出國報告（出國類別：國際會議）

第十屆亞洲漁業和水產養殖論壇暨第四屆國際箱網養殖研討會

服務機關：國立屏東科技大學
姓名職稱：葉信平教授、劉俊宏教授、張欽泉助理教授、林鈺鴻助理教授

派赴國家：韓國
出國期間：民國 102 年 4 月 29 日至 5 月 4 日
報告日期：民國 102 年 5 月 15 日

出國報告摘要

內容摘要

由水產養殖系葉信平教授帶領同系劉俊宏、張欽泉與林釭鴻等老師，以及助理徐雅麗小姐一同前往韓國麗水市參加第 10 屆亞洲水產與養殖論壇暨第 4 屆亞洲箱網養殖國際研討會 (10AFAF/CAA4)，總計發表壁報論文五篇，且皆為為本系近年的研究成果。本屆論壇的目的為探討"藍海及綠色漁業"「Blue Waters and Green Fisheries」，藉由論文發表將可提升本校與本系的國際知名度，且會議中與各國專家學者的討論與交流更能提升本系未來之研發能量及國際產學合作。

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壹、會議目的及背景

一、會議目的

本屆論壇的目的為集結亞太地區水產專家學者,共同探討"藍海及綠色漁業"「Blue Waters and Green Fisheries」，詳如會議背景。

二、會議背景

亞洲水產學會(Asian Fisheries Society, 簡稱亞水會)之成立緣自於 1983 年 5 月間由當時在菲律賓馬尼拉 ICLARM (International Center for Living Aquatic Resources Management)工作之 Dr. Richard Neal 出面邀請包括我國廖一久院士在內的各國七位相關人士在其本部開會討論的結論，認為有必要成立亞洲地域性之國際水產學會組織，故於翌(1984)年 5 月 2 日由 14 位 Charter Member 共同簽名學會憲章(Society's Constitution)後正式成立。亞水會由理事會(The Council)負責運作，理事會係由亞水會會員大會就亞洲各國所提名之人選中選出 15 位理事(Councilor)所組成。原則上，代表同一國家理事不超過 2 位。15 位理事推選一位理事擔任理事長，主持及領導理事會。我國的劉錫江教授、廖一久院士分別擔任過亞水會第四及第六屆理事長。此外，蕭錫延講座教授、郭欽明教授、陳瑤湖教授、方力行教授及陳宏遠教授等都曾擔任過亞水會理事。亞水會理事會除會員投票選出之 15 位理事外，另設一席合作(Co-op)理事，由該屆亞洲水產論壇舉辦國家會員擔任，以協助籌備及處理論壇相關事宜。

亞洲漁業和水產養殖論壇(Asian Fisheries and Aquaculture Forum, AFAF)為亞水會之正式國際學術會議，每三年舉行一屆，提供亞洲各國乃至世界其他各地水產相關研究成果與意見交流之平台，為亞洲地區最重要的水產學術研討會。第 33 次亞水會理事會議在印度召開時鑑於水產養殖在此論壇中份量已超過捕撈漁業,故決定將論壇名稱由「亞洲水產論壇(Asian Fisheries Forum)」改為「亞洲漁業和水產養殖論壇(AFAF)」。第十屆亞洲漁業和水產養殖論壇(10th AFAF)於 2013 年 4 月 30 日至 5 月 3 日在韓國麗水市 The Ocean Resort 度假旅館舉行。本屆論壇的主題為「Blue Waters and Green Fisheries」，希望藉由本屆論壇提供相關學者專家一個交換水產養殖與漁業科學的平台。本次除論壇外，亦同時舉辦第四屆國際箱網養殖研討會(4th International Symposium on Cage Aquaculture in Asia, CAA4)，並有相關水產廠商贊助參展(Trade Show)。

貳、參加會議過程

一、會議議程

詳細議程如下:

							Seminar A	Seminar B	Seminar C
							Presentor	VIP	Staff Room
10AFAF / CAA4 Session Program							Waitroom	Waitroom	
		Hotel Side		**Condo Side (B2)**					
Day	Time	Grand Ballroom	Emerald Hall	Geomundo Hall A	Geomundo Hall C	Odongdo Hall	Geumodo Hall	Ballasta Hall	Exhibition & Poster
Apr. 29, Mon	09:00 - 1700					Council Meeting			
	1800 - 2000					Dinner			
Apr. 30, Tue	13:00 - 1730		Joint Symposium (Kor-Chi-Jap)						
	18:00 - 18:30	Pre-event							
	18:30 - 19:00	Opening Ceremony							
	19:00 - 21:00	Buffet							
May 01, Wed	09:00 - 09:40	Keynote 1							
	09:40 - 10:20	Keynote 2							
	10:20 - 11:00	Keynote 3							
	11:00 - 11:20	coffee break							
	11:20 - 11:40		CAA4 Special Keynote 1, 2	Genetics& Breer' ' 1, 2, .., ,	Feed & Animal Nutrition 1, 2, 3, 4	Environmental Impact & Pollution 1, 2, 3, 4	Fishery Policy & Economics 1, 2, 3, 4		
	11:40 - 12:00								
	12:00 - 12:20							GAF4 1, 2	
	12:20 - 12:40								
	12:40 - 13:40	Lunch							
	13:40 - 14:00		CAA4 Special Keynote 3, 4, 5	Genetics& Breeding 5, 6, 7, 8, 9, 10	Feed & Animal Nutrition 5, 6, 7, 8, 9, 10	Fish for Human 1, 2, 3, 4, 5, 6	Fishery Policy & Economics 5, 6, 7, 8 9, 10	GAF4 3, 4, 5, 6, 7, 8	Exhibition & Poster
	14:00 - 14:20								
	14:20 - 14:40								
	14:40 - 15:00								
	15:00 - 15:20								
	15:20 - 15:40								
	15:40 - 16:00	coffee break							
	16:00 - 16:20		CAA4 1, 2, 3, 4, 5	Genetics& Breeding 11, 12, 13, 15	Environmental Impact & Pollution 5, 6, 7, 8, 9	Fish for Human 7, 8, 9, 10, 11	Fishery Policy & Economics 11, 12, 13 14, 15	GAF4 9, 10, 11, 12	
	16:20 - 16:40								
	16:40 - 17:00								
	17:00 - 17:20								
	17:20 - 17:40								
	17:40 - 18:00							AFS Assembly	
	18:00 - 18:30								
	18:30 - 20:30	Student Day							
May 02, Thu	09:00 - 09:20		CAA4 6, 7, 8, 9, 10	Genetics& Breeding 16, 18, 19, 20	Feed & Animal Nutrition 11, 12, 13 14, 15	Fishery Policy & Economics 16, 17, 18 19, 20	Fisheries Processing 1, 2, 3, 4, 5	GAF4 13, 14, 15 16, 17	
	09:20 - 09:40								
	09:40 - 10:00								
	10:00 - 10:20								
	10:20 - 10:40								
	10:40 - 11:00	coffee break							
	11:00 - 11:20		CAA4 11, 12, 13, 14, 15	Genetics& Breeding 21, 23, 24, 25	Feed & Animal Nutrition 16, 17, 18 19, 20	Fishery Policy & Economics 21, 22, 23 24, 25	Fisheries Processing 6, 7, 8, 9, 19	GAF4 18, 19, 20 21, 22	
	11:20 - 11:40								
	11:40 - 12:00								
	12:00 - 12:20								
	12:20 - 12:40								
	12:40 - 13:40	Lunch							Exhibition & Poster
	13:40 - 14:00		CAA4 16, 17, 18 19, 20	Genetics& Breeding 26, 27, 28 29, 30	Environmental Impact & Pollution 10, 11, 12 13, 14	Fisheries Assessment 13, 14	Fisheries Processing 10, 11, 12 13, 14	GAF4 23, 24, 25 26, 27	
	14:00 - 14:20					Feed & Animal Nutrition 21, 22, 23			
	14:20 - 14:40								
	14:40 - 15:00								
	15:00 - 15:20								
	15:20 - 15:40	coffee break							
	15:40 - 16:00		CAA4 21, 22, 23, 24	Genetics& Breeding 31, 32, 33 34, 35	Aquaculture 1, 2, 3, 4, 5	Industry Seminar (Wenger)	Fisheries Processing 15, 16, 17, 18	GAF4 28, 29 30	
	16:00 - 16:20								
	16:20 - 16:40								
	16:40 - 17:00								
	17:00 - 17:20								
	17:20 - 17:40						Korea Session (General Meeting)		
	17:40 - 18:00								
	18:00 - 20:00	Farmers Day							

May 03, Fri	09:00 - 09:20	Fisheries Assessment 1, 2, 3, 4, 5	Fishing Gear 1, 2, 3, 4, 5	Shrimp & Crustaceans 1, 2, 3, 4	Animal Health 1, 2, 3, 4, 5	Aquaculture 7, 8, 9, 10, 11	Fishery Policy & Economics 26, 27, 28 29, 30	GAF4 31, 32, 33 34, 35	Exhibition & Poster
	09:20 - 09:40								
	09:40 - 10:00								
	10:00 - 10:20								
	10:20 - 10:40								
	10:40 - 11:00	coffee break							
	11:00 - 11:20	Fisheries Assessment 6, 7, 8, 9	Fishing Gear 6, 7, 8, 9	Shrimp & Crustaceans 5, 6, 7, 8	Animal Health 6, 8, 9, 10	Feed & Animal Nutrition 24, 25, 26, 27	Environmental Impact & Pollution 15, 16, 17, 18	NORAD-NACA Wrokshop	
	11:20 - 11:40								
	11:40 - 12:00								
	12:00 - 12:20								
	12:20 - 13:20	Lunch							
	13:20 - 13:40	Fisheries Assessment 10, 11, 12		Shrimp & Crustaceans 9, 10	Animal Health 11, 12, 13	Korea Session (Assembly)	Environmental Impact & Pollution 19, 20, 21	ASEM AQUACULTURE	
	13:40 - 14:00								
	14:00 - 14:20		New Councilor Meeing						
	14:20 - 14:40					Feed & Animal Nutrition 28, 29, 30		GENDER Research Roundtable	Exhibition & Poster Close
	14:40 - 15:00								
	15:00 - 15:20								
	15:20 - 15:40	Pre-event							
	15:40 - 16:00	Farewell Reception							
	16:00 - 16:20								
	16:20 - 16:40								
	16:40 - 17:00								
	17:00 - 17:20								
	17:20 - 17:40	Sightseeing for Jinnamje							
	17:40 - 18:00								
	18:00 - 18:30								
	18:30 - 20:30								
May 04, Sat	08:30 - 18:00	Farm Tour							
	08:30 - 18:00	Sightseeing							

二、相關行程

此次論壇由筆者與本系劉俊宏、張欽泉、林鈺鴻等教師及徐雅麗助理等共同出席第十屆亞洲漁業和水產養殖論壇，一行人於 4 月 29 日早於高鐵站出發前往桃園國際機場搭乘 13 時 15 分釜山航空 BX 702 班機，並於當日 16 時 25 分抵達釜山清海機場，隨即由韓國當地導遊小吳引領搭乘接駁車接送至位於全羅南道東南端的麗水市區內的 U-Castle 飯店(離大會會場 The Ocean Resort 約 15 分鐘車程)。第二日參觀麗水市梧桐島、興國寺及綜合水產市場，隨後約在近 17 時抵達大會會場報到、拍照及張貼海報，並參加開幕式及歡迎晚宴，晚宴有穿著韓國傳統服飾的演唱一些西洋及韓國經典名曲，及兩項傳統舞蹈(頭上帶著有彩帶帽子的甩頭舞及扇子舞)表演。

三、會議內容

在三天論壇中包括了密集的口頭論文發表及海報展示。總計有三場大會邀請主題演講 (keynote speech)，251 篇口頭發表論文及 245 篇壁報展示論文，另據大會宣布參予此次會議者超過 620 名，其中韓國水產學會也配合各項專題辦理年度論文發表會。

照片一、第十屆亞洲漁業和水產養殖論壇會場台灣團全體合照

照片二、第十屆亞洲漁業和水產養殖論壇開幕式，理事長 Dr. Derek Staples 致開幕詞 (April 30, 2013, The Ocean Resort)

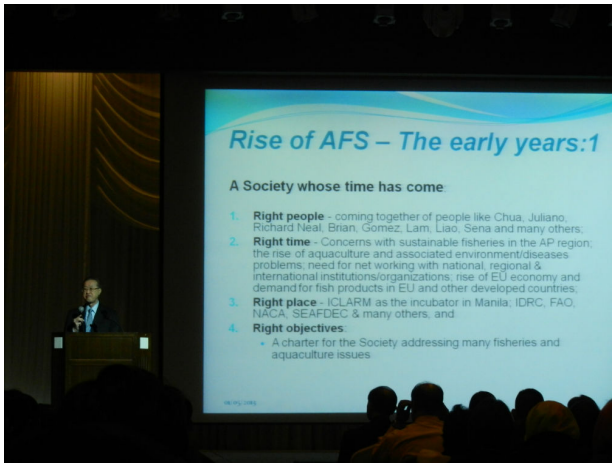
10th AFAF 會議共同討論亞洲水產當前面臨的問題及水產的可持續發展，並分為 11 個技術專題"Technical Sessions"及一個特別專題"Special Section"：

1. Aquatic animal Nutrition and Feeding 水生動物營養與飼料
2. Aquaculture, Production System 水產養殖及生產系統
3. Fisheries Processing 水產加工
4. Fisheries and Policy, Social Science, Economic and Livelihood 漁業及政策、社會科學、經濟及生計
5. Fish for Human Nutrition and Health 魚類與人類的營養和健康
6. Environment Impacts, Pollution and Ecotoxicology 環境影響，汙染及環境生態毒理學
7. Biodiversity, Genetics, Biotechnology and Breeding, Conservation 生物多樣性、遺傳、生物技術及培育、保育
8. Fisheries Gear and Technology 漁具及技術
9. Fisheries Assessment and Aquatic Resources Management, Ecology 水產養殖與環境的影響
10. Aquatic Animal Health and Management 水產動物健康及管理
11. Shrimp and Other Crustacean Aquaculture 蝦類及其他甲殼類養殖

Special Section: 4th Global Symposium on Gender in Aquaculture and Fisheries (GAF4) 第四屆性別參與水產養殖及漁業國際研討會

還有第四屆國際箱網養殖研討會(CAA4)分為兩場次：

1. Marine and Freshwater Cage Culture, Seed Production 海洋及淡水箱網養殖、種苗生產
2. Disease Prevention and Health Management, Pollution, Ecotoxicology 疾病防治及健康管理、汙染、環境生態毒理學

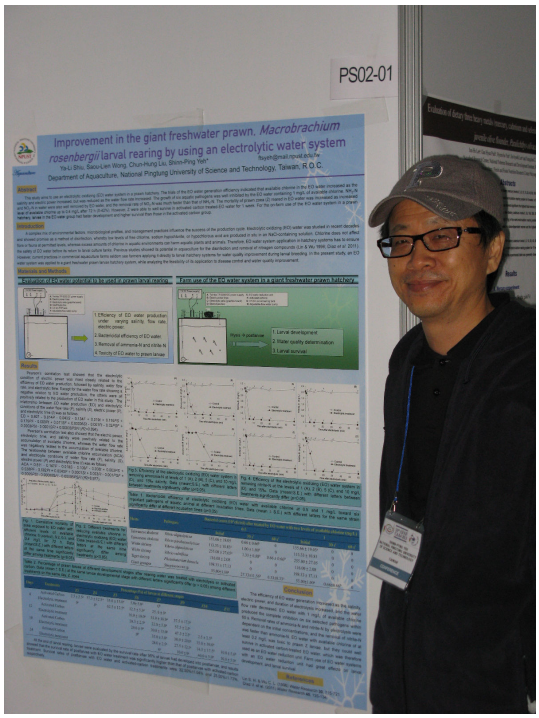


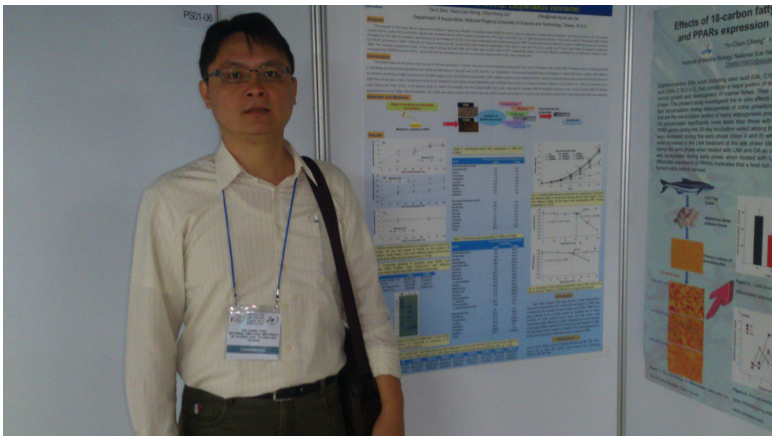
照片三、邀請演講：第八屆亞水會澳洲籍會長 Dr. Chan-Lui Lee 介紹亞水會成立典故(May 01, 2013, The Ocean Resort)

照片四、聆聽會議論文發表(May 01, 2013, The Ocean Resort)

筆者於 ”環境影響，汙染及生態毒理學” 專題「Environment Impacts, Pollution and Ecotoxicology」Section 中發表一篇壁報論文 ”電解水系統應用於改善淡水長臂蝦苗之培育”「Improvement in the giant freshwater prawn, *Macrobrachium rosenbergii* larval rearing by using an electrolytic water system」。(摘要內容請見附註, P.11)

劉俊宏老師於此次會議中共計發表三篇壁報論文，包括於”水產動物營養與飼料”專題「Aquatic animal Nutrition and Feeding」Section 中發表之壁報論文”枯草桿菌-E20 醱酵豆粉做為替代性原料取代白蝦飼料中之魚粉原料”「*Bacillus*





照片五(左)、筆者與發表之壁報論文(May 02, 2013, The Ocean Resort)

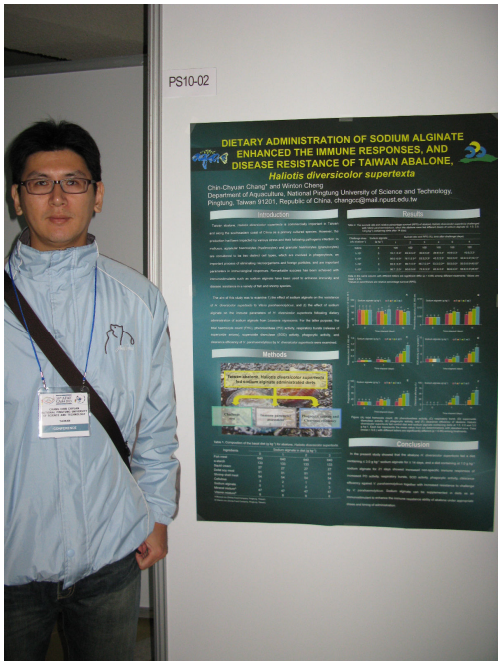
照片六(右)、劉俊宏老師與發表之壁報論文(May 02, 2013, The Ocean Resort)

subtilis E20-fermented soybean meal as a replacement for fish meal in the diet of white shrimp, *Litopenaeus vannamei*」；與筆者共同於環境影響，汙染及生態毒理學”專題「Environment Impacts, Pollution and Ecotoxicology」Section 中發表之壁報論文”電解水系統應用於改善淡水長臂蝦苗之培育”「Improvement in the giant freshwater prawn, *Macrobrachium rosenbergii* larval rearing by using an electrolytic water system」；及於”生物多樣性、遺傳、生物技術及育種”專題「Biodiversity, Genetics, Biotechnology & Breeding, Conservation」Section 發表之壁報論文”點帶石斑魚兩型胰蛋白酶原之分子選殖及特性分析”「Molecular cloning and characterization of two trypsinogens in the orange-spotted grouper, *Epinephelus coioides*」。

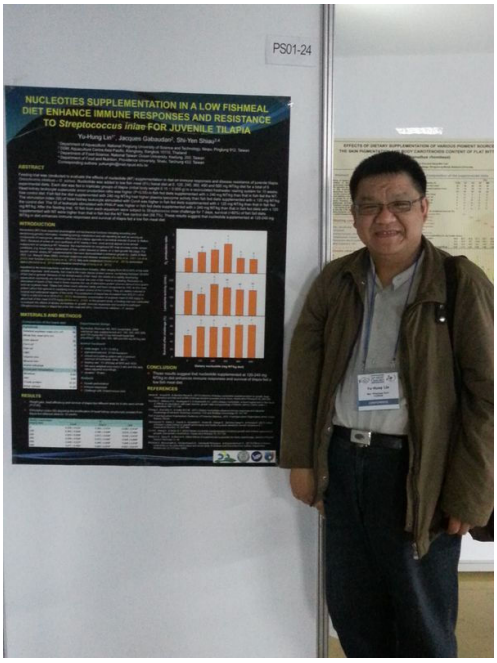
張欽泉老師於” 水生動物營養與飼料” 專題「Aquatic animal Nutrition and Feeding」Section 中發表一篇壁報論文”飼料添加藻酸鈉增強台灣鮑魚免疫反應及抗病能力”「Dietary administration of sodium alginate enhanced the immune responses, and disease resistance of Taiwan abalone, *Haliotis diversicolor supertexta*」。

林鈺鴻老師於”水生動物營養與飼料”專題「Aquatic animal Nutrition and Feeding」Section 中發表一篇壁報論文”低魚粉飼料中添加核苷酸對吳郭魚免疫反

應及抗病能力之影響”「Nucleotides supplementation in a low fishmeal diet enhance immune responses and resistance to *Streptococcus iniae* for juvenile tilapia」。



照片七、張欽泉老師與發表之壁報論文(May 02, 2013, The Ocean Resort)



照片八、林鈺鴻老師與發表之壁報論文(May 02, 2013, The Ocean Resort)

論壇舉行期間，5 月 1 日晚間 6 點召開亞水會全體會員大會，在理事長、秘書與財務分別報告學會事務後，投票選舉亞水會第十一屆理事，台灣由現任理事蕭錫延講座教授提名陳弘遠及黃承輝兩位教授參選本屆理事，投票後兩位均順利當選新任理事。中國上海海洋大學副校長黃碩琳博士獲選為新任理事長。此外，國立台灣海洋大學水產養殖學系陳建初教授也卸下亞水會台灣分會會長一職，新任分會長則由同校海洋生物研究所黃將修教授接任。

論壇於 5 月 3 日閉幕，依例過去皆會在會議結束後公布下屆主辦國，原訂第十一屆亞洲漁業和水產養殖論壇將由日本接辦並於東京召開，但由於日本有意將論壇延後至 2017 年舉辦，因此理事會有考慮另尋願意承接的國家，而越南則是優先表達強烈承接意願，由於此次理事會並未做出決議，故下屆主辦國亦延後公告。

照片九、亞水會頒發感謝狀予卸任理事蕭錫延講座教授(May 01, 2013, The Ocean Resort)

照片十、新任理監事改選。新任理事-嘉義大學生命科學院黃承輝院長發言(May 01, 2013, The Ocean Resort)

照片十一、頒發感謝狀予卸任理事長 Dr. Derek Staples (May 03, 2013, The Ocean Resort)

四、參展廠商

本次會議廠商參展項目涵蓋養殖系統，打氣及水質檢測設施、飼料機械、標籤等，甚至有柬埔寨王國的漁業單位前來擺攤，介紹該國湄公河漁業局及其出版的 CD、刊物及魚類海報。其中較為特別的是有廠商展示銅製箱網模型，活鮑魚展示及海鮮產品試吃等。

照片十二(左)、參展廠商現場展示及解說-韓國水產器材製造商
-A-MI Coporation。

照片十三(右)、參展廠商現場展示銅製箱網模型

五、其他

總計共有 28 位成員出席本屆論壇，分別為國立台灣海洋大學講座教授廖一久院士、蕭錫延講座教授、陳建初教授、陳瑤湖教授、黃將修教授、陳歷歷助理教授及海地碩士生莫洛緬，國立台灣大學劉錫江教授(退休)、國立中山大學陳宏遠教授、博士生鄭宇君、國立彰化師範大學李奇英教授、國立嘉義大學黃承輝特聘教授及其夫人、賴弘智教授、陳淑美副教授、碩士生蔡旻珊、謝曉瑩及李岱靜、國立成功大學陳宗嶽教授、王涵青副教授、國立屏東科技大學葉信平教授(筆者)、劉俊宏教授、張欽泉助理教授及其夫人、林鈺鴻助理教授、助理徐雅麗、嘉南藥理科技大學林美芳助理教授及 Nutriad 亞太區總監吳明勳先生。本屆論壇台灣代表團共口頭發表論文 3 篇，壁報論文 18 篇。

論壇結束後，筆者一行人於 5 月 4 日搭乘 11 時 05 分釜山航空 BX 701 班機自釜山起飛，12 點 25 分時抵達桃園國際機場，結束此次韓國之行。

參、與會心得及建議事項

本屆論壇舉辦前，巧逢北韓正以軍事(發射飛彈)恫嚇韓國及其他國家，部分

國家(含大陸)學者專家取消行程，也造成會議中有不少口頭報告及壁報遭取消(no show)，因而影響會議之流暢度，與會者部分時間多在枯等，或聆聽自願者上台發表陳篇感言。對有不少原本計畫聆聽的報告或壁報因故取消，多少帶有遺憾。

雖然部分論文並未發表，但從聆聽的報告中明顯可感受到，相較於過去幾屆，本屆論壇論文質量均有顯著提升，特別是東南亞國家的論文質量，無論實驗設計或構想，均不亞於水產養殖的傳統大國，如日本或台灣，且這些國家的大學或研究單位也積極送學生到這些日本，甚至歐美等國取經，相當值得台灣借鏡，若未積極擴展國際視野，恐怕很快就為東南亞各國所趕上甚至超前。

本屆亞水會理事的選舉，台灣提名之陳宏遠與黃承輝兩位教授均順利當選，對於推展台灣水產養殖與漁業的國際事務大有助益，未來也希望藉由理事的協助，承辦此類國際會議，相信對國內學界與產業界能有許多幫助。

最後由衷感謝學校大力補助而得以參加本次論壇，對於學術交流與論文發表，廣增國際視野，也冀望未來能繼續給予補助參與更多之國際會議。

肆、攜回資料

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12. Yeosu and Korean Tourist Maps, Korea Travel Guide

附註、本屆論壇所發表之論文摘要

Improvement in the giant freshwater prawn, *Macrobrachium rosenbergii* larval rearing by using an electrolytic water system

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This study aims to use an electrolytic oxidizing (EO) water system in a prawn hatchery. The trials of the EO water generation efficiency indicated that available chlorine in the EO water increased as the salinity and electric power increased, but was reduced as the water flow rate increased. The growth of six aquatic pathogens was well inhibited by the EO water containing 1 mg/L of available chlorine. NH_3-N and NO_2-N in water were also well removed by EO water, and the removal rate of NO_2-N was much faster than that of NH_3-N. The mortality of prawn zoea (Z) reared in EO water was increased as increased level of available chlorine up to 0.4 mg/L after 72 h (0-42%). However, Z were able to well survive in activated carbon treated-EO water for 1 week. For the on-farm use of the EO water system in a prawn hatchery, larvae in the EO water group had faster development and higher survival than those in the activated carbon group.

Keywords: electrolytic oxidizing, *Macrobrachium rosenbergii*, larval rearing, pathogen, water quality

Bacillus subtilis E20-fermented soybean meal as a replacement for fish meal in the diet of white shrimp, *Litopenaeus vannamei*

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This purpose to this study was to improve the nutritional value and utilization of soybean meal (SBM) for shrimp using an approach of solid-state fermentation with *Bacillus subtilis* E20. The protein content and *B. subtilis* E20 proliferation significantly increased as the initial moisture increased from 300 g kg^{-1} up to 500 g kg^{-1} in SBM during fermentation. The protein content of fermented SBM (FSBM) increased by 19% after fermentation, accompanied by an increase of 18.75% in the total hydrolyzed amino acids compared to SBM. The free amino acid profile and content in FSBM also obviously increased by 374.9% compared to SBM. FSBM did not improve shrimp growth, but the level which could be substituted in fish meal in a diet with 370 g kg^{-1} protein and 7 g kg^{-1} lipid content increased compared to SBM. The maximal replacement levels of fish meal in shrimp diet with SBM and FSBM were 37.42% and 61.67%, respectively, based on the feed efficiency estimated by a broken-line analysis. It was concluded that FSBM fermented with *B. subtilis* E20 can be a potential protein source used as a replacement for fish meal in shrimp diet.

Molecular cloning and characterization of two trypsinogens in the orange-spotted grouper, *Epinephelus coioides*

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The aim of this study was to clone and characterize two trypsinogens of the orange-spotted grouper, *Epinephelus coioides*. Two full-length trypsinogen cDNAs, named T1 and T2, were 900 and 875 nucleotides, and translated 242 and 244 deduced amino acids (aa), respectively. Both trypsinogens contained highly conserved residues essential for serine protease catalytic and conformational maintenance. Results from isoelectric and phylogenetic analyses suggested that both trypsinogens were grouped into trypsinogen group I. Both trypsinogens expression were first detected at 1 day post-hatching (DPH), and exhibited steady-state expression during early development at 1~25 DPH. Both expression and activity levels significantly increased after 30 DPH due to metamorphosis. The increased trypsin activity was considered to be contributed from live food and important for food digestion and survival of larvae during early larval development.

Dietary administration of sodium alginate enhanced the immune responses, and disease resistance of Taiwan abalone, *Haliotis diversicolor supertexta*

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The non-specific immune parameters including the total hemocyte count (THC), phenoloxidase (PO) activity, respiratory bursts, superoxide dismutase (SOD) activity, phagocytic activity, and clearance efficiency to *Vibrio parahaemolyticus* by *Haliotis diversicolor supertexta* were determined when the abalone (4.5 ±0.4 g) were fed with the diets containing sodium alginate at 0, 1.0, 2.0, and 3.0 g kg^{-1}; meanwhile, the survival rates of the abalone against *V. parahaemolyticus* infection were also evaluated. The abalones fed a diet containing sodium alginate at 2.0 and 3.0 g kg^{-1} for 14 days had significantly higher survival rates than those fed the control diet after challenging with *V. parahaemolyticus*. The relative survival percentages of abalone fed the 1.0, 2.0, and 3.0 g kg^{-1} sodium alginate-containing diets for 14 days were 16.1%, 40.0%, and 48.0%, respectively. The SOD, and phagocytic activity and clearance efficiency to *V. parahaemolyticus* infection of the abalone fed the 2.0 and 3.0 g kg^{-1} sodium alginate-containing diets were significantly higher than those fed the 1.0 g kg^{-1} sodium alginate diet and control diet for 7 days. The PO activity, respiratory bursts, SOD activity, and phagocytic activity and clearance efficiency of *V. parahaemolyticus* of abalone fed the sodium alginate containing diets at 1.0, 2.0, and 3.0 g kg^{-1} were significantly higher than those of abalone fed the control diet for 14 days. It was concluded that sodium alginate can be used as an immunostimulant for abalone through dietary administration to enhance immune responses of abalone and resistance against *V. parahaemolyticus*, which were related to the dose and timing of administration.

NUCLEOTIES SUPPLEMENTATION IN A LOW FISHMEAL DIET ENHANCE IMMUNE RESPONSES AND RESISTANCE TO *Streptococcus iniae* FOR JUVENILE TILAPIA

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The study was aimed to evaluate the effects of nucleotides (NT) supplementation in a low fishmeal diet enhance immune responses and disease resistance for juvenile tilapia, *Oreochromis niloticus* × *O. aureus*. Commercial NT (Rovimax NX) was supplemented at 0, 120, 240, 360, 480 and 600 mg NT/kg diet in low fish meal (5%) basal diet. Each diet was fed to triplicate groups of tilapia (initial body weight 0.15 ± 0.005 g) in a recirculated fresh water rearing system for 10 weeks. Weight gain, feed efficiency and survival of tilapia were not significantly (P>0.05) different among the dietary groups. Headkidney leukocyte superoxide anion production ratio was higher in fish fed diets with ≥240 mg NT/kg than that in fish fed the NT-unsupplemented control diet. Fish fed the diet with 240 mg NT/kg had higher plasma lysozyme activity than fish fed diets with ≤ 120 mg NT/kg. The stimulation index of proliferation stimulated by mitogens of headkidney isolated from tilapia were higher in fish fed diets with ≥120 mg NT/kg diet than that in fish fed the control diet. After challenged with *Streptococcus iniae* for 7 days, the survival (>80%) of fish fed diets with NT were higher than that of fish fed the control diet (56.7%). Results indicated that dietary supplementation levels of 120-240 mg NT/kg diet can enhance immune responses and disease resistance for juvenile tilapia, when the fish fed a low-fish meal diet.

Table 1. Superoxide anion (O_2^-) production ratio, plasma lysozyme activity and survival after *Streptococcus iniae* challenge for 7 days in tilapia fed differents for 10 weeks.

Dietary nucleotides (mg NT/kg diet)	O_2^- production ratio	Lysozyme (U/mL)	Survival (%)
0	1.15 ± 0.24[a]	139.33 ± 22.11[a]	56.7 ± 5.77[a]
120	1.66 ± 0.19[ab]	122.22 ± 19.02[a]	80.0 ± 10.0[b]
240	1.88 ± 0.30[b]	182.22 ± 28.19[b]	80.0 ± 10.0[b]
360	2.36 ± 0.42[b]	163.29 ± 32.10[ab]	80.0 ± 0.00[b]
480	1.24 ± 0.30[a]	152.14 ± 19.23[ab]	86.7 ± 5.8[b]
600	1.17 ± 0.28[a]	149.15 ± 25.58[ab]	86.7 ± 5.8[b]