

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ABSTRACT

There remain many uncertainties in the ocean component of the global C cycle. Among others, ocean margins add in more complexicity in our understating of the ocean carbon cycle. Ocean margins are the most heterogeneous areas of the world's oceans, and thus it is extremely difficult to constrain the carbon transport fluxes, including the air-sea CO_2 fluxes and the interior carbon fluxes within the ocean margin. In addition, because of the diversity of the ecosystems and/or physical regimes (e.g., coral, upwelling, mesoscale eddies) coexisting in marginal seas, processes that modulate the carbon cycle therein remain poorly understood.

Moreover, this presentation will take the South China Sea, a largest low-latitude marginal sea as an example to examine the dynamics of carbon fluxes and processes based upon our field observations in the past 10 years. While our primary focuses will be on the air-sea CO_2 and export fluxes and their controls at a seasonal base, diurnal and longer term variability will also be examined. In addition, the river-ocean carbon connection will also be investigated to see how the riverine input will affect the carbon transport and transformation in the marginal systems. In addition, we will examine the potential the carbon exchanges between the South China Sea and the Pacific ocean.

With the attempt to shape the current understanding the carbon biogeochemistry in the South China Sea, this presentation will also touch the potential changes of the South China Sea biogeochemistry in the context of global changes.

南海的碳生物地球化學：
在全球變遷的範圍內談目前的瞭解與潛在的變化

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摘 要

我們對於全球碳循環中海洋的角色仍有許多未知。其中，海洋邊緣（ocean margins）又為我們對於海洋碳循環的瞭解更添複雜度。海洋邊緣是全世界海洋中成分最多元複雜的區域，因此很難限制碳通量，包括海空二氧化碳流量以及海洋邊緣區內的碳通量。另外，因為生態系統的多樣性、陸緣海的物理環境（如珊瑚、上升流、中尺度渦旋），我們對於影響碳循環的過程仍瞭解甚少。

本簡報將會以地球上最大的低緯陸緣海，南海為例，根據我們過去十年來累積的實地觀察檢視碳的流量與流程。我們將重點置於海空二氧化碳、輸出通量（export fluxes），並檢視季節控制、日間變異性、長期變異性。另外，我們也調查河流與海洋之間的碳連結，以瞭解河川流入如何影響陸緣系統的碳傳輸與轉型。除此之外，我們還會檢視南海與太平洋之間潛在碳交易量。

為建構目前對南海碳生物地球化學（the carbon biogeochemistry）的瞭解，本報告將會在全球變遷的範圍內簡述南海生物地球化學的潛在變化。

Marine Biodiversity and Conservation in the South China Sea, with Emphasis on Ichthyofauna (Malaysia)

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EXTENDED ABSTRACT

Malaysia comprises two land masses separated by the South China Sea (SCS). With a total landmass of 330,000 km^2, territorial waters of 546,500 km^2 and a coastline of 4,675 km, the maritime nation boasts of three of the world's most productive habitats: mangroves, coral reefs and seagrass meadows (Fig. 1). Coastal mangroves cover 5,669 km^2 while coral reefs occupy an estimated area of 4,006 km^2. Indeed the SCS and adjoining waters are home to a third (previously half) of the world's mangroves and a third of the world's coral reefs. Seagrass meadows here are considered the most diverse in the world. Thus, the large expanse of ocean space and varied marine habitats provide good opportunities for colonization by a diversity of fish and other marine fauna.

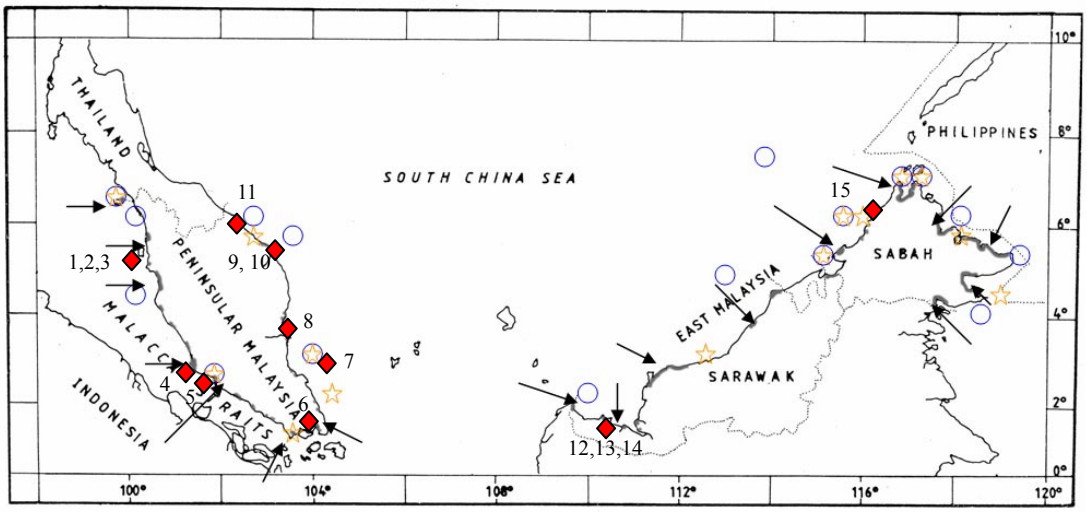

Figure 1. Major coastal habitats and marine research institutes/ stations in Malaysia.

Mangrove forests (green, arrowed), coral reefs (blue circles), seagrass meadows (orange star). Marine research institutes, centres and stations indicated by red diamonds: 1,2, 3) Fisheries Research Institute, World Fish Centre, Centre for Marine & Coastal Studies, University Science Malaysia; 4) Mangrove Research Centre (University of Malaya-Sime Darby); 5) Putra University Malaysia (UPM); 6) University of Technology Malaysia (UTM); 7) Pulau Tioman Research Station (Marine Parks Malaysia);8) Institute of Oceanography & Maritime Studies (International Islamic University of Malaysia); 9, 10) SEAFDEC, Institute of Oceanography (University Malaysia Terengganu- UMT); 11) Institute of Ocean & Earth Sciences or IOES (University of Malaya); 12, 13, 14) University Malaysia Sarawak (UNIMAS), Fisheries Research Institute Sarawak Branch; Sarawak Museum; 15) Borneo Marine Research Institute or BMRI (University Sabah Malaysia).

A recent review of Malaysia's ichthyofauna estimates a total of 1951 species (including 470 species of freshwater species) with 296, 925 and 182 species from mangrove, coral reef and seagrass, respectively (Table 1). Interestingly, 178 fish species had been recorded from mixed mangrove and seagrass habitats, while 110 species were from mixed mangrove and coral habitats, indicating the possibility of usage of multiple biotopes by marine fish species to complete their life history. Unfortunately, habitat connectivity studies are nil or very few in the SCS, so are ecological studies identifying temporal patterns or exploring fish-habitat interactions. The problem lies in the general lack of interest attributable to the limiting meteorological and ocean conditions, inadequate infrastructural, logistical and technological support (see Figure 1), lack of scientific man-power capacity and insufficient research funding.

Table 1. Fish richness of Malaysian marine and freshwater habitats

Type of fish	Habitat type	No. of species
Freshwater	Streams	314
(470 spp.)	Rivers	291
	Lakes and ponds	70
	Peat swamps	92
	Other freshwater swamps	78
	Paddy fields	9
Brackishwater	Estuary	326
(81 spp.)	Mangroves	296
	Seagrass meadows	182
	Mixed mangrove & seagrass	178
Marine	Coral reefs	925
(1400 spp.)	Mixed mangrove & coral	110
	Coastal waters	539
	Offshore waters	100
Total no. of species		**1951**

Source: Chong et al. (2010). J Fish Biol. (doi:10.1111/j.1095-8649.2010.02685.x)

Although the Department of Fisheries had begun extensive fish resource surveys as early as 1970, albeit irregularly, such surveys including trawling and the use of acoustics serve mainly the purpose of stock assessment. Other studies result from the requirement of environmental impact assessments made mandatory for large scale developmental projects such as constructions of coastal resorts and jetties, dredging, sand mining, and offshore oil extraction. Recent more concerted research stems from realization of the importance of the SCS as part of the region/global ocean-atmospheric regime and its huge contribution to the socio-economy of the country via its rich biodiversity and ecosystem services. For instance, present fisheries catches (2006) from the SCS amount to an annual total of 740,000 metric tons of mainly pelagic fishes and squids with an economic value of USD842 million (RM2694 million). The SCS fisheries in Malaysia sustain 66 coastal fishing communities (districts) with an estimated 60,500 fishermen directly dependent on fishing for their livelihood.

Resource use impacts however have caused the fall in demersal and pelagic shrimp landings (due to mangrove area reduction) and the decline of the coral reef fishery (due to poor reef health). A recent review identifies the leading causes of threat to Malaysian fishes as habitat degradation, over-harvesting and by-catch. Fifteen marine fishes are considered highly threatened, while another 123 species are moderately threatened.

Coral reef research is perhaps the most prominent in the SCS compared to that of other coastal habitats. Coral species and reef-associated species of seaweeds, invertebrates and vertebrates are relatively well studied, although largely pertaining to checklists and distribution. At the centre of much controversy and concern are the Humphead Wrasse and several coral reef groupers relentlessly hunted for the live reef fish trade. The demand for seahorses and pipefishes from China and Taiwan for traditional Chinese medicine has

similarly endangered local populations. Extreme fishing methods have caused massive destruction of marine habitats including exacerbating the problem of by-catch and discards. Sharks and rays, slaughtered for their fins and discarded at sea, had been the subject of study by SEAFDEC, with the discovery of some rare/new species of sharks, sawfish and stingrays. The Tropical Shad is rarely reported in the Straits of Malacca where a substantial fishery existed in the 70s. Substantial populations are perhaps only confined to the Batang Lupar estuary and coastal waters of the state of Sarawak (SCS). Because of its unique biology, highly-priced roe and depleted population, the fish's ecology had been intensely studied by the state with the assistance of CSIRO experts to conserve the species. By-catch and fishing of sea turtles, including egg hunts, have been a contentious issue, particularly, since it involves indigenous hunting rights and illegal poaching. Sea turtle populations in SCS are considered critically endangered, and for many years, SEATRU (UMT) and the Sarawak Museum have been conducting research on their population dynamics, migratory behavior, reproductive ecology and habitat requirements. The elusive dugong, with a distribution that highly correlates to large seagrass meadows, is being studied by the IOES and BMRI to understand their low population numbers and to assess the threats to their survival. Similarly, there are many other cases of marine biodiversity impacted by anthropogenic causes. Global climate change including elevated sea temperature, sea level rise and ocean acidification are emerging issues. Their effects superimposed on those of habitat degradation, overexploitation and pollution are estimated to have far reaching effects on coastal habitats, marine species and human communities of the SCS. The past studies have shown that the current problems and issues of marine biodiversity and management (in the present scenario of global climate change), as similarly experienced by nations of the SCS, are best addressed through regional collaborative research with expertise from outside the region.

南海的海洋生物多樣性與保育－以魚類區系（馬來西亞）為重點

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摘 要

馬來西亞是由兩塊被南海分隔的陸地所組成。陸地面積為三十三萬平方公里，領海面積為五十四萬六千五百平方公里，海岸線總長四千六百七十五公里，涵蓋了全球三個物種：紅樹林、珊瑚礁，與海草床最多的海洋國家(圖 1)。沿岸紅樹林覆蓋伍仟六百六十九平方公里的地區，而珊瑚礁約佔四千零六平方公里的面積。事實上，全世界三分之一的紅樹林(以前是一半)以及三分之一的珊瑚礁都生長在南海與其鄰近海域。這地區的海草床是全世界最具多樣性的。因此，遼闊的海洋空間與多樣的海洋棲地，透過魚類與其它海洋生物的多樣性提供了群殖的絕佳生機。

一項最近針對馬來西亞魚類區系所作的普查，估計有二百九十六種紅樹林、九百二十五種珊瑚礁，與一百八十二種海草，總共有一千九百五十一種(包括四百七十個淡水種)(表 1)。值得注意的是，在紅樹林與海草混生的地區曾發現一百七十八種魚類的記錄，而在紅樹林與珊瑚的混生棲地則有一百一十種，這顯示出海洋魚類能利用多重群聚棲地來完成其生活史的可能性。可惜的是，對於南海海域缺乏關於棲息地連接性的研究，即使有也相當有限，另外在關於確認時態模式或探討魚類與棲地互動關係方面的生態研究也有同樣的情形。問題在於有限的氣象學與海洋相關條件、不充足的基礎結構、後勤與技術支援而對忽略了這個區域(參閱圖 1)，另外也是因為缺少科學方面的人力資源與足夠的研究經費。

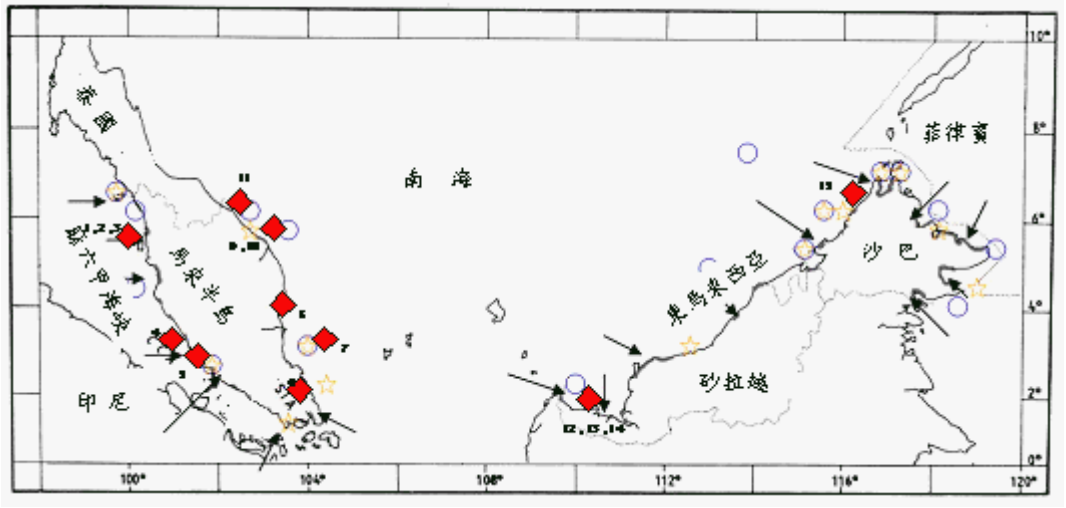

圖 1. 馬來西亞的主要沿海棲地與海洋研究機構/觀測站

紅樹林(綠色箭頭所指處)、珊瑚礁(藍色圈起處)、海草床(橙色星號處)，海洋研究機構、中心，與觀測站以紅色菱形標示：1、2、3)漁業研究所、全球魚類研究中心、馬來西亞理科大學海洋與沿海研究中心； 4)紅樹林研究中心(馬來亞-森那美大學)； 5)馬來西亞博特拉大學； 6)馬來西亞理工大學； 7)刁曼島研究站(馬來西亞海洋公園)； 8)海洋學與海洋研究所(馬來西亞國際伊斯蘭大學)； 9、10)東南亞漁業發展中心、海洋學研究所(馬來西亞登嘉樓大學) ；11)海洋與地球科學研究所(馬來亞大學)； 12、13、14)馬來西亞砂拉越大學、漁業研究所砂拉越分所、砂拉越博物館； 15)婆羅洲海洋研究所(馬來西亞沙巴大學)

表 1. 馬來西亞海洋與淡水棲地的魚類豐度

魚種類型	棲地類型	種 數
淡水	溪流	314
(470 種)	河川	291
	湖泊與池塘	70
	沼澤	92
	其它淡水沼澤	78
	水田	9
半鹹水	河口	326
(81 種)	紅樹林	296
	海草床	182
	紅樹林與海草混生	178
海水	珊瑚礁	925
(1,400 種)	紅樹林與珊瑚礁混生	110
	沿海海域	539
	近海海域	100
總 數		**1,951**

資料來源: Chong et al. (2010). J Fish Biol. (doi:10.1111/j.1095-8649.2010.02685.x)

雖然漁業局早在 1970 年就開始普遍進行漁業資源的調查，儘管是不定期性質，但是這些調查都包括了拖網與聲探流速儀的使用，主要是用來進行現存漁量的推估。另外，還有針對例如建造沿海度假村與防波堤、挖泥、採沙、以及近海鑽油等大型開發專案，依規定必須強制進行的環境影響評估的一些其它研究結果。還有，最近更具協調性質的研究，也是因為體認到南海是區域/全球海洋大氣環境的一部份，以及其豐富的生物多樣性與生態系服務對於國家社經重大貢獻的重要性。例如，目前產自南海主要是遠洋魚類與魷魚的每年漁獲總量(2006)達到七十四萬公噸，而經濟產值也達八億四千二百萬美元(馬幣二十六億九千四百萬)。馬來西亞的南海漁業維繫了六十六個沿海漁業群聚(地區)中約六萬伍佰名直接依賴漁業為生的漁民。

然而，濫用資源的衝擊已經導致深海與遠洋蝦類捕獲量降低(因為紅樹林面積減少)，以及珊瑚礁漁業的衰落(因為健康惡化的礁脈)。有一項最近的調查指出，威脅馬來西亞魚類的最主要因素是棲地劣化、過度捕獵與混獲。有十五種海水魚被認為受到嚴重威脅，而另外有一百二十三種則受到中度威脅。

與其它沿海棲地的研究相較之下，南海的珊瑚礁研究可以說是最重要的了。雖然必須配合相關的大量直接計數法與分佈推估，但是對於珊瑚與礁體棲性的海草類、無脊椎動物、脊椎動物等物種都普遍作了相當仔細的研究。許多爭議與關注的焦點是，波紋唇魚與多種珊瑚石斑魚都因為活礁石魚貿易而被無情的獵捕。中國與台灣因為傳統中藥對於海馬與海龍魚的需求，也同樣危及當地群體數量。偏激的捕魚方式已經造成海洋棲地的破壞，這包括讓問題更加惡化的混獲捕獵與丟棄漁獲。鯊魚與魟魚因為要取鰭而被屠殺並棄置海邊，這一直是東南亞漁業發展中心的研究課題，同時也發現了一些稀有/新種的鯊魚、鋸鯊與刺魟。熱帶鯡在麻六甲海峽已很罕見，而當地在 70 年代的漁獲量極大。大量魚群也僅限於魯巴河河口與砂拉越沿海水域(南海)。因為其特殊的生物學特性、高價格的魚子，以及遺存的群體數量，使得該魚種的生態在政府當局與澳洲聯邦科學與工業研究組織專家的協助下，進行仔細研究並得以保育其物種。混獲與捕獵海龜，包括獵蛋，一直都是爭議的焦點，尤其這也牽涉到原住民的捕獵權和非法盜獵的問題。南海的海龜數量嚴重的瀕臨絕滅，許多年來，馬來西亞登嘉樓大學的海龜研究小組與砂勞越博

物館就一直在研究其族群動態、洄游行為、繁殖生態學與棲地環境的需求。高度依存廣闊海草床的儒艮，也由海洋與地球科學研究所與婆羅洲海洋研究所進行研究，來了解其低群體數量，並判別危害其生存的各種威脅。同樣，還有許多海洋生物多樣性的其它案例，也都是受到人為因素的影響所造成的。全球氣候變遷包括海水溫度上升、海平面升高，與海洋酸化等，都是新出現的問題。這些效應突顯了棲地劣化、過度開發，與汙染問題，預期更將會影響到南海的沿海棲地、海洋物種，以及人類社群。以往的研究已經顯示，目前黃海週邊國家所共同面臨的海洋生物多樣性與處理(在目前的全球氣候變遷情況下)方面的問題與議題，最好是透過由區域以外專家所協助的區域性合作研究來處理。

Enhancing Biodiversity in the South China Sea through Restoration and Restocking

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EXTENDED ABSTRACT

While some parts of the South China Sea may be considered to still exhibit high levels of marine biodiversity, many of the areas that are either near population centers or which are relatively accessible to human exploitation have lost many populations of commercially important species, and possibly entire species. This, in part, is the reason for the interest of many groups to establish marine protected areas in various parts of the region, including possibly the greater part of the Spratly Islands archipelago. The underlying assumption is that a high biodiversity results in high productivity, probably also providing resilience in the face of climate change. It is common knowledge that many nations depend on the marine resources of the South China Sea. Hence, it is to the interest of all the riparian states to maintain and enhance this productivity, not only by reducing the stresses whether by overexploitation or by destructive or pollutive practices, but also by active restoration measures coupled with marine protected area development.

Since marine protected areas will be a major topic in this symposium, I will limit my treatment of the topic. If there is to be any enhancement of biodiversity in the South China Sea, some measure of protection or conservation of significant areas will be necessary. The conservation measures need not require strict reserves that are "no-take" zones, but any exploitation must be regulated so as not to destroy the support ecosystems, principally coral reefs, and no species must be depleted to the point of depensation or local extirpation. The sessions on mpa's and management may deal with the details of this need.

When people talk about preservation or conservation, the common thinking is simply to provide protection of an area, assuming that nature will then take care of the rest. In many situations, this is probably all that is necessary, plus the requisite amount of time, anywhere from years to decades, or possibly centuries. Depending on the management goals that are put in place, it may be necessary to consider active restoration of some form in. Restoration is to be considered if there is a desire to accelerate the recovery of ecosystems or of populations of certain species.

The science of restoration in the marine environment is perhaps most advanced with respect to mangroves, while that addressing coral reefs is still in its infancy, despite the claims of many commercial enterprises that promise to bring back reefs instantly. The focus of this presentation will be on coral reef restoration, to be followed by some proposals for restocking of some invertebrate species where the technology is available. I will not deal with the topic of artificial reefs because, with the extensive natural substrate that is available for transplantation or recruitment, the introduction of artificial substrates is considered a waste of resources.

Advances in recent years include the improvement of methods of attaching corals to natural substrates, the development of the nursery concept in coral restoration, and the continuing research on sexual methods of reproduction to produce genetically diverse juveniles in large numbers. The recent availability of epoxy clay and other adhesives for underwater use have

made initial attachment of coral fragements practical. Initial nurseries were of the floating or suspended types practical for deep water use, but more recent innovations adapting these to shallower sites and making them benthic structures make them less costly and just as efficient. Even more recently, the development of "rope nurseries" or "multiple clothes lines" for growing coral nubbins to the right size for transplantation has shown great promise. On the other hand, further research is needed on the use of inducers to attract larvae to settle on target substrates, as well as to enharnce the survival of settled larvae. This latter issue is generally side-stepped when one uses coral fragments or branches for transplantation, although the question of genetic diversity is sometimes brought up and the impact of coral predators needs to be reduced as well.

Questions about the appropriate species to use, the mix of species, the positioning of the transplants, all need to be further investigated. There has not been enough time to determine the proper positioning of source reefs and sink reefs, but this is obviously a need if there is to be large scale restoration. For this, the biologists will need the collaboration of the oceanographers.

Related to the above is the question of the restocking of invertebrates. The technology exists for the giant clams, the Tridacnidae, and recent efforts in the Philippines have given us an indication that the true giant clam, *Tridacna gigas*, has now begun to recruit locally from maricultured stock that was deployed in various localities. The restocking of echinoderms in some reefs has shown good results, specifically with the sea urchin *Tripneustes gratilla.* The sea cucumbers, particularly the sandfish, *Holothuria scabra*, are probably next in line. The restocking of fin fish is further down the road, but something that must be considered seriously, particularly for the highly desirable species like the Napoleon wrasse.

Ecological restoration has been defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Society for Ecological Restoration International, www.ser.org). By judiciously undertaking some of the activities mentioned above in various areas of the South China Sea, we would be contributing to its ecological restoration. The question is whether this can be done in a coordinated fashion and in a large enough scale to make a difference. Scientist, managers, and politicians must join hands if we are to enhance the biodiversity of the South China Sea significantly and ensure its continued productivity.

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The International Conference on Marine Environment and Biodiversity Conservation in the South China Sea

16-17 July 2010, Kaohsiung, Taiwan

透過復育與放流的方式提昇南海的生物多樣性

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摘 要

雖然南海的部分地區仍被視為具有高度的生物多樣性，但大部分地區已經成為人口中心或人類可以到達的地區，在人類開發程度高的區域裡具有經濟價值的動物數量已大幅減少或甚至完全消失。因此許多團體必須在南海的不同地點建立海洋保護區，包含大部分的南沙群島。建立保護區的基本假設是生物多樣性愈多、生產力就會愈高，因此可能提供了面對氣候變遷時的適應力與恢復力。大家都知道許多國家仰賴南海的海洋資源，所以沿海國家必須維持並提升南海的生產力，不只要減低過度開發、破壞、污染所造成的壓力，也要積極採取復育措施並規劃海洋保護區。

既然海洋保護區是本研討會的重要主題，我將以此為重點。若要提昇南海的生物多樣性，必須落實重點區域的保護與保育措施。不需要嚴格地規劃「禁補區」，但所有的漁撈活動都必須妥善規範，以免破壞生態系統，尤其是珊瑚礁，也絕對不可導致任何物種瀕臨絕種或區域性滅絕的情況。相信在海洋保護與管理的研討會中將會有更多細節的討論。

當大家提到保育時，通常都認為只要將一個區域劃定為保護區，接下來就交給大自然來處理就好了。在許多情況下，這個想法或許沒錯，假以時日，或許幾年、幾十年、幾百年後環境就會自然修復。但如果有不同的管理目標，或許就必須採取更積極的復育作為。若要加速恢復生態系統或特定物種數量的進度，就必須考慮復育措施。

海洋環境中關於復育的研究，最深入的應屬紅樹林，而珊瑚礁的相關研究還在嬰兒期，儘管許多商業機構宣稱他們將在短時間內讓珊瑚礁再現。本報告的重點是珊瑚礁復育，我會先介紹幾種無脊椎動物的放流（restocking）方式，因為我們已有現成的科技了。我今天不會提到人造珊瑚因為可移植或補充的自然資源很多，在這裡介紹人造物種顯得很多餘。

近年來的進展包括：改良珊瑚固定在天然基質上的方式、發展珊瑚復育中的養護觀念、持續發展養殖方式以大量培育富遺傳多樣性的新生珊瑚。目前可在水下使用環氧樹脂粘土（epoxy clay）與其他黏著劑修復珊瑚斷枝。早期深水養護採取漂浮或懸吊式，但近來的創新作法是讓珊瑚適應較淺的區域，我們可以把淺水區打造成海底結構，這樣花費較低、但效率不減。更近期的發展是「繩式養護（rope nurseries）」或「複布線（multiple clothes lines）」即栽培珊瑚小分枝到足以移植的尺寸，這種作法極可能成功。另一方面，我們也必須深入研究如何利用誘導劑吸引珊瑚蟲定居在目標基質上，並提升珊瑚蟲定居後的存活率。通常利用珊瑚斷枝或分枝移植時就不會採取誘引珊瑚蟲的方式，但移植法不會增加遺傳多樣性。此外，我們也必須降低珊瑚天敵的影響。

關於要用哪些物種才適合、何處適合放置移植物，這些問題都必須深入探討。我們沒有足夠的時間決定放置源礁（source reefs）與沉礁（sink reefs）的地點，但如果要大規模復育的話，顯然這是必須的。為此，生物學家必須要與海洋學家合作。

無脊椎動物的放流與上述各項議題相關。目前已有大蛤蚌、硨磲蛤的放流技術，菲律賓最近也開始將以海水養殖的大硨磲放流到不同地區。棘皮動物放流在珊瑚中的成果也很

優秀，尤其是白棘三列海膽。而海參，尤其是糙參，可能是接下來要放流的項目。鰭魚放流排序雖然較晚，但也是我們必須慎重考慮的項目，尤其是像蘇眉魚等受到高度期待的魚種。

生態復育的定義是「協助已退化、遭破壞、或被摧毀的生態系統恢復痊癒的過程」(參見國際生態復育協會 Society for Ecological Restoration International)。在南海確實執行上述措施可有效促進生態復育。問題是我們能不能透過良好的協調進行大規模活動以真正發揮效果。科學家、管理單位、政治人物必須攜手合作才能大幅提昇南海的生物多樣性並確保南海的生產力得以永續。

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南海海洋環境與生態多樣性保育國際研討會
2010 年 7 月 16 至 17 日，台灣，高雄

Landscape Diversity and Connectivity of Tropical Coastal Ecosystems

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ABSTRACT

Coral reefs, mangrove forests, seagrass beds, and sandy beaches are fundamental ecosystems on tropical or subtropical coasts, and their ecosystem function and services have been discussed intensively to clarify their importance. Landscape diversity constructed by these ecosystems should be discussed from the viewpoint of interactions and ecological connectivity among these ecosystems. As such, biogeochemical linkage and animal migration must be important topics for this discussion.

The biodiversity has to be discussed from various viewpoints, and one of the benefits of biodiversity is the provision of insurance that the ecosystem is stabilized against natural and anthropogenic environmental changes. However analysis of landscape diversity has frequently been ignored simply because of a lack of scientific background on the ecological connectivity among them.

Today, I will talk about the ecological connectivity among the tropical and subtropical coastal ecosystems, emphasizing the scientific interest in landscape diversity with some case studies in Okinawa, southern Japan.

The ecological study on the fish communities in seagrass beds and coral reefs gives us useful message for the discussion of ecological connectivity. According to visual surveys in the seagrass beds and adjacent coral reefs, most of the fish species were roughly divided into 4 groups based on habitat use patterns; (1) permanent residents (e.g. *Stethojulis strigiventer* and *Calotomus spinidens*); juveniles and adults living only or mainly in seagrass beds, (2) seasonal residents (e.g. *Cheilodipterus quinquelineatus* and *Lethrinus atkinsoni*); juveniles living only or mainly in seagrass beds, (3) transients (e.g. *Parupeneus indicus*); occurring in seagrass beds in the course of foraging over a variety of habitats, and (4) casual species (e.g. *Acanthurus blochii*); occurring only occasionally in seagrass beds. Some seasonal residents showed a possible ontogenetic habitat shift from seagrass beds to coral reefs. These results indicated that seagrass habitat use patterns by fishes changed temporally and regionally and there may be habitat connectivity between seagrass beds and coral reefs via foraging or ontogenetic migration. In addition, high fish diversity is maintained by healthy landscape diversity.

A major functional consequence of landscape diversity also derives from the complex ontogenic habitat shift characteristic of many marine animals whose larvae have a long pelagic life stage. Tropical seagrass and mangrove habitats serve as nursery areas for many fishes that live as adults on nearby reefs. Thus, the proximity of different habitats in the landscape is critical to the populations of these fishes.

Other large animals showing high mobility also have a possibility to move between different ecosystems and affect the flora and fauna via their feeding behavior. Sea turtles, for example, migrate in much wider areas, visiting different ecosystems including the open sea, coral reef and sandy beach. Dugongs also come in to intertidal zones with seagrass beds during high tides. The connectivity between intertidal and subtidal zones is also an important research

topic.

Mangrove forests, which are predominant in river mouth areas or the inner part of bays in tropical and subtropical regions, are characterized by high primary production. The organic material produced by mangroves enriches the bottom substrates and has been offering food sources during their decomposition processes to various animals living in mangrove forests and neighboring ecosystems. However, quantitative studies on the transportation and dynamics of the organic materials produced by mangroves are insufficient and more discussion is required to clarify the role of mangroves on coastal zones. For example, there are different reports, i.e. some reports have emphasized that mangroves are important for sustaining the microbial food chain and nutrient regeneration in adjacent ecosystems, but other ones did not.

The dynamics of particulate organic matter (POM) and mangrove litter were investigated in a subtropical mangrove in Okinawa, in order to quantify the impact of mangrove POM on adjacent intertidal sediments. A distinct seasonal pattern was found with maximum litter fall during the autumn season, and minimum during winter. Analysis of fatty acids in the surface sediments of an adjacent mud flat and sand flat during the winter, spring, and autumn seasons indicated that outwelling of POM from the mangrove ecosystem occurs. However, it is spatially restricted to within 300 m from the mangrove forest. The magnitude of the outwelling increased during spring and autumn consistent with the increase in the total litter production. Despite the presence of mangrove-derived organic matter in the estuarine surface sediments, autochthonous sources of organic matter, green macroalgae (*Ulva pertusa* and *Enteromorpha intestinalis*), diatoms and bacteria are the main contributors of sedimentary organic matter.

We have been studying the role of mucus produced by corals in a coral reef ecosystem. The organic matter, chlorophyll *a* concentration, microalgal density, and bacteria-derived fatty acid contents of mucus aggregates were higher than those observed in sediment, suggesting that mucus aggregates, which are carried to various places in a reef, contain not only high levels of organic matter, but also dense concentrations of microalgae and bacteria. Therefore, mucus aggregates trapping a large number of diatoms may serve as a qualitatively more energetic food source for benthic fauna compared to sediments.

In conclusion, research in a wide range of ecosystems demonstrates that interactions among the communities of different habitats on coastal and river ecosystems, mediated by both migrations of animals and the transportation of organic materials and nutrients, can influence community structure and ecosystem function. Such landscape diversity should be essentially important to the functioning of marine systems.

熱帶海岸生態系統之景觀多樣性及關聯性

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摘 要

珊瑚礁、紅樹林、海草床、以及沙質海灘是構成熱帶或亞熱帶海岸的基本生態系統，其生態系統功能及優點經過諸多討論，重要性已是不言自明。應由各生態系統間的互動及生態關聯性觀點切入，進而討論這些生態系統所構築起的景觀多樣性。如此一來，生物地質化學及動物遷徙必成為此中討論的重點。

須由多方面的觀點切入討論生物多樣性；無論受到自然或人為因素而造成的環境變化影響，生物多樣性均能夠確保生態系統的穩定—這正是其好處之一。但是針對不同系統間彼此生態關聯性卻缺乏科學性的背景研究，以致於大眾忽略了景觀多樣性的分析。

我今天要講的是關於熱帶及亞熱帶海岸生態系統間的生態關聯性，所強調的重點將放在景觀多樣性的科學價值，並引用一些在日本南方的琉球所做的個案研究。

針對海草床及珊瑚礁中魚群的調查，為生態關聯性的相關研究提供了重要的訊息。藉由觀察可將海草床及鄰近珊瑚礁當中的魚種,依其棲息模式分為以下4類:(1)永久居民 (像是虹紋紫胸魚還有台灣鸚鯉)；僅是或主要生活在海草床中的幼魚及成魚；(2) 季節性居民 (像是五線巨齒天竺鯛及太平洋黃尾龍占)；僅是或主要生活在海草床中的幼魚；(3) 過住旅客 (像是印度海緋鯉)；在眾多棲所間遊牧時會出現在海草床；以及(4) 偶遇物種 (像是布氏刺尾魚)；僅是偶爾現身在海草床。在某些季節性居民身上會有從海草床轉向珊瑚礁的個體發育棲所轉變情形發生。前述的結果說明，以魚群所劃分出的海草床棲所模式會因時間性及地域性變化，而透過遊牧行為或是個體發育遷徙，海草床及珊瑚礁可能因此存在著棲所關聯性。另外，健全的景觀多樣性才能夠維持高度的魚種多樣性。

許多海洋生物的幼體在漫長遠洋生命階段裡頭，會因為複雜的個體發育而造成棲所轉變，而這正是造成景觀多樣性的關鍵性因素。許多生活在鄰近礁岩區的成魚會將熱帶海草及紅樹林生態區作為繁衍後代的溫床。所以在同一個景觀裡頭是否涵蓋不同棲所，對於這些魚種的數量來說是很重要的。

其它機動性較高的大型生物也有可能在不同的生態系統之間穿梭來回，而他們的進食行為也進而影響到該區的動植物生態。以海龜為例，在較大的區域中悠遊、遷徙，會越過外海、珊瑚礁還有沙質海灘等不同的生態系統。儒艮在漲潮的時候會隨著海草床一起來到潮間帶。潮間帶及次潮間帶之中的關聯性也是個值得研究的課題。

紅樹林大多生長在熱帶地區及亞熱帶地區的河口或是內灣，高度初級生長力為其特性。紅樹林所產生的有機物質使得底部基質更為肥沃，而在分解腐爛的過程中則成為棲息在紅樹林及鄰近生態系統中動物的食物來源。不過目前針對紅樹林所產生的有機物質所做的量化研究並不充分，須要更進一步的討論才能夠釐清紅樹林之於海岸地區的角色定位。當前的研究並沒有整合出統一觀點，像有些報告中強調的是對於鄰近的生態系統而言，紅樹林在維生物食物鏈及養份更新方面都扮演著舉足輕重的角色；但其他報告卻對此不置可否。

為了能夠量化紅樹林中有機質(particulate organic matter, POM)對於鄰近潮間帶的沉積影響程度，所以在沖繩的某處亞熱帶紅樹林生態區中，仔細地調查了有機質及紅樹林枯枝落葉間的動態機能。從研究結果可以明顯看出季節性的差異，最大落葉量出現在秋季；而冬季的落葉量則是最小。在不同的季節裡頭於一處鄰近的泥層及沙層中採樣分析沉積表面的脂肪酸，發現了紅樹林有機物溢出的情況。不過這情形僅發生於以紅樹林為中心的 300 公尺範圍內。在春季及秋季的溢出增加幅度與總落葉量的增加值一致。雖然紅樹林的有機質造成了部份入海口的表面沉積物，但原生有機質、大型綠藻(孔石蓴和腸滸苔)、矽藻跟細菌才是造成沉積有機物的重要推手。

我們已針對珊瑚礁生態系統中，珊瑚所產生的黏液進行角色定位的研究。黏液中無論是有機質、海域綠素濃度(chlorophyll a concentration)、微藻密度(microalgal density)、還是因細菌而產生的脂肪酸總計，均較沉積物當中的數值高；表示黏液當中不僅含有大量的有機質，更含有高濃度的綠藻及細菌。正因為會在珊瑚中不同的部位出現，其中更含有大量的矽藻，所以對於海底動物而言，黏液可能是比沉積物更營養的食物。

無論是動物的遷徙還是有機物質或營養物的移動，都可能促使不同生態系統間的互動，而從廣泛的研究這些系統中發現，再微小的互動也會影響到整個生態的結構及系統的功能。如此的景觀多樣性應是維持海洋系統運作的重要因素。

Remote Sensing with Noise

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ABSTRACT

Acoustic noise is ubiquitous in the ocean. The noise comes from many sources including ships, marine life, and breaking waves. For sonar systems, this ambient noise has generally been considered a nuisance. However, recent studies have shown that the noise itself contains valuable information about properties of the ocean, Earth and atmosphere. For example, distant storms have been observed using measurements of low frequency (0.1 Hz) noise that has propagated through the Earth's core. Wind speed over the ocean has also been determined from hundreds of kilometers away using noise measurements at coastal observing stations.

An example of this involves tracking a storm in the deep East Pacific ocean (water depth about 5 km) from the noise sensed on an array of land-based geophones in southern California 8000 km away. The storm created ocean waves at a period of about 10 s. These ocean waves attenuate with depth and cannot be sensed at the ocean bottom. However two wave systems can interact and create a standing wave at half the period, 5 s, which will reach the bottom nearly unattenuated. This is the wave that can be sensed 8000 km away.

Another example is the process of using breaking wave noise to image the seabed structure tens of meters below the ocean floor. The breaking waves provide a type of overhead acoustic lighting analogous to the moon and stars providing natural light that allows one to see at night. The basic principle involves correlating noise signals arriving from the sea-surface with the echoes that reflect from the seabed. This echo processing is similar to active sonar systems (such as those used in nature by bats), but the sound source is the background noise. As concerns are raised about the impact of man-made sound on the marine environment, it is not surprising that using naturally occurring noise for remote sensing has become a hot topic in acoustical oceanography. Essential components of noise processing will be described along with examples illustrating applications. A recent application involves extracting the ocean bottom profile from noise.

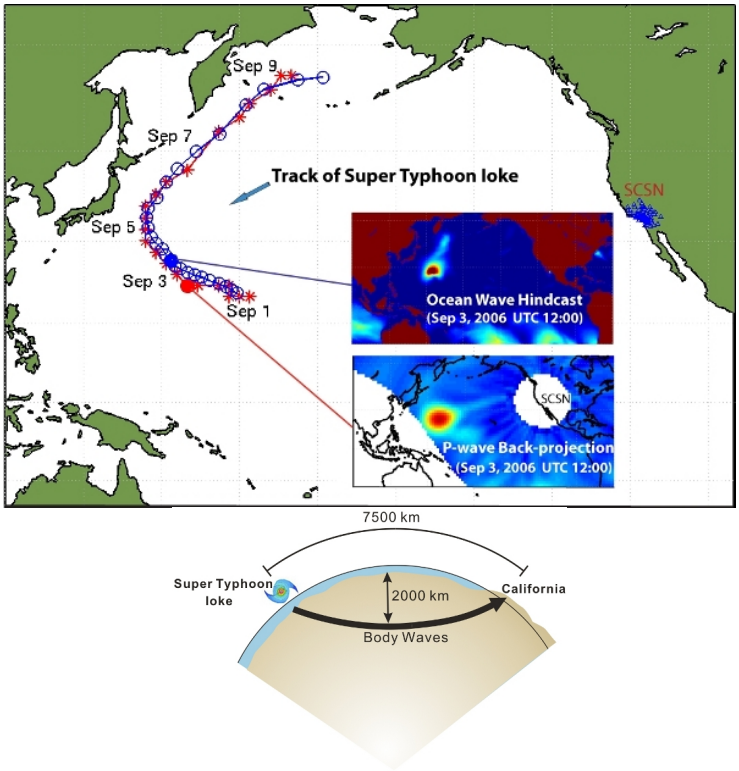

Figure 1. Map showing tracks of the *P*-wave source regions (*) and Super Typhoon Ioke (o). The track of peak energy of source regions is derived from back-projecting the SCSN beamformer outputs as indicated in the insert. The best track of Super Typhoon Ioke is extracted from an ocean wave hindcast, as indicated in the insert. Bottom figure shows sketch of propagation path.

地圖中標示出 P-波頻源(*)及強颱 Ioke 的路徑圖(o)。頻源路徑的最大能量可以從 SCSN 的波束構成器輸出資料(如插圖所示)中反推。而 Ioke 颱風的最可能途徑則從一個海波歷史模擬預報(如插圖所示)摘錄。下圖則為海波的路線。

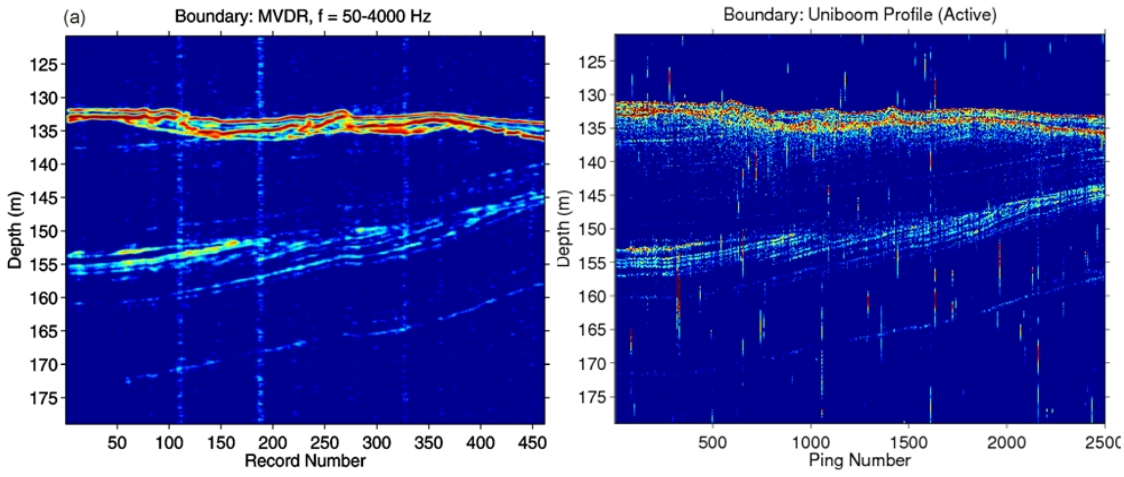

Figure 2. Seismic profile (left) obtained from noise and (right) obtained from active source. As the vertical array drifts over the seabed the reflection time between the down- and up-going noise gives the reflections in (a). In (b) a horizontal array and a source is towed over the same ground. Note the strong resemblance of the two profiles

左邊的震波圖來自噪音，而右邊則來自活動源。當垂直波通過海底，上下噪音的反射時間形成了(a)影像。而(b)影像則顯示平行波和波源被拉向同一地方。請注意到兩個圖片有高度的相似度。

噪音遙測法

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摘 要

海洋中的噪音（acoustic noise）無所不在。噪音的來源很多，包括了船隻、海洋生物、碎波等等。對聲納系統而言，這些環境噪音都是干擾。不過，近來的研究指出這些噪音隱藏著珍貴的資訊，可讓我們了解海洋、陸地、大氣的特性。譬如說，科學家發現風暴的低頻噪音(0.1 Hz)可傳達到地心，所以利用噪音測量法也可觀察到遠處的風暴。近岸觀測站也可以利用噪音測量法觀測數百公里外的海面風速。

南加州外海八千公里遠的陸基地震檢波器利用這個概念追蹤到東太平洋深處的風暴（水深約五公里），風暴每十秒鐘就會激起海浪，而海浪的強度隨深度遞減，所以在海底無法偵測。不過兩個波浪系統（wave systems）會互相影響，造成週期一半的駐波（standing wave），也就是五秒鐘一次，而駐波會在強度幾乎不減的情況下抵達海底。而八千公里外的偵測站就可偵測到這個駐波。

另一個應用實例是利用碎波噪音來繪製海底數十公尺的海床結構圖，碎波會產生一種空中聲光（overhead acoustic lighting），這個原理類似月球和星星的自然光讓我們可以在夜晚看得到星月。基本原則是建立海面噪音信號與海床反射回音之間的相關分析。回音處理就類似主動聲納系統（就像蝙蝠）只不過音源是背景噪音。儘管目前會顧慮到海洋環境裡的人為聲響，但顯然利用自然聲響進行遙測已經是水聲海洋學中的熱門議題。噪音處理的主要元素將會在介紹應用實例時詳加敘述，近來的應用也包括利用噪音瞭解海底地形。

Biological Impacts of Global Warming on Coral Reefs: Lessons from Coral Bleaching Studies

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ABSTRACT

Most ecosystems on the earth, except deep-sea hydrothermal vent environments [1], are sustained by solar energy from the sun. The primary producers including plants and algae utilize solar energy to produce carbohydrates through photosynthetic activity. Since plant growth and development are highly affected by ambient temperature, temperature beyond the growth optimum, either higher or lower, potentially harms plants by acting as environmental stressors.

In certain plants and also in coral-algal symbiotic systems, only a few degrees increase in temperature causes growth inhibition and sometimes it is lethal. However, its fundamental mechanism for the action of heat stress on plants and algae remains yet obscure. In the context of global warming, the issue has become more important than before because many endemic species may go extinction due to elevated ambient temperature. Coral bleaching phenomenon, which can be ascribed to disruption of the symbiotic photosynthesis due to an increase in sea surface temperature (SST), is well known as an impact of global warming.

Many studies have suggested that high SST is a major cause for mass-scale bleaching events and it leads to a degradation of coral-reef ecosystems via mass mortality of reef-building corals. A recent model predicts more than a 1 °C increase in SST during the next half century, a situation that may result in disastrous coral bleaching on a regional as well as global scale. A heat-sensitive coral species that may be close to local extinction would be placed under greater threat by global climate change. Until recently, however, there have been a limited number of reports available on interspecies difference in bleaching tolerance. The absence of measurable indicators for the bleaching tolerance was a difficulty in research.

To explore species-difference in bleaching tolerance, simple and reliable measures are needed for comparisons. Applying PAM chlorophyll *a* fluorescence technique, we have demonstrated that recovery potential of photosystem II (PSII) in photosynthesis is an important determinant for bleaching tolerance in corals. Figure 1 shows a comparison of the recovery rates of three coral species under different temperatures. Although little effect on recovery is observed among them up to 28°C, species-specific differences become evident above 30°C [2]. This new parameter shows a good agreement with ecological observations.

It has been suggested that *Pocillopora damicornis* and *Stylophora pistillata* are typical bleaching-susceptible species that show high mortality under high SST conditions. Investigating a large number of corals, McClanahan et al. (2004) reported a clear species-dependence in bleaching-susceptibility and mortality in GBR and Kenyan reefs. These reports have provided the essential information on inter-species difference in bleaching tolerance but did not account for intra-species differences that have sometimes been observed in the field. Thus, exploration of such intra-species differences is also required to find out a practical way for preventing local extinctions of bleaching-susceptible species. We have shown substantial evidence that water-flow facilitates the survival of bleaching-susceptible corals under high SST conditions and reduces photodamage of photosynthesis under strong

light conditions, observations implying the involvement of water-flow effects in the intra-species as well as the inter-species difference of bleaching tolerance [3, 4].

In this talk I will present an overview of coral bleaching studies on a mechanistic aspect. Based on recent findings [5-7], some implications that should be taken into the consideration for the conservation of coral reefs will be discussed.

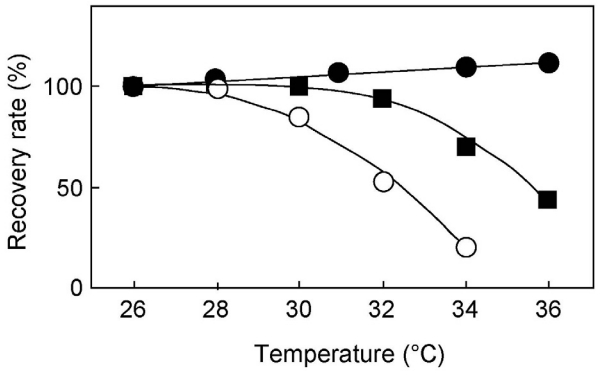

Figure 1. Temperature dependence of the recovery of damaged photosystem II (PSII) in coral species. Open circle, *Acropora digitifera*; closed circle, *Pavona decussata*; closed square, *Stylophora pistillata*. Redrawn from [2].
珊瑚在不同溫度下所吸收的受損光合系體（photosystem II, PSII）。空心圓圈：指形鹿角珊瑚；實心圓圈：板葉雀屏珊瑚；實心方塊：萼柱珊瑚。摘自[2]。

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全球暖化對於珊瑚礁帶來的生物衝擊：珊瑚白化研究

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摘 要

除了深海熱泉生態圈[1]外，地球上絕大部份的生態系統都是藉由太陽供給熱能維持運作。植物及藻類等初級生產者則透過光合作用製造碳水化合物。既然周遭的溫度對於植物的生長及發育都有著很大的影響，那麼無論是造成高於或低於最適成長溫度的環境刺激，都有可能傷害到植物。

對某些植物還有珊瑚海藻共生的生態系統而言，溫度上升個幾度就會抑制其生長，有時甚至造成其死亡。不過目前關於熱刺激之於植物還有藻類等的作用機制仍究不得而知。這問題隨著全球溫度上升而有加遽的現象，因為許多瀕臨絕種的物種可能會隨著周遭溫度的上升而走向滅絕。全球暖化最著名的衝擊之一就是珊瑚白化現象，造成珊瑚白化的原因可歸咎於海平面溫度(Sea Surface Temperature, SST)上升，造成共生圈的崩解而無法行光合作用。

許多的研究結果都將造成大規模白化的元兇指向海平面高溫；珊瑚群的大規模死亡就是所謂的珊瑚白化現象，也是引起珊瑚礁生態系統的崩坍的主因。最近的暖化研究推估接下來 50 年內海平面溫度將再升高攝氏 1 度以上，如此一來將會引發區域性或是全球性的珊瑚白化災害。對溫度敏感度很高的瀕臨絕種珊瑚而言，全球氣候變遷將是很可怕的威脅。不過時至今日針對跨物種間抗白化差異程度的研究仍為數不多。在現階段未有有效測量白化程度的尺標造成研究實驗上的困難。

為了能夠更進一步探討不同物種間抗白化的差異程度，還是必須透過比較來找出簡單又可靠的測量方法。透過葉綠素光合測定法(PAM chlorophyll a fluorescence technique)，我們發現珊瑚在光合作用下吸收潛在的光合體系 II(photosystem II)正是抗白化的一項重要指標。三個不同的珊瑚物種在不同溫度下的吸收率比較如下圖一所示。雖在攝氏 28 度左右時差異不大，但到了物種差異性在攝氏 30 度以上時[2]就非常明顯。此一新的指標能夠與我們在生態觀察時的需求吻合。

細枝鹿角珊瑚(Pocillopora damicornis)及萼柱珊瑚(Stylophora pistillata)是典型易白化物種，也就是在海平面溫度較高的情況下其死亡率較其它珊瑚為高。McClanahan 等人(2004)在澳洲大堡礁及肯亞珊瑚礁發現了易白化以及死亡率好發率是跟珊瑚物種息息相關。那些報告為跨物種間的抗白化差異性提供了重要的資訊，卻沒有將常見的同種內差異列入考量。所以我們須要更進一步探討同種內的差異性，才可以更實際的預防易白化物種發生本土性區域性滅絕。我們有充份的證據顯示流水裝置有助易白化珊瑚在海平面高溫的狀況下存活，並且能夠在強光的情形下減少光合作用帶來的光害。同時我們也觀察跨物種以及同物種內在有流水裝置的情況下抗白化差異程度。

我的報告中將會以機能的觀點切入關於珊瑚白化研究。其中也將根據一些近來的研究結果[5-7]，深入探討珊瑚礁保育的重點。

Eutrophication and Hypoxia: Problems and Scientific Challenges

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ABSTRACT

During the last few decades, anthroppgenic input of nutrients into the coastal environment has increased several times. Such an increase has already caused large scale hypoxia over large coastal areas in many areas all over the world. Currently, there are more than 400 dead zones worldwide, and the number of "dead zones" has doubled every ten years since the 60's.

On a global scale, hypoxia has lead to major changes in the structure and function of marine communities and trophic relationship of marine food chains. In hypoxic coastal waters, a shift from demersal to pelagic fish, a decrease in dominance of predators, and an increase in dominance of smaller size predators and preys with a short life cycle are generally found.

Recent scientific evidence showed that hypoxia is an endocrine disruptor, and can alter the balance of sex hormones, leading to reproductive impairment and a male biased F1 population in fish and may threaten the sustainability of natural populations. Hypoxia is also a teratogen, leading to malformation in fish through disrupting hormonal balance and/or apoptosis during development. The above new findings make hypoxia probably the most pressing global problem in marine environments.

The problems of eutrophication and hypoxia are difficult to deal with. Furthermore, climate change will further exacerbate the problem in the coming years. There is an urgent need to develop cost-effective control and monitoring technologies and measures to reduce the ecological risk of hypoxia.

優養化與缺氧：問題與科學上的挑戰

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摘 要

在過去的十年裡，流入沿海地區的人造養分以倍數成長。這個情況在全世界許多地區的沿海中造成了大規模的缺氧現象。目前，全世界有超過四百處的死亡海域，而這個數目自六十年代起每十年增加一倍。

缺氧現象已經引發全球海洋結構、功能以及海中食物鏈營養關係的改變。在缺氧的沿海中，底棲魚被遠洋魚類取代，獵食者的數量減少，取而代之的是小型獵食者以及生命週期短暫的獵物。

最近的科學研究發現缺氧是一種內分泌干擾物，會改變荷爾蒙的平衡，造成不育以及雄魚數目的增加，並威脅自然族群的永續性。缺氧也是一種畸形原，透過干擾荷爾蒙以及/或細胞凋亡讓魚類產生畸形。以上的發現使得缺氧現象成了全球海洋最迫切的問題。

優養化與缺氧是非常棘手的問題。氣候變遷將近一步惡化這個問題。當務之急便是發展符合成本效益的管控機制、監控技術和措施以減低缺氧所造成的生態危機。

Coastal and Marine Ecosystem Services and Poverty Alleviation: A Case Study of Vietnam

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ABSTRACT

I. BACKGROUND

The linkages between ecosystems and human well-being have been the focus of a global scale study - the Millennium Ecosystem Assessment (MEA). The MEA deals with the full range of ecosystems—from those relatively undisturbed, such as primary forests, to landscapes with mixed patterns of human use, to ecosystems intensively managed and modified by humans such as agricultural land and urban areas. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services (MEA, 2005).

Coastal ecosystems—coastal lands, areas where fresh water and salt water mix, and nearshore marine areas—are among the most productive yet highly threatened systems in the world. These ecosystems produce disproportionately more services relating to human well-being than most other systems, even those covering larger total areas (MEA, 2005). At the same time, these ecosystems experience the heaviest impacts from human uses and environmental changes. These pose critical challenges for the maintenance of ecosystem services and poverty alleviation.

As part of the South East Asia regional efforts, this national analysis for Vietnam aims to assess the state and trends in ecosystem services associated with marine and coastal systems; driven factors; how they support the livelihoods and well-being of human societies and particularly poor communities in Vietnam; and the threats, opportunities and constraints to these. It will also identify the key challenges for research, as well as current gaps in knowledge and capacity in order to inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation (ODG, 2007). The research was carried out by the Centre for Marinelife Conservation and Community Development (MCD) in collaboration with external research agencies in Vietnam. The research team consists of multidisciplinary experts including marine biologist, human ecologists, coastal resources managers and climate change professionals.

II. CURRENT SITUATION OF THE COASTAL AND MARINE ECOSYSTEM SERVICES AND MANAGEMENT APPROACHES

Coastal and marine ecosystems in Vietnam (including coral reefs, seagrass bed, lagoons, mangroves and tidal flats) provide a wide range of economic benefits (food, income, employment) and many social values (such as sight-seeing, entertainment, culture) to human well being and the poor through its important functions and services of regulating, provisioning, cultural and supporting.

There is an increasing demand for ecosystem services due to a high population growth and economic development in the coastal areas (such as aquaculture, tourism, industry).However, there is trend of decrease in ecosystem services, especially provisioning and regulating, due to the reduced ecosystem area, decreased productivity and less resilience, caused by anthropogenic and natural factors. This has directly negatively affected the lives of humans, especially the poor who have fewer opportunities to get access and benefits from ecosystem services.

The key issues identified by the national assessment about the linkages between ecosystems services and poverty are i) climate change effects on coastal communities; ii) nearshorenear shore over-exploitation and destructive exploitation iii) reduction and degradation of habitat, iv) low livelihood resilience and poor coastal zone management.

As part of the research assessment results, it is identified that a number of critical challenges exist in relation to knowledge and capacity to address ecosystem services and poverty alleviation issues. While data and information about the ecosystems are largely available, the understanding about services and values they provide for human being is very limited. In addition, there is an inadequacy of public knowledge about the poverty in the coastal zone. Therefore, the knowledge about the linkages between ecosystem services and poverty alleviation is also limited. This has led to uncertainty and is a dilemma for the government's decision making and policy development for possible interventions at the national level. Studies of the root cause and problems of poverty in the coastal areas and linkages of ecosystems and poverty alleviation are rare and are usually limited in scope. Research tends to be focused on ecosystem services or poverty alleviation separately and more often conducted at the local level (coastal province/district) rather than national level.

Coastal and marine ecosystem services are important for millions of people in Vietnam, especially for the small scale fishers and the poor who are highly dependant on the coastal resources for their livelihood. Their economic and social benefits and costs should be valuated properly, for awareness raising, actions and policy development to sustain the ecosystem services for the purpose of poverty alleviation and sustainable development.

Several trade-offs are considered in linking ecosystem services and poverty alleviation. It seems that the key practical trade-off is found in long-term economic development and ecosystem conservation versus the short-term goals. In addition, there are conflicts between different resources users (such as aquaculture vs. capture fisheries, tourism vs. conservation), between the poor and the rich, women and men. How to address this problem would be a question for the government in terms of political, socio-economic development and conservation of ecosystems should be in the way that can be supported to the poor.

To address ecosystem services and poverty alleviation in coastal areas in the long term, it is suggested relevant national policies and strategies are formulated and enacted. Several possible policy options could be:

i) Co-management is applied in fisheries management, with enforcement and support from both the government and community;

ii) Ecosystem based management approach is introduced and applied widely to improve the rehabilitation and productivity of the ecosystems to sustain their services for the benefits of the human-being;

iii) Integrated coastal zone management (ICZM) to enhance the planning of coastal zone and coastal resources uses, the cooperation of responsibilities between different stakeholders and the coordination of actions related to coastal areas;

iv) Private-public partnership would be studied and examined as to better manage and sustain the resources to allocate the user rights and ownership of the resources.

The following sections further summarie and analyse specific aspects and issues of ecosystem services and poverty alleviation linkages (see also table 1, below).

2.1 General national trends in supporting, regulating, provisioning and cultural Ecosystem Services

Vietnam currently has a diverse marine and coastal ecosystems - including more than 155,000 ha of mangrove forests, about 1300 km^2 of coral reef, nearly 500 km^2 of lagoons, about 16,000 ha of seagrass and many tidal flats and estuaries. These ecosystems have long provided important services to Vietnamese people, including supporting, regulating, provisioning and cultural services.

Among a total population of approximately 85 million people, it is estimated that 20 million people are indirectly affected by marine and coastal services while 8 million poor people are directly dependant on such services.

Provisioning services:

The value for the annual production of goods and services of the coral reefs in Vietnam is estimated about USD 100 million. One square km of coral reef can provide a total of fish an equivalent to USD 10,000. One ha of mangrove reforest supports a marine catch of about 450 kg in the Mekong Delta. Vietnam seagrass support both commercial fisheries and services value at over USD 20 million per year. The total economic value of lagoon in Vietnam is estimated at more than USD 2000 per ha.

Regulating services:

The value of shoreline protection of the coral reefs can easily be seen in some marine area in the central provinces of Vietnam like Bai Tien and Hon Khoi, Khanh Hoa province. Mangrove forests significantly reduce coastal erosion and may provide protection from tropical cyclones and tidal waves. Mangrove roots, especially where vegetative communities grow densely, help sediment to accumulate more rapidly. Natural hazards, such as typhoons and storm surges, are not uncommon in coastal communities, particularly in the North-Central and Central Coastal macroregions. Thus, the protection role of mangrove should be increased to ensure the security for local people. Each square meter of sea-grass can generate ten liters of dissolved oxygen that contributes to balancing O_2 and CO_2 in the water environment, and assists to mitigate the greenhouse effects due to efficient absorption of the CO_2 in the water.

Supporting services:

A single square meter of seagrass can product over 25 tons of leaves per year. This vast biomass provides food, habitat, and nursery areas for myriad of adult and juvenile vertebrates and invertebrates. Seagrass epiphytes also contribute to food webs - either directly via organisms grazing on seagrass, or indirectly following the deaths of epiphytes which then enter the food web as a detritus carbon source. Seagrass beds serve as a favourable breeding and hatching ground for numerous marine species, and are important nearshore fishing grounds. Several offshore islands such as Hoang Sa and Truong Sa archipelago were created by the build up of dead coral skeleton. Many beautiful swimming beaches found in Ha Long and Cat Ba are related to the marine depositional regimes associated with the coral reef

production.

Cultural services:

Coral reefs play a central role in Vietnam's marine tourism industry. The major recreation activities on reefs are snorkeling and scuba diving. Nha Trang City, for example, is one of the first marine tourism centers in Viet Nam, showcasing its very diverse and abundant coral reefs surrounding the nearby islands. The number of visitors to Nha Trang is increasing (30,000 people in 1995 and 400,000 people in 2003). About ten percent of these visitors participated in diving and snorkeling on the reefs of Hon Mun MPA. These services brought a benefit about US$400,000 and accounted for approximately 2% of the total revenue from the tourist sector in Khanh Hoa province. Mangrove areas has the potential to eco-tourism, which contribute to local livelihoods, especially in cases where the natural environment is the main attraction. Protected areas are a major existing and potential tourist attraction. There are a number of ongoing community-based tourism initiatives in Vietnam like Can Gio and Giao Thuy.

General trends

The ecosystems are degrading in term of both quantity and quality over the last decades.

Among 1300km^2 of coral reefs distributed along the coast of Vietnam only 1% are in good condition. Coral coverage has declined down to 30% in some areas since 1993-2004. General trend is towards wide scale coral reef degradation.

Mangrove ecosystems have shown a trend of increasing degradation during the period from the early 20th century to the 1990s – however, they appear to have stabilized in the last ten years.

Fish caught per ha per year from lagoon reduced by nearly half over the last decade.

Significant reduction of seagrass beds in recent years with the averages rate of 80ha loss per year from 1997-2002 (Khanh Hoa province).

The demands for ecosystem services are increasing, driven largely by population growth.

Policy makers and coastal managers have paid more attention to provisioning and cultural services while the importance of regulating and supporting services remains at a basic level of awareness and academic knowledge. For example, a total area for shrimp aquaculture has increased from 250,000 ha in 2000 to 478,000ha in 2001 and 530,000 ha in 2003. Today, Vietnam probably has the largest total area for shrimp aquaculture in the world.

However, the capacity of ecosystem services to respond to such high demand remains low due to general trends toward reduced ecosystem area and productivity caused by anthropogenic and natural factors.

There are a number of key factors driving the above mentioned trends.

Direct factors include: nearshore overfishing and destructive fishing, unsustainable aquaculture, industrial and land based activities, and the effects of climate change.

Indirect factors include: poor coastal resources management and enforcement, increasing market demand for marine products and low livelihood resilience.

These direct and indirect driven factors are described below.

- Population increase: The population in Vietnam has doubled over the past 60 years (approximately 85 million in 2008). The population density of Vietnam is more than 200 people per 1 km2. Vietnam has become one of the countries that have the highest population density in the world. This has drastically reduced the rate of available agricultural land per person. Population increase has placed a large burden on the natural

resources in a few ways. The need to find extra cash income for the food demand and it led to the over-exploited natural resources

- Over and destructive exploitation: After the war, the demands for building timber, firewood and charcoal, and the increasing exploitation by forestry agencies lead to resources becoming exhausted. Overfishing caused break down of the coral community structures (fishing down marine food web phenomenon). Destructive fishing practices - bad habits and short-term thinking are reducing diversity in habitats and species of mangrove, destroying the coral structure and causing mass mortality of the coral colonies.
- Unplanned Aquaculture: Due to the big benefits from shrimp exports and because the fish catch yield has decreased, shrimp farming has been encouraged by the government and many local authorities. Therefore, both local people and state bodies have felled lush mangrove forests to make natural extensive shrimp ponds over all coastal mangrove areas of Vietnam. Since 1980s, this happened on a large scale in Ca Mau, Minh Hai, and a large number of mangrove areas were destroyed. In the end of 1980s, shrimp practice has developed strongly in the central and northern region of Vietnam and also cause the reduction of mangrove forests.
- Impact of the urbanization and industrial production: The construction of towns, ports and factories has many other bad effects on the environment as a result of discarding solid domestic and industrial waste into water; by gathering ships, motor boats which discharge oil and other substances, thus polluting the mangrove environment as well as adjacent areas and killing many animals or forcing them to move away
- Ineffective coastal management: The management of the coastal areas shows the weakness of law enforcement and the conflicts in exploitation of the natural resources. The coordination and co-management among the economic sectors/stakeholder areas are not close enough (Hue, 2004; Dao et al., 2007).
- Increasing demand from the domestic and international market: Ever since shrimps, crabs, and other marine animal products became valuable, the consumption markets have also extended. As of today, marine-products are consumed throughout cities of Vietnam and other countries. The main export product is shrimp and clam. As the markets become more and more extensive, the fishery production has been also become more extensive. As a consequence of such actions, the pressure on natural marine resources as well as ecosystem has been increasing
- Climate change effect: There are many environmental factors that affect these ecosystems as a whole, but climate change plays an important role as it not only influences the biodiversity directly but also has indirect impacts through factors such as the environmental hydrology and edaphon. Frost caused by low temperature damages the mangroves in the north of Vietnam. Inundation is one of the effects generated by sea level rise
- Poverty is also one of the causes of overexploitation by poor people. Poverty has been studied at the district level of most coastal areas where the main ecosystems services are provided. In general, the poverty rate in coastal regions is lower than that in Vietnam's mountainous interior. However, in terms of density, the two deltas (Red river and Mekong river) and the Central Coast are the regions with highest absolute numbers of poor

Poor people in our analysis are typified as artisanal fishermen, often have small landholdings or are landless, and with very limited financial capital. Their livelihoods are strongly dependent on access to "common resources". Over the last two decades, the 'enclosure of the commons' and the privatization open-access resources have excluded

many poor artisanal fishermen from their own livelihoods. Low resilience of livelihoods has exacerbated the situation of the poor people.

The Vietnamese government is now trying to apply the co-management concept in terms of the sustainable utilization of ecosystem services. In addition to the traditional agricultural sector, aquaculture development is being promoted. For example, marine and brackish water aquaculture is developing rapidly in Khanh Hoa and coastal region. Total area for shrimp aquaculture has increased from 250,000 ha in 2000 to 478,000ha in 2001 and 530,000 ha in 2003. Today Viet Nam probably has the largest total area for shrimp aquaculture in the world.

Poor people can apply to get funding through the credit schemes at the women's association that are active in every village. Farmers can also get a land registration card for their own aquaculture area in the long term. However, the long-term positive and negative impacts of current aquaculture practices are not fully assessed yet and further promotion of aquaculture should be carefully thought out. Environmentally, expansion of aquaculture ponds and sea water channels creates groundwater salinization. Waste water from those ponds which is not treated is a source of pollution for the surrounding sea water. In truth, aquaculture can bring in high turnover, but maintaining such profit requires a certain level of skills, capital, technology, infrastructure and land which are often less accessible to the poor.

2.2 Key national trade-offs

The most critical national trade-off appears to be short term interests driving policies towards the exploitation of provisioning services rather than long term interests that might best be protected by conserving or enhancing regulating and supporting services. Cutting of mangrove forest for shrimp aquaculture or using coral reef for decoration or construction materials are typical examples of this conflict.

Conflicts also occur in the competing use of coastal resources by various user groups, such as small scale fisheries vs. aquaculture. Untreated waste from aquaculture ponds creates pollution in surrounding waters. Industrial vs. artisanal fisheries contributed by case of oil spills and environmental pollutions is severe in many areas. Examples of such conflicts can be taken from Halong bay in the north or Van Phong Bay in the central of Vietnam.

Other conflicts regarding the provisioning of benefits from ecosystem services are fuelled by the increasing gap between the rich and the poor. Aquaculture development makes the rich become richer and the poor become relatively poorer. When people with available funds participate in such marine-product rearing, the area utilized by low-income individuals to catch such products becomes limited. Therefore, their low-income becomes even lower. As a result, the boundary line between rich and poor becomes even wider.

There is also a gender issue in some cases in the coastal areas between women and men in access to the ecosystem services benefits (such as mangroves, coral reefs and lagoons). In the traditional fishing communities, women have more working hours than men, and they have less opportunities to training, education activities because of spending more time on reproductive work such as taking care of the children and thus this has limited their opportunities for income generation and their participation and roles in the social and community development.

The reduction of ecosystems (such as mangroves) has significantly socially impacts to the poor people and especially women, who collect the fish and resources in the nearshore coastal areas. The privatization of the land resources for aquaculture industry activities in the coastal areas has led to the fact that more power to the rich and poor people (including women) seem to have more challenges in finding other livelihoods due to their limited access to capital, technology and other resources (land) in the coastal areas.

There is a conflict between national and local interest as well. Overlapping in function of various agencies involving in marine and coastal resources management, poor coordination among them and weak enforcement of law and regulations have all contributed to this conflict. The case of Xuan Thuy national park, a RAMSAR site in Nam Dinh province best illustrates this conflict.

2.3 National state of knowledge

There is a well developed body of knowledge about ecosystems and their services in Vietnam, compiled primarily by research institutions and individuals. The information about these services is usually broken down to the regional and local levels. Updated information is available in hard copy and Vietnamese languages. Only limited number of information are ready in English language and in a soft version.

More than 200 coral sites have been surveyed along Vietnam's coast over the last 10 years. Some research organisations are devoted to wetlands and mangrove research, such as MERC.

Both the scientific and local communities are aware of the changes to mangrove ecosystems. However, the studies on the processes underlying these changes are limited and tend to focus on the reduction of fishery production and the change of soil.

There have been reports of large-scale seagrass decline at 17 locations in Vietnam, almost all of which were attributable to human-induced disturbance. Trends for recovery remain unknown

Most of the research was done within a scope of a project or a certain area, thus, it is not possible at the moment to know about all services at national level. Most of the information about these services remain at researchers level, not yet available to policy makers and general managers.

Poverty has also been studied in coastal areas - mainly at the district level; however, the data and information has been no longer updated. There is limited analysis regarding the linkage between ecosystems services and poverty in coastal areas. General information about the access by the poor to various ecosystem services is available at the case specific level, creating an incomplete national picture.

2.4 Key knowledge gaps

Information available on the ecosystems services have been remained at research and academic level, not yet updated or interpreted for other important stakeholders such as managers, policy makers and community members.

Policy makers at various levels, from national to provincial and local levels all need to first understand the ecosystems services, how they work, how they link with poverty and factors that influence their functioning. Many decisions relating to natural resources managements are made based on administrative or political aspects without a sound scientific justifications. Partly it was due to lack of up to date information.

Coastal managers also need to see the linkage between the ecosystems services and poverty so that their work can be well harmonised. Sometime their management is based on the research results. But researchers have different focuses when studying coastal ecosystems. They do not often integrated natural and social sciences perspectives nor expound on the relationship between the two. While other indirect factors come from ecosystem services such as mitigation of climate change through absorption of CO_2 in the seawater or shoreline protection values are overlooked.

The poor coastal people themselves also need to see the linkage between their livelihoods and the services that ecosystem services provided. This awareness will help them to see other longer benefit of ecosystems such as regulating and supporting rather than just a short term and visible services like provisioning. Local people will only committed to protect the

ecosystems once they well understand that they link to their own livelihoods and that all the community is also committing to management.

Any intermediate agents such as NGO or community based organisations who work in the coastal areas also need to fully understand such linkages.

Knowledge of the poverty in the coastal zone is limiting and outdated

The poverty in coastal areas in broader context of social development and justice needs to be studied thoroughly. Specifically, what factors facilitate or prevent the poor to accessing ecosystem services, how to promote/limit these factors? From the sectoral and intersectoral points of view?

Furthermore, the adaptive capacity of key stakeholders to address the issue mentioned above needs to be elucidated.

Knowledge of the linkages between ecosystems services and poverty in the coastal areas of Vietnam is limiting

The quantitative data to demonstrate the linkages between ecosystems services and poverty is still limited and a major study on increasing the access of poor people to benefits from ecosystem services should be conducted.

Future research needs to analyse in depth other aspects of ES and poverty alleviation within the context of specific provinces and in particular address the question of how people employ ecosystem services aside from the capture fishery? (For example: fishers may use coral reefs for supporting eco-tourism; aquaculture as an alternative to capture fishery…).

Furthermore, other factors should be incorporated into the assessment of poverty alleviation such as distance from main land (offshore islands), distance between the fishing communities and the city/town, infrastructure influencing the transportation of goods, etc.

Very few previous studies deal with the linkages between the reduction of ecosystem services (eg. typhoons,– floods) and the poverty conditions of fisher communities in the coastal lagoons of Vietnam. Since 80% of the population depends on wetlands where lagoon system provides most services, it is need to conduct such studies.

All these needs of understanding of the ecosystem services and their linkage with poverty in coastal areas of Vietnam are not met at the moment.

2.5 Key policy options

Ecosystem based management approach to the use and management of natural resources need to be promoted in Vietnam. Most of management decisions are made based on administrative or political aspects which are not good for natural resources management. Any province or district when making decision on developing certain economies need to base on the services that the ecosystems existing in their location could provide and respect the rule of nature.

Co-management in the fisheries sector should be strengthened by institutionalizing the models from pilot activities at the national level. Since most of the poor identified in the coastal areas of Vietnam are engaged with fisheries, the way fisheries are managed need to be improved. The top down and central management does not work well and only community participation also is not enough. Thus, co-management of fisheries resources need to be promoted and leveraged to policy level.

Non fisheries options should be sought when confronted with low livelihood resilience. Near shore resources are recorded to be depleted and fishing efforts are encouraged to be reduced in Vietnam. Thus, options to alternative livelihoods are encouraged to seek, However, other options outside fisheries need to be found. The adoption of other sectors like IT, tourism or services should be studied to help the future generation of fishers to convert their way of making living.

Integrated coastal zone management (ICZM) should be promoted at both policy and practical levels. Sectoral management sometimes creates severe conflicts in the coastal areas as interests differ. A mechanism supported by a sound scientific justifications and a balance of economic and conservation purposes should be in place to ensure a sustainable development of the vulnerable coasts. ICZM was piloted in some provinces of Vietnam and need to further promoted at national level and concretized at local levels.

A Public Private Partnership model should be promoted to invest in further studies of the linkages between ecosystems services and poverty. Burden to government need to be reduced by promoting the investment from private sector. Business taken services from ecosystems need to pay back to those who are dependant on these resources. This philosophy works in many places and need to be promoted in coastal areas of Vietnam. The government encourages the development of marine and coastal economies. It needs to create policy to engage others stakeholders to invest and benefit from their investment in a sustainable way.

III. MATRIX OF ECOSYTEM SERVICES, TRENDS AND INTERACTIONS

1	2	3	4	5	6	7
Ecosystems status and geographical coverage	**ES**	**Issues Relevant to poverty alleviation**	**General national trends and driven factors linked to poverty**	**Key national trade off**	**National state of knowledge/gap**	**Key policy options**
Mangrove • Distributed in the north and south of Vietnam • Total area of 155,290ha, • 21% of which is natural forest and 79% is planted. **Coral reef** • Distributed widely in central Vietnam • Total area is about 1300 km2. • More than 300 coral species • 1 ha of coral reef can harverst fish = 10,000 USD	**(A). REGULATING** • Protection: beaches/coastlines from storm surges, floods, and waves • Reduction of beach and soil erosion • Formation of beaches and islands • Land stabilization: trapping sediments • Water quality maintenance • Climate regulation	Climate Change • Coastal flooding • Coastal erosion • Changes in ecosystem productivity • Sea level rise	• Reduced ecosystem area leading to reduced protection function, affecting the poor strongly. • Demand for regulating services increased **Direct:** • Human activities- convert mangrove and lagoon area into aquaculture • Human activities destroy, reduce and weeken coral reefs • Climate change **Indirect:** • Lack/Low awareness • poor planning • weak enforcement	• Economic development vs ecosystem protection • Use conflicts between aquaculture and other uses (mangrove removal), destruction of coral reef)	• Limited information available on regulating services of ecosystems • Total Economic Value is available at regional and local levels.	• Increased awareness of protection function • Valuation in monetary terms • Integrated Planning
	(B). PROVISIONING • Fisheries for food • Fisheries for aquarium trade • Aquaculture for food and aquarium	Near shore overfishing and destructive fishing Low resilience of livelihoods Poor management of	• Nearshore fishstock reduced significantly and low resilience in short term • Increasing demand, mainly for capture – small scale fishery and	• Capture fishery vs aquaculture • Offshore exploitation vs nearshore • Rich vs poor	• Availability of information about provisioning services - but only at regional and local levels. • Available info on poverty conditions in areas where	• Integrated coastal planning • Co-management of fisheries • Ecosystem based approach - Restoration of

1	2	3	4	5	6	7
Ecosystems status and geographical coverage	**ES**	**Issues Relevant to poverty alleviation**	**General national trends and driven factors linked to poverty**	**Key national trade off**	**National state of knowledge/gap**	**Key policy options**
Lagoon • Concentrated in central part of VN • Total area of 447.7 km2 • **Sea Grass** • 8,940 ha of seagrass supports both commercial fisheries and services valued at over 20 million USD per year **Tidal flat** Including estuaries and coastal tidal flat areas.	• Pharmaceutical products • Building materials • Jewelry and other decorations • Fuel-wood • Traditional medicines	resources	aquaculture • Used extensively by the poor: 28 coastal provinces, 20 million people directly and indirectly dependant • Food security • Directly affecting the jobs and income of 8 million people	• Long term vs short term goals • Industrial vs artisanal fisheries	provisioning services are provided, but the linkage between the two is not analysed • Poverty status data is not updated (dated back nearly a decade) • Mainly on fisheries aspects	habitat • Fair and Sustainable trading • Non-fisheries options.
	(C). CULTURAL • Tourism and recreation • Spiritual, aesthetic appreciation	Marine and coastal ecotourism Marine tourism 2% of total income from tourism (Khanh Hoa province) Low access by the poor	**Direct:** • Demand increasing • Limited capacity and skills • Poor support services **Indirect**: • Poor planning • Improper investment	• Economic interests vs, conservationio n • Social status of the poor	Limited information and understanding of status, trend and dynamics	• Community based ecotourism • Public - Private Partnerships • Education
	(D). SUPPORTING • Cycling of nutrients • Nursery habitats	Climate change • Change in types of species • Change in capacity of nursery habitats Destructive human activities • Reduction of nursery habitat coverage	Maintenance and restoration **Direct:** • Climate conditions **Indirect:** • Lack of awareness • Week enforcement	Short term vs long term goals Rich vs Poor	• Basic biophysical info available at regional levels. • Limited link to whole ecosystems and their services	• Awareness raising on interactions between ES and poverty alleviation • Public Private Partnership

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海岸及海洋生態系統服務及減貧：越南個案研究

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摘 要

一、背景介紹

千禧年生態系統評估（MEA）之研究遍及全球，一直以來皆著眼於生態系統與人類福祉之關聯性。千禧年生態系統評估對生態系統之研究鉅細靡遺，內容包含較不受影響的原生林等，到被人類以不同方式使用的山區，再到農地及城市這些受到人類密集使用及改變的生態系統。生態系統服務意指生態系統為人類社會帶來的利益，其中包括供應服務如食物、水、林木及纖維，調節服務則影響氣候、洪水、疾病、荒地及水資源品質，文化服務提供娛樂、美學及精神調劑，支援服務則為成土作用、光合作用及養分循環。人類與環境改變間雖有文化及科技作緩衝，但人類生存基本上仍仰賴生態系統服務之流動（千禧年生態系統評估，2005）。

海岸生態系統意指沿海土地，是淡鹹水交會處和近海區，也是世界上最具生產力又最受威脅的系統之一。與其它甚至總面積更大的系統相比，海岸生態系統為人類生活提供了更高比例的服務（千禧年生態系統評估，2005）。然而，人類使用及環境變化卻帶給海岸生態系統最嚴重的衝擊。這些衝擊為生態系統服務保育及減貧帶來嚴苛的考驗。

此份越南全國性分析報告是東南亞區域計劃的一部分，主要評估海洋及海岸系統相關生態系統服務之狀態及趨勢、驅動因素，以及系統服務如何支持人類社會，特別是越南貧窮地區之生計及福祉。本報告亦評估上述各點之相關威脅、機會及限制。此報告更指出研究時之關鍵難處，以及當前知識和能力之差距，以期研究策略發展在生態系統服務保育上專注於減貧（ODG，2007）。此研究由海洋生物保育及社區發展中心（MCD）進行，接受越南外部研究機構協助。研究小組成員包括海洋生物學、人類生態學、海岸資源管理及氣候變遷等專家學者。

SESSION A:
Marine Environmental Change / Science & Technology / Management

3D Imaging of Coral Reefs

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ABSTRACT

The reliability of statistics can be improved with larger amount of unbiased and accurate samples. The prediction of global climatic changes varies greatly among models, because weather data are not reliable enough to confirm any of the predicted climates. Coral reefs are sensitive to the climatic changes, e.g. up to 50% of coral reefs were bleached during the 1997-98 El Nino events. Because data collection speed is limited by funding and manpower, this finding was not confirmed nearly two years after the event. A method for fast collection of 3D images of coral reefs is demonstrated here. The principle is similar to the along-track stereography that is used for aerial and satellite photography, i.e. using successive images to build 3D images of terrains. One of the requirement of this method is a stable platform for taking underwater pictures. With 3D images in hand, coral experts can spend more time in lab analysis, than in diving for collecting pictures. Sharing the task of surveys can greatly reduce the cost of surveys, therefore makes this method more sustainable for documenting and for managing coral reefs. Fast coverage of coral reefs over vast area, makes 3D imaging an ideal method for early warning system on the bleaching of coral reefs.

珊瑚礁的立體攝影

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摘 要

大量、無偏差、正確的採樣方式，可以提升統計數據的可靠性。全球氣候變遷的預測差異相當的大，部分原因是現代的氣象資料無法確認長期預報氣候的可靠性。珊瑚礁對於氣候的變遷相當的敏感，例如在 1997 到 1998 年的艾爾尼紐事件,，全世界將近 50%的珊瑚礁產生白化的現象。這個現象是在艾爾尼紐事件發生 2 年之後才確認，這個時間上的延遲是由於資料收集的速度，受限於經費與人力而無法提升。此處我們要報告一個快速收集珊瑚礁 3D 影像的方法，這個方法的原理是與飛航空或衛星產生立體影像的方式相同，也就是利用沿航線連續拍攝影像，製造一對對的圖片，進而產生立體的地形影像。使用這方法的要求之一是穩定的載具，以利潛水與攝影技術人員拍攝水下的珊瑚影像，並且建立 3D 的影像資料庫，珊瑚專家因此可有更多的時間作實驗室的專業分析，而非到現場去潛水及採樣。這個分工合作的方法，大幅增加珊瑚礁的立體影像數目，也大幅縮減了調查的費用，因此可以作為紀錄及經營管理珊瑚礁的基礎調查方式之一，快速收集大範圍的珊瑚礁的影像，以利專家決定重點調查區域及方式，因此這個方法也可作為珊瑚白化的早期預警監測系統。

Underwater-Intruder Detection in Harbor Environments Using Doppler-Sensitive Waveforms

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ABSTRACT

A method to detect underwater intruders by Doppler processing is evaluated experimentally in Woods Hole Harbor, Cape Code, Massachusetts, and Kaohsiung Harbor in Taiwan. An air-filled sphere is towed behind a ship to emulate a moving target. A directional transducer is used as a source and a directional hydrophone is used as the receiver, both pointing to the target. Using pulsed linear frequency modulated (LFM) signals, the data showed high level reverberation returns, which are often confused with the target echo. The high level returns are attributed to backscattering from objects moving with the tidal currents. Target tracking/ motion-analysis (track before detect) is then required to distinguish the target from the clutter (false alarms). Using Doppler sensitive signals, such as M-sequence signals, it is shown that target and reverberation are well separated in the Doppler space (since the reverberation normally has zero or low Doppler shift). A target moving at speed > 0.5 m/s (including a swimmer) can be detected with high reliability with just a few snapshots of data, given a high enough source level. Target can be tracked in the Doppler space using Dopplergram.

運用都卜勒敏感波型於港區環境中水下入侵目標物偵測之研究

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摘 要

本研究分別以在美國麻州鱈魚角伍茲霍港及台灣高雄港所進行的實驗，探討都卜勒訊號處理方法在水下目標物偵測應用之相關問題。本實驗乃以拖曳於船隻後面充氣圓體為目標物，並以具指向性之聲源及接收器作為發射與接收。由於目標物追蹤或運動分析（追蹤然後偵測）需要從混雜的聲訊中分離出目標物訊號，若利用線性調頻（LFM）作為發射波型，結果將發現，在港區環境中，高混響的回音將掩蓋了目標物的訊號而難以達到偵測的效果，這些混響乃因夾雜在潮流中的散射體所造成。若利用對都卜勒效應具高敏感度的波型，例如 M-序列波型，實驗結果可發現，目標物訊號與混響可以方便的分離開來，此乃因為造成混響的因子（如，界面或水體的散射）一般而言只會導致很小的都卜勒頻移效應，甚至沒有。本研究結果發現，只要目標物移動速度大於 0.5 m/s，儘管只有幾筆瞬間資料，若聲源強度夠高的話，即可獲得信賴度很高的偵測，而目標物的追蹤，可利用都卜勒譜在高都卜勒空間進行。

Techniques for Automatic Mapping Coral Reef Habitats off Southern Taiwan Using Side-Scan Sonar

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ABSTRACT

Side-scan sonar is one of the most effective underwater mapping equipment for seafloor characterization and habitat classification. The prominent benefits offered by this equipment include high area coverage rate, extremely high image resolution and precise geo-referenced coordinates of the image. To evaluate the real value of side-scan sonar technology for habitats mapping in complex coral reef environments, a rich and complex coral reef ecosystem off Kenting was selected for mapping. The intrinsic factors which may influence the capability and accuracy of the mapping activity include: quality and resolution of the sonograph, habitat classification scheme (manual or automatic) as well as complexity of reef system (size, growth forms and local reef architecture). The current investigation was, therefore, involved two major components, i.e., collection of good quality and high resolution (pixel resolution of 3 cm, feature resolution of about 10 cm) sonographs and development of an automatic recognition and classification procedure to characterize the habitats. Three major components were incorporated into the proposed automatic classification program, i.e., gray-level co-occurrence matrix method for texture features extraction, unsupervised Baysian classification and cluster analysis.

A hierarchical seafloor habitats classification procedure, based on texture characteristics of the sonographs, was adopted which can be split into three stages. At the first stage, the sonographs, was classified into four broad categories, i.e., unconsolidated seafloor (sandy seafloor), consolidated seafloor (rocky seafloor), submerged aquatic vegetation (algae; seagrass), and acoustic shadow area. At the second stage, the consolidated seafloor was then subdivided into four categories based on biological or coral coverage rate considerations, i.e., under 20%, 20% to 50%, over 50% and unknown (i.e., texture in near-range pixels). In addition the unconsolidated seafloor was split into smooth sand and sand with ripples. Under similar criteria, the biological or coral coverage rate under 20% was split into two categories, i.e., rock boundaries with small rocks and rocks with smooth surface. The biological or coral coverage rate between 20% to 50% was split into two types of coral forms (i.e., low relief and high relief), and the biological or coral coverage rate over 50% was subdivided into two categories, i.e., rocks with large amount of coral and reef colonies or rocks fragment.

Ground-truthing of the automatic classification system was performed by a series of underwater photographs. The accuracy of the seafloor classification conducted at the first stage was estimated to be 93%. At the second stage, an accuracy of 74% was concluded regarding the classification results based on morphological and biological considerations respectively. The characteristic texture features selected in this investigation (i.e., entropy and homogeneity) for the classification of various coral reef seafloors were proved effective.

The results of this investigation indicated that at a specific site off Kenting (i.e., Shiniuzai offshore area) where the length of the coast line is 1.2 km, the area covered by rocks is 213,906 m3 and the maximum extended distance can reach 470 m from the shore. The percentages of the three classification categories based on three distinctive biological coverage rate, i.e., under 20%, 20% to 50% and over 50%, were concluded to be 38%, 28% and 34% respectively. The results were incorporated into geo-referenced maps within a

Geographic Information System (GIS) for further applications.

Keywords: side-scan sonar, coral reef, gray level co-occurrence matrix, unsupervised Baysian classification, cluster analysis, coral reef coverage rate

“Creative a New Concept” from Marine Pollution Control

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ABSTRACT

Kaohsiung City Marine Bureau has made a lot of efforts working on marine pollution control when the bureau was firstly established six years ago. Upholding the concept of “prevention is better than punishment,” the bureau organized “Kaohsiung City Jurisdiction Marine Team” with military, industry and government in prevention, propaganda and emergency measure. Following by the “3 links and 4 elements of the marine pollution prevention scheme,” there have been great results these years that the fish jumping and egrets flying or foraging in the area of Kaohsiung City jurisdiction can be found very often everywhere.

There are three essential links of marine pollution: “monitoring”,” prevention” and “emergency measure.” Without the precise execution of monitoring, without effective establishment of the background value of water area, there will be lack of standard or basis in dealing with the related works of the emergency measures. If there is no emergency exercise or preparation, when ocean pollution actually happens it would cause a lot of hassle.

The four elements of marine pollution are “building up the united protection system,” “marking off the key prevention district,” “execution inspection” and “building up the complete notice regulation system.” Efficiently integrating the power of marine teams, the key prevention districts are planned; and strengthen the notice regulation systems between all units for getting the illegal discharge waste water information as soon as possible. Also an overall plan has to be made to reduce the harm efficiently and to use the related personnel and resource to pay in a smarter way.

During the critical moment of city-country consolidation of Kaohsiung, Marine Bureau will be more enthusiastic with a macroscopic view to keep the blue waters of Kaohsiung beautiful and passionate, and the dazzling ocean scene in this city will be always shiny with the flower fragrance under the warmest sunshine in southern Taiwan.

海洋污染防治「創意新思維」

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摘 要

高雄市政府海洋局成立6年以來，為落實海洋污染防治工作煞費苦心，以污染前的稽查阻嚇，取代污染後的清潔付出為宗旨，執辦相關之防治、宣導、應變事宜，並秉行政一體原則與軍、產、官方單位籌組「高雄市轄海洋團隊」，戮力齊心依據海洋污染防治的「三環四要」執辦相關工作，從近年來在市轄海域隨處可見之魚兒飛躍、白鷺鷥翱翔覓食的情景，已確實反映出良好的執辦成果。

海洋污染防治工作三項環節為「監測」、「防治」及「應變」，三者缺一不可；沒有確實執行監測工作，未能有效建立轄管海域背景值，執辦相關防治應變工作時將缺乏標準和依據；倘若不能戮力執行防治工作，則將遇到海洋污染事件層出不窮的窘境；平時如果沒有應變工作的整備和演練，則在海污事件發生時便會手足無措。

海污防治四項要素則是「建擘聯合防護體制」、「劃分各重點防治區」、「戮執稽查」及「建置完備通報應變系統」，有效整合海洋團隊的力量，規劃應變防治重點責任區，強化各單位間之通報應變系統，俾得於團隊成員間共同監督稽查之下，消弭非法排放廢油水的污染情事，並得以於污染事件發生之第一時間，統籌各單位力量投入減輕災害，有效降低環境危害程度及相關人力與資源付出。

值此市縣合併的關鍵時刻，海洋局將以更宏觀的視野，藉由更嶄新且積極的作為，讓整個大高雄市的蔚藍海域持續保有它的美麗熱情，並伴隨著南台灣的四季花香與豔陽照耀的粼粼海景，更加閃爍耀眼下去。

The Effect of Changjiang Nutrient Loading on Benthic Oxygen Demand in the East China Sea: A Numerical Study

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ABSTRACT

Recent studies demonstrated the dramatic increase of Changjiang nutrient loading in the last four decades (Yan et al., 2010), while the seasonal hypoxia in the East China Sea was observed. We employ a coupled 3-D physical-biogeochemical model developed by Liu et al. (2010) to explore how Changjiang nutrient loading may have affected the benthic oxygen demand in the past. The model results reveal a non-linear response of the benthic oxygen consumption rate to the exponentially increasing Changjiang nitrogen loading.

Spar Buoy Breakwater for South China Sea Islands

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ABSTRACT

The small islands in South China Sea, such as Spratly Island, are quite remote from the civilization. However, an environment-friendly facility is still required to berth ships for cargos and passengers, i.e. a temporal port. In this paper an artificial marine forest, which is composed of many aerated semi-closed pipe, is proposed to serve as a floating breakwater. The wave energy dissipation characteristics of the spar buoy breakwater are obtained theoretically and experimentally. Photo A is a picture of a semi-closed pipe which was prepared for installation. The pipe was at first sunk to the sea bottom and a rope connected to an anchor. Then air was pumped into the pipe and it floats up tautly (Photo B). Spar buoys can be installed randomly. Considering the drag force only, the average energy dissipation rate of a spar buoy in waves is

$$\overline{P_M} = \frac{4\pi}{3T^3} C_D \rho_w D[(l_0 + l)^4 - l_0^4] \cdot \theta_{\max}^3 \quad (1)$$

, in which T is the wave period, C_D the drag coefficient (take 1), ρ_w the water density, D the pipe diameter of spar buoy, l_0 the anchor rope length, l the spar length, $\theta_{\max}$ the maximum pitch angle of spar buoy.

If the wave height is 2 m, the wave period 8 seconds, buoy length 4 m, buoy diameter 0.6 m, buoy density 0.2 ton/m^3 and water depth 8 m, the average energy dissipation rate of a spar buoy in waves is 1300 watt by eq.(1). The wave power per meter is 54420 watt. If 80% of the wave power is diminished, 33 pieces of spar buoys are required for a unit width of breakwater. If the breakwater width amounts to 100 m, then 3300 spar buoys are needed to be installed randomly. Because eq.(1) does not consider the phase lag between wave and the drag coefficient may be larger than 1 due to bio-fouling, the estimated average energy dissipation rate is underestimated that the required spar buoy will be reduced.

Keywords: semi-closed pipe, artificial marine forest, average energy dissipation rate.

Photo A　A semi-closed pipe prepared for installation（準備安裝的半封閉圓管）

Photo B　A semi-closed pipe after installation（半封閉圓管安裝完成後情形）

適用於南海島嶼的圓柱浮体防波堤

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摘 要

南海的小島，如太平島，遠離文明開發地區環境較少破壞，彌足珍貴。然而這些島嶼仍然需要簡易又環保的港灣，以便在非惡劣天候停靠船舶，以便裝卸貨物及人員上下。本文提出人工海中森林，可作為浮式防波堤，由充氣的半封閉圓管外套廢輪胎構成，對其消波特性作理論與實驗研究。照片 A 是準備安裝的半封閉圓管，安裝時先將管沉到海底，潛水人員把纜繩與錨塊繫上，將空氣灌入管內，半封閉圓管即浮直，再把廢輪胎套上固定，如照片 B 所示。圓管可隨意安裝，如海中森林般。只考慮牽引力，半封閉圓管在波浪中的平均能量損失率如下:

南海的小島，如太平島，遠離文明開發地區環境較少破壞，彌足珍貴。然而這些島嶼仍然需要簡易又環保的港灣，以便在非惡劣天候停靠船舶，以便裝卸貨物及人員上下。本文提出人工海中森林，可作為浮式防波堤，由充氣的半封閉圓管外套廢輪胎構成，對其消波特性作理論與實驗研究。照片 A 是準備安裝的半封閉圓管，安裝時先將管沉到海底，潛水人員把纜繩與錨塊繫上，將空氣灌入管內，半封閉圓管即浮直，再把廢輪胎套上固定，如照片 B 所示。圓管可隨意安裝，如海中森林般。只考慮牽引力，半封閉圓管在波浪中的平均能量損失率如下:

$$\overline{P_M} = \frac{4\pi}{3T^3} C_D \rho_w D[(l_0 + l)^4 - l_0^4] \cdot \theta_{\max}^3 \tag{1}$$

其中 T 為波週期，C_D 為牽引力係數(取 1)，ρ_w 為水密度，D 為管徑，l_0 為纜繩長，l 為管長，$\theta_{\max}$ 為圓管在波浪中最大縱傾角度。

假設波高為 2 米、週期 8 秒、管長 4 米、管徑即輪胎直徑 0.6 米、管密度 0.2 ton/m^3 及水深為 8 米，依公式(1)在波浪中平均能量損失率為 1300 瓦。每公尺寬波浪功率為 54420 瓦，如 80%波浪功率被圓柱浮体消殺，則每公尺防波堤寬需要 33 支半封閉圓管。如防波堤寬為 100 m，共需 3300 支半封閉圓管。由於公式(1)未考慮圓管和波浪間的相位差，及生物附著使牽引力係數加大，實際上效果會更好。

關鍵詞：半封閉圓管；人工海中森林；平均能量損失率。

In-situ Observation and Biogeochemical Effect of Nonlinear Internal Waves in the South China Sea

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ABSTRACT

Nonlinear internal waves (NLIWs), ubiquitous features in the northern South China Sea (SCS), are on the receiving end of the energy cascade initiated by tides over topography in the Luzon Strait. These waves transport energy over hundreds km distances across SCS basins and shelf regions and dissipate remotely away from their generation sites. The strongest magnitude and dissipation of NLIW was found in the Dongsha Plateau with water depth 300-600m. In-situ observations suggest that NLIWs appear at tidal periodicity with amplitudes modulated at a fortnightly tidal cycle. The passage of NLIW can rapidly change the ocean environment in several minutes. The NLIWs have typical vertical displacements of >100 m with a period 10-20 minutes and maximum current speeds of > 1.5 m s-1, westward in the upper 200 m and eastward below 200 m. The temperature variability induced by NLIWs is ~10^{o}C. The outstanding environmental changes are known to induce the remarkable biogeochemical effect. In this presentation, we will present the basic properties and characteristics of NLIWs in the SCS and some known biogeochemical response associated with the presence of NLIWs.

南海非線性內波之現場觀測及其生地化效應

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摘 要

非線性內波是南海北部普遍存在的海洋特徵，源自於呂宋的潮-地形交互作用而產生，是此區域潮能量往高頻運動輸送進而消散的重要媒介。這些非線性內波將潮能量傳送到起源區數百公里之外，橫越北南海海盆與陸棚/坡，進而消散殆盡。最大強度的非線性內波及其最大能量消散率發生在東沙島海域附近水深約 300-600 公尺的陸棚區，由現場觀測證實，非線性內波的出現與潮週期一致，強度變化跟隨大小潮循環變化，非線性內波的經過可在數分鐘內快速改變海洋環境。典型的非線性內波具有大於 100 公尺的垂直振福，週期約 10-20 分鐘，產生的海流變化大於 1.5 m/s，其流場約於 200 公尺以上為西流，200 公尺以下為東流，其引起的溫度場變化可達 10^{o}C。上述的顯著海洋環境變化已知會引起生地化效應，在此報告中，我們將呈現南海非線性內波的基本性質及特性，與一些與非線性內波存在相關的生地化反應。

The Search for Physiologically Relevant Biomarkers for Reef Coral Health Assessment: Two Case Studies from Pacific Rim Pocilloporids Exposed to Acute Temperature Increases

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ABSTRACT

Due to the potential for increasing ocean temperatures to detrimentally impact reef-building corals, there is an urgent need to better understand the thermal stress response of these ecologically important anthozoan-dinoflagellate endosymbioses. In an attempt to address this issue, colonies of the Pacific scleractinians *Seriatopora hystrix* and *Pocillopora verrucosa* were exposed to elevated (30 and 31˚C, respectively) temperatures, and expression of the gene encoding the molecular chaperone heat shock protein-70 (*hsp70*) was measured at regular intervals over two and seven days, respectively, with PCR-based approaches in the host anthozoan in both corals and likewise in the *Symbiodinium* compartment in *S. hystrix* samples. Additionally, the biological composition of the *S. hystrix* holobiont was approximated by a genome copy ratio (GCR), and copper-zinc superoxide dismutase (CuZnSOD) protein expression was measured in *P. verrucosa*. Contrary to our hypothesis, *hsp70* mRNA expression was not significantly induced by elevated temperature in either coral species, or in either of the two compartments within *S. hystrix*, though in both experimental groups, mRNA levels of this gene varied significantly over time. The *S. hystrix* GCR was also unaffected by temperature, though was temporally variable in both treatments, potentially suggesting diel expulsion of *Symbiodinium* or synchronized division of host cells. CuZnSOD levels were significantly elevated in thermally challenged *P. verrucosa* samples, confirming a previous hypothesis that this protein may be superior for determining relative levels of heat stress in reef corals. However, as this assay measures the expression of this protein across the entire holobiont and is thus not compartment-specific, future studies should seek to target environmentally sensitive analytes that can be individually measured within the two dominant eukaryotes composing reef corals, such that a more thorough understanding of their physiological response to temperature stress may be acquired.

尋找反應生理之生物性指標以評估珊瑚礁健康狀況

－兩研究案例於短時間暴露於溫度上升下之太平洋鹿角珊瑚科

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摘 要

由於全球暖化所可能對珊瑚礁造成嚴重有害的影響，瞭解在生態上扮演重要角色的珊瑚-共生藻共生體如何應對溫度上升的壓力是迫切需要的。為了探討此議題，本研究使用尖支列孔珊瑚 (*Seriatopora hystrix*)和疣鹿角珊瑚 (*Pocillopora verrucosa*)。珊瑚使用高溫處理(攝氏 30 和 31 度)，尖支列孔珊瑚以及其共生藻之熱休克蛋白-70 (heat shock protein-70)基因表現分別測量於第兩天及第七天；此外，尖支列孔珊瑚共生體的生物組成比例則使用基因拷貝數比例(genome copy ratio) 大略估計。疣鹿角珊瑚之銅鋅超氧化物歧化酶 (copper-zinc superoxide dismutase protein)的蛋白表現為另一生物性指標測試於本研究。相反於我們的預期，即使於實驗中，訊息核醣核酸(mRNA)隨時間而改變，但不論是尖支列孔珊瑚或是其共生藻之熱休克蛋白-70 的訊息核醣核酸表現並未顯著地受溫度升高所誘發。同樣地，基因拷貝數比例並未受到溫度所影響。雖然可見到短暫性的變動，可能僅為週期性之共生藻排出或珊瑚宿主細胞同步分裂所造成。疣鹿角珊瑚之銅鋅超氧化物歧化酶蛋白顯著升高證實先前的假設：蛋 白較適用於測定珊瑚所受熱壓力之程度。然而，此蛋白質表現測定法僅能測量共生體之總蛋白質而無法專一於特定部份例如珊瑚宿主或是共生藻之蛋白質。未來，需持續尋找對環境改變敏感性更高並可分別測定於共生體中各組成之方法以及更透徹的研究對溫度改變之生理反應。

The Study of Marine Biodiversity in the South China Sea: Joint Efforts Made in the SCS Workshop Process

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ABSTRACT

The South China Sea (hereinafter referred to as SCS) is a semi-enclosed sea connected to the Java Sea and the Strait of Malacca in the South and the Strait of Taiwan and Bashi Channel to the North, and is a part of the Pacific Ocean, encompassing an area around 3,500,000 square kilometers. It is located south of China and Taiwan, west of the Philippines, northwest of Sabah (Malaysia), Sarawak (Malaysia), and Brunei, north of Indonesia, northeast of the Malay Peninsula, and east of Vietnam. Countries with borders on the sea include the People's Republic of China (China), the Republic of China (Taiwan), the Philippines, Brunei, Malaysia, Cambodia, Vietnam, Thailand, Singapore, and Indonesia. All of these countries, with exception of Taiwan, Cambodia, and Thailand, are parties to the 1982 United Nations Convention on the Law of the Sea (hereinafter referred to as UNCLOS) and bear the treaty obligation to cooperate with each other in the exercise of their rights and in the performance of their duties under the Convention in this semi-enclosed sea. In particular, they are required: (1) to coordinate the management, conservation, exploration and exploitation of the living resources of the SCS; (2) to coordinate the implementation of their rights and duties with respect to the protection and preservation of the marine environment in the SCS; and (3) to coordinate their scientific research policies and undertake where appropriate joint programmes of scientific research in the SCS.

A multitude of islands, atolls, banks, reefs, and shoals, some rising only slightly above the sea surface and others remaining submerged, abound throughout the SCS, and are clustered into four large archipelago groups, namely the Pratas (Dongsha), the Paracels (Xisha), the Macclesfield Bank (Zhongsha), and the Spratlys (Nansha). Several countries that border the SCS have made competing claims over the ownership of the island groups and over the maritime jurisdiction in the waters surrounding the disputed islands. For the Paracel Islands, China, Taiwan, and Vietnam claim entire title to this island group, located in the northern part of the SCS. For the Spratly Islands, six states assert claims: China, Taiwan, and Vietnam claim the entire archipelago, while the Philippines, Malaysia and Brunei claim sovereignty over portions of the Spratlys that are located in the southern part of the sea. Sovereignty and maritime jurisdictional disputes in the SCS have been regarded as Asia's most potentially dangerous point of conflict.

The SCS is one of the world's richest marine biodiversity areas, with abundant and diverse marine resources. It was reported that forty five species of mangrove from the global total of fifty seven; fifty of seventy coral genera; twenty of fifty species of seagrass; and, seven of nine giant clam species are found in the nearshore areas of the SCS. The high species diversity of the shallow water habitats, combined with the variation in geomorphic and geological setting and formation type, contribute to the global significance of these habitats in the SCS. In addition to its significance as a global center of shallow water marine biodiversity,

the SCS supports a significant world fishery of importance to the food security, and as a source of export income, for the countries bordering this sea. It was reported that capture fisheries from the South China Sea contributed 10% of the world's landed catch at around five million tons per year and five of the eight top shrimp producers in the world are border states of the South China Sea, which are Indonesia, Vietnam, China, Thailand, and the Philippines. The countries bordering the South China Sea produce 23% of the world tuna catch and almost three-quarters of the world's canned tuna.

Beginning in 1991, the participants of the Informal Workshop on Managing Potential Conflicts in the South China Sea (hereinafter referred to as the SCS Workshop) agreed to recommend to the relevant governments to explore areas of cooperation in the SCS, which include the preservation and protection of marine environment and conducting marine scientific research. As a result of the discussion, in March 2002, a joint biodiversity project was carried out around the undisputed Indonesian Islands of Anambas in the SCS, with 29 participating experts and researchers from Malaysia, the Philippines, China, Taiwan, Thailand, Vietnam, Singapore and Indonesia. In 2003, another joint project was proposed to study the state of marine biodiversity in the waters near Palawan of the Philippines. After the implementation of the biodiversity projects in Anambas and Palawan, the countries that border the northern portion of the SCS, namely, China, Taiwan, Vietnam, and the Philippines, have been asked to consider the possibility of conducting biodiversity expedition that will include Northeast and Northwest area of the SCS in order to complete the picture of biodiversity in the SCS as a whole. However, so far there has been seen no project proposals submitted to the SCS Workshop for discussion.

The purpose of this paper is to study the joint efforts made by the participating authorities in the SCS Workshop process to understand better the current state of marine biodiversity in the SCS.

南中國海海洋生物多樣性之研究: 南海會議對話過程所作共同努力

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摘 要

自 1990 年起，「處理南中國海潛在衝突非正式研討會」(簡稱「南海會議」)由印尼外交部政策規劃暨發展署主辦下共召開十九次之多。「南海會議」主要由南海周邊國家政府官員和學者以個人身份參加。此會議係藉由探究合作領域以管理南中國海潛在衝突為目的之區域持續性對話過程。除了「南海會議」外，此對話過程自 1993 年也開始召開一系列有關南海海洋科學研究、海洋環境保護、海洋資源評估、海洋法律等技術工作小組會議與專家會議。2002 年 3 月，「南海會議」架構下所通過執行之安納巴斯(Anambas) 海洋生物多樣性共同研究計畫在南中國海屬印尼無爭議之海域舉行，共有來自馬來西亞、菲律賓、中國、台灣、泰國、越南、新加坡、以及印尼之 29 位科學家參加。安納巴斯海洋生物多樣性共同研究計畫係「南海會議」所通過並被成功執行的計畫，有助瞭解南中國海之海洋生物多樣性現況，並加強南海周邊國家在海洋科學研究與海洋環境保護領域上之共同合作。2003 年，「南海會議」也曾討論菲律賓所提出之巴拉望海洋生物多樣性共同研究計畫(Palawan Expedition) ，但後來因為菲國擅自將此海洋生物多樣性共同研究計畫由非正式「二軌」之活動改為正式之「一軌」活動，因此中國、台灣、泰國、新加坡、以及印尼等國之科學家決定不參加。就目前而言，南海海洋生物多樣性之現況並無全盤瞭解，因此，「南海會議」中曾建議推動中國、台灣、菲律賓、以及越南在南中國海西北和東北區域進行海洋生物多樣性共同研究計畫。2010 年是國際海洋生物多樣性年，也正值「南海會議」召開二十周年紀念，倘若中國、台灣、菲律賓、以及越南能夠同意合作在南中國海西北和東北區域進行海洋生物多樣性共同研究計畫，此將是「南海會議」配合慶祝 2010 年國際海洋生物多樣性所能做出最重要、最有意義的活動。

Planning for Marine Protected Area - Case Study for Guishan Island

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ABSTRACT

Recently, with the development of the coastal environment and advances in fishing technology, marine biodiversity and fisheries resources are rapidly reducing. Each state is starting to focus on the conservation of the marine environment. Among various planning strategies, many scholars advocate planning “Marine Protected Areas” as the one of the most efficient ways to conserve marine ecosystem (Chiu, 2000; Shao, 2000), By planning protected areas to conserve the natural environment, maintenance of biological diversity.

In recent years, there has been a lot of research about marine protected areas, Taiwan has also gradually started to value the surrounding environment. However, it’s often a problem of communication with the stakeholder when planning marine protected areas. In this study through geographic information system to analysis of data, and the use of images to show how Guishan Island will be planning in the future. In order to better communicate with stakeholder to reduce the controversy.

By the grace of a long period military control, Guishan Island suffered very little pollution or destruction, and has many special landscapes, such as volcanic terrain, whale activity and submarine hot spring vents, etc. Furthermore, the Kuroshio Current pass attracts a gathering of fish, and has very rich marine resources, it’s one of Taiwan's three major fishing grounds. Guishan Island has planning potential of marine protected areas. This study proposes a plan for Guishan Island as marine protected area, to conserve the environment, therefore, allowing for the marine environment’s sustainable development.

Keywords: Marine Protected Area (MPA), Gueishan Island, Marine Ecosystem Conservation, Geographic Information System (GIS)

海洋保護區的規劃－以龜山島為例

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摘 要

近年來隨著沿海環境的開發以及漁業技術的進步，導致海洋生物多樣性和漁業資源正快速減少，各國開始重視海洋環境的保育，而許多的學者認為在各種保育海洋生態可行的策略方法中，以劃設海洋保護區為較有效的方法（邱文彥，2000；邵廣昭，2000），藉由劃設保護區來維護自然環境，維持生物多樣性等，使的海洋環境能夠永續發展。

現階段全世界對於海洋保護區之相關研究相當的廣泛，台灣方面目前也漸漸的開始重視海洋保護區的發展，然而劃設海洋保護區時，往往會面臨到與權益關係人（stakeholder）的溝通問題，雙方立場的不同導致有所爭議，為此希望透過地理資訊系統（Geographic Information System, GIS）來彙整相關數據資料，利用圖像的方式來呈現出龜山島未來可能劃設的樣貌，加以溝通，進而減少爭議。

由於龜山島過去受到軍事管制的關係而長期封島造就出龜山島低污染及干擾的環境，同時龜山島擁有許多特殊的景觀（如：火山地形、鯨豚活動和海底熱泉噴口等），加上其附近海域有黑潮經過，擁有非常豐富海洋生物資源，為台灣三大漁場之一，讓龜山島具有劃設成海洋保護區之潛力，因此本研究將以龜山島為例，將龜山島劃設成海洋保護區，藉此保育當地的環境，達到永續發展。

關鍵字：海洋保護區、龜山島、海洋生態保育、地理資訊系統

N_2-fixing Filamentous Cyanobacteria in the South China Sea

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ABSTRACT

Filamentous cyanobacteria belonging to genera *Trichodesmium* and *Richelia* are important N_2-fixers in tropical-subtropical oceans. The South China Sea (SCS), with its warm, stratified and nitrate depleted surface water, is an ideal habitat for the filamentous algae. Our studies in the northern SCS did not reveal their abundant presence, when compared to their abundances in the neighboring Upstream Kuroshio. With a mean of 77×10^3 trichomes m^{-3}, *Trichodesmium* in surface SCS water showed great spatial and temporal variations in its density ranging between 0 and 962×10^3 trichomes m^{-3}. It distributed mainly in the top 60 m, with a maximum at 10 m depth or 46% light depth. Its abundance in the 0-60 m water column was greater in warm season than cold season; and was positively related to both nitracline depth and surface water temperature. *Trichodesmium* was found in sediment trap deployed as deep as 374 m in the SCS despite its surface dwelling nature. *Richelia* spp. form *Richelia*/diatom associates (RDA) as a symbiont of diatoms. Like *Trichodesmium,* water-column integrated abundance of *Richelia* was lower in the SCS than the Kuroshio; was higher in warm season than in cold season; and was positively related to surface water temperature and nitracline depth. Vertical distribution studies indicated that >80% of *Richelia* population inhabited in the upper water column above nitracline. The abundance of *Richelia* was related positively to abundance of *Trichodesmium* and negatively to abundance of total diatoms. The N_2-fixation rates of *Richelia* in the SCS were <20% of those of *Trichodesmium* with little seasonal variation. As N_2-fixers in the surface water, *Trichodesmium* together with the minor partner *Richelia* could contribute to the new production of SCS, but the relative importance is apparently less than that in the Kuroshio.

南海的絲狀固氮藍綠藻

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摘 要

熱帶—亞熱帶海洋中，最重要的絲狀固氮藍綠藻為 *Trichodesmium* 及 *Richelia*。南海以其溫暖，水體分層顯著及表水硝酸鹽極低之特質，似乎是這類固氮浮游植物適合之生存海域。唯實地採樣結果顯示其生物量出乎意料的低，迥異於緊鄰之黑潮上游。南海表水 *Trichodesmium* 平均為 77×10^3 trichomes m^{-3}, 時空變異頗大，密度介於 0 與 962×10^3 trichomes m^{-3} 間。在水柱中，主要分佈在 60 公尺以淺。最大密度在 10 公尺左右或表水光照強度 46%之水深。其 0– 60 公尺水柱累計生物量呈現明顯季節變化，以暖季高於冷季，且與表水水溫及硝酸鹽躍層深度皆呈顯著正相關。雖然主要分佈在表水層，但佈放在水深 374 公尺之沈積物收集槽可收集到 *Trichodesmium*。*Richelia* 通常與矽藻共生。類似 *Trichodesmium*，*Richelia* 生物量在南海亦比黑潮低，且是暖季高於冷季，並與表水水溫及硝酸鹽躍層深度呈顯著正相關。其垂直分佈顯示約有>80%生物量集中在硝酸鹽躍層以淺之上層水柱。*Richelia* 生物量與 *Trichodesmium* 生物量呈顯著正相關，但與總矽藻生物量呈顯著負相關。估計南海中 *Richelia* 的固氮量約<20%*Trichodesmium* 者。對新生產力而言，*Trichodesmium* 及 *Richelia* 的固氮貢獻在南海中之比重，不及在黑潮中來得重要。

Observations of Vertical Mixing due to Shoaling of Internal Waves at Dongsha Atoll South China Sea

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ABSTRACT

Internal waves have been identified as one of the most active mechanisms producing vertical mixing in continental slope and shelf waters. In this study, we observe the vertical mixing of huge internal waves in the Dongsha Atoll South China Sea, based on multiple cruises of CTD measurements, water samples and moored thermister strings. The mixing processes are related to depths of water and the interfacial of wave. For depression wave in the deep water zone, upper layer water may push downward producing vertical mixing beyond the thermocline. The mixing usually dilutes the nutrients in the upper layer of water column. The depression solitons in deep water may evolved to a packet of elevation waves in the shallow water area at "turning point" of approximately equal depth of upper and lower layers. The mixing of shallow water internal waves can entrain cold nutrient rich water from the lower layer into the frequently nutrient depleted subsurface layer to enhance the local coral reef ecosystem. The MODIS chlorophyll images confirm the high concentration fertilized by the internal wave pumping near Dongsha Atoll.

南海內波由內波湧升對東沙環礁水文垂直混合影響之觀測研究

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摘 要

呂宋海峽產生，向西傳遞至南海北部，消散於西側大陸棚上，東沙環礁為內波必經之處，當內波通過時其內部強勁的流場促使海水上下層翻轉且造成強烈的混合及擴散，內波混合能將深層冷水具高營養鹽的海水帶至淺層較暖的海域。本研究利用海研三號航次 CTD 資料與採水資料，配合錨錠溫度計串與衛星觀測進行分析，探討內波對東沙海域造成水文特性的差異。由採水分析結果之溫度對營養鹽的關係，顯示有良好的負相關，即低溫具有高營養鹽的特性，環礁外圍氮磷值為 12:1，顯示為營養鹽缺氮之海域。從 CTD 溫度、溶氧、葉綠素及密度之垂直結構與溫度計串資料顯示，當取樣在內波上時，下沉型內波能將表層暖水、高溶氧、高葉綠素濃度及密度較低的水往下帶，在淺化過程中造成水體混合導致整層溶氧及葉綠素濃度值皆偏高。若取樣不在內波上時，溫度和溶氧皆在表層時較高且隨深度增加而遞減。即內波前水體主要為兩層水體，因內波影響經混合及擴散後使得水體呈多層分佈。當內波通過後，冷水湧升會將底層低溶氧及低葉綠素濃度混合至表層裡造成稀釋且經混合稀釋後導致營養鹽及葉綠素濃度的降低。

SESSION B:
Marine Biodiversity

12 Years After the 1998 Massive Bleaching — Temperature Effects within Dongsha Atoll, South China Sea

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ABSTRACT

The 1997-98 massive bleaching event affected most coral reefs of the world and caused massive coral mortalities in some of them. At Dongsha Atoll, virtually all branching acroporids, a dominant group, in the 25-km-cross lagoon were selectively killed whereas most other corals survived. The coverages of the remaining live corals were highly variable among sites. It was suggested that there may be areal differences that is related to temperature variations within the lagoon. Here we investigated the same types of habitats, i.e., patch reefs, within the lagoon to look for possible patterns in coral distribution, coral extension rates (using massive *Porites* as an index), and the recruitment (using corals <5 cm in diameters as an index). The water temperature in the hottest season, between June and September 2009, were also recorded to look for possible environmental correlates.

The hundreds of patch reefs distributed in the lagoon of Dongsha Atoll have a typical mound-like vertical profile with bases at 10-20 m, and flat tops at 2-3 m. The diameters of the tops of these patches, estimated from satellite pictures, are mostly <200 m, although a few may reach ~1 km. The tops and bases were investigated for 10 patch reefs distributed throughout the lagoon.

Among the parameters assessed, some statistically significant differences were found. For example, dead-coral coverage was lower in eastern than in western sites. Coral extension rates were higher in eastern than western sites, and higher in bases than in tops of patch reefs. The small corals had both higher densities and biodiversity indices in bases than in tops of patch reefs. Environmentally, higher sea-water temperatures were found in western than in eastern sites and in tops than in bases of patch reefs. The same patterns were found in frequencies when sea water temperature exceeded 30°C. It is noted that all the significant poorer biological indices in the above comparisons were associated with higher water temperatures.

The branching acroporids have yet to return to the lagoon. What used to be acroporid beds are now bare skeleton and fragments with fouling and boring organisms. It remains to be tested whether the absence of branching acroporids is due to lack of recruitment or due to frequent high temperature in summers.

The high temperature, besides being responsible for the single event that has a global-scale influence in 1997-98, may also be responsible for variations of corals in local scales.

1998 年大白化之後 12 年—溫度對東沙環礁的影響

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摘 要

1997-1998 年的大白化事件對全世界多數的珊瑚礁產生影響，造成許多珊瑚死亡。在東沙環礁潟湖 700 平方公里範圍內的支狀軸孔珊瑚，幾乎都白化死亡，其他珊瑚則多半存活。存活珊瑚覆蓋率在各地點有著相當高的變異，這顯示了可能有一定程度的變異與潟湖內的溫度變化有關。我們在 2009-2010 調查了潟湖內的塊礁，想尋找一些可能的珊瑚分佈現象，例如利用團塊形的微孔珊瑚作為指標比較石珊瑚的生長速率，利用直徑小於 5 公分的小珊瑚作為指標比較珊瑚入添。此外也記錄了 2009 年 6-9 月，當年最熱季節的水溫，希望可以找到與環境相關的因子。

上百個分佈在東沙環礁內的塊礁都有類似的型態，有深約 10-20 公尺的礁底以及 2-3 公尺深的礁頂。這些塊礁礁頂的直徑可以利用衛星照片測量而得，大多數都在 200 公尺左右，也有少數直徑可達 1 公里的塊礁。目前調查了分佈在潟湖內 10 個塊礁的礁頂與礁底。

在觀測的幾項指標裡，發現了一些顯著的差異。例如：死珊瑚覆蓋率在潟湖東邊較西邊低；另一方面，珊瑚生長速率則是潟湖東邊高於西邊，且塊礁的礁底高於礁頂；小珊瑚則是在礁底都有較高的密度與多樣性。環境方面，海水溫於潟湖西邊較東邊高，且礁頂高於礁底；同樣的現象也在超過 30 度的水溫分佈中發現。值得注意的是以上所有比較中，顯著較差的生物指標都與東沙環礁潟湖中的高水溫區(西邊、礁頂)有關連。

支狀軸孔珊瑚尚未在潟湖中回復，曾經形成軸孔珊瑚床的地點，現在只剩下裸露骨骼及片段，還有許多附著及鑽孔生物，這顯示有需要去驗證支狀軸孔的缺乏是因為缺乏入添還是因為夏天頻繁的高水溫而導致。

高水溫除了在 1997-98 年造成全球尺度上影響之外，可能也是造成東沙當地小尺度珊瑚變異的重要因素。

Adaptive Plasticity and Constrain on Larval Release from Reef Corals

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ABSTRACT

Global coral reefs are threatened by environmental change especially ocean warming. The pelagic larval phase in corals might be particularly vulnerable to the effects of environmental change. Understanding the plasticity and constrain of coral larval release timing in response to temperature change is crucial for their conservation. Using 4 year data of larval release timing by two brooding reef coral species from a well developed coral reef influenced by strong internal tide-induced upwelling, we demonstrated high synchronization and plasticity in phase shift on monthly lunar periodicity of larval release. The plasticity is likely regulated by temperature, but is constrained during high temperatures in summer. The conditional plasticity in reproductive timing reflects the biophysical coupling and highlights the strengths and constrains of coral capacity to respond to environmental change.

石珊瑚釋放幼生時機的適應性可塑性與制約

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摘 要

全球珊瑚礁受環境變遷，特別是海洋暖化的威脅，但關鍵珊瑚生活史特徵－生殖時機受海洋暖化的影響仍不清楚；瞭解珊瑚釋放幼生時機對溫度變化反應的可塑性與制約，對其保育非常重要。利用採集自受內潮引發強烈湧升流所影響，卻發育良好珊瑚礁的兩種孵育幼生型珊瑚釋放幼生的 4 年資料，我們闡明其釋放幼生月週期在種間相似，並且具有季節性、月週期和潮汐週期的相轉移現象，冬季放苗高峰在滿月大潮，而夏季在上弦月小潮並避開湧升流。放苗的平均農曆日隨月平均水溫升高而提早，但在較高溫則維持不變。此珊瑚釋放幼生時機的條件式可塑性反映生物物理的連結，並呈現珊瑚對環境變化反應的潛力與制約。

Study on the Biodiversity of Nudibranchs in the Northern South China Sea (Taiwan and the Adjacent Islands)

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ABSTRACT

Four sites in three adjacent islands, namely Shilang (Green Island), Beauty Cave and Lobster Cave (Liuchiu Yu), and Wai-an (Penghu Islands), were surveyed on a monthly basis for between 2007 and 2010. 63, 67, 74 species of nudibranchs were collected at Green Island, Liuchiu Yu and Pascadores respectively. The mean number of species sighted per monthly survey for these sites was highest at Wai-an (12) followed by Beauty Cave (10), Lobster Cave (8.5) and Shilang (5.5). The increase in accumulative of species recorded from the monthly sample reached a plateau after 10 dives. The lower number of species at Green Island may be caused by the relatively stronger surge. Similarity in species composition among the monthly samples was low. *Phyllidiella pustulosa* is the most abundant species at these sites which was sighted in almost every survey. According to various surveys, a total of 163 nudibranch species in 47 genera, 17 families, and 4 suborders have reported in Taiwan and adjacent islands including Green Island, Liuchiu Yu, and Penghu Islands. The species list was compared to those for other parts of the South China area and Western Pacific Ocean (e.g. Okinawa) and results show similarities in species composition in Chromodorididae and Phyllidiidae were higher than other families. The sponge feeder *P. pustulosa* is still the most common seen species in these areas.

南中國海北緣 (台灣及離島)之裸鰓目生物多樣性研究

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摘 要

本調查於 2007 至 2010 年間，於台灣各地沿近海域的離島地區進行逐月調查裸鰓目種類，包含了綠島 (Green Island)的石朗 (Shilang)、小琉球 (Liuchiu Yu)的美人洞 (Beauty Cave) 與龍蝦洞 (Lobster Cave)、澎湖 (Penghu Islands) 的外垵 (Wai-an)。分別於綠島、小琉球、澎湖紀錄到 63、67、74 裸鰓目之物種。每月紀錄到的平均物種數目以外垵地區的 12 種為最高，其他依序為美人洞 (10 種)、龍蝦洞(8.5 種)、石朗(5.5 種)。逐月之物種累積數目在第 10 次以後會趨於平緩。綠島地區種類較少的原因可能為採樣時水流較強。各地之月份物種組成相似度皆不高。逐月調查發現突丘葉海蛞蝓 (*Phyllidiella pustulosa*)為數量和出現頻率最高的種類。目前本研究團隊已收集 163 種裸鰓目標本分屬 47 屬 17 科 4 亞目。比對南中國海域和西太平洋海域 (如沖繩) 的裸鰓目種類顯示了多彩海蛞蝓科 (Chromodorididae)和葉海蛞蝓科 (Phyllidiidae)的物種相似度較其他科來的高。以海綿為食的突丘葉海蛞蝓仍是這些區域中最常見的物種。

Numerical Assessment for the Contribution of Different Size Class Phytoplankton to Primary and New Production in the Northern South China Sea

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ABSTRACT

Two different biogeochemical modules were coupled with a one-dimensional model based on the Mellor and Yamada level 2.5 turbulence closure scheme and a carbon-cycle module to investigate the contribution of different size class phytoplankton to primary and new production at the South-East Asian Time-series Study (SEATS) station (18°N, 116°E) in the northern South China Sea (SCS). The two biogeochemical modules are based on, respectively, nitrogen-controlled growth in a NPZD ecosystem module (Liu et al., 2002), and silicon- and nitrogen-controlled growth in the CoSiNE ecosystem module (Chai et al., 2002). The NPZD module includes four compartments: dissolved inorganic nitrogen (DIN), phytoplankton (P), zooplankton (Z), and detritus (D) with a variable chlorophyll / phytoplankton ratio according to a photoacclimation scheme. The CoSiNE module consists of silicate ($Si(OH)_4$), nitrate (NO_3^-), ammonium (NH_4^+), small and large phytoplankton groups (P1 and P2), small micrograzer (Z1), large mesozooplankton (Z2), and two detritus pools (PN and PSi) with a constant chlorophyll/phytoplankton ratio. The carbon-cycle module was derived from the second phase of Ocean Carbon-Cycle Model Intercomparison Project (OCMIP-2, http://www.ipsl.jussieu.fr/OCMIP/phase2), and used to calculate the air-sea exchange of CO_2. The coupled model has a vertical resolution of 1 m, and the time step is 60 s. Driven by six hourly wind stress and surface heat fluxes derived from the National Centers for Environmental Prediction (NCEP) reanalysis data, the two coupled models successfully reproduced the seasonal cycles of sea surface temperature (SST), integrated primary productivity (IPP), and air-sea CO_2 flux as compared to mooring data, SeaWiFS data derived values, and shipboard observations. The two model results are comparable except the more complicated CoSiNE module provides more information about biogeochemical pathways. Model results of IPP, integrated new productivity (INP), and export productivity (EP) appear to be higher in winter than summer. The ratio of simulated INP/IPP (f-ratio) and EP/IPP (e-ratio) are higher in summer than winter with an average of 0.46 and 0.37, respectively. Model results of air-sea CO_2 flux show that the SEATS station is a weak sink of atmospheric CO_2 in winter, and a weak source in the other seasons. The relative contributions of small and large phytoplankton to IPP and INP are also investigated.

運用數值模擬實驗評估不同大小的浮游植物對南海北部初級生產力與新生產力的貢獻

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摘 要

本研究將 Mellor and Yamada 之一維紊流閉合模式分別與兩個不同的生地化模式耦合，並加入碳循環模式，嘗試探討不同大小的浮游植物對南海北部東南亞時間序列研究測站(South-East Asian Time-series Study (SEATS) station; 18°N, 116°E)之初級生產力與新生產力的貢獻。這兩個不同的生地化模式分別為：以氮為控制生長因子的 NPZD 生態模組(Liu et al., 2002)與以矽和氮為控制生長因子的 CoSiNE 生態模組(Chai et al., 2002)。NPZD 生態模組包含溶解態無機氮(DIN)、浮游植物(P)、浮游動物(Z)和碎屑物質(D)四個部門，其中葉綠素和浮游植物的比例會根據光適應方程式而隨時間改變。CoSiNE 生態模組則由矽酸鹽($Si(OH)_4$)、硝酸鹽(NO_3^-)、氨鹽基(NH_4^+)、大與小型浮游植物(P1&P2)、大與小型浮游動物(Z1&Z2)及含氮或矽的兩種不同碎屑物質(PN&PSi)所組成，其葉綠素和浮游植物的比例為定值，不隨時間改變。本研究的碳循環模式來自於第二階段的海洋碳循環模式相互比較計畫(Ocean Carbon-Cycle Model Intercomparison Project, OCMIP-2; http://www.ipsl.jussieu.fr/OCMIP/phase2)，此部份模式將被用來計算海氣間的二氧化碳交換通量。耦合模式垂直方向的網格解析度為 1 米，模式積分時步為 1 分鐘。利用美國國家環境預測中心(National Centers for Environmental Prediction, NCEP)的海氣熱通量與風應力再分析資料來驅動此耦合模式，結果顯示兩個不同的生地化耦合模式都成功模擬出海表水溫(SST)、表層積分的初級生產力(IPP)與海氣間二氧化碳交換通量的季節性變化，且模擬數值近似於錨碇資料、SeaWiFS 衛星水色估算數據及船測資料。兩個模式的模擬結果相當一致，但 CoSiNE 生態模組因為比較複雜，因此可提供較多的生地化過程與相關資訊。模擬結果的 IPP、表層積分的新生產力(INP)與輸出生產力(EP)均顯示在冬季高於夏季，INP/IPP (f 比例)與 EP/IPP(e 比例) 比例為夏季高於冬季，而 f 與 e 比例的年平均值則分別為 0.46 與 0.37。海氣間二氧化碳交換通量的模擬結果顯示，SEATS 測站在冬季為大氣二氧化碳微弱的匯(sink)，在其他季節則為大氣二氧化碳的弱源(source)。不同大小的浮游植物對初級生產力與新生產力的相對貢獻也將在本研究中進一步探討。

Population Connectivity of Reef Organisms between the South China Sea and Northern West Pacific

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ABSTRACT

Population connectivity, representing the interactions of hydrodynamic systems and life history traits, is the key issue in conservation and management of marine biological resources. We applied the mitochondrial DNA, microsatellites and otilith microchemistry to study the population connectivity of a coral, *Seriatopora* species complex, and two reef fishes, *Amphiprion clarkii* and *Pomacentrus coelestis,* from the South China Sea and northern West Pacific. The results of genetic analyses of *Seriatopora* species revealed that populations from Taiping Island, Taiwan, Okinawa, and the Philippines form a panmixia with very low genetic differentiation, while genetic breaks were found between the above panmixia and populations in Similan Island and New Caledonia. The results of genetic analysis of *A. clarkia* showed that populations from Dongsha Atoll and southern Taiwan (Kenting, Lutao and Xiaoliuchiu) formed a panmixia and they differed significantly from the Penghu population. The results of genetic analysis of *P. coelestis* also revealed high connectivity between Hainan, southern Taiwan and Japan populations. Studies on the microchemical signatures in otolith of *P. coelestis* showed that the $\delta^{18}O$ value of pre-settlement stage in southern Taiwan population was very low, suggesting those fish might originate from the South China Sea. Besides, the elemental ratios of post-settlement signatures among 4 localities in Taiwan showed clear separation reflecting their sedentary behavior after settlement. The high connectivity of reef organisms between the South China Sea and northern West Pacific populations indicated that their genetic structure was mainly influenced by the Kuroshio current. Moreover, southern Taiwan may serve as a stepping stone for the northward dispersal of *P. coelestis* from the South China Sea to Japan. The high connectivity in this region indicates that a network of marine protected areas should be established for the conservation of marine biodiversity.

南中國海及西太平洋北部珊瑚礁生物的族群連通性

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摘 要

族群連通性代表海洋水團與生活史特徵的交互作用，是海洋生物資源保育及管理的關鍵因子。我們利用粒線體基因、微衛星基因及耳石微化學為標誌，探討列孔珊瑚種群、克氏海葵魚及變色雀鯛在南海至西太平洋北部海域之間的族群連通性。列孔珊瑚的族群遺傳分析結果顯示，太平島、菲律賓、台灣及琉球群島族群之間的分化極低，自成一充分混合的大族群，但是此大群與印度洋 Similan 群島、南太平洋的 New Caledonia 族群之間都有明顯分隔。針對克氏海葵魚的研究則顯示，台灣南部墾丁、綠島、蘭嶼及東沙海域的族群形成一充分混合的大族群，並與澎湖群島的族群有明顯分化。針對變色雀鯛的研究顯示，台灣南部與海南島、日本南部的族群具有高度的連通性，而澎湖則與台灣北部海域自成另一群；此外，台灣南部變色雀鯛耳石微化學的訊息顯示，其定棲前期區的 $\delta^{18}O$ 值較低，意謂著幼魚可能來自南海，而定棲後期區的訊息在台灣周圍四處海域皆有差異，意指其定棲之後即甚少遷移。綜合上述三種生物的研究結果皆顯示，南海及西太平洋北部的族群具有高度的連通性，皆受到黑潮的影響，而台灣南部則是珊瑚礁生物向北散布的中繼站，我們建議此區域的海洋資源保育應整體考量，以設立海洋保護區網路的方式進行。

Seagrass Production of the Dongsha Island, the South China Sea

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ABSTRACT

Seagrass beds are important ecosystems in coastal waters and may serve as significant carbon sinks in the global carbon budget. The Dongsha Island, the South China Sea, has the largest area of seagrass beds (11.85 km^2)(4.8 Km^2) and the most diverse seagrass species (7 species) in Taiwan. In order to estimate seagrass production, we applied the leaf marking method to six dominant species every two months from November 2009 to April 2010. We found clear seasonal variations in seagrass production, with higher production rates in spring and lower rates in winter. Moreover, there were taxonomic variations in seagrass production. In winter, the highest productive species is *Thalassia hemprichii* (2.73 g m^{-2} day^{-1}), followed by *Cymodocea rotundata* and *Syringodium isoetifolium*. In spring, the highest productive species is *Halodule uninervis* (4.43 g m^{-2} day^{-1}), followed by *C. rotundata* and *T. hemprichii*. The total seagrass production rates around the Dongsha Island were estimated to be 330 tons in winter and 500 tons in spring.

Keywords: carbon sink, *Thalassia hemprichii*, *Cymodocea rotundata*, *Syringodium isoetifolium*, *Halodule uninervis*

東沙海草葉片生產力

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摘 要

海草床是重要沿岸生態系，海草本身也是許多海洋生物的食物來源。東沙擁有全台灣面積最大的海草床(11.85 km^2)與種類最多的海草(六屬七種)，其生產力是我們估計整個東沙海草床碳吸收的重要基礎資料。我們的研究顯示東沙海草葉片的生產力與其他熱帶地區的海草相當，皆扮演重要的碳匯功能。各種海草於春季時的生產力皆高於冬季。生產力最高的是春季時的單脈二藥草(*Halodule uninervis*)，達 4.43 g m^{-2} d^{-1}；生產力最低的是冬季時的卵葉鹽草(*Halophila ovalis*)亦有 0.47 g m^{-2} d^{-1}。整個東沙海草床的冬季可吸收 330 公噸的碳，而春季可吸收 500 公噸的碳，約相當於 50 座台北市大安森林公園的固碳能力。

關鍵詞：碳吸收，碳匯，單脈二藥草，卵葉鹽草，熱帶海域

Seagrass Beds are Important Habitats for Coral Reef Fish at Tongsha

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ABSTRACT

Seagrass beds are often considered important nursery grounds for juvenile fish in coastal area. The Tongsha (Prata) Island in South China sea have the largest area seagrass bed of Taiwan and would be an important ground for many fishes. To understand fish assemblages and usage of each fish species in such large seagrass environment. We used transects to survey fish assemblages of seagrass beds at Tongsha from winter 2009 to spring 2010. We found large number of from fish individual enter shallow water from spring to summer at Tongsha. Most of them are juvenile coral reef fish recruit into seagrass bed. Fish species compositions of each area are different with depth, seagrass or other environment factors. The most dominant fish belong to Labridae, Lethrinidae, Scaridae, and Mullidae. Their juveniles composite the most part in fish assemblage. Beside these dominant nursery species, there are some species into seagrass bed of temporary food or shelter, which include some large predatory species like some Carcharhinidae or Carangidae species. The diverse fish species, abundant juvenile recruit and the complete food web shows the important role of seagrass bed for marine ecosystem at Tongsha.

Keywords：Seagrass bed, Coral reef fish, Juvenile recruit, Nursery ground, I Prata Island

Spatial-Temporal Variations of Epiphytic Algae on Seagrass Leaves around Dongsha Island

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ABSTRACT

Seagrass-epiphytic algae are an important functional group, contributing up to 30% of the primary production in marine ecosystem. The seagrass meadows around Dongsha Island expand extensively and consist of a variety of species. The study started from December 2009, aiming to evaluate the spatial-temporal variations of epiphytic algal biomass on seagrass leaves around Dongsha Island. Further, the epiphytic algal biomass among seagrass species will also be compared. We used chlorophyll *a* concentrations to evaluate the epiphytic algal biomass. The present results as comparing 2 seasons (winter, spring) and 5 sites, showed that the epiphytic algal biomass had significant interactions between seasons and sites. A very highly significant difference of epiphytic algal biomass was also presented among 5 dominant seagrass species (*Cymodocea rotundata*, *C. serrulata*, *Halodule uninervis*, *Syringodium isoetifolium*, *Thalassia hemprichii*). According to the correlation analysis, the epiphytic algal biomass was significantly positively correlated with water depth, while no significant correlation with nutrients. Epiphytic algae growing on *S. isoetifolium* tended to have higher biomass than others, indicating this seagrass species might be a better subtrate for epiphytic algae.

Keywords: Biomass, chlorophyll *a*, epiphyte, *Syringodium isoetifolium*, water depth

東沙島海草葉片附生藻的時空變化

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摘 要

海草葉片附生藻類是海洋生態系中十分重要的功能群，其初級生產力可佔海草生態系的30%以上。東沙島周圍的海草床面積廣大且種類多樣，本研究希望藉此評估東沙島周圍海草葉片附生藻類生物量的時空變化，並比較不同海草種類間附生藻類生物量的差異。研究自 2009 年 12 月開始，藉由測定葉綠素 a 濃度來估計附生藻生物量。研究結果顯示冬、春 2 個季節與 5 個樣區的附生藻生物量有顯著的交互作用，而 5 種優勢海草間(圓葉水絲草、鋸齒葉水絲草、單脈二藥草、水韭菜、泰來草)的附生藻生物量亦有極顯著的差異。根據相關分析結果，附生藻生物量與水深有顯著正相關，但與水體營養鹽濃度無關。水韭菜上的附生藻生物量較其他種類高，顯示其葉片表面可能為較適合附生藻生長的基質。

關鍵字：生物量、葉綠素 a、附生生物、水韭菜、水深

The Deepwater Discovery of Unexplored Gobioid Species Diversity from Taiwan, Japan and the Philippines

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ABSTRACT

Gobioid fishes are the most speciose group of teleost fishes from high mountain hill streams to marine habitats which most of them belong to benthic fish fauna. Till present, although fishes may be most well-known taxonomic group conducted in marine biology, there are still some of them await for formal discovery and documentation.

This current report will be presented that the recent discovery for deep water gobioid fauna which beyond the depth limit (30 m) of general SCUBA diving and up to 250 m depth as following discoveries in Taiwan, Japan and the Philippines: (1) One undescribed *Tryssogobius* sp. and two *Trimma* spp. recently discovered from the deep water coral reef habitat (30-50 m depth) of central Philippines; (2) two very rare *Discordipinna* spp. turned to light from the shallow and deepwater habitats of the Ryukyu islands, Japan for the monotypic boiid genus; (3) two undescribed *Oxuyrichthys* spp. came from deep water habitats (50-200 m depth) of southern Taiwan and the Philippines; (4) one undescribed gobid genus from deep water habitat (50-200 depth) of southern Taiwan; and (5) six undescribed *Obliquogobius* spp. came from deep water habitats (100-250 m depth) of Japan, Taiwan and the Philippines.

Overall, the real species diversity of such deep water tiny-size benthic gobiid fishes is actually still far from well understanding of current research progress and more intensive survey either for special equipment of deep water diving system or benthic trawling by research vessel is very essential especially in the West Pacific region.

Endocrine Disrupting Chemicals (EDCs) in Aquatic Environment: A Potential Reason for Organism Extinction?

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ABSTRACT

Endocrine disrupting chemicals (EDCs) are now taken into account to explain the bioresource decline in aquatic ecosystem. Many studies have confirmed that EDCs can damage the reproductive health, impair the fecundity, and decrease the survivorship of aquatic organisms, which eventually result in population density reduction and biodiversity decline. These changes, to some extent, are the premonitions of the extinction of an organism. In fact, laboratory evidence has shown that EDCs can induce reproductive dysfunction and developmental abnormity of aquatic organisms. Molecular evidence has shown that EDCs can trigger genotoxicity and destroy genetic diversity and structure. The evolutionary toxicology has also speculated that EDCs can affect the pattern of Nature Selection and eventually lead to evolutionary potential loss. More important, the field studies have further provided direct data that EDCs contribute to the biomass decline and local extirpation of populations. Taken together, it is hypothesize that EDCs may be a latent agent and responsible for aquatic creature extinction.

Keywords: Endocrine disruptors, Reproductive dysfunction, Aquatic organisms, Extinction

水體中環境內分泌干擾物的存在是否是構成水生生物功能性滅絕的潛在風險？

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摘 要

環境內分泌干擾物（Endocrine disrupting chemicals，EDCs) 已被視為是引發水生生物資源下降的可能原因。許多研究證實 EDCs 能損害水生生物的繁殖健康、削弱生育能力以及降低存活率，並最終影響到種群數量和生物多樣性。事實上，從某種程度上說，這些現象的出現預示著生物資源或生物數量的區域性滅絕。現存的各類報導，也從不同的角度或層面為這一事實提供了證據。實驗室資料表明，EDCs 物質能導致水生生物繁殖功能障礙和發育異常。分子證據表明 EDCs 能引發遺傳毒性，並損害種群的遺傳多樣性和遺傳結構。進化毒理學的證據也表明 EDCs 能干擾生物的自然選擇的能力，並最終導致遺傳潛力的喪失。更重要的是，野外的實驗證據提供了更直接的證據，即 EDCS 引起了生物量的下降和區域性種群數量的降低。因此，綜合各項證據，我們可以推測環境內分泌干擾物的存在，是構成水生生物功能性滅絕的一個潛在風險。

Will Climate Change Influence Role-Reversal between Tropical and Temperate Environments? – A Review

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ABSTRACT

Climate change is altering various ecosystems across the planet including marine environment. The marine biodiversity that hovers around coral reefs in the tropics play an important role in supporting the economy of the island nations present along the coast. Various organisms in the coral reef ecosystem, including corals and fishes are on the verge of facing a direct impact due to changing climate conditions. There have been reports that in the wake of changing environmental conditions, temperate areas could act as a refuge for the survival of different marine organisms. Studies looking at the behavior of fish species have shown that the tropical fish tend to migrate to temperate waters to survive rising seawater temperatures. Very few studies have focused on such potential migratory patterns of various marine organisms or even shift in their environmental selection due to climate change. There is a need to focus on this area of study in detail so as to understand the occurrences of such pattern, if any. This talk will review the ongoing studies on potential role-reversal of environments.

Can Brooding Corals Hybrdize?

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ABSTRACT

Hybridization, a potential mechanism caused by interspecific fertilization, is recognized as an important role in species diversity of reef-building corals. While most of the studies are focused on the broadcasting lineages, only few studies on the hybridization in brooding corals have been inferred, and the potential of gamete introgression remains unsettled. The mating system of brooding corals is to release the sperm, fertilize the eggs internally, and release planula larvae. Hybridization is much less likely to be encountered in brooding corals, for instance, sperm need to recognize the mouth of polyps for a cross fertilization to occur to facilitate hybridization. In this study, *Isopora palifera* and *Isopora cuneat*a were proposed as model system to study hybridization in brooding corals. Both *I. palifera* and *I. cuneata* are sister species, and have plate form (PF) and columnar form (CF) which are ecomorphs and sympatric in Green Island, Taiwan. The aims of this study are to infer whether hybridization could occur in brooding corals and ecormoph divergence in the genus *Isopora* by analyzing morphometric measurement, reproduction cycle, genetics, ecological distribution and cross-fertilization studies.

Keyword: hybridization, brooding corals, *Isopora palifera*, *Isopora cuneata*

Benthic Trawling Crustacean and Environmental Factors in Beibu Gulf, South China Sea

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ABSTRACT

Base on the data of four seasonal surveys in Beibu Gulf, South China Sea during 2006 and 2007, the species composition and distribution of benthic trawling crustaceas and environmental factors were analyzed. The results showed there were 175 species of benthic trawling crustaceas in Beibu Gulf. Among them, there were 42 species of shrimp, 116 species of crab, 14 species of squill, 2 species of Isopoda and 1 species of Cirripedia. Most of them were tropical and subtropical species, and belonged to fauna of India-western Pacific Ocean. The dominant species of benthic trawling crustaceas were *Portunus hastatoides*, *Metapenaeopsis barbata*, *Alpheus distinguendus*, *Raphidopus ciliatus* and *Oratosquilla inornata*. The abundance of trawling crustacea was highest in the north of the Gulf, second highest in the south of the Gulf, lowest in the center of the Gulf. Correlation analysis showed there was significant negative correlation between abundance of *Alpheus distinguendus* and salinity, significant positive correlation between abundance of *Alpheus distinguendus* and clay content. There were significant negative correlation between abundance of *Raphidopus ciliatus* and water depth, significant positive correlation between abundance of *Raphidopus ciliatus* and clay content and chlorophyll-*a*. There were significant negative correlation between abundance of *Oratosquilla inornata* and clay content, significant positive correlation between abundance of *Oratosquilla inornata* and median particle diameter. BIO-ENV analysis showed that salinity, dissolved oxygen (DO), silt, median particle diameter, chlorophyll-*a* were the key factors on the species composition of crustacean assemblage.

北部灣底棲拖網甲殼動物與環境因子關係的研究

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摘要

根據 2006 年和 2007 年四個季度在北部灣 16 個站位底棲拖網獲得的資料，對該海區底棲拖網甲殼動物的種類組成、資源分佈及其與環境因數的關係進行了分析。結果表明，底棲拖網甲殼動物有 175 種，其中蝦類 42 種，蟹類 116 種，蝦蛄類 14 種，等足類 2 種，蔓足類 1 種。以熱帶和亞熱帶暖水性種類為主，屬於印度-西太平洋區系。優勢種有矛形梭子蟹（*Portunus hastatoides*）、須赤蝦(*Metapenaeopsis barbata*)、鮮明鼓蝦（*Alpheus distinguendus*）、絨毛細足蟹（*Raphidopus ciliatus*）和無刺口蝦蛄（*Oratosquilla inornata*）。甲殼動物豐度北部海域最高，南部海域次之，中部海域最低。相關分析表明優勢種鮮明鼓蝦豐度與底鹽呈極顯著負相關，與粘土含量呈顯著正相關；絨毛細足蟹豐度與水深呈顯著負相關，與粘土、葉綠素呈顯著正相關；無刺口蝦蛄豐度與粘土呈極顯著負相關，與中值粒徑呈顯著正相關。生物-環境分析表明影響底拖網甲殼動物種類組成的主要因數是鹽度、溶解氧、粉沙、中值粒徑和葉綠素。

The Fishing and Farming Activities Resulting in Abundance of Antibiotic-Resistant Bacteria

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ABSTRACT

The occurrence of antibiotic-resistant bacteria is found from the ocean with a long period of human activities such as fishing and farming. Some of the bacteria cause the animals diseases; some are opportunistic. To demonstrate the evolution of bacteria on resisting multiple antibiotics, this research employed the environment around the cage near National Parks to highlight genetic diversity in antibiotic-resistant bacteria. We found seventeen isolates of 370 colonies, which were obtained from internal organs (spleen, liver, and kidney) of diseased cobia and grouper, could resist to multiple antibiotics using the disc agar diffusion method. The 16S rDNA sequence analysis revealed four groups of pathogenic strains found in diseased fish: *Vibrio, Psychrobacter, Photobacterium,* and *Lactococcus*. 12 of 17 bacterial isolates belong to the genera *Vibrio* that includes species close to *Vibrio alginolyticus, Vibrio harveyi, Vibrio natriegens*, and *Vibrio parahaemolyticus*. Among the 17 isolates, high resistance rates were observed against five major types of antibiotics: beta-lactam (94.1%), nitrofuran (94.1%), quinolone (88.2%), aminoglycoside (82.4%), and tetracycline (70.6%). Sixteen isolates were resistant to more than ten antibiotics. The samples from water body at the upstream current of the cage were also analyzed and compared. It is hypothesized that horizontal transfers of antibiotic-resistant genes within or between microbial genera occurs and this model can be applied for the South China Sea where the frequency of human visiting is increasing due to research or fishing activities.

Keywords (Complete): Multidrug-resistant bacteria; genetic diversity; 16S rDNA; Tetracycline Resistance Genes; horizontal transfer

養殖和漁撈行為造成抗藥細菌高豐富度

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摘 要

是由於人類長期的養殖和漁撈行為造成抗藥細菌的存在，部分抗藥細菌會造成宿主動物的疾病；有些則伺機會而為。本研究為了證明多重抗藥細菌演化情形，主要在國家公園鄰近的海洋箱網養殖環境中分離出抗藥細菌並了解其抗藥基因的歧異度。從患病的海鱷和石斑魚的器官(脾臟、肝臟和腎臟)分離出 370 株細菌，使用瓊酯紙錠擴散法檢測出 17 株多重抗藥細菌；由 16rDNA 序列和定序分析顯示：屬於 4 群致病菌，分別為 *Vibrio*，*Psychrobacter*，*Photobacterium* 和 *Lactococcus*；又其中 12 株屬於弧菌屬，與 *Vibrio alginolyticus*，*Vibrio harveyi*，*Vibrio natriegens* 和 *Vibrio parahaemolyticus* 相似；對五類抗生素反應有高抗性表現，分別是抗 bata-lactam (94.1%)，nitrofuran (94.1%)，quinolone (88.2%)，aminoglycoside (82.4%)和 tetracycline (70.6%)；其中抗 10 種抗生素以上多重抗藥細菌高達 16 株。近一步的我們也在箱網的上游採集水樣進行分析和比較。推測抗藥細菌的抗藥基因會透過細菌不同屬間、種間彼此的水平轉移，造成細菌演化的歧異。此模式可被應用於人類捕撈行為頻繁的南中國海之生物多樣性相關研究。

Marine Nematode Assemblage and Environmental Factors in the Northern Beibu Gulf, South China Sea

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ABSTRACT

Free-living marine nematodes were sampled seasonally at 9 stations in the northern Beibu Gulf, South China Sea. The number of genera, genera composition, diversity, feeding types of marine nematodes and the relationship between nematode community structure and environmental variables were analyzed. A total of 102 genera were identified, and *Dorylaimopsis*, *Sabatieria*, *Sphaerolaimus*, *Parodontophora*, *Elzalia*, *Terschellingia* were the dominant genera, accounting for approximately 50%. Also, *Dorylaimopsis* and *Sabatieria* existed in all stations and every season. Two-way crossed ANOSIM analysis showed that there were significant differences of nematode community among stations, but not among seasons. The community structure of three stations (A3, A6, A9) which were the deepest had significant differences with other stations. The dominant feeding type of nematodes was 2A (epigrowth feeders), and no significant differences of feeding types were detected among stations and seasons. *Sabatieria* and *Terschellingia* have coexistence relationship. BIOENV analysis indicated that salinity and organic carbon content were the most important factors to affect the nematodes community structure. The number of genus was related to water depth, salinity and dissolved oxygen.

中國南海北部灣北部海域海洋線蟲群落和環境因數

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摘 要

根據中國南海北部灣北部海域的 9 個站位、4 個季度獲得的小型底棲動物樣品，研究自由生活海洋線蟲的屬數，種類組成，多樣性，攝食類型並分析了海洋線蟲群落結構和環境因數之間的關係。共鑒定出海洋線蟲 102 屬，主要優勢屬是 *Dorylaimopsis, Sabatieria*, *Sphaerolaimus*, *Parodontophora*, *Elzalia*, *Terschellingia*，這些屬豐度的總和約占線蟲總豐度的 50%。其中，*Dorylaimopsis* 和 *Sabatieria* 兩個屬在每個站和每個季度均有分佈。Two-way crossed ANOSIM 分析結果表明海洋線蟲不同站位的群落結構具有顯著差異，而不同季度的群落結構則沒有顯著差異。離中國大陸最遠的 3 個站位（A3, A6, A9）的群落結構與其他站位有顯著差異。線蟲營養結構中刮食者（2A）佔優勢，不同的站位和季度，營養結構沒有顯著差異。*Sabatieria* 和 *Terschellingia* 兩個屬具有共存關係。BIOENV 分析結果表明鹽度和有機碳含量是影響線蟲群落結構的最重要環境因數。線蟲的屬數與水深，鹽度和溶解氧具有顯著相關關係。

Taiwan as the Key Stone to Serve the Connectivity among three "Triangles" (Coral Triangle, Kuroshio Triangle, and SCS Triangle) and Implication for Coral Ecosystems under the Impacts of Climate Change

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ABSTRACT

Coral reef biodiversity has a centralised hot spot in the Indo-Pacific region, ranging between Paupa New Guinea, Indonesia, Philippine, and Malaysia, which is also known as the "Coral Triangle (CT)". The CT has attracted lots of attention due to its values in terms of biodiversity conservation and social economics. However, the roles of CT contributed to the other major regions of coral reef biodiversity, namely South China Sea (SCS) and Kuroshio-impacted areas, in the West Pacific, remains unexplored. In this report, a new triangle, SCS-Triangle, is proposed based on the current available knowledge of coral reef biodiversity in this region. Together with the Kuroshio Triangle (KT), proposed in 2008, we identified Taiwan as a key stone site to serve the connectivity among these three triangles. Lastly, the knowledge gaps and potential research projects under the impact of climate change are highlighted to call for the needs of interdisciplinary and transboundary collaboration to elucidate connectivity and future conservation of coral ecosystems across Coral Triangle, South China Sea Triangle, and Kuroshio Triangle.

Siliceous Sponge Spicules in Peng-hu Intertidal Sediments

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ABSTRACT

Biogenic silica fragment in marine sediments is an important indicator to understand the distributions of living siliceous organisms and paleoproductivities. Organisms which produce biogenic silica skeletons include diatoms, silicoflagellate, radiolarians and sponges. Among these biogenic silica skeletons, sponge spicules have a low dissolution rate in sediments and are abundant, especially in Antarctic areas which likely to be a silica sink. On the other hand, keratose sponges have long been observed to obtain siliceous skeletons from environments as their supporting structures. Although the amount of biogenic silica in keratose sponges is not estimated, the keratose sponge species reach about one tenth in the South China Sea or coral reefs in Taiwan. The question arises: What does the keratose sponges play on the recycle of biogenic silica in marine environments? We investigated siliceous spicules in surface sediments and the abundance of sponges in the intertidal coral reefs in Peng-hu Islands, Taiwan. We found that sponge spicules were most abundant in sites without keratose sponges. And the lowest spicule amount was recorded in habitats having abundant keratose sponges. It is suggested that keratose sponges may complicate the recycle of sponge spicules from environments.

澎湖潮間帶沈積物中的海綿骨針

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摘 要

海洋沈積物中的矽質生物碎屑是一個基礎生產力與當地矽源生物量之重要指標。矽藻、矽鞭毛藻、放射蟲與海綿均會生產矽質骨骼。在這些沈積的矽質骨骼當中，海綿的骨針的溶解度最低，且分布範圍亦最廣泛。在南極地區，由於海綿骨針量高且難溶解於海水中，更使得海綿可能成為一個地球矽循環的匯池(sink)。另一方面，研究指出無法自行製造骨針的角質海綿類亦會由環境當中吸收他種海綿的骨針作為其支持結構。雖然各種角質海綿中的矽質骨針含量研究尚未完成，然而角質海綿在中國南海以及台灣的珊瑚礁海域的海綿多樣性當中就佔了其中的 1/10。在這些海域環境當中，角質海綿在矽循環當中所扮演的角色為何呢？本研究在澎湖的珊瑚礁潮間帶觀察了沈積物中的骨針含量與海綿種類的關係性。我們發現在角質海綿生物例較低的環境當中海綿骨針在沈積物中的含量較高，而在角質海綿數量最高的環境，沈積物中的骨針含量則最低。此研究指出海綿骨針在沈積之後，溶解再進入矽循環之前可能被回收利用，而延遲進入矽循環的可能性。

The Study of Filtration Efficiency of Sponges

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ABSTRACT

Sponges have remarkable ability to filter DOC (dissolved organic carbon) and POC (particular organic carbon) in the water. The filtration efficiency depends on particle sizes and growth stage of sponges. The present study was investigated the filtration efficiency of two intertidal sponges, i.e. *Spongia cylonesis* and *Tedania klausi* under laboratory condition. The microalgae of *Isochrysis galbana* (3-5 um) and *Tetraselmis chui* (8-11 um) were fed to the sponges. At low algal concentration (l), the clearance rates of *S. cylonesis* and *T. klausi* were not significantly different from each other. By contrast, at high algal concentration (10^6 cells/ml), the clearance rates of the two sponges were significantly different. *Spongia cylonesis* preferred small size microalgae (*I. galbana*), while *T. klausi* preferred large size (*T. chui*). The results indicated that *S. cylonesis* and *T. klausi* have different filtration efficiency which depends on particle size.

海綿濾食效率的探討

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摘 要

海綿為濾食性生物，其對於水中溶解性有機碳(DOC，dissolved organic carbon)和顆粒狀有機碳(POC，particular organic carbon)有優於其他生物的過濾能力，而濾食效率(filtration efficiency)會因食物顆粒大小和海綿成長階段不同有所影響。本篇研究探討兩種潮間帶海綿 *Spongia cylonesis* 和 *Tedania klausi* 餵養於實驗室內濾食效率的差異;實驗方法是以兩種微藻 *Isochrysis galbana* (3-5 um)和 *Tetraselmis chui* (8-11 um)餵食海綿來比較其清除率(clearance rate)。結果顯示，以低濃度藻水(10^4 cells/ml)餵食，兩種海綿的清除率並無顯著差異;但在高濃度藻水(10^6 cells/ml)的環境下，兩物種的清除率有顯著不同，*Spongia cylonesis* 偏好較小的微藻(*I. galbana*)，*T. klausi* 則是選擇大顆粒微藻(*T. chui*);換言之，兩種潮間帶海綿的濾食效率會受到顆粒大小影響而有所不同，且其應用於生物復育之效果會因種而異。

POSTER
海報

Dongsha Atoll Coral Growth Monitoring

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ABSTRACT

Dongsha Atoll is formed by reef coral, abundant with coral reef ecology. In 1998, by the great global warming, tropical oceans around the world, including Dongsha Atoll's coral reef ecosystems have been seriously challenged, resulting a large number of coral bleached and died. After 12 years, until now the Dongsha lagoon coral communities are also not yet rehabilitated to the original landscape. Dongsha Atoll National Park, established in 2007, the conservation of coral has been one of the important work. In this area, a 2 year observation shows that within the atolls coral seedlings generally grew poorly, while near the east shore of Pratas island relatively more coral seedlings were found on the coral wreckages. In addition, in the atoll, the *Acropora* species is generally not heat resistant, yet some healthy communities appear in seagrass beds surrounding Pratas island. This phenomenon deserves further study.

東沙環礁珊瑚生長監測

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摘 要

東沙環礁是由造礁珊瑚形成，擁有豐富的珊瑚礁生態。1998 年全球大暖化，世界各地包括東沙環礁的珊瑚礁生態都受到嚴重的衝擊，造成大量珊瑚白化死亡。12 年之後，直到現在東沙潟湖內的珊瑚族群都還尚未回復原有的景觀。東沙環礁國家公園成立於 2007 年，珊瑚的保育研究是其中一項重要的工作。在這 2 年多以來的海域觀察中，環礁內的珊瑚幼苗生長情況普遍不佳，相對地在東沙島東岸的珊瑚殘骸上，則有較多的珊瑚幼苗。在沿岸的消波塊上，珊瑚著苗生長的情況亦佳。另一方面，環礁內很難找到較不耐熱的軸孔珊瑚，在東沙島周邊海草床卻有一些健康的族群，這個現象值得進一步研究。

Nutrient Enrichment Caused by Marine Cage Culture in the Subtropical Coral Communities at Penghu Islands, Taiwan

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ABSTRACT

The scale and intensity of marine cage culture have increased in the Asia-Pacific region, particularly in oligotrophic waters where coral reef organisms flourish. In this study, the influence of marine cage culture on coral reefs was evaluated by measuring environmental parameters and benthic community compositions at Magongwan in the Penghu Islands, Taiwan. A canonical discriminant analysis of environmental parameters clearly distinguished between the polluted (cage-culture zone) and clean zones (intermediate and reference zones), with ammonium, nitrite, and chlorophyll-*a* as pollution indicators. Results of the canonical correlation analysis indicated that the coverage extents of macroalgae, sponges and zoanthids were strongly correlated with ammonium, nitrite, phosphate, chlorphyll-*a*, and dissolved oxygen. Coral communities in the culture zone were mostly composed of stress-tolerant massive and submassive corals but were lacking branching *Acropora* corals. In contrast, coral communities in the intermediate and reference zones, with high habitat complexity and species richness, were dominated by coral species with diverse morphologies, including branching *Acropora* coral communities. In the intermediate zone in particular, the extra nutrients from the adjacent marine cage culture might have resulted in the high coral coverage and diversity found there. These results suggested that marine cage culture has been causing chronic nutrient enrichment in the surrounding waters at Magongwan, which may have resulted in the deterioration of suitable habitats for coral reef organisms.

台灣澎湖海洋箱網養殖漁業引起營養鹽增生對於鄰近亞熱帶珊瑚群聚的影響

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摘 要

近年來，海洋箱網養殖漁業的規模與密度在亞太地區中蓬勃發展，特別是在貧營養鹽的珊瑚礁海域裡急速成長。本研究藉由調查澎湖群島的馬公內灣，2006-2007 年的底棲生物群聚（珊瑚、大型藻類、海綿及菟葵）以及海域環境參數來分析探討海洋箱網養殖漁業對於鄰近珊瑚礁生態系的影響程度 。經由典型判別分析（Canonical discriminant analysis）的結果顯示，海域環境參數中的氨氮鹽、亞硝酸鹽及葉綠素 a 濃度，可以作為區分箱網養殖區（cage-culture zone）與對照區（中間區及參考區; intermediary zone and reference zone）的環境判別因子。而養殖區內的大型藻類、海綿以及菟葵的覆蓋率也和對照區有統計上的差異。根據典型相關分析（Canonical correlation analysis）結果指出，大型藻類、海綿以及菟葵覆蓋率與氨氮鹽、亞硝酸鹽、磷酸鹽、葉綠素 a 濃度及溶氧呈現強烈的正相關。此外，養殖區內的珊瑚群聚大多數由團塊狀（massive）及次團塊狀（submassive）等環境耐受力高的種類所組成，並且缺乏分枝狀的軸孔珊瑚種類。相較之下，對照區內的珊瑚群聚則具有較多樣化的形態組成及分枝狀軸孔珊瑚，也因此具有較高的棲地複雜性及物種豐富度。值得注意的是，海洋箱網養殖漁業所產生額外的有機污染物可能因為提供本研究中的中間區額外的營養鹽，而造成該區域中的珊瑚覆蓋率及多樣性明顯高於其他採樣分區。統合上述研究結果指出，澎湖馬公內灣的海洋箱網養殖漁業長期以來已經造成鄰近海域的營養鹽增生現象，並且可能導致適合底棲生物棲息的珊瑚礁環境惡化。

The Influence of Water Temperature on the Seasonal Recruitment of Marine Benthic Invertebrates

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ABSTRACT

The present study was aimed to determine the influence of water temperature on the seasonal recruitment of benthic invertebrates in Kenting, Taiwan. Field experiments were conducted at two sites, i.e. Efflu-3 with water depth of 3m and Efflu of 9m, near a Nuclear Power Plant. Seasonal variation in water temperature varied in the ranges of 25 ~ 28 ℃ with a constantly 0.7 ~2.0 ℃ higher at Efflu-3 than that of the Efflu. Polychaete abundance was high in spring and summer when water temperature increased, and it was usually higher in the Efflu-3 than that of the Efflu. It is strongly suggested that polychaetes prefer high temperature environment. The abundance of mollusks, corals and bryozoans was low especially in Effle-3. And, barnacle was not found in Efflu-3. The recruitment of marine benthos is influenced by water temperature. However, other disturbance such as human activities seems to have been at play.

Keywords: water temperature, benthic invertebrates, Kenting, recruitment

水溫對海洋底棲動物季節性著生量影響之探討

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摘 要

本研究的目的在了解水溫對海洋底棲動物季節性著生量的影響。以墾丁核能電廠溫水排放口南側小灣海域水深 3 公尺的 Efflu-3 測站和其下方 9 公尺深的 Efflu 測站為實驗地點，比較其水溫及季節性底棲動物著生量的變化。水溫記錄顯示季節性變化在 25 至 28 ℃之間，各季皆以 Efflu-3 的水溫高於 Efflu，兩測站間差距在 0.7 至 2℃之間；底棲動物之著生量亦有明顯的季節性差異存在，多毛蟲的豐度在春夏季時較高，且 Efflu-3 的著生量常明顯高於 Efflu，推測多毛蟲可能偏好高水溫環境；而貝類、珊瑚及苔蘚蟲等底棲動物偶爾會在 Efflu-3 著生，其豐度低於 Efflu，但藤壺在 Efflu-3 未被發現，由底棲動物著生量的差異可知水溫為一影響因子，但此海域不只受溫排水之影響，遊客潛水的人為干擾也是影響因子之一。

關鍵詞：水溫、底棲動物、墾丁、著生量

The Role of Snail *Cerithium Zonatum* in an Intertidal Coral Reef Ecosystem

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ABSTRACT

Cerithium zonatum is a dominant species in the intertidal coral reefs in Green Island. This study aimed to characterize the trophic ecology and population dynamics of *C. zonatum* in an intertidal of Shi-Lang, Green Island. We constructed trophic structures of the intertidal zone by using $\delta^{13}C$ and $\delta^{15}N$. Population dynamics of *C. zonatum* included the variation of population density and frequency of shell length was determined. Results indicated that *C. zonatum* was a primary consumer and they feed on seagrass leave, seagrass litter, and epiphyte algae. The population density in rocky shore was higher than that in seagrass beds and sandy substrates. Seasonal variation with a high density in the fall and winter were also observed. The reproduction season began from spring to summer with a pattern of low population density and large snail size.

Keyword: Trophic Ecology, C, N Stable Isotopes, Population Dynamics, *Cerithium zonatum*

項鍊蟹守螺(*Cerithium zonatum*)在潮間帶珊瑚礁生態系角色之探討

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摘 要

項鍊蟹守螺(*Cerithium zonatum*)在綠島潮間帶珊瑚礁是優勢物種。本研究探討棲息在綠島石朗潮間帶項鍊蟹守螺的族群動態與攝食生態。每季在海草床、礁岩、沙地三種棲所採集，分析其族群密度與體長頻度；並利用碳氮穩定同位素研究蟹守螺的攝食生態。結果顯示礁岩區族群密度高於海草床與沙地，春夏之密度低於秋冬；生殖季始於春季，春夏族群密度降低，多為成熟之大型個體，秋冬兩季的蟹守螺以小體型較多。碳氮穩定同位素的結果顯示蟹守螺為初級消費者，可能攝食海草、枯海草或附生藻類等食物來源。

The Diversity of Epibenthic Shrimps in Coastal Waters off Southwestern Taiwan

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ABSTRACT

Shrimp samples were collected from April 2002 to July 2003, with a beam trawl operated by R/V Ocean Researcher NO. 3 at 7 stations, Jiading, Zouying, Jhongjhou, Linyuan, Dapeng, Linbian, and Fangliao, along the Southwestern waters off Taiwan. In total, 15,591 individuals of shrimp were obtained, including 10 families, 20 genus, and 39 species and a checklist of all shrimp species is given. Among them, Penaeidae contained the most species (20 species, 51.3%). *Metapenaeopsis palmensis* (88.2%), *Trachysalambria curvirostris* (3.6%), *Metapenaeopsis barbata* (3.5%) and *Parapenaeopsis cornuta* (1.4%) were numerical dominants, contributing 96.7% of the total catches. The cluster analyses reveal that there was significant spatial variation with different species composition and represent different areas. Based on the abundance, *M. palmensis* was the most abundant species in this area, but the second dominant species was changed from *M. barbata* (Jiading to Jhongjhou) to *P. cornuta* (Linyuan to Dapeng) and to *T. curvirostris* (Fangliao).

Keywords: Southwestern Taiwan, epibenthic shrimps, spatial distribution, *Metapenaeopsis palmensis*.

台灣西南近岸海域底棲蝦類多樣性

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摘 要

於 2002 年 4 月至 2003 年 7 月間，於茄萣、左營、中洲、林園、大鵬、林邊及枋寮海域，水深 15m 及 25m 處，利用海研三號進行採樣。共捕獲底棲蝦類 10 科 20 屬 39 種 15,591 尾，所紀錄種類以對蝦科最多（20 種；51.3%）。前四優勢種類依序為婆羅門赤對蝦（88.2%）、彎角鷹爪對蝦（3.6%）、鬚赤對蝦（3.5%）及角突仿對蝦（1.4%），佔總捕獲量 96.7%。優勢蝦種組成的改變，造成底棲蝦類群聚種類組成呈現空間差異，婆羅門赤對蝦雖在各測站皆為優勢種，第二優勢種則依海域而異，在枋寮海域為彎角鷹爪對蝦，而在茄萣則為鬚赤對蝦及角突仿對蝦。

關鍵詞：台灣西南海域、底棲蝦類、空間分佈、婆羅門赤對蝦

Assemblages and Tempospatial Distribution of Epibenthic Crabs in Coastal Waters off Western Taiwan

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ABSTRACT

The present study used beam trawl net to collect crabs by Ocean Researcher III at four sites, Wanggong, Taisi, Cigu and Jiading, in western waters off Taiwan from July 2006 to October 2008. In total, 3,210 crabs were obtained, including 11 families, 22 genus, 40 species and 9 unknown species. Among these families, Portunidae contained the most species (20 species, 41%), followed by families Majidae (4 species, 8%), Leucosiidae (3 species, 6%) and Dorippidae (3 species, 6%). Six dominant species were *Portunus hastatoides* (61.2%), *Portunus argentatus* (11.5%), *Portunus sanguinolentus* (6.8%), *Matuta victor* (5.4%), *Charybdis truncata* (3.2%) and *Portunus pelagicus* (2.0%), contributing 90.1% of the total catch. Spatial distributions of the benthic crabs by number were significantly different. *P. argentatus* was the most dominant species in Cigu, whereas *P. hastatoide* in the other three stations. Among the six species, *P. sanguinolentus* and *P. pelagicus* are the most important species in terms of economic value. The former appeared in large numbers in Jiading and composed 35.6% of the total catch in weight, while the latter frequently occurred in the other three sites and contributed 16.3% to the overall sample weight. The distributions of the dominant species were influenced by grain size of substrate, hydrological condition and water depth. *P. hastatoides* occurred mostly in very fine sand habitat. *P. sanguinolentus* increased in number and weight with decreasing of salinity and water depth. *P. argentatus* had a narrowest optimum temperature range from 24.3 to 28.3℃.

Keywords: Community structure, *P. hastatoides, P. argentatus, P. sanguinolentus,* grain size, Salinity

台灣西部沿海蟹類種類組成、時空分佈及優勢種生物學之研究

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摘 要

2006 年 7 月至 2008 年 10 月於王功、台西、七股和茄萣四個測站之 12m 至 53m 水深處，以海研三號進行 10 航次 74 網次的採樣，總共得 3,210 隻樣品，包含 11 科 22 屬 40 種及未知種類 9 種。其中梭子蟹科的種類最多（20 種，41%）其次依序為蜘蛛蟹科（4 種，8%）、玉蟹科（3 種，6%）和關公蟹科（3 種，6%）。豐度的前六優勢種（90.1%）為矛形梭子蟹（61.2%）、銀光梭子蟹（11.5%）、紅星梭子蟹（6.8%）、勝利黎明蟹（5.4%）、直額蟳（3.2%）及遠海梭子蟹（2.0%）。這些底棲蟹類在四個測站中的分佈，除七股測站以銀光梭子蟹為數量優勢種外，其他三個測站皆以矛形梭子蟹為豐度最優勢種。上述優勢物種中的紅星梭子蟹（三點仔）和遠海梭子蟹（花市仔）均為經濟性物種。紅星梭子蟹則是除茄萣以外的生物量最優勢種，佔所有測站的 35.6%，而茄萣則以遠海梭子蟹的生物量為最高，佔 16.3%。矛形梭子蟹偏好極細沙（1/16～1/8 mm）的底質，其生物量與深度有顯著的正相關，紅星梭子蟹則與鹽度和深度呈現顯著的負相關，而銀光梭子蟹的最適溫度範圍最窄（24.3~28.3℃）。

關鍵字：群聚結構、矛形梭子蟹、銀光梭子蟹、紅星梭子蟹、顆粒大小、鹽度

KEYNOTE SPEAKER CV

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2003/9 – 2004/1, Visiting Research Fellow, IHAS, Nagoya University
1989 – 1995, Director, Marine Sciences Research Center, NSYSU
1989 – 1992, Dean, College of Marine Sciences, NSYSU
1985 – 1989, Director, Institute of Marine Geology, NSYSU

Professional Activities (International)

1. International Geosphere Biosphere Programme (IGBP), Scientific Committee (2008 – 2010), Vice-Chair (2009 – present)
2. Continental Shelf Research; Editorial Board (2007 – present)
3. IAPSO/SCOR Working Group (127) on Thermodynamics and Equation of State of Seawater (2006 – present)
4. IGBP/WCRP/IHDP/DIVERSITAS Monsoon Asia Integrated Regional Study (MAIRS): Planning Committee, member (2002 - 2005); Scientific Steering Committee, member (2006 – present)
5. Journal of Ocean University of China; Editorial Board (2005 – present)
6. Pacific East Asia Circulation Experiment: Scientific Steering Committee, member (2004 – present)
7. Acta Oceanologica Sinica; Editorial Board. (2004 – present)
8. Journal of Marine Systems; Editorial Board (2001 – present)
9. UNESCO/ICES/SCOR/IAPSO Joint Panel of Experts on Oceanographic Tables and Standards, Invited Expert (1976 – 1988)

Professional Activities (National)

1. Presidential Office: Science and Technology Advisory Committee, member (2005 – 2006)

2. Prime Minister's office:
   - Global Environmental Change Policy Steering Committee, member (1994 – 1997);
   - National Sustainable Development Committee, member (1997 – 2000);
   - Science and Technology Advisory Board, senior researcher (1988 – 1996).
3. Academia Sinica:
   - International Geosphere Biosphere Programme ROC Committee, member (1988 – 2004), Chair (1990 – 1994), executive member (1994 – 2008);
   - International Human Dimensions Programme on Global Environmental Change Taiwan Committee, executive member (2002 – 2004);
   - International Union of Geodesy and Geophysics ROC Committee, member (2000 – 2003);
   - Scientific Committee on Oceanographic Research ROC Committee, member (1987 – 2001), executive member (1992 – 1994);
   - Pacific Science Association ROC Committee, member (1991 – 1993)
4. National Science Council: Natural Sciences Advisor (1990 – 1992, 2002 – 2004), Biological Sciences Advisor (1990 – 1991)
5. Environmental Protection Administration:
   - Environmental Impact Assessment Board, member (1993 – 2005; 2007 – present);
   - Environmental Quality Advisory Board, member (1996 – 2001).
6. Water Resources Administration: Sustainable Development Center, advisor (1999 – 2002).
7. ROC Marine Science and Technology Association, executive member (1986 – 1990, 1995 – present), president (1990 – 1994).
8. Proceedings, Marine Science and Technology, Publisher (1991 – 1995)

Honors

Hsi-Wan Chair Professorship, 2006 – 2009, 2009 – 2012
Outstanding Research Award, National Science Council, 1992, 2004, 2010
Cheng Chung Chair Professorship (Xiamen University), 2009
Ho Chin-Tuei Outstanding Honorable Award (500,000 TWD award), 2004
Distinguished Research Award, National Science Council, 1990, 1993 – 2001
Biwako Prize for Ecology (5 M Japanese Yen award), 1997
Sun Yat-Sen Research Award, 1984
Outstanding Young Man of America, 1978
Listed in Who's Who in the World and 30 other Who's Whos

Recent Publications

Papers Published in the Past Five Years

1. **Chen, C.T.A.***, 2005. Tracing tropical and intermediate waters from the South China Sea to the Okinawa Trough and beyond; Journal of Geophysical Research, Vol. 110, C05012, doi:10.1029/2004JC002494, 2005 (SCI: 3.147; cited 12 times until 2010/03/16; this paper acknowledged NSC 92-2611-Z-110-005 and 92-2611-M-110-014).
2. **Chen, C.T.A.***, B.J. Wang, J.F. Huang, J.Y. Lou, F.W. Kuo, Y.Y. Tu and H.S. Tsai, 2005. Investigation into extremely acidic hydrothermal fluids off Kueishan Tao, Taiwan, China; Acta Oceanologica Sinica, 24(1), 125-133 (SCI: 0.441; cited 4 times until 2010/03/16; this paper acknowledged NSC 91-2611-M-110-010).
3. **Chen, C.T.A.*** and L.Y. Hsing, 2005. Degree of nutrient consumption as an aging index of upwelling or vertically mixed water in the Northern Taiwan Strait; Acta Oceanologica Sinica, 24(1), 115-124, (SCI: 0.441; cited 4 times until 2010/03/16; This paper acknowledged NSC-92-2611-M-110-014).
4. **Chen, C.T.A.***, J. Zhang, T.R. Peng, and T. Hagiwara, 2005. Exploratory sampling of submarine groundwater discharge in Taiwan; Geochemistry, 39, 165-171 (cited once until

2010/03/16; this paper acknowledged NSC 93-2621-Z-110-004 and 93-2621-Z-005-002).

5. **Chen, C.T.A**.* **(Chentung, A.C.)**, Z.G. Zeng, F.W. Kuo, T.Y. F. Yang, B.J. Wang, and Y.Y. Tu, 2005. Tide-influenced acidic hydrothermal system offshore NE Taiwan; Chemical Geology, 224, 69-81, doi:10.1016/j.chemgeo.2005.07.022 (SCI: 3.531; cited 9 times until 2010/03/16; this paper acknowledged NSC 89-2611-M-110-001).
6. Chou, W.C.*, D.D.D. Sheu, **C.T.A. Chen**, S.L. Wang and C.M. Tseng, 2005. Seasonal variability of carbon chemistry at the SEATS Time-Series Site, northern South China Sea between 2002 and 2003; Terrestrial, Atmospheric and Oceanic Sciences, Vol. 16, No. 2, 445-465 (SCI: 0.594; cited 11 times until 2010/03/16).
7. Yang, T.F., T.F. Lan, H.F. Lee, C.C. Fu, P.C. Chuang, C.H. Lo, C.H. Chen, **C.T.A. Chen**, C.S. Lee; Gas compositions and helium isotopic ratios of fluid samples around Kueishantao, NE offshore Taiwan and its tectonic implications; Geochemical Journal, 39(5), 469-480 (SCI: 0.798; cited 13 times until 2010/03/16).
8. Liu, C.H.*, Z.G. Zeng, X.B. Yin and Zhen-Dong **(Chen-Tung) Chen**, 2006. Basic characters of native sulfur chimneys near the sea off Kueishantao from the Northern Taiwan; Journal of Oceanography in Taiwan Strait, 25, 309-317 (in Chinese with English abstract).
9. Selvaraj, K.* and **C.T.A. Chen**, 2006. Moderate chemical weathering of subtropical Taiwan: Constraints from solid-phase geochemistry of sediments and sedimentary rocks; The Journal of Geology, volume 114, p. 101-116 (SCI: 3.035; cited 13 times until 2010/03/16; this paper acknowledged NSC 93-2611-M-110-009, 93-2821-M-110-006 and 93-2621-Z-110-004).
10. **Chen, C.T.A**.* and D.D. Sheu, 2006. Does the Taiwan Warm Current originate in the Taiwan Strait in winter-time? Journal of Geophysical Research, VOL. 111, C04005, doi:10.1029/2005JC003281 (SCI: 3.147; cited 12 times until 2010/03/16; this paper acknowledged NSC 94-2611-M-110-001, NSC 94-2621-Z-110-001 and Aim for the Top University Plan 95C 030211).
11. **Chen, C.T.A**.*, W.P. Hou, T. Gamo, and S.L. Wang, 2006. Carbonate related parameters of subsurface waters in the West Philippine, South China and Sulu Seas; Marine Chemistry, 99, 151-161, doi:10.1016/j.marchem.2005.05.008 (SCI: 2.977; cited 13 times until 2010/03/16; this paper acknowledged NSC 93-2621-Z-110-004).
12. **Chen, C.T.A**.*, S.L. Wang, W.C. Chou and D.D. Sheu, 2006. Carbonate chemistry and projected future changes in pH and CaCO3 saturation state of the South China Sea; Marine Chemistry, 101, 277-305, doi:10.1016/j.marchem.2006.01.007 (SCI: 2.977; cited 7 times until 2010/03/16; This paper acknowledged NSC 94-2611-Z-110-001, 95-2611-M-110-001, EPA 85-1003-09-13 and Aim for the Top University Plan 95C 100302).
13. **Chen, C.T.A. (Chen, TA)*** and S.L. Wang, 2006. A salinity front in the southern East China Sea separating the Chinese coastal and Taiwan Strait waters from Kuroshio waters; Continental Shelf Research, 26, 1636-1653, doi:10.1016/j.csr.2006.05.003 (SCI: 2.136; cited twice until 2010/03/16; this paper acknowledged NSC 94-2611-M-110-001, 94-2621-Z-110-001 and Aim for the Top University Plan 95C 030211).
14. **Chen, C.T.A**.* and H.C. Tseng, 2006. Abnormally high CH4 concentration in seawater at mid-depths on the continental slopes of the northern South China Sea; Terrestrial, Atmospheric Oceanic Sciences, 17(4), 951-959 (SCI: 0.594; cited 9 times until 2010/03/16; this paper acknowledged NSC 94-2621-Z-110-001, 94-2611-M-110-001 and Aim for the Top University Plan 95C 030211; HiCi in 2007).
15. Zhang, S.R.*, X.X. Lu, D.L. Higgitt, **C.T.A. Chen**, H.G. Sun and J.T. Han, 2007. Water chemistry of the Zhujiang (Pearl River): natural processes and anthropogenic influences; Journal of Geophysical Research, 112, F01011, doi:10.1029/2006JF000493 (SCI: 3.147; cited 6 times until 2010/03/16).
16. Selvaraj, K.*, **C.T.A. Chen** and J.Y. Lou, 2007. Holocene East Asian monsoon variability: links to solar and tropical Pacific forcing; Geophysical Research Letters, 34, L01703, doi:10.1029/2006GL028155 (SCI: 2.959; cited 3 times until 2010/05/19; this paper acknowledged NSC 94-2621-Z-110-001 and 94-2611-M110-001).

17. N.Z. Jiao*, Y. Zhang, Y.H. Zeng, W.D. Gardner, A.V. Mishonov, M.J. Richardson, N. Hong, D.L. Pan, X.H. Yan, Y.H. Jo, **C.T.A. Chen**, P.X. Wang, Y.Y. Chen, H.S. Hong, Y. Bai, X.H. Chen, B.Q. Huang, H. Deng, Y. Shi and D.C. Yang, 2007. Ecological anomalies in the East China Sea: Impacts of the Three Gorges Dam? Water Research, 41, 1287-1293, doi:10.1016/j.watres.2006.11.053 (SCI: 3.587; cited 18 times until 2010/05/19).
18. Nagender Nath, B.*, A. Aldahan, G. Possnert, K. Selvaraj, M.B.L. Mascarenhas-Pereira and **C.T.A. Chen**, 2007. 10Be variation in surfacial sediments of the Central Indian Ocean Basin; Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 259, 610-615, doi:10.1016/j.nimb.2007.01.293 (SCI: 0.999; cited once until 2010/03/17; this paper acknowledged NSC 94-2621-Z-110-001, 94-2611-M110-001 and 95-2621-Z-110-005).
19. Chou, W.C.*, D.D. Sheu, B.S. Lee, C.M. Tseng, **C.T.A. Chen**, S.L. Wang and G.T.F. Wong, 2007. Depth distributions of alkalinity, TCO2 and δ13CTCO2 at SEATS time-series site in the northern South China Sea; Deep-Sea Research II, 54, 1469-1485, doi: 10.1016/ j.dsr 2.2007.05.002 (SCI: 1.411; cited 6 times until 2010/05/19).
20. Chou, W.C.*, D.D. Sheu, **C.T.A. Chen**, L.S. Wen, Y. Yang and C.L. Wei, 2007. Transport of the South China Sea subsurface water outflow and its influence on carbon chemistry of Kuroshio waters off southeastern Taiwan; Journal of Geophysical Research, Vol. 112, C12008, doi:10.1029/2007JC004087 (SCI: 3.147; cited 4 times until 2010/05/19).
21. Zeng, Z.G.*, C.H. Liu, **C.T.A. Chen**, X.B. Yin, D.G. Chen, X.Y. Wang, X.M. Wang and G.L. Zhang, 2007. Origin of a native sulfur chimney in the Kueishantao hydrothermal field, offshore northeast Taiwan; Science in China (D), 50(11), 1746-1753, doi: 10.1007/s11430-007-0092-y (SCI: 0.725).
22. **Chen, C.T**.* and K. Selvaraj, 2008. Evaluation of elemental enrichments in surface sediments off southwestern Taiwan; Environmental Geology, 54, 1333-1346, DOI 10.1007/s00254-007-0916-2, (SCI: 1.026; cited once until 2010/03/17; This paper acknowledged NSC 86-2611-M-110-007W, 93-2621-Z-110-004, 95-2621-Z-110-005, 95-2611-M-110-001 and Aim for the Top University Plan 95C 0312).
23. Zhang, S.R.*, X.X. Lu, D.L. Higgit, **C.T.A. Chen**, J.T. Han and H.G. Sun, 2008. Recent changes of water discharge and sediment load in the Zhujiang (Pearl River) Basin, China; Global and Planetary Change, 60, 365-380, doi:10.1016/j.gloplacha.2007.04.003 (SCI: 2.670; cited 10 times until 2010/03/17).
24. Kurian, S.*, B. Nagender Nath, V. Ramaswamy, D. Naman, T. Gnaneshwar Rao, K.A. Kamesh Raju, K. Selvaraj and **C.T.A. Chen**, 2008. Possible detrital, diagenetic and hydrothermal sources for Holocene sediments of the Andaman backarc basin; Marine Geology, 247, 178-193; doi:10.1016/j.margeo.2007.09.006 (SCI: 2.100; This paper acknowledged NSC 94-2621-Z-110-001 and 94-2611-M-110-001).
25. **Chen, C.T.A**.*, S.L. Wang, X.X. Lu, S.R. Zhang, H.K. Lui, H.C. Tseng, B.J. Wang and H.I. Huang, 2008. Hydrogeochemistry and greenhouse gases of the Pearl River, its estuary and beyond; Quaternary International, 186, 79-90, doi:10.1016/j.quaint.2007.08.024 (SCI: 1.482; cited 3 times until 2010/03/19; this paper acknowledged NSC 95-2621-Z-110-005, 95-2611-M-110-001 and Aim for the Top University Plan 95C 0312).
26. Cai, W.J.*, X.H. Guo, **C.T.A. Chen**, M.H. Dai, L.J. Zhang, W.D. Zhai, S.E. Lohrenz, K. Yin, P.J. Harrison and Y.C. Wang, 2008. A comparative overview of weathering intensity and HCO3- flux in the world's largest rivers with emphasis on the Changjiang, Huanghe, Zhujiang (Pearl) and Mississippi Rivers; Continental Shelf Research, 28, 1538-1549, doi:10.1016/j.csr.2007.10.014 (SCI: 2.136; cited 5 times until 2010/03/17; this paper acknowledged NSC 95-2621-Z-110-005).
27. **Chen, C.T.A**.*, W.D. Zhai and M.H. Dai, 2008. Riverine input and air-sea CO2 exchanges near the Changjiang (Yangtze River) Estuary: Status quo and implication on possible future changes in metabolic status; Continental Shelf Research, 28, 1476-1482; doi:10.1016/j.csr.2007.10.013, 2008. (SCI: 2.136; cited twice until 2010/03/17; this paper acknowledged NSC 94-2621-Z-110-001, 95-2611-M-110-001 and Aim for the Top University

Plan 95C 0312).

28. Peng, T.R.*, **C.T.A. Chen**, C.H. Wang, J. Zhang and Y.J. Lin, 2008. Assessment of terrestrial factors controlling the submarine groundwater discharge in water shortage and highly deformed island of Taiwan, Western Pacific Ocean; Journal of Oceanography, 64, 323-337 (SCI: 1.189; this paper acknowledged NSC 93-2621-Z-005-002, 94-2621-Z-005-006, 95-2621-Z-005-005, 95-2611-M-110-001, 95-2621-Z-110-005).
29. Naik, H.* and **C.T.A. Chen**, 2008. Biogeochemical cycling in the Taiwan Strait; Estuarine, Coastal and Shelf Science, 78, 603-612; doi:10.1016/j.ecss.2008.02.004 (SCI: 2.072; cited once until 2010/03/17; this paper acknowledged NSC 95-2621-M-110-001 and 94-2621-Z-110-001).
30. Rabouille, C.*, D.J. Conley, M. Dai, W.-J. Cai, **C.T.A. Chen,** B. Lansard, R. Green, K. Yin, P.J. Harrison, D. Magg, B. McKee, 2008. Comparison of hypoxia among four river-dominated ocean margins: The Changjiang (Yangtze), Mississippi, Pearl and Rhône rivers; Continental Shelf Research, 28, 1527-1537; doi:10.1016/j.csr.2008.01.020 (SCI: 2.136; cited 3 times until; 2010/03/17).
31. Selvaraj, K.*, **C.T.A. Chen** and J.Y. Lou, 2008. Holocene weak summer East Asian monsoon intervals in subtropical Taiwan and their global synchronicity; Climate of the Past Discussions, 4, 929-953 (this paper acknowledged NSC NSC-95-2621-Z-110-005 and 95-2611-M110-001).
32. **Chen, C.T.A**.*, 2008. Distributions of nutrients in the East China Sea and the South China Sea connection; Journal of Oceanography, 64, 737-751 (SCI: 1.189; cited twice until 2010/03/17; this paper acknowledged NSC 96-2621-Z-110-002, 96-2628-M-110-002-MY3 and Aim for the Top University Plan (95C 0312)).
33. Aldrian, E.*, **C.T.A Chen**, S. Adi, Prihartanto, N. Sudiana and S. P. Nugroho, 2008. Spatial and seasonal dynamics of riverine carbon fluxes of the Brantas catchment in East Java; Journal of Geophysical Research - Biogeochemical, VOL. 113, G03029, doi:10.1029/2007G000626 (SCI: 3.147; cited once until; 2010/03/18; this paper acknowledged NSC 95-2621-Z-110-005 and Aim for the Top University Plan (94C 030200).
34. Liu, Z.F.*, S. Tuo, C. Colin, J.T. Liu, C.-Y. Huang, K. Selvaraj, **C.T.A. Chen**, Y. Zhao, F.P. Siringan, S. Boulay and Z. Chen, 2008. Detrital fine-grained sediment contribution from Taiwan to the northern South China Sea and its relation to regional ocean circulation; Marine Geology, 255, 149-155, doi: 10.1016/j.margeo.2008.08.003 (SCI: 2.100; cited 3 times until; 2010/03/18)
35. **Chen, C.T.A.(Arthur, C.C.T.)***, 2008. Buoyancy leads to high productivity of the Changjiang Diluted Water: a note; Acta Oceanologica Sinica, 27(6), 133-140 (SCI: 0.441; This paper acknowledged NSC 96-2621-Z-110-002, 96-2628-M-110-002-MY3 and Aim for the Top University Plan 96C 0312).
36. **Chen, C.T.A.***, 2009. Chemical and physical fronts in the Bohai, Yellow and East China Seas; Journal of Marine Systems, 78(3), 394-410, doi:10.1016/j.jmarsys.2008.11.016 (SCI: 2.255; cited 3 times until 2010/05/19; this paper acknowledged NSC 95-2611-M-110-001, 94-2621-Z-110-001 and Aim for the Top University Plan (Contract No. 95C 0312)).
37. **Chen, C.T.A.*** and A.V. Borges, 2009. Reconciling opposing views on carbon cycling in the coastal ocean: continental shelves as sinks and near-shore ecosystems as sources of atmospheric CO2; Deep-sea Research II, 56, 578-590, doi:10.1016/j.dsr2.2009.01.001 (SCI: 1.411; cited 13 times until 2010/05/19; this paper acknowledged NSC 95-2621-Z-110-005 and 95-2621-M-10-001; HiCi in 2010).
38. Dai, M.H.*, Z.M. Lu, W.D. Zhai, B.S. Chen, Z.M. Cao, K.B. Zhou, W.J. Cai and **C.T.A. Chen**, 2009. Diurnal variations of surface seawater pCO2 in contrasting coastal environments; Limnology and Oceanography, 54(3), 735-745, 2009. (SCI: 3.663; cited once until 2010/05/19).
39. Jan, S.* and **C.T.A. Chen**, 2009. Potential biogeochemical effects from vigorous internal tides generated in Luzon Strait: A case study at the southernmost coast of Taiwan; Journal of Geophysical Research, 114, C04021, doi:10.1029/2008JC004887 (SCI: 3.147; cited once until; 2010/03/18; this paper acknowledged NSC 95-2621-Z-110-005, NSC 96-2628-M110-002-MY3, and Aim for the Top University Plan 95C0312).

40. Sheu, D.D.*, W.C. Chou, **C.T.A.Chen**, C.L. Wei, H.L. Hsieh, W.P. Hou and M.H. Dai, 2009. Riding over the Kuroshio from the South to the East China Sea: Mixing and transport of DIC; Geophysical Research Letters, VOL. 36, L07603, doi:10.1029/2008GL037017 (SCI: 2.959).
41. Luh, L.J.*, M.H.A. El-Razek, C.-C. Liaw, **C.T.A. Chen**, Y.S. Lin, Y.H. Kuo, C.T. Chien, and Ya-Ching Shen, 2009. Tri- and Bicyclic Taxoids from the Taiwanese Yew Taxus sumatrana; Helvetica Chimica Acta, 92(7), 1349-1358 (SCI: 1.396).
42. Liu, C.H.*, X.M. Wang, X.D. Jin, Z.G. Zeng, **C.T.A Chen**, 2009. The contribution of trace elements from seawater to chimneys: a case study of the native sulfur chimneys in the sea area off Kueishantao, northeast of Taiwan Island; Chinese Journal of Oceanology and Limnology, 27 (1), 162-171, 2009.
43. West, A.J.*, H.C. Wang, K. Selvaraj, **CTA Chen**, TC Lin, 2009. An empirical case study of contrasting chemical depletion of hillslope regolith and eroding sediment, and implications for soil-derived catchment weathering rates; Geochimica et Cosmochimica Acta, 73(13): A1430-A1430 (SCI: 4.235)
44. Andreev, A.G.*, **C.T.A. Chen**, S. Watanabe, 2009. Calculation methods and the distribution of anthropogenic variations of pH values in the Pacific Subarctic; Oceanology, 49 (3), 418-428, doi: 10.1134/S000143700903014X (SCI: 0.343)
45. Peng, T.R.*, C.H. Wang, C.C. Huang, L.Y. Fei, **C.T.A. Chen**, J.L. Hwong, 2010. Stable isotopic characteristic of Taiwan's precipitation: A case study of western Pacific monsoon region; Earth and Planetary Science Letters, 289 (3-4), 357-366, doi:10.1016/j.epsl.2009.11.024 (SCI:3.955; cited once until; 2010/03/18)
46. Gao, X.L.*, **C.T.A. Chen**, G. Wang, Q.Z. Xue, C. Tang, S.Y. Chen, 2010. Environmental status of Daya Bay surface sediments inferred from a sequential extraction technique; Estuarine, Coastal and Shelf Science, 86 (3), 369-378, doi:10.1016/j.ecss.2009.10.012 (SCI: 2.072)
47. **Chen, C.T.A.***, S. Jan , T.H. Huang , Y.H. Tseng, 2010. The Spring of no Kuroshio Intrusion in the Southern Taiwan Strait; Journal of Geophysical Research, accepted.(SCI: 3.147; This paper acknowledged NSC96-2621-Z-110-002; NSC96-2628-M-110-002-MY3, and the "Aim for the Top University" program (Contract No. 96 C0312)
48. Selvaraj, K.*, G. Parthiban, **C.T.A. Chen,** and J.Y. Lou, 2010. Anthropogenic effects on sediment quality offshore southwestern Taiwan: Assessing the sediment core geochemical record; Continental Shelf Research, 30 (10), 1200–1210, doi:10.1016/j.csr.2010.03.010 (SCI: 2.136; This paper acknowledged NSC NSC 97-2611-M-110-002 and 97-2811-M-110-026) and the Aim for the Top University Program)
49. Kim, T.-W., K. Lee*, R.A. Feely, C.L. Sabine , **C.T.A. Chen**, H.J. Jeong and K.Y. Kim, 2010. Prediction of East/Japan Sea acidification over the past 40 years using a multiple-parameter regression model; Global Biogeochemical Cycles, in press (SCI: 4.090).
50. Yung-Yao Lan, Ben-Jei Tsuang*, Noel Keenlyside, Shu-Lun Wang, **Chen-Tung Arthur Chen**, Bin-Jye Wang, Tsun-Hsien Liu, 2010. Error estimations of dry deposition velocities of air pollutants using bulk sea surface temperature under common assumptions; Atmospheric Environment, accepted, doi:10.1016/j.atmosenv.2010.04.021 (SCI: 2.89)

Books and Book Chapters Published in the Past Five Years

1. Salomons, Wim, H.H. Kremer, R.K. Turner, E.N. Andreeva, R.S. Arthurton, H. Behrendt, P. Burbridge, **C.T.A. Chen**, C.J. Crossland, J. Gandrass, V.V. Gordeev, N. Harvey, G.H. Hong, B. Kjerfve, L.D. de Lacerda, J.I. Marshall Crossland, N. Morcom, E. Odada, J. Pacyna, N.N. Rabalais, D. Swaney, W.J. Wiebe, 2005. The catchment to coast continuum; in "Coastal Fluxes in the Anthropocene", C.J. Crossland, H.H. Kremer, H.J. Lindeboom, J.I. Marshall Crossland, M.D.A. Le Tissier (Eds.), Springer, Berlin, ISBN: 3-540-25450-1, 145-200 (231pp) (cited 5 times until 2010/03/16).
2. Fu, C., F.W.T Penning de Vries, Ailikun, **C.T.A. Chen**, L. Lebel, M. Manton, A. Snidvongs, H. Virji (eds), 2006. The Initial Science Plan of the Monsoon Asia Integrated Regional Study; MAIRS-IPO, IAP-CAS, P.O. Box 9804, 100029 Beijing, China, 80 pp.
3. Nihoul, J.C.J. and **C.T.A. Chen**, 2007. Oceanography; in: "Oceanography"

(http://www.eolss.net/eBooks), ed. by J.C.J. Nihoul and C.T.A. Chen, in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, ISBN: 978-1-905839-62-9 e-Book, Vol. 1, 1-36.

4. **Chen, C.T.A.**, 2007. The Oceans; in: "Oceanography," ed. by J.C.J. Nihoul and C.T.A. Chen, in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, ISBN: 978-1-905839-62-9 e-Book, Vol. 1, 37-59.
5. **Chen, C.T.A**., 2007. The Open Oceans; in: "Oceanography," ed. by J.C.J. Nihoul and C.T.A. Chen, in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, ISBN: 978-1-905839-62-9 e-Book, Vol. 1, 60-79.
6. **Chen, C.T.A**., 2007. Continental margins and marginal seas; in: "Oceanography," ed. by J.C.J. Nihoul and C.T.A. Chen, in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, ISBN: 978-1-905839-62-9 e-Book, Vol. 1, 80-99.
7. **Chen, C.T.A**., 2007. Role of the oceans in global cycles of carbon and nutrients; in: "Oceanography," ed. by J.C.J. Nihoul and C.T.A. Chen, in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, ISBN: 978-1-905839-62-9 e-Book, Vol. 1, 100-118.
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Current Positions

Deputy Minister of Environmental Protection Administration, ROC
Professor and Director, Institute of Marine Affairs and Resource Management, National Taiwan Ocean University, since 2005

Education

Ph.D. in City and Regional Planning , University of Pennsylvania, U.S.A., 1991
M.A. in Urban Planning, National Chuang Hsing University, 1980
B.S. in Urban Planning, National Cheng Kung University, 1976

Research Specialties

Marine Policy, Ocean Governance, Coastal Management, Wetland Conservation, Environmental Law, Environmental Planning and Management, Maritime Heritage, APEC Marine Resource Conservation Affairs

Professional Experience

Academia

2005 – present, Professor and Director, Institute of Marine Affairs and Resource Management, National Taiwan Ocean University.
1991 – 2005, Associate Professor, Dept. of Marine Environment and Engineering, National Sun Yat-sen University.

Government

- Member, Commission on Marine Education, Ministry of Education (2007 – present)
- Council Member, National Council for Marine Affairs Advancement, Executive Yuan (Cabinet) (2004 – present)
- Member, Commission on Research and Planning, Taiwan Coast Guard Administration, Executive Yuan (Cabinet) (2005 – present)
- Advisor, Advisory Commission on National Land Conservation and Development to the Presidential Hall (2002 – 2004)
- Council Member, National Council for Sustainable Development, Executive Yuan (Cabinet) (2002 – 2004)
- Advisor, Committee for Sustainable Development, Legislative Yuan (Congress) (2000 – 2002)
- Member, Committee on Environmental Impact Assessment, Penghu County Government (2007 – present)
- Advisor, Kaohsiung County Government (2000 – present)
- Advisor, Kaohsiung City Government (2004 – 2006)
- Advisor, Pingtung County Government (2000 – 2004)
- Member, Advisor Commission on Wildlife Conservation, Council of Agriculture, Executive Yuan (Cabinet) (1995 – 1997)
- Delegate of Chinese Taipei, APEC Marine Resource Conservation Working Group (1994 –

present)

- Senior Specialist, Construction and Planning Administration, Ministry of the Interior (1980 – 1984)

NGOs

- CEO, Foundation of Ocean Taiwan (1999 – present)
- President, Taiwan Association of Marine Pollution Control (2004 – 2006)
- President, Wetlands Taiwan (2002 – 2004)
- Board Member, Asia Environmental Council – Asia-Pacific NGOs Environmental Conference, Korea (2002 – present)
- Member, Ramsar CenterJapan, Japan (2002 – present)
- Member, Association of Marine Affairs and Policy, Taiwan (1997 – present)
- Member, Society of Environmental Education, Taiwan (1997 – present)
- Permanent member, Society of Urban Planning, Taiwan
- Permanent member, Society of Environmental Engineering, Taiwan
- Permanent member, Society of Underwater Technology, Taiwan
- Permanent member, Green Association of Kaohsiung City, Taiwan

Recent Achievement

- Editor-in-chief, APEC Bulletin on Marine Resource Conservation and Management. Vol. 8 (two issues) and Vol. 9 (two issues)
- Editor, A White Paper of Marine Education, Ministry of Education (2007 – present)
- Editor, 2006 Marine Policy White Paper, Executive Yuan (Cabinet) (2004 – 2006)
- Organizer, The 2007 National Summit on Marine Education, Ministry of Education (January 2007)
- Organizer, The 7th APEC Roundtable Meeting on the Involvement of Business/Private Sector in the Sustainability of Marine Environment, Taipei, Taiwan (April 2007)
- Organizer, The 2007 International Symposium on Marine Affairs and the Law of the Sea, Taipei, Taiwan (May 2007)
- Organizer, The Second Taiwan-Japan Seminar on Development and Management of Fisheries, Taipei, Taiwan (July 2007)
- Organizer, The 8th APEC Roundtable Meeting on the Involvement of Business/Private Sector in the Sustainability of Marine Environment, Taipei, Taiwan (November 2007)
- Co-organizer, 2007 International Conference on National Parks and Green Network – Toward "Green" Taiwan, Taipei, Taiwan (December 2007)

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2. 邱文彥編著（2003），「海洋與台灣：海洋文化與歷史」，台北：胡氏出版社。
3. 邱文彥編著（2003），「海洋與台灣：海洋產業發展」，台北：胡氏出版社。
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38. Chiau, Wen-Yan (2006), The Conservation Strategies of Dongsha (Pratas) Marine Park, Chinese Taipei. APEC Bulletin on Marine Resource Conservation and Fisheries 8(1): 23-25.
39. Chou, C.L., T. C. Shih and W. Y. Chiau (2006), Assessment of Environment Capacity and Development of Risk Assessment Mythologies and Guidelines for Use in Marine Aquaculture in APEC Region：A Pilot Study in Chinese Taipei. APEC Bulletin on Marine Resource Conservation and Fisheries 8(2): 12-17.
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41. Chiau, Wen-Yan (2007), The marine environment in the South China Sea：Issue and challenges. In: Special Issues: Transboundary Environmental Issues in Southeast Asia. Asia-Pacific Forum 36: 227-247.
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Islet in Taiwan, Science of the Total Environment 407: 1824-1833 (SCI).

43. Chiau, Wen-Yan (2009), Environmental changes in Dongsha (Pratas) Atoll, Taiwan: Lessons from maritime archaeology. In: Special Issue: Island Environmental Histories and Management in the Asia-Pacific Region. Asia-Pacific Forum 44: 233.
44. Yi-Che Shih, Y-C. and Chiau, W-Y.(2009), Planning a marine protected area at Chinwan, Penghu, Taiwan, Ocean & Coastal Management 52: 433- 438 (SCI).
45. Chiau, Wen-Yan (2009), Integrated Coastal Zone Management. In: Critical States: Environmental Challenges to Development in Monsoon Southeast Asia. Eds. Lebel, L., Snidvongs, A., Chen, A. C-T., and Daniel, R. Malaysia, Strategic Information and Research Development Centre. pp. 343-357.
46. Shih, Y-C., Chou, C. L., and Chiau, W-Y. (2010), Maritime safety for fishing boat operations and avoidable hijacking in Taiwan, Marine Policy 34: 349-351 (SSCI).

Conference Papers

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2. Chiau, Wen-Yan (2001), Integrated coastal management and local community involvement. International Workshop on Fisheries Policy and Management for the South-Pacific Region. 10-24 July 2001, Keelung.
3. Chiau, Wen-Yan (2001), Capability building and empowering local communities in wetland management: two cases in Taiwan. Symposium Program and Abstracts. Asia Wetland Symposium, 27-30 August 2001, p. 57.
4. Chiau, Wen-Yan (2001), The Canadian oil spill response regime and its possible application to coastal management in Chinese Taipei. Proceedings of APEC Roundtable Meeting on the Involvement of the Business/Private Sector in the Sustainability of the Marine Environment, Kaohsiung City, 11-12 October 2001, p. III.3-1—3-2.
5. Chiau, Wen-Yan (2002), Estasblishing the Tungsha (Pratas) Islands as Taiwan's first marine protected areas: key issues and challenges. Proceedings of the Fourth Conference on the Protected Areas of East Asia, IUCN/WCPA-EA-4, Yangmingshan National Park, Taiwan. March 18-23, pp. 387-397.
6. Chiau, Wen-Yan (2002), Wetland conservation and its vision for Taiwan. Proceedings of Wetland Conservation and Need for International Cooperation in the Northern Asia. Pusan, Korea. May 24-25, 2002. Pp. 29-44.
7. Chiau, Wen-Yan (2002), Planning and management of marine ecotourism. Proceedings of Eco-turism Conference. Palau, September 12-13, 2002.Pp. 32-46.
8. Chiau, Wen-Yan (2002), Water resource management and its vision for Taiwan, Paper presented at the Conference of Society for Environmental Economics and Policy Studies. Hokkaido, Japan, September 28-29, 2002.
9. Chiau, Wen-Yan (2002), Ocean policy and management in Taiwan: issues and challenges. Paper presented at Oceanic Asia: Island's Forum. Fukuoka, Japan, November 29, 2002.
10. Chiau, Wen-Yan (2003), Marine protected areas in Taiwan: recent initiatives and issues. Proceedings of Marine Environmental Protection and Resources Sustainability. Taipei, Taiwan, November 3-4. 2003.
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18. Chiau, Wen-Yan, 2007, The coastal policy in Taiwan: Recent development and challenges ahead. Final report of the 2007 International Symposium on Marine Affairs and the Law of the Sea, May 10-11, Taipei, Taiwan, pp. 3-33~3-45.
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Current Positions

Unit Head, Marine Living Resources, Biotechnology and Ecosystems Studies, Institute of Ocean and Earth Sciences (IOES), University of Malaya
Professor, University of Malaya, since 2004
Coordinator, Division of Ecology and Biodiversity, Institute of Biological Sciences, University of Malaya

Education

Ph.D., University of Malaya, 1994
M.Sc., University of Malaya, 1984
B.Sc. (Hons.) in Zoology, University of Malaya, 1977
Study leave: Biological Oceanography, University of Rhode Island, Spring Semester, 1980

Research Interests

Mangrove, Mudflat and Coastal Fisheries Ecology, Zooplankton and Macrobenthos Ecology, Biofouling, Aquaculture, Feed Enrichment for Hatchery Culture of Fish, Bioremediation of Aquaculture Effluents

Experience

1999 – 2003, Associate Professor, University of Malaya
1989 – 1999, Lecturer, University of Malaya
1977 – 1988, Career tutor, University of Malaya

Major Research Awards & Collaborative Research

- Study on the biology, ecology and management of commercially-important fish species in mangrove estuaries and related coastal waters of Malaysia, (Japan International Center for Agricultural Sciences, JIRCAS, 2006-2010)
- Effects and control of biofouling on mangrove seedlings (FRIM – RMK-9 Project, 2008-2010)
- Bioremediation of mariculture effluents using indigenous microbial organisms (National Oceanographic Directorate, 2008-2010)
- Ecology and management of mud lobsters in Carey Island (UM- Golden Hope Biodiversity of Heritage Island Research Projects, 2005-2010)
- Linking marine biotopes: Fish diversity-seascape mosaics interrelationships, trophodynamics and life-cycle dependencies. UMRG grant, 2009-11
- Quantifying nursery value of mangroves for fisheries: A multi-criteria approach, (R&D, 2006-2008)
- Enrichment of live zooplankton feed for aquaculture (FS271/2007C, 2007-8)
- Floristic and faunistic studies of northeast Langkawi (PFF award) 2004-2005; 2006

(continuation)

- Sustainable production systems of aquatic animals in brackish water mangrove areas (Japan International Center for Agricultural Sciences, JIRCAS, 2001-2005)
- Environmental effects of cage culture in mangrove waters (R &D award, 1999-2002)
- Containment and mortality risks of larval fish and prawn in mangrove waters (R&D award, 2002- 2004)
- Productivity and sustainable utilization of brackishwater mangrove ecosystems (JIRCAS, 1995-1999)
- Production of Indigenous Microbial Feed for Aquaculture (R & D award, in collaboration with leader, S. Vickineswary, 1996-2002)
- Ecology of the Klang Straits (R & D award, 08-02-03-0249, 1996-1998)
- Contribution of mangrove detritus to the production of commercially-important shrimp species. (USAID award, in collaboration with University of Maryland, 1989-1991)
- ASEAN-AUSTRALIA Cooperative Program on Marine Science - Living Resources in Coastal Areas (Phases I & II). (Australian International Development Assistance Bureau (AIDAB) award, in collaboration with leader, A. Sasekumar, 1987-1994)

Recent Publications

Books /Edited Books

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2. **Chong VC** & Choo PS. (1999). Productivity and Sustainable Utilization of Brackish Water Mangrove Ecosystems", JIRCAS and University of Malaya.
3. **Chong, V.C.** (1999). Mangrove Fisheries of the Sungai Johor Estuarine System. Preparation of an Integrated Management Plan for Sustainable Use of the Johor Mangrove Forests. Project Document No. 8, Forestry Department Peninsular Malaysia, Danish Cooperation for Environment and Development and Johor State Government.
4. Phang SM, **Chong VC,** Ho SC, Noraieni Mokhtar & Jillian Ooi LS (2004). Marine Science into the New Millenium: New Perspectives and Challenges, University of Malaya Maritime Research Centre, Kuala Lumpur.
5. Azhar Hussin, **Chong VC,** Md Yusoff Musa, Md Sofian Azirun, Rosli Hashim, Phang SM. (eds) (2005). Scientific Expedition to Langkawi by the University of Malaya Maritime Research Centre, Special Issue, October 2005, Malaysian Journal of Science 24, University of Malaya.
6. Sasekumar A. & **Chong VC.** (2006). Ecology of Klang Strait, University of Malaya Press, University of Malaya, Kuala Lumpur.
7. Phang SM, Azhar Hussin, **Chong VC,** Mary George, Siti Aisyah Alias & Ho SC. (2006). Innovations and Technologies in Oceanography for Sustainable Development, University of Malaya Maritime Research Centre, Kuala Lumpur.
8. Phang SM, Azhar Hussin, **Chong VC,** Rosli Hashim & Siti Aisyah Alias (2007). Gems in the Straits of Malacca, University of Malaya Maritime Research Centre, Kuala Lumpur.
9. Siti Aisyah Alias, **Chong V.C.** (eds) (2008). Scientific Expedition to the Seas of Malaysia (SESMA I & II), Institute of Ocean & Earth Sciences, University of Malaya. Malaysian Journal of Science Vol. 27 (special issue), Faculty of Science, University of Malaya.
10. **Chong V.C.,** A. Sasekumar (eds) (2010). Scientific Expedition to the Seas of Malaysia (SESMA IV), Institute of Ocean & Earth Sciences, University of Malaya. Results of the Research Findings on the Scientific Expedition to Bachok's Coastal Environment, Kelantan, 14-20 June 2008, Malaysian Journal of Science (Special Issue), in press.

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8. Singh, H.R., Chong V.C. & M.Zakaria-Ismail (2003). Morphological differentiation among estuarine catfishes of the family Ariidae of the Matang ecosystem, Perak. Malayan Journal of Science 22: 7-13.
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PUBLICATIONS

Peer Reviewed Journals

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2. Dai, M.H., J.M. Martin and G. Cauwet 2000. Colloidal organic carbon and trace metals. In, Venice Lagoon Ecosystem-Inputs and Interactions between Land and Sea, P. Lasserre & A. Marzollo (editors), Chapter 3, pp. 47-58, Parthenon Publishing, UK.
3. da Silva, J-M. Martin, M.H. Dai & L. Xu, 1998 Exploring Data from the Pearl River Estuary with simple tools, Proceedings Second International Conference on the Pearl River Estuary in the Surrounding Area of Macao, GUANGZHOU and MACAO, 11-15 MAY, 1998.
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12. Wang, X. and M. Dai, 1986，Environmental Science, in New Fronties of Science, Bao Zhengyuan (editor), Fujian People's Press, pp. 113-118.

CURRICULUM VITAE

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Current Position

Research Geophysicist, Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego, since 2004

Education

Ph.D. in Engineering, Technical University of Denmark, 1986
M.S. in Engineering, University of Western Ontario, Canada, 1984
M.S. in Engineering, Technical University of Denmark, 1983

Research Specialties

Global optimization, Modeling, and Inversion of Acoustic, Elastic, and Electro-magnetic Signals

Experience

2004 – present, Research Geophysicist, Marine Physical Laboratory, Scripps Institution of Oceanography (SIO), UCSD
1997 – 2004, Associate Scientist, Marine Physical Laboratory, SIO, UCSD
1999 – 2000, Senior Seismic Acoustic Officer, Comprehensive Nuclear-Test-Ban Treaty Organization
1992 – 1997, Senior Scientist, NATO SACLANT Undersea Research Centre, La Spezia, Italy
1989 – 1990, Visiting Scientist, Dept. of Ocean Engineering, Massachusetts Institute of Technology
1987 – 1992, Scientist, Odegaard & Danneskiold-Samsoe Acoustics and Vibrations

Publications

1. Bromirski, Peter D, and Peter Gerstoft (2009), Dominant source regions of the Earth's hum, Geophys. Res. Lett., 36, L13303,doi:10.1029/2009GL038903
2. Brooks, Laura A, Peter Gerstoft (2009), Green's function approximation from cross-correlation of active sources in the ocean, J Acoust. Soc. Am., 126, 46-55.
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17. Sabra, Karim G, Philippe Roux, Peter Gerstoft, WA Kuperman, and Mike C Fehler, Extracting coherent coda arrivals from cross-correlations of long period seismic waves during the Mount St. Helens 2004 eruption, Geophys. Res. Lett., 33, L06313, doi:10.1029/2005GL025563, 2006.
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Synergistic Activities

Developed widely used computer codes for the scientific community:

1. SAGA (1992- present) - General geoacoustic and electromagnetic inversion program: about one hundred installations performed in twenty countries. www.mpl.ucsd.edu/people/gerstoft/saga
2. CABRILLO (1997-1999) – Seismic exploration Finite difference modeling of acoustic, elastic and poroelastic media. www.mpl.ucsd.edu/people/gerstoft/cabrillo
3. OSIRIS (1987-1992) - Commercial seismic exploration software for modeling of synthetic seismograms. www.oedegaard.com/products.htm

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Current Positions

University Professor Emeritus, University of the Philippines, since 2005
Honorary Professor, University of Queensland, since 2005

Education

Ph.D. in Marine Biology, Scripps Institution of Oceanography, University of California-San Diego, 1973
M.Sc. in Biology, St Mary's University, Minnesota, 1967
B.A./ B.S.Ed in Social Science/ English, De La Salle University, Manila, 1962

Research Specialties

Coral Reef Ecology and Restoration, Conservation of Marine Resources, Reproduction of Marine Invertebrates and Culture of Giant Clams

Experience

1992/3 – 2005/10, University Professor, University of the Philippines
1975 – 1995, 1996 – 2000, Director, The Marine Science Institute, University of the Philippines
1978/12 – 1992, Professor, College of Science, University of the Philippines
1976 – 1978/11, Associate Professor, College of Science, University of the Philippines
1974 – 1975, Assistant Professor, College of Science, University of the Philippines
1974 – 1975, Acting Director, Marine Sciences Center, University of the Philippines
1967 – 1968, Dean of Student Affairs/Instructor, La Salle University, Bacolod City, Philippines
1962 – 1965, Instructor, La Salle High School, Bacolod City, Philippines

Scholarships/Honors/Awards:

- Lifetime Achievement Award, The Honor Society of Phi Kappa Phi, UP Chapter, 2009
- Achievement Award, De La Salle University Alumni Association (Marine Biology), 2006
- Honorary Professor, University of Queensland Australia, 2005 – 2010
- University Professor Emeritus, University of the Philippines, Diliman, 2005
- Concepcion D. Dadufalza Distinguished Achievement Award, University of the Philippines, Diliman, 2003
- Honorary Member, Asian Fisheries Society, 2001
- Pew Marine Conservation Fellow, The Pew Charitable Trusts, 2001 – 2004
- Group Award for the Species Conservation Category, ROYALE 2001 Awarding- Rotary Club of Makati, 2001
- Presidential Lingkod Bayan (Service to the Nation) Award, Civil Service Commission, 2000
- Gregorio Y. Zara Award (Basic Science), Philippine Association for the Advancement of Science (PHILAAS), 1998
- Gawad Chanselor: Outstanding Administrator of an Institute, University of the Philippines

Diliman, 1997

- Outstanding Science Administrator, Department of Science and Technology/NSTW, 1996
- Academician, National Academy of Science and Technology, 1993
- The Outstanding Filipino (TOFIL) in Science (Marine Biology), Philippine Jaycee Senate, 1992
- University Professor, University of the Philippines, 1992
- Likas Yaman Award, Department of Environment and Natural Resources, 1989&1982
- Global 500 Roll of Honour, United Nations Environment Programme, 1989
- Outstanding Administrator, University of the Philippines, 1988
- Earth Award, National Environment Protection Council, Min. of Human Settlements, 1982
- Foreign Graduate Scholarship, National Science Development Board (now DOST), 1968 – 1973
- Fulbright Travel Grantee, Philippine American Educational Foundation, 1965 – 1966
- Graduated Summa cum laude/Gold Medal for General Excellence, De La Salle University, Manila, 1962

Publications

Referred Journals

1. Guest, JR., R.M. Dizon, A.J. Edwards, C. Franco and **E.D. Gomez.** How quickly do fragments of coral "self-attach" after transplantation. Restoration Ecol. DOI: 10.1111/j.1526-100X.2009.00562.x
2. Palomar, M.J.S., H.T. Yap and **E. D. Gomez**. Coral transplant survival over 3 years under different environmental conditions at the Hundred Island, Philippines. Philipp. Agric. Scientist. 92(2): 143-152
3. Dizon, R.M., A.J. Edwards and **E.D. Gomez**. Comparison of three types of adhesives in attaching coral transplants to clam shell substrates. Aquatic Conservation: Marine and Freshwater Ecosystems. 18(7): 1140-1148
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8. Raymundo, L.J., A.P. Maypa, **E.D. Gomez** and P. Cadiz. Can dynamite-blasted reefs recover? A novel, low-tech approach to stimulating natural recovery in fish and coral populations. Mar. Pollut. Bull. 54: 1009-1019
9. Hoegh-Guldberg, O., P.J. Mundy, A.J. Hooten, R.S. Steneck, P. Greenfield, **E. Gomez**, C.D. Harvell, P.S. Sale, A.J. Edwards, K. Caldeira, N. Knowlton, C.M. Eakin, R. Iglesias-Prieto, N. Muthiga, R.H. Bradbury, A. Dubi, and M.E. Hatziolos. Coral reefs under rapid climate change and ocean acidification. Science 318:1737-1742.
10. Raymundo, L.J., A.P. Maypa, **E.D. Gomez** and P. Cadiz. Can dynamite-blasted reefs recover? A novel, low-tech approach to stimulating natural recovery in fish and coral populations. Mar. Pollut. Bull. 54: 1009-1019
11. Newman, W. and **E. Gomez**. The significance of the giant clam *Tridacna squamosa* at Tubuai,

Austral Islands, French Polynesia. Coral Reefs 26: 909 [**short communication**]

12. **E.D. Gomez** and S. S. Mingoa-Licuanan. Achievements and lessons learned in restocking giant clams in the Philippines. Fisheries Research 80: 46-52
13. **Gomez, ED.**, P.C. Cabaitan and K.C. Vicentuan. Coral Culture and Transplantation and Restocking of Giant Clams in the Philippines. Pp 39-48. In Proc. of the Regional Technical Consultation on Stock Enhancement for Threatened Species of International Concern. (Primavera, J.H., et al., eds.), 13-15 July 2005, Iloilo City, Philippines.
14. Kaufman, L., J.B.C. Jackson, E. Sala, P. Chisholm, **E.D. Gomez**, C. Peterson, R. V. Salm and G. Llewellyn. Restoring and maintaining marine ecosystem function. Chapter 9, pp. 165-181: In Glover, L.K. and S.A. Earle (eds.). Defying Ocean's End: An Agenda for Action. Island Press, Washington, xxiv, 283 pp.
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16. Licuanan, W. Y. and **E. D. Gomez.** Philippine coral reefs: Status and the role of academe to improve their management Proc. 9th Int. Coral Reef Symp. 2:835-840.
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27. **Gomez E.D.** Reef management in developing countries: the Philippines as a case study. In Proc. 8th Int. Coral Reef Symp. (Lessios, H.A. and Macintyre, I.G. (eds.) 2429 June 1996, Panama. 1:123-128.
28. **Gomez E.D.** and LT McManus. Case Study 4 – Coastal management in Bolinao town and the Lingayen Gulf, the Philippines. GESAMP Rep. Stud. (61):57-66.
29. **Gomez E.D.** and L.M. Chou. Assessment and management of coral reef resources in the ASEAN region. In De Silva, Sena S. (ed.), *Perspective in Asian Fisheries: a volume to commemorate the 10th Anniversary of the Asian Fisheries Society*. Asian Fisheries Society,

Makati City, Philippines. pp. 173-188.

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31. *Perspective in Asian Fisheries: a volume to commemorate the 10th Anniversary of the Asian Fisheries Society.* Asian Fisheries Society, Makati City, Philippines. pp. 281-299.
32. McManus J.W., C.L. Nafiola, A.G.C. del Norte, R.B. Reyes, J.N.P. Pasamonte, N.P. Armada, **E.D. Gomez,** and P.M. Aar). Coral reef fishery sampling methods. (Ch. 5). pp. 226-270. In V.F. Gallucci, S.B. Saila, D.J. Gustafson, and B.J. Rothschild (eds.). Stock assessment: quantitative methods and applications for small-scale fisheries. CRC Press, Inc. Boca Raton, x, 527 p.
33. Alino P.M. and **E.D. Gomez**. Philippine coral reef conservation: its significance to the South China Sea. In Proc. Reg. Conf. East-West Center Assoc. "Regional Development in the 21st Century - Think Globally, Act Locally" Nov. 5-6, 1993, Naha, Okinawa, Japan. pp.222-229.
34. **Gomez E.D.** Coastal zone management and ecosystem protection: prospects for cooperation in Southeast Asia. pp. 191-206. In SEAPOL Singapore Conf. on Sustainable Development of Coastal and Ocean Areas in Southeast Asia: Post-Rio Perspectives. 26-28 May 1994. The Regent, Singapore. (National University of Singapore).
35. Alino P.M., M.A. Juinio-Mefiez and **E.D. Gomez**. Developments in planning and management of coastal resources in the Philippines. pp. 21-31 In Proc. Reg. Workshop on Planning and Management of Coastal Resources, Sabah, Malaysia, 7-9 November 1994.
36. **Gomez E.D.** Capacity building: a case study of the Marine Science Institute, University of the Philippines. pp. 110-114 In Proc. Rhode Island Workshop on Educating Coastal Managers. 4-10 March 1995, University of Rhode Island, U.S.A.
37. Dela Paz R.M. and **E.D.Gomez.** Faunal diversity in the marine coastal zone. In: Biodiversity Conservation-- Reports 1995/No. 2. U.P. Center for Integrative and Development Studies, University of the Philippines Press, Quezon City.
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41. **Gomez E.D.**, M.A.R. Juinio and N.A. Bermas. Reproduction of *Panulirus longipes longipes* in Calatagan, Batangas, Philippines. Crustaceana 67(1):110-120.
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44. **Gomez E.D.** and E.B. Miclat. Implications for integrated planning & management of coastal and marine areas, pp. 81-89. In: Report of the Planning Workshop for Integrated Ocean Planning and Management Strategies & their Implementation for Philippine Fisheries, PRIMEX, DA-BFAR, CIDA and OIC, Manila, 21-23 February, 161 pp.
45. **Gomez E.D.** The Marine Science Institute: center of excellence, pp. 31-48. U.P.: In Search of Academic Excellence. Lecture in honor of President Jose V. Abueva, (1987-1993). Center for Integrative & Development Studies/U.P. College of Public Administration, Quezon City, University of the Philippines Press. 236p.
46. Wilkinson, C.R., L.M. Chou, **E.D. Gomez**, I. Mohammed, S. Soekarno, and S. Sudara. A regional approach to monitoring coral reefs: studies in Southeast Asia by the ASEAN-Australia Living Coastal Resources Project. Proc. Seventh Int. Coral Reef Symp. (1992) 1:138-143.

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49. **Gomez E.D.** Coastal, inshore and marine problems. In: Brookfield, H. and Byron, Y., eds. South-East Asia's Environmental Future: The Search for Sustainability. p. 268-274.
50. Ablan MCA, JM Macaranas and **E.D. Gomez.** Genetic structure of the giant clam *Tridacna derasa* from five areas in Asia and the Pacific. In Proc. AADCP Workshop in Genetics in Aquaculture and Fisheries Management (Penman D, Roongratri N and McAndrew B, eds.) 31 Aug – 4 Sept 1992, University of Stirling , Scotland. pp. 57-62.
51. **Gomez E.D.** Conservation of marine resources. Proceedings of the Seventh Asian Symposium in Medicinal Plants, Spices and other Natural Products (ASOMPS VII). pp. 164-173.
52. **Gomez E.D.** and N.A. Bermas. Coastal zone management in the Philippines: development and perspectives, pp. 115-122. In: Matics, K.I., T.L. McDorman and C. Parker (eds.). Proceedings: Selected papers presented at the Phuket and Chianmai SEAPOL Workshops (1989 and 1991).
53. Alino P.M., A.J. Uychiaoco, N.A. Bermas and **E.D. Gomez.** Assemblage structure of coral reef fish: multi-scale correlations with environmental variables, pp. 119-124. In: Chou, L.M. and C.R. Wilkinson (eds.). Third ASEAN Science and Technology Week Conference Proceedings, Vol. 6, Marine Science: Living Coastal Resources, 21-23 September 1992, Singapore. Department of Zoology, National University of Singapore and National Science and Technology of Board, Singapore.
54. Pamintuan I.S., P.M. Alino, **E.D. Gomez** and M.R.S. Yap. Patterns of recruitment of the fish and macrobenthic organisms on two artificial reef sites in Bolinao, Pangasinan, Philippines, pp. 369-375. In: Chou, L.M. and C.R. Wilkinson (eds.). Third ASEAN Science and Technology Week Conference Proceedings, Vol. 6, Marine Science; Living Coastal Resources, 21-23 September 1992, Singapore. Department of Zoology, National University of Singapore and National Science and Technology Board, Singapore.
55. Yap H.T., P.M. Alino and **E.D. Gomez.** Trends in growth and mortality of three coral species (Anthozoa: Scleractinia), including effects of transplantation. Mar. Ecol. Prog. Ser. 83:91-101.
56. Sajise P.E., N.E. Tapay, E.P. Pacardo, N.D. Briones, R.D. Jimenez, **E.D. Gomez**, P.M. Zamora, M.D. Fortes, M.T. Zafaralla, and I. Zosa-Feranil. Saving the present for the future: the state of the environment. State of the Nation Reports No. 1. University of the Philippines Center for Integrative and Development Studies and University of the Philippines Press. 54p.
57. **Gomez E.D.** Coral reef ecosystems and resources of the Philippines. Philipp. Tech. J. 16(4):48-58. Also in Canopy Int. 16(5): lf.
58. **Gomez E.D.** The marine ecosystem. pp. 5-6. In: Trono, G.C., Jr., C.R. Pagdilao and M.M. Acedera (eds.). Training on Seaweed Research, Proceedings of the Seaweed Research Training and Workshop for Project Leaders. Marine Science Institute, University of the Philippines, Diliman, Quezon City, 23 November-10 December 1987, Los Baflos, Laguna, Philippine Council for Aquatic and Marine Research and Development 1991. 175p. (Book series No. 11/1991).
59. **Gomez E.D.** Marine science education in the Philippines: prospects for a program in coastal zone management, p. 31-36. In T.E. Chua (ed.) Coastal area management education in the ASEAN region. ICLARM Conference Proceedings 29, 92p. International Center of Living Aquatic Resources Management, Manila, Philippines.
60. Corrales R.A., **E.D. Gomez**, S. Hall and C. Gonzales. Paralytic shellfish poisoning in the Philippines: Are *Pyrodinium* blooms necessary? In Aubert and Auber (eds.) Actes du 9e Colloque International D' Oceanographic Medicate. 22-24 October 1990, C.E.R.B.O.M. Nice, France. pp. 161-167.

61. Juinio A.R., J.M. Macaranas, and **E.D. Gomez.** Sympatric occurrence of two subspecies of *Panulirus longipes*Milne Edwards 1868 (Decapoda: Palinuridae) and biochemical evidence of interbreeding. 1990 International Crustacean Conference. Memoirs of Queensland Museum 31:209.
62. Miles D.H., V. Chittawong, D.S. Lho, A.M. Payne, A.A. dela Cruz, **E.D. Gomez**, J.A. Weeks and J.L. Atwood. Toxicants from mangrove plants, VII. Vallapin and vallapianin, novel sesquiterpene lactones from the mangrove plant *Heritiera littoralits*. J. Nat.Products 54(1): 286-289.
63. Miles D.H., V. Chittawong, A.A. dela Cruz, A.M. Payne, and **E.D. Gomez**. Novel fish toxins of the cadinane sesquiterpene class. American Chemical Society Symposium Series No. 449, 317-322.

Other international:

Report:

1. Hoegh-Guldberg, O., Hoegh-Guldberg, H., Veron, J.E.N., Green, A., **Gomez, E. D.**, Lough, J., King, M., Ambariyanto, Hansen, L., Cinner, J., Dews, G., Russ, G., Schuttenberg, H. Z., Penaflor, E.L., Eakin, C. M., Christensen, T. R. L., Abbey, M., Areki, F., Kosaka, R. A., Tewfik, A., Oliver, J. (2009) The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk. WWF Australia, Brisbane, 34 pp. (Summary report) ISBN 978-1-921031-35-9.

Book chapter:

1. White, A.T., **E.D. Gomez,** A.C. Alcala and G. Russ. Evolution and Lessons from Fisheries and Coastal Management in the Philippines. (Ch. 5). Pp 88-111. In T. McClanahan and J.C. Castilla (eds.). *Fisheries Management: Progress Toward Sustainability.* Blackwell Publishing.

Manuals:

1. Edwards, A.J. and **E.D. Gomez.** *Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty.* Coral Reef Targeted Research and Capacity Building for Management Programme: St Lucia, Australia. iv + 38 pp.
2. Mingoa-Licuanan, S.S. and **E.D. Gomez.** *Giant Clam Hatchery, Ocean Nursery and Stock Enhancement.* SEAFDEC AQD, Iloilo City, AEM No. 37, x, 109 pp.

CURRICULUM VITAE

John W. McManus

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Miami, Fl. 33149, USA
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Current Positions

Professor and Director, National Center for Caribbean Coral Reef Research (NCORE), Rosenstiel School for Marine and Atmospheric Sciences, University of Miami

Education

PhD. in Biological Oceanography, University of Rhode Island, 1985
M.A. in Zoology, University of Connecticut, 1978
B.A. in Biology, University of Connecticut, 1974

Research Specialties

Coral Reef Assessment, Monitoring, Modeling and Management; Ecology; Fisheries; Natural and Man-Made Hazard Mitigation; Population Biology; Computer and Computation Research; Coastal Development; Ecological Indicators; Ecotourism; Endangered Species; Habitat Loss; Harmful Algal Blooms; Invasive Species; Overfishing and Bycatch; Sustainable Development; Geographic Information Science (GIS); Decision, Risk and Management Science

Experience

1993 – 2000, Senior Scientist (and Program Leader from Jan. 1996), Aquatic Environments Program International Center for Living Aquatic Resources Management (ICLARM, now WorldFish)

1992 – 1993, Associate Professor, Fisheries, University of Rhode Island

1986 – 1992, Assistant Professor, Fisheries, University of Rhode Island

Honor

One of the most innovative people or organizations in the world, 2006

Recent Publications

5 Selected Publications Relevant to this Proposal (of more than 80)

1. Brandt M, McManus JW (2009) Dynamics and impact of the coral disease white plague: insights from a simulation model. Disease of Aquatic Organisms 87: 117 – 133. doi: 10.3354/dao02137.
2. Brandt, M. and McManus, J.W. (2009). Disease incidence is related to bleaching severity in reef-building corals. Ecology 90(10): 2859 – 2867.
3. Yñiguez, A, McManus, J.W. and DeAngelis, D.L. (2008) Allowing macroalgae growth forms to emerge: use of an agent-based model to understand the growth and spread of macroalgae in Florida coral reefs, with emphasis on Halimeda tuna. Ecological Modelling 216: 60 – 74.
4. Kleypas, J., McManus, J.W. and Meñez, L.A.B. 1999. Environmental limits to coral reef development: Where do we draw the line? American Zoologist.39, 146 – 159.
5. McManus, J.W., C.L. Nañola, and R.B. Reyes. 1997. Effects of some destructive fishing methods on coral cover and potential rates of recovery. Environmental Management. 21(1): 69 – 78.

5 Other Selected Publications:

1. McManus, J.W. and J.F. Polsenberg. 2004. Coral-algal phase shifts on coral reefs: ecological and environmental aspects. Prog. Oceanogr. 60:263 – 279.
2. Chen CA, Ablan MCA, McManus JW, Bell J.D., Tuan V.S., Cabanban A.S. and Tsao K.S, 2004. Population structure and genetic variability of six bar wrasse (Thallasoma hardwicki) in northern South China Sea revealed by mitochondrial control region sequences Marine Biotechnology 6 (4): 312 – 326.
3. McManus, J. W., L.A.B. Meñez, K.N.K. Reyes, S.G. Vergara, and M.C. Ablan. 2000. Coral reef fishing and coral-algal phase shifts: implications for global reef status. ICES Journal of Marine Science 57(3): 572 – 578.
4. Pollnac, R.B., McManus, J.W., del Rosario, A. E., Banzon, A.S., Vergara, S.G. and Gorospe, M.L.G. 2000. Unexpected relationships between coral reef health and socio-economic pressures in the Philippines: ReefBase/RAMP applied. Marine & Freshwater Research 51:529 – 533.
5. McManus, J.W. 1997. Tropical marine fisheries and the future of coral reefs: a brief review with emphasis on Southeast Asia. Coral Reefs 16 Suppl. S121 – S127.

Synergistic Activities

1. Published the first large-scale source-sink marine connectivity study indicating a need to turn the Spratly Islands into an international marine peace park in order to maintain existing regional fisheries and marine biodiversity – forming a working hypothesis for several major international investigations in the South China Sea. The concept was based on a study of potential connections among reef populations, a study that led to considerable follow-up research in areas such as the Caribbean. My subsequent research on the issue has included leading a 6-nation, 3-year cooperative population genetics project. The peace park effort is now official policy in Taiwan and has broad regional support.
2. Demonstrated that for many developing countries, one can assume that the fishing effort should be reduced by 60% to achieve maximum economic yields. The result arises from the properties of the Gordon-Schaefer Bioeconomic Model, and applies where there is an excess labor force, open access to coastal resources, a history of poverty among fishers and some other conditions that are widely met. The 60% rule is used by international development agencies and appears in documents associated with the Convention on Biological Diversity.
3. Founded Reef Base: a Global Database on Coral Reefs and their Resources – now the official database of the Global Coral Reef Monitoring Network with a broad range of data on more than 10,000 coral reefs. It has served as the basis for many global analyses including the 1995 International Coral Reef Initiative State of the Reefs Report and the 1999 Reefs at Risk Analysis.
4. Led the development of the International Coral Reef Action Network (ICRAN), involving UNEP, ICLARM and several other agencies in a 5-yr integrated umbrella project to reduce global reef degradation through research, information and training. Development funds of $1.5 million and expected $10 million in seed funds from the UN Foundation will start a Coral Reef Fund involving multiple donors. The program now guides most of the coral reef work of UNEP.
5. Selected for membership in World Technology Society as “one of the most innovative people or companies in the world in 2006”,then selected as plenary speaker at the World Summit on Innovation and Enterprise, April 1 – 3, 2008, Dubai, to describe to a select international group of government ministers and corporate representatives how to bolster innovation in marine science. Chair of the 2007 NOAA National and International Coral Reef Conservation Program Review Panel. Currently chair of the Gaps and Priorities Working Group of the Ecosystem-Based Tool Developers Consortium (International), and scientific advisor to the Living Oceans Foundation.

CURRICULUM VITAE

Van Quan Nguyen

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Current Position

Head, Department of Marine Biodiversity and Conservation, IMER, Vietnam, since 2010

Education

Ph.D. in Marine Biology, National University at Hanoi, Post Graduate Council at Research Institute for Marine Fisheries, Vietnam, 2009

M.Sc. in Marine Science (Marine Fish Biology), Marine Science Institute, College of Science, University of the Philippines, Diliman, Vietnam, 2001

B.Sc. in Marine Biology (Marine Aquaculture - With Excellence), National University at Vinh City, Vietnam, 1996

Research Specialties

Coral reef fish species with research interests in fish taxonomy, Fish - habitat relationships, Ecological restoration of coral reef ecosystems, Sustainable coastal resources

Experience

2009 – 2010, Member of the Steering Committee of DIVERSITAS in Western Pacific and Asia

2005 – 2009, Head, Ecological Underwater Research Division, Department of Marine Biodiversity and Conservation, IMER

1996 – 2007, Research Associate

Recent Publications

1. Nguyen, Van Quan (2009) On the gut content, community structure and potential using of butterflyfishes (Chaetodontidae) as bioindicators for coral reef health. Journal of Biology. No 31, Volume 2, pp: 42-49 (in Vietnamese)
2. Nguyen, Van Quan (2009) Lack of information about the spawning aggregation sites for coral reef fishes – ecological challenges when establishment of the marine protected areas in Viet Nam. Journal of Marine Sciences, No 1, Vol. 3 (in progress, Vietnamese version)
3. Nguyen, Van Quan, Chu Tien Vinh (2009) Study on potential usage of the family Chaetodontidae as the bioindicators for reef health in coastal areas of Vietnam. Journal of Agricultural Sciences. No 1, Vol 1, pp: 15-23 (in Vietnamese).
4. Nguyen, Van Quan (2008) Coral reef fish resources in Nha Trang Bay Marine Protected Area. Journal of Marine Science and Technology Issue 4, Vol. IV: 40-51 (in Vietnamese).
5. Nguyen, Van Quan (2008) Status of the utilization and trade of the keystone reef animals in the coastal area of Ninh Thuan province. Journal of Marine Science, No. 6, pp: 36-42 (in Vietnamese)
6. Nguyen, Van Quan, et al (2008). The coral transplantation experiment contributes a tool for rehabilitation of degraded coral reefs in Ha Long Bay Natural World Heritage Site, Vietnam.

Proceedings of The 4th global conference on oceans, coasts and islands, 4-5 April Hanoi, Vietnam. pp 116-122.

7. Nguyen, Van Quan (2008). Ecological challenges faced by the establishment of the marine protected areas. International Conference on Health of the Marine Ecosystems of South East Asia *Towards an Integrated and Holistic Strategy* Hanoi, Vietnam, Feb. 18-20, 2008
8. Nguyen, Van Quan and Bui Dinh Chung (2007). Community structure of fishes in Nha Trang Bay Marine Protected Area, Vietnam. LIPI and JSPS Joint Seminar on Coastal Marine Science, August 3-5, Yogjakarta, Indonesia.
9. Lang Van Ken and Nguyen Van Quan (2007). Status and changes in biotic resources of the Tam Giang Cau Hai lagoon. Journal of Marine Science and Technology, Vol. I pp 44-52.
10. Nguyen, Van Quan, 2007. Marine ornamental fish resources in Vietnam. Journal of Marine Sciences, No 4 (In Vietnamese).
11. Nguyen, Van Quan, Nguyen Nhat Thi (2007). Influencing of the fishing practices on the community structure and living resources of coral reef fish in the marine waters of Nam Yet Island, Truong Sa Archipelago. National Symposium on the Basic Research on Life Sciences, Quy Nhon 10/8/2007.
12. Nguyen Van Quan, 2006. Experiment of coral transplantation as the tool for rehabilitation of degraded reefs in Ha Long Bay Natural World Heritage Site, Vietnam. Proceedings of the 1st Asia Pacific Coral Reef Symposium, Hong Kong SAR, China.
13. Nguyen, Van Quan 2006. Coral reef fishes in the marine area of Ba Mun Island, Quang Ninh Province. *Journal of Coastal Marine Sciences*, Special Issue No.1 of the JSPS Multilaterial Project in the coastal oceanography of the South East Asia, Tokyo, Japan, pp. 43-52
14. Nguyen, Van Quan 2005. Coral reef fish resources of Ha Long Bay. *Journal of Marine Science and Technology* Issue No. 5, Vol. IV. pp. 39-51 (In Vietnamese)
15. Nguyen, Van Quan and Nguyen Nhat Thi 2005. Species composition and distribution of coral reef fishes in marine waters of Vietnam. *Proceedings of the 2005 National Conference on Life Sciences, Hanoi Medical University* (in Vietnamese). pp. 1075-1077 (in Vietnamese)
16. Nguyen, Van Quan and Porfirio M. Alino 2005. The influence of habitat complexity and monsoon on the coral reef fish communities in Bolinao, Lingayen Gulf, Philippines. In: *Abstracts of the 10th International Conference on Coral Reefs*, Okinawa, Japan. pp. 312
17. Nguyen, Van Quan 2005. May habitat complexity support more fishes? A case study of the Hai Van Son Cha marine protected area, Vietnam. In: *Abstracts of 7th International Indo-Pacific Fish Symposium*, May15th - May 20th, Taipei, Taiwan. pp. 54
18. Nguyen, Van Quan 2005. Why coral reefs are consistent with global climate changes? *Journal of Marine Sciences* No. 4. pp. 41-42 (in Vietnamese)
19. Nguyen, Van Quan 2005. Some challenges of ecological studies with establishment of marine protected areas. *Journal of Marine Sciences* No. 9. pp. 35-39 (in Vietnamese)
20. Nguyen, Van Quan and Nguyen Nhat Thi 2004. Biodiversity and living resources of coral reef fishes in the Spratly Archipelago, Vietnam. *Journal of Marine Sciences and Technology* No. 4. pp. 47-63 (In Vietnamese)
21. Nguyen, Van Quan 2003. Biodiversity of the coastal fish in North Vietnam. *Proceedings of the first Vietnam-Italy Scientific Symposium about biodiversity in the coastal zone of North Vietnam.* 11st - 12nd September , Hai Phong City. pp. 236-243
22. Nguyen, Van Quan and Chu Tien Vinh 2002. Artificial Reef. Is this effective for fishery Management and potential application in Vietnamese conditions. *Journal of Fisheries Review*. Hanoi, Vietnam Issue No. 9. pp. 26-29 (In Vietnamese)
23. Nguyen, Van Quan and Nguyen Nhat Thi 1999. Marine fish in Ha Long Bay. *Proceedings of the 4th International Conference on the Marine Biology of the South China Sea*, Manila 22nd - 25th November 1999. pp 30-41
24. Nguyen, Van Quan 1997. Potential resources of marine fish fauna in Ha Long Bay. pp.1-47. Published by Hai Phong Institute of Oceanography (In Vietnamese)

CURRICULUM VITAE

Henrik Schmidt

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Current Position

Professor, Mechanical and Ocean Engineering, M.I.T.

Education

Ph.D., Department of Structural Engineering, Technical University of Denmark, 1978
M.Sc., Department of Structural Engineering, Technical University of Denmark, 1974

Research Specialties

Arctic acoustics, Shallow water acoustics, Scattering and reverberation due to sea surface and ice roughness, Development of robust algorithms for parameter estimation by matched field processing, Determination of seismic-acoustic propagation and reverberation in range dependent ocean environments as well as anisotropic elastic media, 3-D acoustics in very shallow water with applications to seabed imaging and mine countermeasures using undersea vehicle methods, Acoustic tomography for coastal ocean observation and forecasting

Experience

2005 – present, Professor, Mechanical and Ocean Engineering, Dept. of Mechanical Engineering, M.I.T.

2007 – 2008, Visiting Scientist, NATO Undersea Research Centre, La Spezia, Italy

1994 – 2005, Associate Department Head, Ocean Engineering, Dept. of Mechanical Engineering, M.I.T.

2000/1 – 2000/6, 2002/9 – 2004/12, Acting Department Head, Ocean Engineering, Dept. of Mechanical Engineering, M.I.T.

1994 – 2004, Professor, Ocean Engineering, Dept. of Mechanical Engineering, M.I.T.

1989 – 2002, Associate Research Director, M.I.T. Sea Grant Program

1997 – 1998, Principal Scientist, NATO Undersea Research Centre, La Spezia, Italy

1987 – 1994, Associate Professor, Dept. of Mechanical Engineering, M.I.T.

1985 – 1987, Senior Scientist, NATO SACLANT ASW Center, La Spezia, Italy

1982 – 1985, Scientist, NATO SACLANT ASW Center, La Spezia, Italy

1980 – 1982, Research Fellow, Risoe National Laboratory, Denmark

1978 – 1980, Research Fellow, Dept. of Structural Engineering Technical University of Denmark

Honors and Awards

- Chief Scientist, ONR Shallow Water Autonomous Minine Search Initiative, 2004 – present
- Chief Scientist, NURC GLINT08, Pianosa Island, Italy, 2008
- Lead PI and Chief Scientist ONR PLUSNet Undersea Persistent Surveillance Program, 2005-2008
- Chief Scientist, RV Wecoma, ONR PN07, Dabob Bay, WA, 2007

- Chief Scientist, ONR MINUS07, Narragansett, RI, 2007
- Pioneers of Underwater Acoustics Medal, Acoustical Society of America, 2005
- Executive Council, Acoustical Society of America, 2000 – 2003
- Chief, Scientist NURC/ONR GOATS '98 experiment, 1998
- Chief, Scientist ONR Frontal Dynamics PRIMER, 1996
- Chief, Scientist for Acoustics, ONR Sea Ice Mechanics Initiative, 1994
- Chair, ASA Technical Committee on Underwater Acoustics, 1991 – 1994
- Doherty Professorship in Ocean Utilization, 1990 – 1993
- Fellow, Acoustical Society of America, 1989

Publications

Books or Chapters

1. Jensen, F.B., Kuperman, W.A., Porter, M., and Schmidt, H., Computational Ocean Acoustics, American Institute of Physics, 1994
2. Diachok, O.,Caiti, A., Gerstoft, P., and Schmidt, H., {eds.}, Full Field inversion methods in ocean and seismic acoustics, Kluwer Academic Publishers, Dordrecht, The Netherlands. 1995.
3. Bovio, E., Tyce, R., Schmidt, H., *editors*. Autonomous Underwater Vehicle and Ocean Modelling Networks: GOATS 2000, SACLANTCEN CP-46, LaSpezia, Italy. 2000.
4. Benjamin, M.B., Newman, P.M., Schmidt, H., and Leonard, J.J. Unmanned Marine Vehicle Autonomy, In Preparation, 2009

Refereed Journal Articles

1. Schmidt, H., Baggeroer, A.B., Kuperman, W.A., and Scheer, E.K., "Environmentally tolerant beamforming for high resolution matched field processing: Deterministic mismatch," *J. Acoust. Soc. Am.*, 88, pp. 1851-1862, 1990.
2. Gerstoft P., and Schmidt, H., "A boundary element approach to ocean seismo-acoustic facet reverberation," *J. Acoust. Soc. Am.*, 89, pp. 1629-1642, 1991.
3. Miller and Schmidt, H., "Observation and inversion of seismo-acoustic waves in a complex Arctic ice environment, "*J. Acoust. Soc. Am.*, 89, pp. 1668-1685, 1991.
4. Rolt, K. and Schmidt, H., "Azimuthal ambiguities in synthetic aperture sonar and synthetic aperture radar imagery," *IEEE J. Oceanic Eng*., 17 (1). Pp. 73-79, 1992.
5. Collins, M., Kuperman, W.A., and Schmidt, H., "Nonlinear inversion for ocean bottom properties," *J. Acoust. Soc. Am.*, 92 (5), pp. 2770-2783, November 1992.
6. Schmidt, H., "Numerically stable global matrix approach to radiation and scattering from spherically stratified shells." *J. Acoust. Soc. Am.*, 94 (4), pp. 2420-2430, 1993.
7. J-Y Liu, Schmidt, H., and Kuperman, W.A., "Effect of a rough sea bed on the spectral composition of deep ocean infrasonic ambient noise," *J. Acoust. Soc. Am.*, 93 (2), pp. 753-769, 1993.
8. Ricks, D. and Schmidt, H., "A numerically stable global matrix method for cylindrically layered shells excited by ring forces," *J. Acoust. Soc. Am.*, 95, (6), pp. 3339-3349, 1994.
9. Kurkjian, A., Coates, R.T., White, J.E., and Schmidt, H., "Finite difference and frequency-wavenumber modeling of seismic monopole sensors in fluid-filled boreholes," *Geophysics*, 59 (7), pp. 1053-1064, 1994.
10. LePage, K., and Schmidt, H., "Modeling of low frequency transmission loss in the Central Arctic," *J. Acoust. Soc. Am.*, 96 (3), pp. 1783-1795, 1994.
11. Goh, J.T. and Schmidt, H., "Validity of spectral theories for weakly range-dependent ocean environments—Numercial results," *J. Acoust. Soc. Am.*, 95 (2), pp. 727-732, 1994.
12. Rolt, K. and Schmidt, H., "Effects of refraction on synthetic aperture sonar imaging," *J. Acoust. Soc. Am.*, 95 (6), pp. 3424-3429, 1994.

13. Rolt, K., Schmidt, H., and Rolt, G.H., "Commentary on 'Effects of propagation on the operation of a synthetic aperture sonar' [*J. Acoust. Soc. Am.*, 82 (4) , 1403-1408, Oct. 1987]," *J. Acoust. Soc. Am.*, 96 (4), pp. 469-475, 1994.
14. Schmidt, H., and Kuperman, W.A., 'Spectral and modal representations of the Doppler shifted field in ocean waveguides," *J. Acoust. Soc. Am.*, 96(4) 386-395, 1994.
15. Livingston, E. and Schmidt, H., "A comparison of the conventional, the minimum variance, and the multiple constraint matched field processors," *J. Comp. Acoust*., 2(3), 217-229, 1994.
16. Schmidt, H., and Kuperman, W.A., "Spectral representations of rough interface reverberation in stratified ocean waveguides," *J. Acoust. Soc. Am.*, 97(4), 2199-2209, 1995.
17. Bondaryk, J., and Schmidt, H., "Array processing for the analysis of stiffened, fluid-loaded, cylindrical shells," *J. Acoust. Soc. Am.*, 97(2), 1067-1077, 1995.
18. Schmidt, H., Seong, W., and Goh, J.T., "Spectral super-element approach to range-dependent ocean acoustic modeling," *J. Acoust. Soc. Am.*, 98(1), 465-472, 1995.
19. Kapoor, T. and Schmidt, H., "Spherical coordinate Green's function for ring tractions in a solid unbounded medium," *J. Acoust. Soc. Am.*, 98(5), 2783-2791, 1995.
20. LePage, K., and Schmidt, H., "Analysis of spatial reverberation statistics in the Central Arctic," *J. Acoust. Soc. Am.*, 99(4), 2033-2047, 1996.
21. Bondaryk, J. and Schmidt, H., "Hybrid processing structure for the analysis of scattering from stiffened, fluid-loaded, cylindrical shells," *J. Acoust. Soc. Am.*, 99(4), 2176-2187, 1996.
22. Goh, J.T. and Schmidt, H., "A hybrid coupled waveguide integration approach to range-dependent seismo-acoustic modeling," *J. Acoust. Soc. Am.,* 100(3):1409-1420, 1996
23. Elisseeff, P., and Schmidt, H., "Acoustic propagation through a low Mach number, stratified flow," *J. Acoust. Soc. Am,* 101(4):1936-1944, April 1997
24. Kapoor, T., and Schmidt, H., "Acoustic scattering from a three-dimensional protuberance on a thin, infinite, submerged elastic plate, "*J. Acoust. Soc. Am.*, 102(1):256-265, July 1997.
25. Kapoor, T., and Schmidt, H., "Matched Field evaluation of acoustic scattering from rough Arctic ice," *J. Acoust. Soc. Am.,* 102(2):865-876, August 1997.
26. Goh, J.T., Schmidt, H., P. Gerstoft and W. Seong, "Benchmarks for validating range-dependent seismo-acoustic propagation codes," *IEEE Journal of Oceanic Engineering*, 22(2) , 1997.
27. Tracey, B., and Schmidt, H., "Seismo-acoustic field statistics in shallow water," *IEEE Journal of Oceanic Engineering,* 22(2):317-331, 1997.
28. Cederberg, R.J., Collins, M., Schmidt, H., Siegmann W.L., "Rational operators for filtering," *J. Acoust. Soc. Am.,* 101(5):.02518-2523, 1997.
29. Dudko, Y., Schmidt, H., von der Heydt, K., Scheer, E., "Edge wave observation using remote seismoacoustic sensing of ice events in the Arctic," *J. of Geophy. Res.,* 103(C10):21775-21781, 1998.
30. Elisseeff, P., Schmidt, H., Johnson, M., Herold, D., Chapman, N.R., and McDonald, M.M. "Acoustic tomography of a coastal front in Haro Strait, British Columbia", *J. Acoust. Soc. Am.,*106(2):169-184,1999.
31. Schmidt, H., and Lee, J.Y., "Physics of 3-D scattering from rippled seabeds and buried targets in shallow water," *J. Acoust. Soc. Am,* 105(3):1605-1617, 1999.
32. Tracey, B. and Schmidt, H., "A self-consistent theory for seabed volume scattering," *J. Acoust. Soc. Am.,* 106 (5):.2524-2534, 1999.
33. Maguer, A., Bovio, E., Fox, W.L., Pouliquen, E., and Schmidt, H., "Mechanisms for subcritical penetration into a sandy bottom: Experimental and modeling results," *J. Acoust. Soc. Am,* 107(3): 1215, 2000.
34. Maguer, E. Bovio, W.L Fox, and H. Schmidt. "*In situ* estimation of sediment sound speed and critical angle," *J. Acoust. Soc. Am J. Acoust. Soc. Am.,* 108 (3) Pt.1:.987-996, Sept. 2000.
35. K. Lepage and H. Schmidt. "Spectral integral representations of volume scattering in sediments in layered waveguides," J. Acoust. Soc. Am., 108 (4); 1557-1567, October 2000

36. M. D. Collins, H. Schmidt, and W. L. Siegmann, "An Energy-Conserving Spectral Solution," J. Acoust. Soc. Am. 107(4), 1964--1966 (2000).
37. LePage, K., Schmidt, H. "Bistatic synthetic aperture imaging of proud and buried targets from an AUV". *IEEE Journal of Oceanic Engineering* 27(3) pp. 471-483, 2002.
38. J. R. Edwards, H. Schmidt and K. LePage, "Bistatic synthetic aperture target detection and imaging with an AUV". *IEEE Journal of Oceanic Engineering* 26(4) pp. 690-699, 2001.
39. LePage, K., Schmidt, H. "Spectral integral representations of monostatic backscattering from threedimensional distributions of sediment volume inhomogeneities". *Journal of the Acoustical Society of America,* 113(2), 789-799, 2003.
40. Tesei, A., Lim, R., Maguer, A., Fox, W.L.J., Schmidt, H. "Measurements of acoustic scattering from partially and completely buried spherical shells". *Journal of the Acoustical Society of America* 112(5), 1817-1830, 2002.
41. Elisseeff, P., Schmidt, H., Xu, W. "Ocean acoustic tomography as a data assimilation problem". *IEEE Journal of Oceanic Engineering*, Vol. 27, No. 2, pp275-282, April 2002.
42. Xu, W., Schmidt, H. "System-orthogonal functions for sound velocity profile perturbation". *IEEE Journal of Oceanic Engineering*, Vol. 31, No. 1, pp. 156-169, January 2006.
43. M. Montanari, J.R. Edwards, and H. Schmidt. "Autonomous Underwater Vehicle-based Concurrent Detection and Classification Concept Using Higher-order Spectral Analysis," *IEEE Journal of Oceanic Engineering*, Vol. 31, No. 1, pp. 188-199, January 2006.
44. Xu, W., Baggeroer, A.B., Schmidt, H., "Performance Analyisis for Matched-Field Source Localization: Simulations and Experimental Results", *IEEE Journal of Oceanic Engineering*, Vol. 31, No. 2, pp. 325-344, April 2006.
45. D.P. Eickstedt, M.R. Benjamin, J.P. Ianniello, H. Schmidt, and J.J. Leonard, "Adaptive Tracking of Underwater Targets with Autonomous Sensor Networks," (Unclassified) *JUA*(USN) **56**, 465-495 (2006) (Secret NoForn).
46. Lucifredi, I., Schmidt, H., "Subcritical scattering from buried elastic shells", *J. Acoust. Soc. Am.* **120** (6), pp. 3566-3583, December 2006.
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Fish Taxonomy, Marine Biology, Fisheries Biology, Ecology and Evolution

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1996/7 – 2002/7, Director, Institute of Zoology, Academia Sinica, Taiwan
1995/8 – 1996/6, Vice Director, Institute of Zoology, Academia Sinica, Taiwan

Recent Publications

1. Chiang, T. Y., H. D. Lin, K. T. Sha**o** and K. C. Hsu, 2010, "Multiple factors shaped the phylogeography of Chinese spiny loach (Cobitis sinensis) in Taiwan as inferred from mitochondrial DNA variation," *Journal of Fish Biology*, 76(5), 1173-1189.. (SCI) (IF: 1.246; ranking: 50%,49.4%)
2. Lee, M. Y., H. M. Chen, K. T. Shao*, 2009, "A new species of deep-water tonguefish genus Symphurus (Pleuronectiformes: Cynoglossidae) from Taiwan," *COPEIA*, 2009 (2): 342–347. (SCI) (IF: 1.1; ranking: 48%)
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4. Liu, P. J., K. T. Shao, R. Q. Jan, T. Y. Fan, S. L. Wong, J. S. Hwang, J. P. Chen, C. C. Chen, H. J. Lin*, 2009, "A trophic model of fringing coral reefs in Nanwan Bay, southern Taiwan suggests overfishing," *Marine Environmental Research*, 68 (2009) 106–117.. (SCI) (IF: 2.032; ranking: 32.5%, 24.1%, 57.3%)
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11. Hsu, K. C., N. T. Shih, I H. Ni, K. T. Shao *, 2009, “Speciation and population structure of three Trichiurus species based on mitochondrial DNA. ”, *ZOOLOGICAL STUDIES*, 48(6), 851-865. (SCI) (IF: 0.772; ranking: 65.6%)
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17. Liao, Y. C., C. H. Chang and K. T. Shao* (2008) Twenty New Records of Stomiiformes Fishes (Pisces: Stomiiformes) from Taiwanese Waters. J. Fish. Soc. Taiwan 35(4): 369-398.
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38. Motomura, H., S. G. Poss and K. T. Shao（2007） *Scorpaena pepo*, new species of scorpionfish (Scorpaeniformes: Scorpaenidae) from northeastern Taiwan, with review of S. onaria Jordan and Snyder.. Zool. Stud, 46(1), pp.35-45. (SCI, Impact Factor:0.943; Ranking:49%)
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40. Chen, X. L., T. Y. Chiang, H. D. Lin, H. S. Zheng, K. T. Shao, Q. Zhang and K. C. Hsu（2007）. Mitochondrial DNA Phylogeography of *Glyptothorax fokiensis* and *G. hainanensis* in Asia.. Journal of Fish Biology, 70, pp.75-93. (SCI, Impact Factor:1.393; Ranking:36%)
41. Lin, H. C., X. X. Dai, K. T. Shao*, H. M. Su, W. T. Lo, H. L. Hsieh, L. S. Fang and J. J. Hung (2006) Trophic structuce and functioning in a eutrophic and poorly-flushed lagoon in southern Taiwan. Marine Environmental Research 62: 61-82. (SCI, Impact Factor:2.106; Ranking:18%)

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43. Wang, M. C, and K. T. Shao* (2006). Ten new records of lanternfishes (Pisces: Myctophiformes) collected around Taiwanese waters. J. Fish. Soc. Taiwan 33(1): 55-67
44. Liao, Y. C., L. S. Chen, and K. T. Shao* (2006). Review of the astronesthid (Stomiiformes: Astronesthidae) fishes from Taiwan with description of the two new species. Zool. Stud. 45(4): 516-527(SCI, Impact Factor:0.943; Ranking:49%)
45. Liao, Y.C., L.S. Chen & K.T. Shao* (2006) Review of the Astronesthid Fishes (Stomiiformes: Stomiidae: Astronesthinae) from Taiwan with a Description of One New Species. Zool. Stud. 45(4): 517-528 (SCI, Impact Factor:0.943; Ranking:49%)
46. Leis, J. M., Hay, A. C., Clark, D. A., Chen, I. S. and Shao, K. T. (2006). Behavioural ontogeny in larvae and early juveniles of the giant trevally, *Caranx ignobilis* (Pisces:Carangidae). Fishery Bulletin. 104(3):401-414(SCI, Impact Factor:1.403; Ranking:34%)
47. Yeh, H. M., M. Y. Lee, and K. T. Shao* (2006) Ten Taiwanese new records of alepocephalid fishes (Pisces: Alepocephalidae) collected from Taiwan. Journal of the Fisheries Society of Taiwan. 33(3):265-279
48. Chen, I.S., K. T Shao, J.P. Chen, (2006) Two new species of shrimp gobiid, Amblyeleotris (Teleostei: Gobiidae), from the West Pacific. Journal of Natural History. 40 (44-46): 2555-2567 (SCI, Impact Factor:0.631; Ranking:68%)
49. Yeh, H. M., M. Y. Lee, and K. T. Shao* (2006) Three Taiwanese new records of halosaurid fishes (Pisces: Halosauridae) collected from the deep waters by the Research essels. Journal of the Fisheries Society of Taiwan.(accepted)
50. Yeh, H. M., M. Y. Lee, and K. T. Shao* (2006) *Neobythites longipes* Smith and Radcliffe, 1913, a Taiwanese new record of ophidiid fish (Pisces: Ophidiidae). Journal of the Fisheries Society of Taiwan.(accepted)

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Current Position

Professor, Faculty of Science, University of the Ryukyus, Japan

Education

Ph.D. & M.Sc. in Biology, Graduate School of Tohoku University, 1976
B.Sc. in Biology, Tohoku University, 1971

Research Specialties

Ecology of Coral Reef Organisms, Ecosystem Function of Coral Reef and Island Ecosystems

Experience

1991/7 – present, Professor, Faculty of Science, University of the Ryukyus

2006 – 2009, Dean, Faculty of Science, University of the Ryukyus

2004 – 2009, Leader of 21st COE (Centre of Excellence) Program entitled Comprehensive Analyses of Biodiversity in Coral Reef and Island Ecosystems in Asia and Pacific Regions, University of the Ryukyus

1995 – 2003, 2006-present, Council member, University of the Ryukyus

2001 – 2003, Chairman, International Exchange Program Committee, University of the Ryukyus

1983/9 – 1991/6, Associate Professor, Faculty of Science, University of the Ryukyus

1976/4 – 1983/8, Instructor, Faculty of Science, Tohoku University

Recent Publications

Books

1. Tsuchiya, M., K. Nadaoka and H. Kayanne (eds.) (2004) Coral Reef of Japan. The Ministry of Environment and the Japanese Coral Reef Society, 356pp. (in English)
2. Tsuchiya, M., M. Hidaka and H. Ota (eds.) (2006) Biodiversity of Coral Reef and Island Ecosystems of the Ryukyus. Tokai University Press, 435pp (in Japanese).
3. Tsuchiya, M. and Y. Fujita (2009) Coral Reefs in Crisis, Tokai University Press, 203pp. (in Japanese).

Scientific papers

1. Tsuchiya, M. (2002) Faunal structures associated with patches of mussels at East Asian coast Helgoland Marine Research, 56, 31-36.
2. Tsuchiya, M. and S. Nojima (2002) Occurrence of *Trapezia* associated with *Acropora*: on the "wrong" host coral? Coral Reefs, 21, 160.
3. Bachok, X, P. L. Mfilinge and M. Tsuchiya (2003) The diet of the mud clam *Geloina coaxans* (Mollusca, Bivalvia) as indicated by fatty acid markers in a subtropical mangrove forest of Okinawa, Japan. J. Exp. Mar. Biol. Ecol., 292, 187-197.
4. Kamimura, S. and M. Tsuchiya, (2004) The effect of feeding behavior of the gastropods *Batillaria zonalis* and *Cerithdeposilla cingulata* on thier ambient environment. Mar. Biol., 144: 705-712.
5. Dominguez, M., A. Takemura and M. Tsuchiya, Shigeo Nakamura, (2004) Impact of different

environmental factors on circulating immunoglogulin levels in the Nile tilapia, *Oreochromis niloticus*. Aquaculture, 241: 491-500.

6. Mfilinge , P.L., T. Meziane, Z. Bachok and M. Tsuchiya (2005) Litter dynamics and particulate organic matter outwelling from a subtropical mangrove in Okinawa Island, South Japan. Estuarine, Coastal and Shelf Science, 63, 301-313.
7. Dominguez, M., A. Takemura and M. Tsuchiya (2005) Effects of changes in environmental factors on the non-specific immune response of Nile tilapia, *Oreochromis niloticus* L. Aquaculture Research, 36, 391-397.
8. Mfilinge, P.L. T. Meziane, Z. Bachok and M. Tsuchiya (2005) Total lipid and fatty acid classes in decomposing mangrove leaves of *Bruguiera gymnorrhiza* and *Kandelia candel*: significance with respect to lipid input. Journal of Oceanography., 61, 613-622.
9. Tsuchiya, M. (2006) Toward integrated coral reef science: A new challenge for the conservation and restoration of coral reefs. Proceedings of the 10th International Coral Reef Symposium, Okinawa.
10. Kamimura, S. and M. Tsuchiya (2006) Effects of opportunistic feeding by the intertidal gastropods *Batillaria zonalis* and *B. flectosiphonata* on material flux of a tidal flat. Mar. Ecol. Prog. Ser. 318, 203-211.
11. Bachock, Z., PL Mfilinge and M. Tsuchiya (2006) Characterization of fatty acid composition in healthy and bleached corals from Okinawa, Japan. Coral Reefs, 25, 545-554.
12. Lecchini, D., Y. Nakamura, M. Tsuchiya and R. Galzin (2007) Spatiotemporal distribution of nocturnal coral fish juveniles in Moorea Island, French Polynesia. Ichthyological Research, 54, 18-23.
13. Meziane, T., S.Y. Lee · P.L. Mfilinge · P.K.S. Shin · M.H.W. Lam · M. Tsuchiya (2007) Inter-specific and geographical variations in fatty acid composition of mangrove leaves: implications for using fatty acids as a taxonomic tool and tracers of organic matter. Marine Biology, 150, 1103-1113.
14. Islam S. S. M. and M. Tsuchiya (2007) Bioturbation activity by the grapsid crab *Helice formosensis* and its effects on mangrove sedimentary organic matter Estuarine, Coastal and Shelf Science, 73, 316-324.
15. Kanjana A., , S. Thongsukdee, T. Hara, N. Arai and M. Tsuchiya (2007) Observation of dugong reproductive behavior in Trang Province, Thailand: further evidence of intraspecific variation in dugong behavior. Marine Biology, 151, 1887-1891.
16. Mfilinge, P. and M. Tsuchiya (2008) Effect of temperature on leaf litter consumption by grapsid crabs in a subtropical mangrove (Okinawa, Japan). J. Sea Res., 59, 94-102.
17. Islam S. S. M. and M. Tsuchiya (2008) Nutrient dynamics in mangrove crab burrow sediments subjected to anthropogenic input. J. Sea Res., 59, 103-113.
18. Nakamura, Y., and M. Tsuchiya (2008) Spatial and temporal patterns of seagrass habitat use by fishes at the Ryukyu Islands, Japan. Estuarine, Coastal and Shelf Science, 76, 345-356.
19. Sakdullah, A. and M. Tsuchiya (2008) One-step method for quantitative and qualitative analysis of fatty acids in marine animal samples. J. Exp. Mar. Biol. Ecol., 354, 1-8.
20. Lecchini, D. and M. Tsuchiya (2008) Temporal consistency of ontogenetic shifts in habitat use by coral reef fishes in the northernmost coral ecosystem in the world (Kudaka Island, Japan). Journal of Fish Biology, 72, 1-10.
21. Tsuchiya, M., René Galzin and Neil Davies (2008) Biodiversity research on coral reef and island ecosystems: scientific cooperation in the Pacific region. Pacific Science, 62, 299-301.
22. Rhaman, Md. S., M. Tsuchiya and T. Uehara (2009) Effects of temperature on gamete longevity and fertilization success in two sea urchin species, Zoological Science, **26**: 1–8
23. Takagi KK, Mchenga ISS, Tsuchiya M. 2009. Hemichordata: Enteropneusta (Acorn worm) bioturbation: Maintaining and facilitating the balance of coral reef biogeochemical cycles. *Proc. International Coral Reef Symposium*. Session 19: 912-916.
24. Sakdullah, A. and M. Tsuchiya (2009) The origin of particulate organic matter and the diet of

tilapia from an estuarine ecosystem subjected to domestic wastewater discharge: fatty acid analysis approach. Aquatic Ecology, 43, 577-589.

25. Nakano, Y., M. Tsuchiya, S. Rungsupa and K. Yamazato (2009) Influence of severe freshwater flooding during the rainy season on the coral community around Khang Khao Islands in the inner Gulf of Thailand. Galaxea, JCRS, 11, 131-138.
26. Tsuchiya, M., M. Nishihira, S. Poung-In and S. Choohabandit (2009) Feeding behavior of the urchin0eating urchin *Salmacis sphaeroides*. Galaxea, JCRS, 11, 149-153.
27. Tsuchiya, M. (in press) Ecology of xanthid crabs (*Trapezia* spp.) and the role of the crown-of-thorns starfish *Acanthaster planci* in mechanisms promoting their coexistence on pocilloporid corals. The Raffles Bulletin of Zoology.

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Current Position

Vice Director, Institute of Oceanography, Nha Trang City, Vietnam, since 2008

Education

Ph.D., Institute of Oceanography, 1996
B.Sc., Hanoi National University, 1980

Research Specialties

Marine/Coastal Ecology, Marine/Coastal Conservation Planning, Public Awareness

Experience

2005 – 2008, Senior Expert, Division of Global Environmental Facility Coordination of United
2001 – 2005, Vice Director, Institute of Oceanography, Vietnam
2004, Chairperson, Regional Project Steering Committee of the UNEP/GEF Project
2002 – 2003, Chairperson, Regional Scientific and Technical Committee of GEF UNEP Project
2001 – 2002, DANIDA missions for Network of Marine Protected Area, Vietnam, Nations Environment Programme
1999 – 2000, Asian Development Bank Project ADB 5712-REG "Coastal and Marine Environment Management in the South China Sea," Phase 2

Selected Publications

1. *A Preliminary Study on Composition of Hard Corals from Spratly Archipelago*. Journal of Biology. III- 1989: 33-36 (Co-authors: Nguyen Huy Yet, Lang Van Ken, in Vietnamese)
2. *Studies On Coral Reefs From Nhatrang And Vanphong Bays*. Collection of Marine Research Works. III-1990: 150-158 (in Vietnamese) 1992-1994.
3. *Structure And Status Of Coral Reefs From Con Dao Islands*. Journal of Biology. X- 1991: 3-6 (in Vietnamese)
4. *Preliminary Studies On The Porites Corals In The Different Waters Of Vietnam*. Proceeding of 2nd WESTPAC Symposium. Penang. 1991: 331-333.
5. *Preliminary Study On Degradation Of Coral Reefs From South Vietnam*. Proceeding of National Seminar on Coastal Research and Management. Ha Noi. 1993: 54-58. (in Vietnamese).
6. *Coral Reefs And Reef Building Corals Of Vietnam. Collection Of Marine Research Works*. VI-1995: 101-10. (co-author: Nguyen Huy Yet).
7. *Reasonable Use And Protection Of Coral Reefs In Coastal Waters Of Khanh Hoa Province*. Fishery Review. VI-1993: 11-12. (in Vietnamese).
8. *Corals*. Item V.3.1. Red Data Book Of Vietnam (ed. Dang Ngoc Thanh). Science and Technique Publishing House: 337-343. (in Vietnamese).
9. *An Introduction To Important Species Of Edible Mollusks In Vietnam*. Out of the Shell. Coastal Resources Research Network Newsletter IV.1-1994. (Co-author: Nguyen Huu Phung.
10. *Main Living Resources Of South Central Vietnam*. Collection Of Marine Research Works. V-1994: 125-139. (Co-author: Nguyen Huu Phung and others, in Vietnamese).

11. *Outline On Special Living Resources From Kiengiang Province*. Fishery Review. I-1995: 9-11. (in Vietnamese)
12. *Exploitation Status Of Scallop Chlamys Nobilis (Reeve) In Binh Thuan*. Fishery Review. IV-1995: 11-14 (in Vietnamese)
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14. *Problems With The Conservation Of Coastal Fishery And Coral Reefs In Vietnam*. Proceeding of 1st International Symposium on Marine Conservation. Hong Kong. 1997: 79-85. (co-author: Truong Si Ki).
15. *Some Data On Ecological Influences Of Strong Upwelling To Bivalve Resources In The Waters Of Binh Thuan Province*. Contribution on Coastal Strong Upwelling in Southern Central Vietnam (ed. Vo Van Lanh). Science and Technique Publishing House: 181-191. (in Vietnamese).
16. *Species Composition Of Scleratinia From The Coastal Waters Of South Vietnam*. Collection of Marine Research Works. VII- 1997: 194-204. (in Vietnamese)
17. *Hermatypic Scleractinia of South Vietnam*. Proc. of Third Int. Conf. on Marine Biology of Hong Kong and South China Sea. Hong Kong, 28 Oct. - 3 Nov. 1996. Hong Kong University Press, 1998: 11-20
18. *Coral Reef of Vietnam*: Recruitment limitation and physical forcing. Proceeding of 8th Coral Reef Symposium. Panama. 1997. I: 477-482 (Co-author: G. Hodgson).
19. *The Characteristics of Environment Chemistry and Their Possible Relation to Degradation of Coral Reefs in Nha Trang Bay*. Proceeding of 1st National Symposium on Marine Biology. Nha Trang. 1997:54-61. (co-author: Pham Van Thom; in Vietnamese).
20. *An Issue on Studying the Influences of Hydrological Dynamic Factors to Marine Organisms*. Proceeding of 1st National Symposium on Marine Biology. Nha Trang. 1997:241-347. (co-author: Bui Hong Long; in Vietnamese).
21. *Shell Ribbing as One Criteria to Study the Growth of the Clam Anadara antiquata in Binh Thuan Province (South Vietnam)*. Proceeding of 1st National Symposium on Marine Biology. Nha Trang. 1997:270-275. (co-author: Hua Thai Tuyen; in Vietnamese.
22. *The Establishment of Marine Protected Area based on Coral Reefs in Vietnam*. Out of the Shell. Coastal Resources Research Network Newsletter. VI.1. Proc. of Conf. on ASEAN Marine Environment Management: Quality Criteria and Monitoring of Aquatic Life and Human Health Protection. Penang, Malaysia. 1996: VIII.73 – 79. (Co-author: Pham Van Thom)
23. *An Outline on the Issue of Sustainable Use of Marine Living Resources in the Coastal Waters of Ba Ria – Vung Tau Province*. Journal of Science and Technology of Ba Ria – Vung Tau province 1. 1998: 12 –14 (in Vietnamese)
24. *On the Establishment and Management of Marine Protected Areas in Vietnam*. Journal of Science and Technology Activities. MOSTE. 1998: 22 – 23 (in Vietnamese).
25. *The Main Resources of Bivalve Mollusks in The Marine Waters of Vietnam*. Collection of Marine Research Works. VIII, 1998: 9 –16 (Co-author: Nguyen Huu Phung; in Vietnamese).
26. *On the Environmental Conditions of The Coastal Waters of Ca Na – Ham Tan and the Relations with Distribution of the Clam Anadara antiquata. Collection of Marine Research Works*. VIII, 1998: 66 – 71 (Co-author: Pham Van Thom; in Vietnamese).
27. *Benthic Coelenterata on the Submersed Banks of Spratly Archipelago*. Collection of Marine Research Works. VIII, 1998: 106 -114 (Co-author: Nguyen Huy Yet; in Vietnamese).
28. *Coral Reefs in the Northern Part of Spratly Archipelago*. Collection Of Marine Research Works. VIII, 1998: 115 - 121 (Co-author: Nguyen Huy Yet; in Vietnamese).
29. *On the Coastal Ecosystems of Vietnam*. Proceeding of The Scientific Conference of The 5th ASEAN Science & Technology Week. Marine Science, Hanoi.1998: 262-270. (Co-author: Dang Ngoc Thanh).
30. *Issues with the Establishment and Management of Marine Protected Areas in Vietnam*.

Proceeding of Coastal Biodiversity Priorities in Vietnam. Ha Noi. November 1997: 58 – 63.

31. *Fishery Management and Biology of The Scallop Chlamys Nobilis In Southern Vietnam*. Phuket Marine Biological Center Special Publication 18(1): 83 – 88. (1998)
32. *Status of Bivalve Exploitation and Farming In The Coastal Waters Of South Vietnam*. Phuket Marine Biological Center Special Publication 18(1): 171 – 174 (1998).
33. *Coastal and Marine Biodiversity Conservation In Vietnam*. Proceeding of the European-Asian Workshop on Investigation and Management of Mediterranean and South China Sea Coastal Zone. November 1998. Hong Kong: 37 - 44.
34. *Coral Reef Ecosystem*. The Training Lecture In "Vietnam's Marine Environment". National Environment Agency of Vietnam. Ha Noi. 1998:137-147.
35. *Conservation of Marine Biodiversity in Vietnam*. Proceeding of National Environment Symposium. Scientific And Technique Publishing House. Ha Noi. 1999: 1141- 1144. (in Vietnamese).
36. *Growth of Silver-Lip Pearl Oyster Restored in the Waters around Cu Lao Cau Island, Binh Thuan Province, Vietnam*. Phuket Marine Biological Center Special Publication 21(1), 2000: 235-237 (Co-author: Hua Thai Tuyen).
37. *Status and Solutions for Farming And Management Of The Clam Meretrix Lyrata At Go Cong Dong, Tien Giang Province, Vietnam*. Phuket Marine Biological Center Special Publication 21(1), 2000:167-170.
38. *Ranking and Prioritizing the Coastal and Marine Protected Areas Of Vietnam*. Collection of Marine Research Works. X. 2000: 246 - 253 (Co-authors: P. McNamee & R. Petocz).
39. *Coral Reefs at Con Dao*. Publishing House of Agriculture. Ha Noi. 2000: 30pp (in Vietnamese, cooperation with WWF).
40. *Status and Perspective Of Marine Protected Areas In Vietnam* Proceeding Int'l Symposium on protection and management of coastal marine ecosystems. UNEP. 2001:79-83
41. *Coastal and Marine Protected Areas Plan For Vietnam In The Framework Of The Project ADB 5712-REG*. Proceeding of the Scientific Conference "BIEN DONG – 2000", Nha Trang, 19-22 September 2000. Agriculture Publishing House. Ho Chi Minh city. 2001 (Co-authors: P. McNamee & R. Petocz): 633-644
42. *Results of The Project for Marine Zoning of Con Dao National Park*. Proceeding of the Scientific Conference "BIEN DONG – 2000", Nha Trang, 19-22 September 2000. Agriculture Publishing House. Ho Chi Minh city. 2001 (Co-authors: Le Xuan Ai, Robinson A.): 615-632
43. *Protection and development of living resources based on coastal ecosystem conservation*. Fisheries Review. No. 4 – 2002: 30-33 (in Vietnamese)
44. *National report of Vietnam for GCRMN EA SEA workshop*. Proceeding of the Global Coral Reef Monitoring Network. Regional workshop for the East Asian Seas. Ishigaki, Japan. 27-30 March 2002. Ministry of the Environment, Government of Japan: 124-130
45. *Report of status of coral reefs in Vietnam: 2000*. Proceeding 9th International Coral Reef Symposium, Bali, Indonesia 23-27 October 2000, vol. 2: 891-894.
46. *The corals at Con Dao Archipelago (South Vietnam): Before, during and after the bleaching event in 1998*. Proceeding 9th International Coral Reef Symposium, Bali, Indonesia 23-27 October 2000, vol. 2: 895-899.
47. *Status and perspective of marine protected areas in Vietnam.* Proceeding Int'l Symposium on protection and management of coastal marine ecosystems. UNEP. 2001:79-83
48. *On the coastal and marine protected areas plan for Vietnam in the framework of the project ADB 5712-REG.* Proceeding of the Scientific Conference "BIEN DONG – 2000", Nha Trang, 19-22 September 2000. Agriculture Publishing House. Ho Chi Minh city. 2001 (Co-authors: P. McNamee & R. Petocz): 633-644
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50. *Protection and development of living resources based on coastal ecosystem conservation.* Fisheries Review. No. 4 – 2002: 30-33 (in Vietnamese)
51. *National report of Vietnam for GCRMN EA SEA workshop*. Proceeding of the Global Coral Reef Monitoring Network. Regional workshop for the East Asian Seas. Ishigaki, Japan. 2730 March 2002. Ministry of the Environment, Government of Japan: 124-130.
52. *Shallow water habitats of Hon Mun Marine Protected Area, Nha Trang bay, Vietnam: distribution, extent and status 2002.* Collection of Marine Research Works. Volume XII, 2002. Institute of Oceanography, Nha Trang, Vietnam: 179-204 (Co-authors: Hua Thai Tuyen, Nguyen Xuan Hoa, Lyndon DeVantier).
53. *On long-term maintenance and cultivation of Hermatypic corals under artificial conditions.* Collection of Marine Research Works. Volume XII, 2002. Institute of Oceanography, Nha Trang, Vietnam: 215-232 (Co-authors: Tilyanov, E.A., Tilyanova T.V.)
54. *Meso*-scale Transboundary Units for the Management of Coral Reefs in the South China Sea Area. Naga, WorldFish Centre Quarterly, vol. 25, No. 3-4, July-Dec. 2002. (Co-authors: M.C.A. Ablan, J.W McManus, C.A.Chen, K.T. Shao, J. Bell, A.S. Cabanban, & I.W. Arthana).
55. *Methodology for study and monitoring of coral reefs*. In: Guideline for investigation and monitoring of biodiversity. Transportation Publishing House. Ha Noi. 2003 (Co-author: Nguyen Van Long, in Vietnamese): 289-314
56. *Coral Reefs of Hon Mun Marine Protected Area, Nha Trang bay, Vietnam: 2002. Species composition, community structure, status and management recommendations*. Proceeding of Scientific Conference "Bien Dong – 2002". Agricultural Publishing House, 2004: 649 – 690 (Co – authors: Lyndon DeVantier, Nguyen Van Long, Hua Thai Tuyen, Nguyen Xuan Hoa, Phan Kim Hoang).
57. *Coral reefs of Viet Nam*. Publishing House of Science and Technique. Ho Chi Minh city, 2005: 212 pp (Chief author with participation of Nguyen Huy Yet and Nguyen Van Long)
58. *Coral reefs of Vietnam: Recent status and conservation perspectives*. Proceedings of the 10th International Coral Reef Symposium, Okinawa, Japan, 28 June – 2 July 2004. 2006: 1045-1054 (Co-author: Hoang Xuan Ben, Nguyen Van Long, Phan Kim Hoang)
59. *Conservation of marine biodiversity: a tool for sustainable management in Cu Lao Cham Islands, Quang Nam Province*. Proceedings of the 10th International Coral Reef Symposium, Okinawa, Japan 28 June-2 July 2004. 2006: 1249-1258 (Co-author: Nguyen Van Long, Phan Kim Hoang, Hua Thai Tuyen)
60. *Monitoring of coral reefs in coastal waters of Vietnam: 1994-2007*. Agricultural Publishing House, 108pp (Co-author: Nguyen Van Long, Hoang Xuan Ben, Hua Thai Tuyen, Phan Kim Hoang)
61. *Mass mortality of corals and reef living features at Con Dao archipelago (Vietnam) in October 2005*. Journal of marine science and technology. Seri 8, No 1, 2008: 59-70 (Co-author: Hoang Xuan Ben, Phan Kim Hoang)
62. *Priorities for establishment and management of marine protected areas in Viet Nam with considerations of fisheries re-stock and coral reef resilience.* The 4th Global Conference on Oceans, Coasts and Islands: Pre-conference MPA workshop proceedings, Ha Noi, April 4-5 2008: 92-98
63. *Wetland management at Con Chim area of Thi Nai lagoon, South Central Viet Nam*. Proceeding of National Conference "Bien Dong-2007", 12-14/9/2007, Nha Trang, 2008: 91-98 (Co-author: Tran Thi Thu Ha, Nguyen Xuan Hoa, Nguyen thi Lien, Ngo Hoang Thanh Song)
64. *Environmental concerns for the South China Sea and some priorities in marine environment cooperation of Viet Nam*. Proceeding of National Conference "Bien Dong – 2007", 12-14/9/2007, Nha Trang, 2008: 59-76

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Current Positions

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Adjunct Senior Researcher, Institution of Earth Sciences, Academia Sinica
Professor, Department of Geosciences, National Taiwan University

Education

Ph.D. in Oceanography, University of Rhode Island, USA, 1987
M.S. in Geology, National Taiwan University, 1978
B.S. in Geology, National Taiwan University, 1975

Research Specialties

Marine Calcareous Microfossils, Tertiary Biostratigraphy, Paleoceanography, Evolutionary Paleobiology

Experience

2000 – present, Adjunct Senior Researcher, Institution of Earth Sciences, Academia Sinica
1988 – 1994, Assistant Professor, Department of Geology and Geophysics, Yale University
1993 – 1994, Visiting Associate Professor. National Taiwan University
1987 – 1988, Post-Doctoral Researcher, University of California Santa Barbara

Publications

1. Löwemark, L., Steinke S., Wang, C.-H., Chen, M.-T., Muller, A., Shiau, L.-J., Kao, S.-J., Song, S.-R., Lin, H.-L., **Wei, K.-Y.**, New evidence for a glacioeustatic influence on deep water circulation, bottom water ventilation and primary productivity in the South China Sea. Dynamics of Atmospheres and Oceans 47:138-153, 2009.
2. **Wei, K.-Y**. et al, Calcareous nannofossil biostratigraphy of the Sankanshan Section, Tsailiao area, Chouchen, Tainan, southwestern Taiwan. Central Geological Survey Special Publication No. 22: 197-214, 2009 (in Chinese with English abstract).
3. **Wei, K.-Y**. et al, Biochronology study of the Tananwan Formation: A revisit. Central Geological Survey Special Publication No. 22: 149-164, 2009(in Chinese with English abstract).
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10. **Wei, K.-Y**. et al, Quaternary Mammalian Fossils of Taiwan: An eclectic overview and prospects for future study. In Studies on the Quaternary Geology of Taiwan: Overview and Prospect. Central Geological Survey Special Publication No. 18: 261-286, 2007.
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Recent Publications

1. **Wu, R.S.S., 2009.** Effects of hypoxia on fish reproduction and development. In: *Fish Physiology* (eds. J.G. Richards, A.P. Farrell and C.J. Brauner) Academic Press. Volume 27, pp. 79-141.
2. Zhang, X., M. Hecker, J.-W.Park, A.R.Tompsett, J.L. Newsted, K. Nakayama, P.D. Jones, D. Au, R. Kong, **R.S.S. Wu**, and J.P. Giesy. 2008. Real time PCR array to study effects of chemicals on the Hypothalamic-Pituitary- Gonadal axis of the Japanese medaka. Aquatic Toxicology **88**:173-182.
3. **Wu, R.S.S**., Chan, A.K.Y., Richardson, B.J., Au, D.T.W., Fang, J.K.H., Lam, P.K.S. and Giesy, J.P. 2008. Measuring and monitoring persistent organic pollutants in the context of risk assessment. Marine Pollution Bulletin **57**:236-244.
4. R.Y.C. Kong, J.P. Giesy, **R.S.S. Wu**, E.X.H. Chen, M.W.L. Chiang, P.L. Lim, B.B.H. Yuen, B.W.P. Yip, H.O.L. Mok, D.W.T. Au, 2007. Development of a marine fish model for studying *in vivo* molecular responses in ecotoxicology. Aquatic Toxicology **86**: 131-141.
5. Shang, E.H.H., R.M.K. Yu and **R.S.S. Wu**, 2006. Hypoxia affects sex differentiation and development, leading to a male-dominated population in zebrafish (*Danio rerio*). Environmental Science & Technology **40**: 3118-3122.
6. **Wu, R.S.S.**, T. C. Lau, W. K.M. Fung, P. H. Ko, K. M. Y. Leung, 2006. An 'Artificial Mussel' for monitoring heavy metals in marine environment. Environmental Pollution **145**:104-110.
7. Zhang, XW, J.P. Giesy, P. Jones, R. M.K. Yu and **R.S.S. Wu**. 2005. Quantitative RT-PCR methods for evaluating toxicant-induced effects on steroidogenesis using the H295R cell line. Environmental Science & Technology **39:** 2777-2785.
8. Shang, E and **R.S.S. Wu**, 2004. Aquatic hypoxia is a teratogen and affects fish embryonic development. Environmental Science and Technology **38:** 4763-4767.
9. **Wu, R.S.S.,** B.S. Zhou, D.J. Randall, N.Y.S. Woo and P.K.S. Lam, 2003. Aquatic hypoxia is an endocrine disruptor and impairs fish reproduction. Environmental Science and Technology **37**: 1137-1141.
10. Gray, J.S., **R.S.S. Wu** and Y.Y. Or, 2002. Effects of hypoxia and organic enrichment on the marine coastal environment. Marine Ecology Progress Series **238**: 249-279.

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Recent Publications

Recent selected book chapters

1. Yamasaki, H., Itoh, R.D., Bouchard, J.N., Dghim, A.A., Hossain, K.K., Grung, S., Cohen, M.F. (2010) Nitric oxide synthase-like activities in plants. In Nitrogen Metabolism Plants in the Post-Genomic Era (Foyer, CH ed.), Springer, in press.
2. Cohen, M.F., Lamattina, L., Yamasaki, H. (2009) Nitric oxide signaling by plant-associated bacteria. In Nitric oxide in plant physiology (Hayat S, Mori M, Pichtel J, Ahmad A, eds.), pp. 161-172, Wiley-Vch, Germany.
3. Arita, N. O., Cohen, M. F., Tokuda, G., Yamasaki, H. (2007) Fluorometric detection of nitric oxide with Diaminofluoresceins (DAFs): Application and limitations for plant NO research. In Nitric oxide in plant growth, development and stress physiology (Lamattina, Polacco eds.),

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6. Grace, S.C., Yamasaki, H., Pryor, W.A. (1999) Spin stabilizing approach to radical characterization of phenylpropanoid antioxidants: an ESR study of chlorogenic acid oxidation in the horseradish peroxidase, tyrosinase, and ferrylmyoglobin protein radical systems. In Plant Polyphenols 2: Chemistry, Biology, Pharmacology, Ecology (Gross, G.G.; Hemingway, R.W.; Yoshida, T., eds.), pp. 435-450, Kluwer Academic / Plenum Publishers, New York.

Recent peer-review papers (Marine Biology)

1. Bouchard, J.N. and Yamasaki, H. (2009) Implication of nitric oxide in the heat-stress induced cell death of the symbiotic alga Symbiodinium microadriaticum. Marine Biology,156, 2209-2220.
2. Yuen, Y. S., Yamazaki, S.S., Nakamura, T., Tokuda, G. and Yamasaki, H. (2009) Effects of live rock on the reef-building coral Acropora digitifera cultured with high levels of nitrogenous compounds. Aquacultural Engineering, 41, 35-41.
3. Nakamura, T. and Yamasaki, H. (2008) Flicker Light effects on photosynthesis of symbiotic algae in the reef-building coral Acropora digitifera (Cnidaria: Anthozoa: Scleractinia). Pacific Science, 62, 341-350.
4. Bouchard, J.N. and Yamasaki, H. (2008) Heat stress stimulates nitric oxide production in Symbiodinium microadriaticum: a possible linkage between nitric oxide and the coral bleaching phenomenon. Plant and Cell Physiology 49, 641-652.
5. Tokuda, G., Yamada, A., Nakano, K., Arita, N. O. and Yamasaki, H. (2008) Colonization of Sulfurovum sp. on gill surface of Alvinocaris longirostris, a deep-sea hydrothermal vent shrimp. Marine Ecology 29, 110-114.
6. Suzuki, A., Nakamura, T., Yamasaki, H., Minoshima, K. and Kawahata, H. (2008) Influence of water flow on skeletal isotopic compositions in the coral Pocilopora damicornis. Coral Reefs 27, 209-218.
7. Nakamura, T., Yamazaki, S., Sakai, K., Yamasaki , H. , Furushima, Y., Yamamoto, H. (2006) Acroporid corals inhabiting over a unique methane-bubbling hydrothermal vent field in a coral reef of Southern Ryukyu Archipelago. Coral Reefs, 25, 382-382.
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9. van Woesik, R., Nakamura, T., Yamasaki, H. and Sheppard, C. (2005) Comment on 'Effects of geography, taxa, water flow, and temperature variation on coral bleaching intensity in Mauritius' by McClanahan et al. MEPS, 305, 297-299.
10. Nakamura, T. and Yamasaki, H. (2005) Requirement of water-flow as an essential factor for growth of Pocilloporidae corals during high temperature period. Marine Pollution Bulletin 50, 1115-1120.
11. Nakamura, T., van Woesik, R. and Yamasaki, H. (2005) Photoinhibition of photosynthesis is reduced by water flow in the reef-building coral Acropora digitifera. MEPS 301, 109-118.

Recent peer-review papers (Plant Biology)

1. Itoh, R.D., Yamasaki, H., Septiana, A., Yoshida, S. and Fujiwara, M.T. (2010) Chemical induction of rapid and reversible plastid filamentation in *Arabidopsis thaliana* roots. ***Physiologia Plantarum***, *in press*
2. Hossain, K.K., Itoh, R.D., Yoshimura, G., Tokuda, G., Oku, H., Cohen, M.F. and Yamasaki, H. (2010) Effects of Nitric Oxide Scavengers on thermoinhibition of Seed Germination in *Arabidopsis thaliana*. ***Russian Journal of Plant Physiology***, 57, 222-232.

3. Savini, I., Smithson, P.C., Karanja N. K. and Yamasaki, H. (2006) Influence of *Tithonia diversifolia* and triple superphosphate on dissolution and effectiveness of phosphate rock in acidic soil. ***Journal of Plant Nutrition and Soil Science***, 169, 593-604.
4. Yamasaki, H. and Cohen, M.F. (2006) NO signal at the crossroads: polyamine-induced nitric oxide synthesis in plants? ***Trends in Plant Science,*** 11, 522-524.
5. Tambuan, T., Baba, S., Kuniyoshi, A., Iwasaki, H., Nakamura, T., Yamasaki, H. and Oku, H. (2006) Light-dependent isoprene emission from 45 tropical tree species on Okinawa Island, Japan. ***Chemosphere***, 65, 2138-2144.
6. Shimoji, H., Tokuda, G., Tanaka, Y., Moshiri, B., Yamasaki, H. (2006) A simple method for two-dimensional color analyses of plant leaves. ***Russian Journal of Plant Physiology*** 53, 126-133.
7. Shimoji, H. and Yamasaki, H. (2005) Inhibitory effects of flavonoids on the alternative respiration of plant mitochondria. ***Biologia Plantarum*** 49, 117-119.
8. Yamasaki, H. (2005) The NO world for plants: achieving a balance in an open system. ***Plant, Cell and Environment***. 28, 78-84

Recent peer-review papers (Microbiology)

1. Cohen, M.F., Mazzola, M. and Yamasaki, H. (2006) Nitrogen oxidation in bacterium-plant interactions. ***Microbe***, 1, 347-347.
2. Cohen, M.F., Yamasaki, H. and Mozzola, M. (2005) *Brassica napus* seed meal soil amendment modifies microbial community, nitric oxide production and incidence of *Rhizoctonia* root rot. ***Soil Biology & Biochemistry*** 37, 1215-1227.

Recent peer-review papers (Others)

1. Mahdi, S.H.A., Tomita, Y., Yamasaki, H. and Otaki, J. M. (2010) Physiological characterization of the cold-shock-induced humoral factor for wing color-pattern changes in butterflies. ***Journal of Insect Physiology***, in press
2. Arawaka, G., Watanabe, H., Yamasaki, H., Maekawa, H. and Tokuda, G. (2009) Purification and Molecular Cloning of Xylanases from the Wood-Feeding Termite, *Coptotermes formosanus* Shiraki, ***Bioscience, Biotechnology, and Biochemistry***, 73, 710-718

Recent invited talks for international congresses

1. “Mechanisms for NO production in plants”, Free Radical Summer School, 2009, Niigata, Japan
2. “Plant nitrite reduction as the source of plant NO”, Second International Role of Nitrite in Physiology, Pathophysiology, and Therapeutics Meeting, 2007, the National Institutes of Health, Maryland, U.S.A.
3. “Nitrite-dependent NO production pathway in plants” the 62th Harden/EMBO joint Conference, 2006, Royal Agricultural College, UK
4. "The NO world: a new frontier of plant biology " Plant Biology 2003, Hawaii, USA
5. "Biochemistry and physiology of active oxygen and nitrogen”, EU scientific congress “Optimization of water use by plants in the Mediterranean", 2003, Mallorca, Spain
6. "Nitric oxide and plant mitochondria", 6th International Congress on Plant Mitochondria, 2002, Perth, Australia
7. "Nitric oxide produced by nitrate reductase: a player in plant oxidative stress?" The Royal Society Discussion Meeting, 2000, London, UK

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