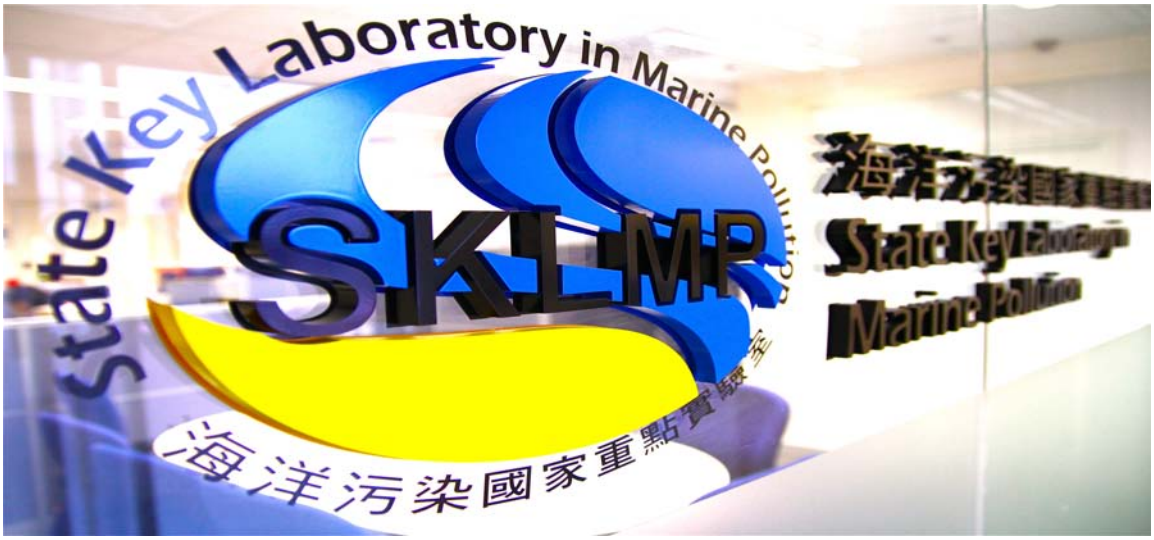
Annual Report

年度報告

海洋污染國家重點實驗室（香港城市大學）
State Key Laboratory in Marine Pollution
(City University of Hong Kong)

OUR **VISION**



SKLMP envisions a solid base where coordinated and long-term research can be conducted to tackle marine pollution problems.

Contents

A Message from the Director

State Key Laboratory in Marine Pollution (SKLMP) is made up of a consortium of six partner universities: City University of Hong Kong (CityU), Hong Kong Baptist University (HKBU), The Chinese University of Hong Kong (CUHK), The Hong Kong Polytechnic University (PolyU), The Hong Kong University of Science and Technology (HKUST) and The University of Hong Kong (HKU). The multidisciplinary nature of the team that has been assembled – drawing from the collective expertise of 31 members and the shared facilities of the six collaborating universities – is the key to SKLMP's future success. The partnership is dedicated to the development of innovative chemical, biological and engineering technologies for the early detection, assessment, prediction and control of pollution impacting the marine environment. SKLMP is also partnered with the State Key Laboratory of Marine Environmental Science (MEL) at Xiamen University. The two facilities have been working together to make even greater contributions to research on issues related to the marine environment and sustainable development in China. SKLMP is continually building upon these strong foundations, and moving forward step-by-step to becoming one of the world's leading research hubs in this discipline. SKLMP is highly focused on conducting high-impact basic research in marine pollution, to stimulate the formation of new biotechnology ventures in China, and to solve complicated and pressing environmental problems over large temporal and spatial scales.

The establishment of the State Key Laboratory in Marine Pollution was officially approved by the Ministry of Science and Technology (MOST) of the People's Republic of China in 2009. The success of our application to MOST was due largely to the synergistic partnership amongst the six universities demonstrated in the Area of Excellence Scheme "Marine Environmental Research and Innovative Technology – MERIT" led by Prof. Rudolf Wu, which is now in its second phase. It is hoped that when the MERIT is completed in a few years' time, SKLMP will continue to provide a platform for synergetic collaboration and will persistently strive for excellence as an infrastructure for research and teaching; inspiring innovative research discoveries.

The City University of Hong Kong, as the host university, strongly views SKLMP as a "must succeed" venture. CityU invested HK$15M start-up funding for its infrastructure building after it was officially founded in 2011. In its first year, SKLMP set up the basic framework, constructed its infrastructure, and was operated in smooth succession to MERIT. SKLMP is built upon the foundation of this well-established infrastructure and advanced laboratory facilities, which will undoubtedly further strengthen our research capability by developing a range of novel technologies for attracting research funding and collaborations.

In addition, the SKLMP has adopted a strategy for providing seed funding through the SKLMP Seed Collaborative Research Fund (SCRF), with twin objectives of attracting large outside grants and bringing together members from collaborating institutions. In 2011, SKLMP received 10 research proposals, involving 17 SKLMP members from ALL of the 6 collaborating institutions and 11 non-SKLMP members (from Hong Kong, overseas and mainland China). These research proposals have been evaluated by a Panel consisting of one Academic Committee member and four outside reviewers. Since SKLMP had allocated HK$1.5 million for 2011 SCRF, grants were awarded to five projects.

Since its establishment, SKLMP has been seeking promising strategic partnerships with first-class academic institutions in mainland China and worldwide, in an attempt to boost bilateral scientific cooperation and foster collaborative projects. The establishment of our "Shenzhen Research Centre for Oceans and Human Health (H2O)" was officially approved by the Shenzhen Municipal Government in 2011. The setting up of H2O will provide a solid base for a coordinated and long-term approach to tackle marine pollution problems and will provide good opportunities for SKLMP's outstanding research team to strengthen its collaboration with mainland institutions in academic and technological exchanges. The move will signify a major step in the collaboration between Hong Kong and the Mainland through the undertaking of frontier research which will contribute to the country's technological advancement.

SKLMP has also conducted intensive networking in the past one year, i.e. paying visits to various first-class academic institutions in the Mainland and worldwide as well as inviting prominent scholars to visit SKLMP and give seminars, with a view to developing long-term strategic partnerships and cooperative relations with these institutions.

Finally, I would like to take this opportunity to deliver my heartfelt thanks to all our colleagues and friends worldwide who have been helping SKLMP in many respects.

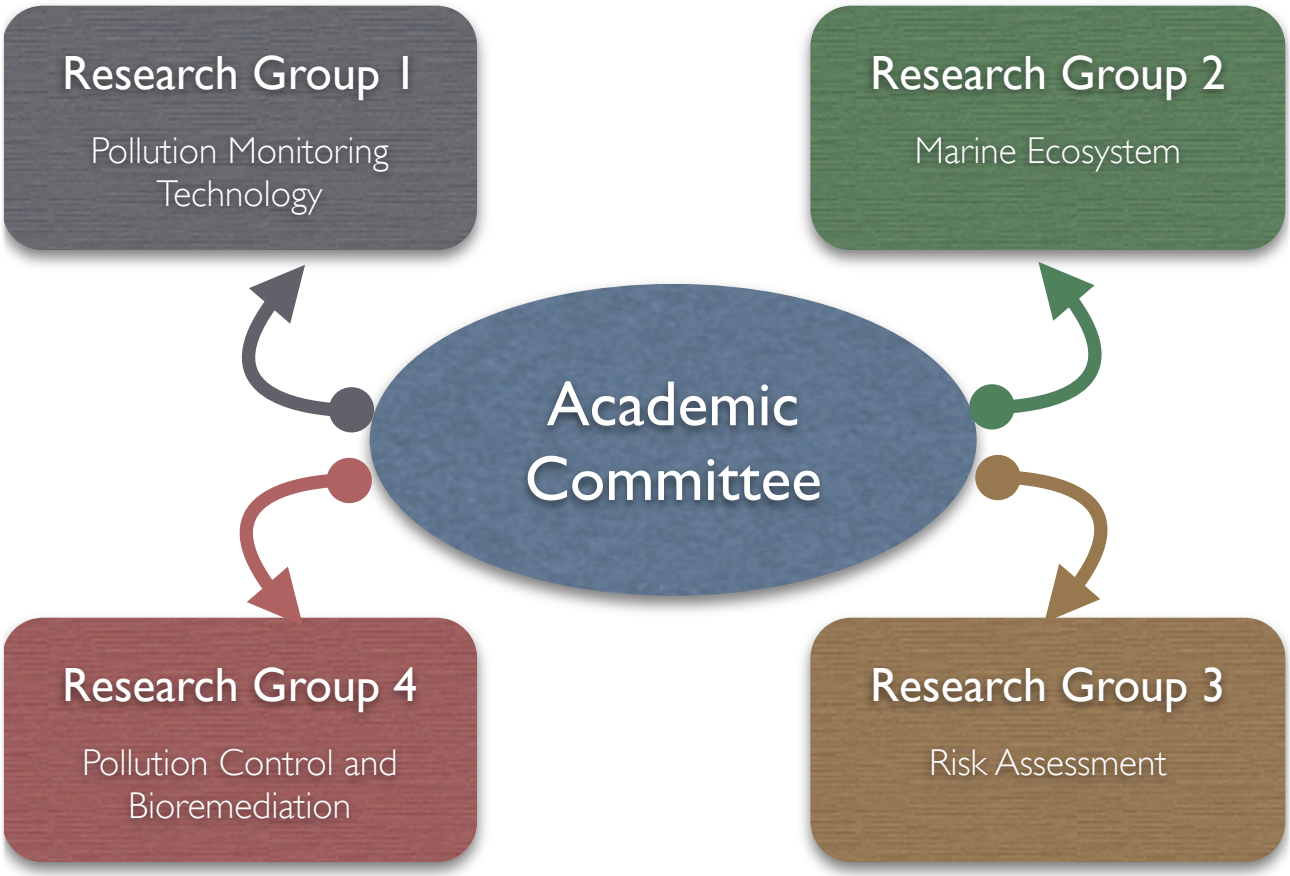
I wish you and your family a very successful and prosperous 2012.

Yours sincerely,

Prof. Paul K.S. Lam

Director of State Key Laboratory in Marine Pollution

Research Scopes in SKLMP



SKLMP Academic Committee Members

Prof. George IWAMA, President and Vice Chancellor of University of Northern British Columbia, Canada.

Prof. Huasheng HONG, Professor of Xiamen University and Vice-President of the Scientific Committee on Ocean Research, International Council for Science and Academic Committee; Member of the Coastal and Ocean Management Institute, China.

Dr. Don ANDERSON, Senior Scientist in the Biology Department of the Woods Hole Oceanographic Institution (WHOI) and Director of the Coastal Ocean Institute, USA.

Prof. Des CONNELL, Professor in the Faculty of Environmental Sciences at Griffith University, Australia.

Prof. John GIESY, Professor and Canada Research Chair in Environmental Toxicology at the Department of Veterinary Biomedical Sciences and Toxicology Centre of the University of Saskatchewan, Canada.

Prof. David HINTON, the Nicholas Professor of Environmental Quality at Duke University, USA.

Prof. Minghan DAI, Professor and Director of State Key Laboratory of Marine Environmental Science, Xiamen University, China.

Prof. Gui Bin JIANG, Academician, Chinese Academy of Sciences; Director of the State Key Laboratory of Environmental Chemistry and Ecotoxicology, Research Center for Eco-Environmental Sciences(RCEES), Chinese Academy of Sciences, China.

Prof. Xiao Yan TANG, Academician, Chinese Academy of Engineering; Professor of Peking University and the Vice President of the Chinese Society of Environmental Sciences, China.

Prof. Jian Hai XIANG, Professor of the Institute of Oceanology, Chinese Academy of Sciences in Qingdao, China.

SKLMP Team Members

Prof. Paul Kwan-sing LAM (CITYU)
Dr. Put O ANG (CUHK)
Dr. Doris Wai-ting AU (CITYU)
Dr. Leo Lai CHAN (CITYU)
Dr. Michael Chi-wang CHAN (CITYU)
Prof. Shuk-han CHENG (CITYU)
Dr. Siu-gin CHEUNG (CITYU)
Prof. Min-han DAI (Xiamen University , CN)
Prof. Paul HARRISON (HKUST)
Prof. Jianping GAN (HKUST)
Dr. Richard Yuen-chong KONG (CITYU)
Prof. Wei GE (CUHK)
Dr. Ji Dong GU (HKU)
Dr. Hon-wah LAM (CITYU)
Prof. Tai-chu LAU (CITYU)
Prof. Joseph LEE (HKUST)
Dr. Kenneth M Y LEUNG (HKU)
Prof. W K LI (HKU)
Dr. X Y LI (HKU)
Prof. Xiangdong LI (PolyU)
Prof. Hongbin LIU (HKUST)
Dr. Margaret Burkhardt MURPHY (CITYU)
Prof. Pei Yuan QIAN (HKUST)
Dr. Bruce J RICHARDSON (CITYU)
Dr. Paul Kam-shing SHIN (CITYU)
Prof. Nora Fung-yee TAM (CITYU)
Prof. Wen WANG (HKUST)
Dr. Chris WONG (HKBU)
Prof. M H WONG (HKBU)
Prof. Norman WOO (CUHK)
Prof. Rudolf Shiu-sun WU (HKU)
Prof. Michael Mengsu YANG (CITYU)
Prof. Peter Kwan-ngok YU (CITYU)

Research Highlights

Papers published in peer-reviewed SCI journals

Part I. Papers with SKLMP included as the author's affiliation

1. Bo J, Cai L, Xu JH, Wang KJ, Au DT (2011) The marine medaka *Oryzias melastigma* - A potential marine fish model for innate immune study. *Mar Pollut Bull* 63: 267-276.

2. Bradley PW, Wan Y, Jones PD, Wiseman S, Chang H, Lam MHW, Long DT, Giesy JP (2011) PBDEs and methoxylated analogues in sediment cores from two Michigan, USA, inland lakes. *Environ Toxicol Chem* 30: 1236-1242.

3. Chan WH, Mak YL, Wu JJ, Jin L, Sit WH, Lam JCW, Sadovy de Mitcheson Y, Chan LL, Lam PKS, Murphy M (2011) Spatial distribution of ciguateric fish in the Republic of Kiribati. *Chemosphere* 84: 117-123.

4. Chen XP, Li L, Cheng JP, Chan LL, DZ Wang, Wang KJ, Baker ME, Hardiman G, Schlenk D, Cheng SH（2011） Molecular staging of marine medaka: A model organism for marine ecotoxicity study. *Mar Pollut Bull* 63: 309-317.

5. Cheung NKM, Hinton DE, Au DT (2011) A high-throughput histoarray for quantitative molecular profiling of multiple, uniformly oriented medaka (*Oryzias latipes*) embryos. *Compa Biochem Physiol C – Toxicol Pharmacol* 155: 18–25.

6. Chiu JMY, PKS Shin, Yang FY, Cheung SG (2011) Can a scavenging gastropod with a mussel conspecific diet induce anti-predator defence in the mussel *Perna virids*? *J Experi Mar Biol Ecol* 401: 85-88.

7. Davi NL, Qi SH, Chakraborty P, Zhang G, Yadav IC (2011) Passive air sampling of organochlorine pesticides in a northeastern state of India, *Manipur. J Environ Sci-China* 23: 808-815.

8. Feng HM, Zheng JC, Lei NY, Yu L, Kong KHK, Yu HQ, Lau TC, Lam MHW (2011) Photoassisted fenton degradation of polystyrene. *Environ Sci Technol* 45: 744-750.

9. Fleddum A, Cheung SG, Hodgson P, Shin PKS (2011) Impact of hypoxia on the structure and function of benthic epifauna in Tolo Harbour, Hong Kong. *Mar Pollut Bull* 63: 221-229.

10. Gao QT, Wong YS, Tam NFY (2011) Removal and biodegradation of nonylphenol by different chlorella species. *Mar Pollut Bull* 63: 445-451.

11. Gao QT, Wong YS, Tam NFY (2011) Removal and biodegradation of nonylphenol by immobilized chlorella vulgaris. *Bioresource Technol* 102: 10230-10238.

12. Horii Y, Ohtsuka N, Minomo K, Nojiri K, Kannan K, Lam PKS, Yamashita N (2011) Distribution, characteristics, and worldwide inventory of dioxins in kaolin ball clays. *Environ Sci Technol* (in press).

13. Hu MH, Wang YJ, Tsang ST, Cheung SG, Shin PKS (2011) Effect of starvation on the energy budget of two Asian horseshoe crab species: *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* (Chelicerata: Xiphosura). *Mar Biol* 158: 1591-1600.

14. Jiang XW, Li XM, Lam PKS, Cheng SH, Schlenk D, Sadovy de Mitcheson Y, Li Y, Gu JD, Chan LL. (2012) A proteomic analysis of hepatic tissue of ciguatoxin (CTX) contaminated coral reef fish *Cephalopholis argus* and moray eel *Gymnothorax undulates*. *Harmful Algae* 13:65-71.

15. Leung HW, Minh TB, Murphy MB, Lam JCW, So MK, Martin M, Lam PKS, Richardson BJ (2011) Distribution, fate and risk assessment of antibiotics in sewage treatment plants in Hong Kong, South China. *Environ Int* (in press).

16. Li CH, Ye C, Wong YS, Tam NFY (2011) Effect of Mn(IV) on the biodegradation of polycyclic aromatic hydrocarbons under low-oxygen condition in mangrove sediment slurry. *J Hazard Mater* 190: 786-793.

17. Liu CC, Chiu JMY, LI L, Shin PKS, Cheung SG (2011) Physiological responses of two sublittoral nassariid gastropods to hypoxia. *Mar Ecol-prog Series* 429: 75-85.

18. Liu CC, Chiu JMY, LI L, Shin PKS, Cheung SG (2011) Respiration rate and swimming activity of larvae of two sub-tidal nassariid gastropods under reduced oxygen levels: implications for their distributions in Hong Kong waters. *Mar Pollut Bull* 63: 230-236.

19. Liu FJ, Wang WX (2011) Differential roles of metallothionein-like proteins in cadmium uptake and elimination by the scallop *Chlamys nobilis*. *Environ Toxicol Chem* 30: 738-746.

20. Liu XS, Xu WZ, Cheung SG, Shin PKS (2011) Marine meiobenthic and nematode community structure in Victoria Harbour, Hong Kong upon recovery from sewage pollution. *Mar Pollut Bull* 63: 318-325.

21. Liu XS, Xu WZ, Cheung SG, Shin PKS (2011) Response of meiofaunal community with special reference to nematodes upon deployment of artificial reefs and cessation of bottom trawling in the subtropical waters, Hong Kong. *Mar Pollut Bull* 63: 376-384.

22. Lo KH, Hui MNY, Yu RMK, Wu RSS, Cheng SH (2011) Hypoxia impairs primordial germ cell migration in zebrafish (*Danio rerio*) embryos. *PLOS ONE 6*: DOI: 10.1371/journal.pone.0024540

23. Loi EIH, Yeung LWY, Taniyasu S, Lam PKS, Kannan K, Yamashita N (2011) Trophic biomagnification of poly- and per-fluorinated compounds in a subtropical food web. *Environ Sci Technol* 45:5506-5513.

24. Lu GH, Yang YL, Taniyasu S, Yeung LWY, Pan J, Zhou BS, Lam PKS, Yamashita N (2011) Potential exposure of perfluorinated compounds to Chinese in Shenyang and Yangtze River Delta areas. *Environ Chem* (in press).

25. Ma YB, Liu CS, Lam PKS (2011) Modulation of steroidogenic gene expression and hormone synthesis in H295R cells exposed to PCP and TCP. *Toxicol* 282: 146-153.

26. Ma YB, Liu CS, Lam PKS, Wu RSS, Giesy JP, Hecker M, Zhang XW, Zhou BS (2011) Modulation of steroidogenic gene expression and hormone synthesis in H295R cells exposed to PCP and TCP. *Toxicol* 282:146–153.

27. Ng PKS, Yu RMK, Kwong TFK, Wong MML, Kong RYC (2010) Transcriptional regulation and functional implication of the grass carp CITED1 (gcCITED1) in the negative regulation of HIF-1. *Int J Biochem Cell Biol*. 42: 1544-1552.

28. Nicholson S, Hui YH, Lam PKS (2011) Pollution in the coastal waters of Hong Kong: case studies of the urban Victoria and Tolo Harbours. *Water Environ J* 25: 387-399.

29. Qiao TJ, Zhang XH, Wu GX, Au DT (2011) Investigation of microbial safety of a full-scale ozonation and biological activated carbon process under high humidity & temperature conditions. *Water Sci Technol* (in press)

30. Qiu Y, Wang L, Leung CF, Liu G, Yang S, Lau TC (2011) Preparation of N-doped K2Nb4O11 with high photocatalytic activity for degradation of organic pollutants under visible light. *Appl Catalysis A: General* 402: 23-30.

31. Shen M, Xu JL, Chan AKY, Au DT (2011) Susceptibility of fish to *Chattonella marina* is determined by its tolerance to hypoxia. *Mar Pollut Bull* 63: 189-194.

32. Shen M, Xu JL, Chiang MWL, Au DT (2011) Unravelling the pathway of respiratory toxicity in goldlined seabream (*Rhabdosargus sarba*) induced by the harmful alga *Chattonella marina*. *Aquatic Toxicol* 104: 185-191.

33. Tian L, Wang MH, Li XM, Lam PKS, Wang MF, Wang DZ, Chou HN, Li Y, Chan LL (2011) Proteomic modification in gills and brains of medaka fish (*Oryzias melastigma*) after exposure to a sodium channel activator neurotoxin, brevetoxin-1. *Aquatic Toxicol* 104: 211-217.

34. Tse WKF, Chow SC, Lai KP, Au DWT, Wong KC (2011) Modulation of ion transporter expression in gill mitochondrion-rich cells of eels acclimated to low-Na^+ or -Cl^- freshwater. *J Experi Zoo Part A: Ecol Gen Physiol* 313A.

35. Wang MJ, Wang WX (2011) Cadmium sensitivity, uptake, subcellular distribution and thiol induction in a marine diatom: recovery from cadmium exposure. *Aquatic Toxicol* 101: 387-395.

36. Wang MJ, Wang WX (2011) Cadmium sensitivity, uptake, subcellular distribution and thiol induction in a marine diatom: exposure to cadmium. *Aquatic Toxicol* 101: 377-386.

37. Wang Y, Murphy MB, Lam JCW, Jiao LP, Wong CCL, Yeung LWY, Lam PKS (2011) Polychlorinated biphenyls and organochlorine pesticides in local waterbird eggs from Hong Kong: Risk assessment to local waterbirds. *Chemosphere* 83:891-896.

38. Wang YF, Tam NFY (2011) Microbial community dynamics and biodegradation of polycyclic aromatic hydrocarbons in polluted marine sediments in Hong Kong. *Mar Pollut Bull* 63: 424-430.

39. Wang YJ, Hu MH, Shin PKS, Cheung SG (2011) Immune responses to combined effect of hypoxia and high temperature in the green-lipped mussel *Perna viridis*. *Mar Pollut Bull* 63: 201-208.

40. Wang YJ, Hu MH, Wong WH, Shin PKS, Cheung SG (2011) The combined effects of oxygen availability and salinity on physiological response and scope for growth in the green-lipped mussel *Perna viridis. Mar Pollut Bull* 63: 255-261.

41. Wiseman SB, Wan Y; Chang H; Giesy JP (2011) Polybrominated diphenyl ethers and their hydroxylated/methoxylated analogs: Environmental sources, metabolic relationships, and relative toxicities. *Mar Pollut Bull* 63-179-188.

42. Wu HF, Wang WX (2011) Tissue-specific toxicological effects of cadmium in green mussels (*Perna viridis*): nuclear magnetic resonance-based metabolomics study. *Environ Toxicol Chem* 30: 806-812.

43. Wu JJ, Mak YL, Murphy M, Lam JCW, Chan WH, Wang MF, Chan LL, Lam PKS (2011) Validation of an accelerated solvent extraction liquid chromatography-tandem mass

spectrometry method for Pacific ciguatoxin-1 in fish flesh and comparison with the mouse neuroblastoma assay. *Anal Bioanal Chem* 400: 3165-3175.

44. Wu XG, Lam JCW, Xia CH, Kang H, Xie ZQ, Lam PKS (2011) Atmospheric concentrations of DDTs and chlordanes measured from Shanghai, China to the Arctic Ocean during the Third China Arctic Research Expedition in 2008. *Atmos Environ* 45:3750-3757.

45. Xia CH, Lam JCW, Wu XG, Sun LG, Xie Z, Lam PKS (2011) Hexabromocyclododecanes (HBCDs) in marine fishes along the Chinese coastline. *Chemosphere* 82:1662-1668.

46. Xia CH, Lam JCW, Wu XG, Sun LG, Xie ZQ, Lam PKS (2011) Levels and distribution of polybrominated diphenyl ethers (PBDEs) in marine fishes from Chinese coastal waters. *Chemosphere* 82:18-24.

47. Xu Q, Chen F, Shin PKS, Cheung SG, Chen Y, Ke CH (2011) AFLP analysis of genetic variation among three natural populations of horseshoe crab T*chaypleus tridentatus* along Chinese coast. *Chi J Oceanol Limnol* 29: 284-289.

48. Yang N, Chu DLH, Wong MML, Qi HZ, Wu RSS, Kong RYC (2011). Major human Hepatitis A Virus in Hong Kong marine waters and detection by quantitative real-time PCR. *Mar Pollut Bull* 62: 2654-2658.

49. Yang YF, Wiseman S, Cohen-BAM, Giesy JP (2011) Effects of in ovo exposure of white leghorn chicken, common pheasant, and Japanese quail to 2,3,7,8-tetrachlorodibenzo-p-dioxin and two chlorinated dibenzofurans on cyp1a induction. *Environ Toxicol Chem* 29:1490-1502.

50. Yu L, Lam JCW, Guo Y, Wu RSS, Lam PSK, Zhou B (2011) Parental transfer of PBDEs and thyroid endocrine disruption in zebrafish. *Environ Sci Technol* 45:10652-10659.

51. Zhao Q, Cheung SG, Shin PKS, Chiu JMY (2011) Effects of starvation on the physiology and foraging behaviour of two subtidal nassariid scavengers. *J Experi Mar Biol Ecol* 409: 53-61.

Part II. Papers with SKLMP grant or support acknowledged

52. Butson ET, Cheung T, Yu PKN (2011). Measuring solar UV radiation with EBT radiochromic film. *Physics Med Biol* 55:487-493.

53. Cohen BAM, Zwiernik MJ; Link JE, Giesy JP (2011) Developmental and posthatch effects of in ovo exposure to 2,3,7,8-TCDD, 2,3,4,7,8-PECDF, and 2,3,7,8-TCDF in Japanese quail (*Coturnix japonica*), common pheasant (*Phasianus colchicus*), and white leghorn chicken (*Gallus gallus domesticus*) embryos. *Environ Toxicol Chem* 30: 1659-1668.

54. Gao QT, Tam NFY (2011) Growth, photosynthesis and antioxidant responses of two microalgal species, *Chlorella vulgaris* and *Selenastrum capricornutum,* to nonylphenol stress. *Chemosphere* 82: 346-354.

55. He YH, Wiseman SB; Hecker M, Giesy JP (2011) Effect of ozonation on the estrogenicity and androgenicity of oil sands process-affected water. *Environ Sci Technol* 45: 6268-6274.

56. Kim S, Choi K, Ji K, Giesy JP (2011) Trans-placental transfer of thirteen perfluorinated compounds and relations with fetal thyroid hormones. *Environ Sci Technol* 45: 7465-7472.

57. Liu HL, Hu W, Sun H, Geo CH (2011) In vitro profiling of endocrine disrupting potency of 2,2 ',4,4 '-tetrabromodiphenyl ether (BDE47) and related hydroxylated analogs (HO-PBDEs). *Mar Pollut Bull* 63: 287-296.

58. Pourrezaei P; Drzewicz P; Wang YN; Giesy JP (2011) The impact of metallic coagulants on the removal of organic compounds from oil sands process-affected water. *Environ Sci Technol* 45: 8452-8459.

59. Qin YY, Leung CKM, Giesy JP, Wong MH (2011) Halogenated POPs and PAHs in blood plasma of Hong Kong residents: *Environ Sci Technol* 45: 1630-1637.

60. Wan HT, Zhao YG, Wong MH, Wong CKC, Giesy JP (2011) Testicular signaling is the po-

tential target of perfluorooctanesulfonate-mediated subfertility in male mice. *Biol Reprod* 84: 1016-1023.

61. Wang XY, Wu J, Hao YQ, Zhu BQ, Shi W, Hu GJ, Han XD, Giesy JP, Yu HX (2011) Reproductive toxicity assessment of surface water of the Tai section of Yangtze River, China by in vitro bioassays coupled with chemical analysis. *Environ Pollut* 159: 2720-2725.

62. Wei X, Huang YQ, Wong MH, Wong CKC, Giesy JP (2011) Assessment of risk to humans of bisphenol A in marine and freshwater fish from Pearl River Delta, China. *Chemosphere* 85: 122-128.

63. Wei X, Leung KS, Wong MH, Wong CKC, Giesy JP (2011) Assessment of risk of PCDD/Fs and dioxin-like PCBs in marine and freshwater fish in Pearl River Delta, China. *Mar Pollut Bull* 63: 5-12.

64. Yu HY, Zhang BZ, Giesy JP (2011) Persistent halogenated compounds in aquaculture environments of South China: Implications for global consumers' health risk via fish consumption. *Environ Int* 37: 1190-1195.

65. Zhang FX, Hu W, Yu HX, Giesy JP (2011) Endocrine disruption effects of 2,2', 4,4 ', 6-pentabromodiphenylether (BDE100) in reporter gene assays. *J Environ Monitoring* 13: 850-854.

66. Zhang XW, Chang H, Wiseman S, Giesy JP (2011) Bisphenol A disrupts steroidogenesis in human H295R cells. *Toxicol Sci* 121: 320-327

67. Zhang XW, Wiseman S, Yu HX, Giesy JP (2011) Assessing the toxicity of naphthenic acids using a microbial genome wide live cell reporter array system. *Environ Sci Technol* 45: 1984-1991.

Attendance at International Conferences

1. Symposium of Cholera and Enteric Diseases in NICED, 26-30 January 2011, Kolkata, India. (Invited speaker).
2. 103rd Annual Meeting of the National Shellfisheries Association, 27-31 March, 2011, Baltimore, Maryland, USA.
3. International Conference on Environment and Health, 11-15 April 2011, United Kingdom (Keynote Speaker).
4. 5th Joint Research Workshop on Arsenicosis, 3 May 2011, Cambodia.
5. The 30th annual International Symposium on Pollutant Responses in Marine Organisms (PRIMO 16), 15-18 May, 2011, Long Beach, California, USA.
6. International Workshop on the Science and Conservation of Asian Horseshoe Crabs, 13-16 June, 2011, Hong Kong, China.
7. 15th International Symposium on Toxicity Assessment, 3-8 July 2011, Hong Kong. (Chairperson, Invited speaker).
8. GEF-UNIDO International Workshop on POPs, 29-30 July, 2011, Da Nang City, Vietnam.
9. 4th International Contaminated Site Remediation Conference, 11-15 September 2011, Australia.
10. 5th Aquatic Animal Models of Human Disease Conference, 20-22 September, 2011, Corvallis, Oregon, USA (Invited Speaker).
11. 1st Strategic Meeting for Medaka Research, 23-24 November, 2011, Okazaki, Japan (Invited Speaker).
12. International Conference on Environment Simulation and Pollution Control, 24-25 November, 2011, Beijing (Invited Speaker).
13. The 5th International Kuroshio Symposium, 10-11 December, 2011 Guangzhou, PR China (Invited Speaker).

14. Chinese First Workshop of Environment and Health, 13-16 December, 2011 Xiamen, PR China (Keynote Speaker).

Titles of presentations

1. Au DT (2011) Bridging the gap between sub-organismal biomarker responses to adverse effect on the population.
2. Au DT (2011) Japanese medaka as alternative model for gender and aging studies.
3. Au DT (2011) The whole medaka histoarray: An integrative approach for molecular biology and histopathology.
4. Bo J, Giesy JP, Au DT (2011) Innate immune relevant gene identification and the gender differential expression in the marine medaka *Oryzias melastigma* challenged with *Vibrio parahaemolyticus.*
5. Chan LL (2011) Ciguatera fish poisoning: recent advances and emerging threats.
6. Chaturvedi G, Tan TF, Giesy JP, Wu RSS, Kong RYC (2011) Hypoxia-inducible factor (HIFs) and associated microRNAs in regulation of steroidogenesis: bioinformatic and expression studies.
7. Cheung ACK, Ge W, Giesy JP, Au DT (2011) Estrogen receptors (ERs) and estrogen related receptors (ERRs) in the Japanese medaka *Oryzias latipes*.
8. Cheung JHY, Lau TCY, Cheung SG, Shin PKS (2011) Conservation in action: A rearing and releasing program of juvenile horseshoe crabs in Hong Kong schools.
9. Cheung NKM, Hinton DE, Au DT (2011) Hypoxia and liver development.
10. Hu M, Wang Y, Cheung SG, Shin PKS (2011) Dietary protein and energy requirement of *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda.*
11. Hu M, Wang Y, Cheung SG, Shin PKS (2011) Effect of starvation on the energy budget of

two Asian horseshoe crab species: *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* (Chelicerata: Xiphosura).

12. Hu M, Wang Y, Cheung SG, Shin PKS, Li Q (2011) Distribution, abundance and population structure of horseshoe crabs along three intertidal zones of Beibu Gulf, southern China.

13. Hu M, Wang Y, Cheung SG, Shin PKS, Li Q (2011) Relationship of environmental variability and spatial distribution of two horseshoe crab species along nursery beaches of Beibu Gulf coast, southern China.

14. Kong R (2011) Molecular characterization of novel genomic islands in pandemic strains of *Vibrio parahaemolyticus.*

15. Lam PKS (2011) Environmental risk assessment: from perception to decision.

16. O SYO, Hu M, Cheung SG, Shin PKS (2011) Development of optimal artificial feed for laboratory culture of juvenile mangrove horseshoe crab *Carcinoscorpius rotundicauda*.

17. Qiao TJ, Zhang XH, Yu ZR, Au DT (2011) Occurrence and effects of pharmaceuticals and personal care products in water sources in south China.

18. Shen M, Xu SJL, Wong CKC, Chiang MWL, Chan AKY, Au DT (2011) Unravelling the fish killing and surviving pathway induced by the harmful alga *Chattonella marina.*

19. Tao Y, Wang Z, Yasojima M, Au DT, Zhang XH (2011) Responses of algal growth and photosynthetic activity upon typical pharmaceuticals and personal care pollutants in rapidly urbanized area in south China.

20. Wang Y, Hu M, Cheung SG, Shin PKS (2011) Characterization of the subpopulations of hemocytes and their immune-related parameters in the green-lipped mussel *Perna viridis.*

21. Wang YJ, Hu MH, Shin PKS, Cheung SG (2011) Immune toxicity of nano titanium dioxide under hypoxia in green-lipped mussel Perna viridis using flow cytometry.

22. Wong MH (2011) Environmental and health effects of emerging chemicals of concern.

23. Wu H, Au DT, Guo BS, Wong YF, Tang T, Li YP, Chiang MWL, Wei L, Hung LK, Qin L, Yang ZJ, Zhang G (2011) Application of lipid nanoparticles for siRNA delivery to bone

marrow.

24. Ye RR, Lei ENY, van de Merwe JP, Bo J, Lam MHW, Segner HE, Wong CKC, Au DT (2011) Immuno-modulatory effects of dietary PBDEs in the marine medaka *Oryzias melastigma.*

25. Ye R, Bo J, Cheung NKM, van de Merwe JP, Wang KJ, Segner HE, Lam MHW, Giesy JP, Wu RSS, Yang MS, Au DT (2011) Development of *Oryzias melastigma* as a marine fish model for immunotoxicology.

Training of Graduate Students

CHAN Wai Fung (MPhil) - COMPLETED

CHAN Wing Hei (MPhil) - COMPLETED

CHEN Xun Wen (MPhil) - ONGOING

CHENG Zhang (PhD) - ONGOING

CHOI Wai Ming (MPhil) - TRANSFERRED TO PhD

CHOW Ka Lai (MPhil) - TRANSFERRED TO PhD

GAYATHRI Charturvedi (PhD) - ONGOING

JIME Sultanah (PhD) - COMPLETED

KWOK Ying (PhD) - ONGOING

LEUNG Ho Wing (PhD) - ONGOING

LI Hui (PhD) - ONGOING

LI Vincent (MPhil) - ONGOING

LIANG Peng (PhD) - COMPLETED

LIU Chi Chi (PhD) - ONGOING

LOI I Ha (PhD) - ONGOING

MAK Yim Ling (PhD) - ONGOING

MO Wing Yin (PhD) - ONGOING

NG Sen (MPhil) - WITHDREW

QIN Yan Yan (PhD) - COMPLETED

SAFA Ashrafus (PhD) - COMPLETED

SHAO Ding Ding (PhD) - COMPLETED

SUN Xiao Lin (PhD) - COMPLETED

SURAIA Nusrin (PhD) - ONGOING

TAN Tian Feng (PhD) - ONGOING

TSUI Mei Po (PhD) - ONGOING

WANG Hong Sheng (PhD) - COMPLETED

WANG Ru Wei (PhD) - ONGOING

WANG Wei (MPhil) - TRANSFERRED TO PhD
WANG You Ji (PhD) - COMPLETED
WU Chuan (PhD) - COMPLETED
ZHANG Hao Yu (PhD) - ONGOING
ZHANG Xiao Jian (PhD) - ONGOING
ZHAO Qian (MPhil) - COMPLETED
ZHU Bing Qing (PhD) - ONGOING

Research Grants

Competitive External Research Grants

Investigator	Grant Type	Project Title	Funding amount (HKD)
PI: Ming Hung Wong	AFCD	Effect of vaccine combined with traditional Chinese medicine on prevention of disease in grey mullet	$0.41M
PI: Paul Lam	AFCD	Provision of services for the technical review and statistical Analysis of the datasets of waterbird monitoring programme for the Deep Bay area and baseline ecological monitoring programme for the Mai Po Inner Deep Bay Ramsar Site	$0.79M
PI: Richard Kong	AoE/RGC	Waterborne viral pathogen detection technologies	$2.0 M
PI: Richard Kong	AoE/RGC	Human leukocyte antigen (HLA) homologues in zebrafish: a key to understanding hypoxia- mediated modulation of offspring sex ratios and reproductive functions in fish.	$1.0 M
PI: Richard Kong	AoE/RGC	Functional analyses of HIF transcription factors and associated microRNAs in the human H295R adrenocortical cell line.	$0.8M
PI: Ming Hung Wong Co-PI: Paul Lam	DSD	Removal efficiencies of toxic chemicals in sewage treatment works in Hong Kong	$0.9M
PI: Ming Hung Wong Co-PI: Paul Lam	ECF	Integrated fish pond farming using food processing waste: for quality fish production and habitat conservation	$1.9M

Investigator	Grant Type	Project Title	Funding amount (HKD)
Co-I: Richard Kong	EPD	Review and development of marine water quality objectives – feasibility study	$8.6 M
PI: Wen Xiong Wang	GRF	Biokinetics, bioavailability, and chronic toxicity of metal nanoparticles in aquatic organisms	$1.05M
PI: Shuk Han Cheng	GRF	The functional roles of zebrafish irx1a gene in heart development and regeneration	$0.82M
PI: Richard Kong	GRF/RGC	Uncovering the molecular links between hypoxia and endocrine disruption: a functional study of zebrafish leptin	$1.0 M
PI: Ming Hung Wong	GRF/RGC	Risk assessment and remediation of cadmium contamination in registered vegetable farms in the Pearl River Delta region	$0.78M
PI: Paul Lam	GRF/RGC	Measurement and assessment of novel halogenated flame retardants in waterbirds and marine cetaceans in Hong Kong	$0.46M
PI: Paul Shin	GRF/RGC	Assessment of benthic community health in subtropical waters using biological indices and life-trait analysis	0.7M
PI: Nora Tam	ITF Tier III	High efficiency-multifunction-green-vertical municipal wastewater treatment system: development and demonstration	$1.08M
PI: Tai Chu Lau	ITF Tier III	Development of highly efficient semiconductor nanoparticles as photocatalysts for the degradation of organic pollutants in water under visible light	$0.99M

Investigator	Grant Type	Project Title	Funding amount (HKD)
PI: Wong Ming Hung	NFSC/RGC	Health risk assessment of toxic trace elements and PAHs via indoor dust from coal-burning households in rural China	$0.9M
PI: Paul Shin	Ocean Park Conservation Foundation	An ecological study of horseshoe crab spawning and nursery beach for conservation purposes: Ha Pak Nai, Hong Kong	0.25M
PI: Nora Tam	Ocean Park Conservation Fund, Hong Kong	Impact of sea-level rise on protection and management of coastal mangrove wetland	$ 0.2M
PI: Paul Lam	Shenzhen Municipality	Establish the Research Centre for Ocean and Human Health	RMB 1.5M
PI: Nora Tam	Shenzhen Municipality	Eco-remediation technology and demonstration of the coastal wetland in Shenzhen Bay	RMB 0.2M
PI: Nora Tam	Shenzhen Overseas Chinese Town Holding Company	Demonstration of circular economy: study on the Eco-remediation of Shenzhen Overseas Chinese Town	RMB 1.2M
PI: Cheng Shuk Han	SRG	The developmental toxicity of UV sunscreens	$0.18M
PI: Nora Tam	UGC	UGC AoE sustained funding sub-project	$0.4M

Other Grants

Investigator	Grant Type	Project Title	Funding amount (HKD)
PI:Nora Tam	CityU Applied R&D Grant	Futian-CityU Mangrove Research and Development Centre	$0.85M
PI: Doris Au	CityU Strategic Research Grant	Understanding the estrogen dynamics and longevity gender gap in medaka	$0.18M
PI: Doris Au	SKLMP CityU Internal Research Seed Fund (IRSF)	Unraveling tissue specific mechanisms for in vivo regulation of estrogen target genes in medaka	$0.20M
PI: SH Cheng	SKLMP CityU Internal Research Seed Fund (IRSF)	International collaborative research on endocrine disrupting compounds (EDC) and emerging persistent organic pollutants (POPs) in South China Sea	$0.20M
PI: Nora Tam	SKLMP CityU Internal Research Seed Fund (IRSF)	Sorption and degradation of polybrominated biphenyl ethers (PBDEs) by green microalgae with and without the effect of metals	$0.20M
PI: Peter Yu	SKLMP CityU Internal Research Seed Fund (IRSF)	Long-term measurements of ultraviolet radiation in marine environments in Hong Kong	$0.15M
PI: TC Lau	SKLMP CityU Internal Research Seed Fund (IRSF)	Development of Highly Efficient ZnO Tetrapods Nanoparticles for Photodegradation of Organic Pollutants in Water under Visible Light	$0.15M
PI: Doris Au	SKLMP CityU Internal Research Seed Fund (IRSF)	Development of novel technology for early diagnosis and monitoring of immunotoxic pollutants in marine environment	$0.10M

Investigator	Grant Type	Project Title	Funding amount (HKD)
PI: Michael Lam	SKLMP CityU Internal Research Seed Fund (IRSF)	Development of a metabolomics platform for the assessment of impacts of environmental contaminants on the central nervous system (CNS) and the hypothalamic-pituitary-gonadal (HPG) axis using marine Medaka (*Oryzias melastigma*)	$0.10M
PI: Margaret Murphy	SKLMP CityU Internal Research Seed Fund (IRSF)	Quantification of poly- and perfluorinated compounds (PFCs) and species identification of shark fins purchased from Hong Kong seafood shops	$0.10M

Seed Collaborative Research Fund

Investigator	Project Title	Funding amount (HKD)
Pei Yun Qian (HKUST) Wen Xiong Wang (HKUST) Rudolf SS Wu (HKU) Jian Wen Qiu (HKBU) On On Lee (HKUST) Jill MY Chiu (HKU)	Assessing the impacts of organic and metal pollution on symbiotic microbial communities in marine corals and sponges by metagenomics and transcriptomics approaches	$0.9M
Ming Hung Wong (HKBU) Hong Sheng Wang (HKBU) Brian YB Man (HKBU) Sheng Chun Wu (CityU) Paul KS Lam (CityU) Chris KC Wong (HKBU) Paul D Jones (University of Saskatchewan, Canada) John P Giesy (University of Saskatchewan, Canada)	Health risk assessments of residents in the Pearl River Delta exposed to brominated flame retardants (BFR)	$0.9M
Richard Kong (CityU) Rudolf Wu (HKU) Richard Yu (University of Newcastle, Australia)	Interactive effects of climate change and hypoxia on fish sex determination: estrogen synthesis and masculinisation	$0.9M
Kenneth Leung (HKU) Paul KS Lam (CityU) Chris KC Wong (HKBU) Leo L Chan (CityU)	Establishing the green lipped mussel *Perna viridis* as a universal marine model organism and pollution biomonitor for ecotoxicology and environmental genomics	$0.9M
Xiang Dong Li (PolyU) Wen Xiong Wang (HKUST)	Sources and bioaccumulation of mercury and cadmium in the Pearl River Estuary (PRE) and Hong Kong coastal waters	$0.9M

Abstracts of the five 2010 IRSF projects

UNRAVELING TISSUE-SPECIFIC MECHANISMS FOR IN VIVO REGULATION OF ESTROGEN TARGET GENES IN MEDAKA

Cheung NKM, Ge W, Cheung Andy ACK, Ye RR, Giesy JP, Au DWT

Estrogen is well known for its crucial function in regulating gonadal development, secondary characteristics and behavior in both male and female individuals. Estrogen also plays an important role in controlling diverse physiological processes including cell growth, differentiation, central nervous system, immune system, cardiovascular function and skeletal development.

Estrogen exerts its effects mainly through interactions with the estrogen receptors (ERs). The ligand-receptor complexes regulate the transcription of over 1,000 target genes by acting either as transcription factors that bind to the targets' promoter region or as signaling molecules that interfere with other intracellular signaling cascades.

Conversely, the estrogen-related receptors (ERRs), a class of orphan receptors that are structurally similar to ERs, also involve in the estrogen signaling pathways. It has been reported that ERRs can either synergize or compete with ERs in regulating gene expression in different tissues. Consequently, thorough understanding of the mechanisms and functioning of estrogen cascade is unattainable without considering the involvement of ERRs, in addition to ERs.

Teleost fishes have been extensively utilized, as alternative models along with mammalian systems, to unravel and generalize the estrogen signaling cascade in vertebrates. In particularly, the complete ensembles of ERs and ERRs have been reported and characterized in Japanese medaka *(Oryzias latipes*), a frequently used fish model for endocrinology and toxicological studies. Herein, we report a systematic analysis on organ- and sex- specific expression profiles of all known ERs and ERRs subtypes in the major organs (brain, gill, gonad, heart, liver and spleen) of medaka. The current results provide pivot insight to gender- and tissue-specific control on transcription mediated via ERs and/or ERRs.

MOLECULAR STAGING OF MARINE MEDAKA: A MODEL ORGANISM FOR MARINE ECOTOXICITY STUDY.

Chen X, Li L, Cheng J, Chan LL, Wang DZ, Wang KJ, Baker ME, Hardiman G, Schlenk D, Cheng SH

Oryzias melastigma, also called *O. dancena*, is becoming a very useful model for estuarine and marine ecotoxicity studies. With *O. melastigma* being adopted by ILSI Health and Environmental Science Institute (HESI) for embryo toxicity testing, improved knowledge of biomarker based embryonic development becomes especially important for mechanism-based toxicity evaluations. Using whole mount in situ hybridization and immunostaining techniques together with widely used molecular markers, this study describes the molecular development of marine medaka embryos, focusing on the brain, eye, heart, pectoral fin, pancreas, liver, muscle and neuron system. These organs are targets of environmental pollutants that disrupt normal embryonic development in medaka and other fish.

EFFECTS OF MIXED HEAVY METALS (COPPER AND NICKEL) ON TOXICITY AND REMOVAL OF TETRA-BROMODIPHENYL ETHER (BDE-47) BY GREEN MICROALGAE

Tam NFY, Zhang H, Xie ZH, Wang DZ

Four green microalgae, namely, *Selenastrum capricornutum, Chlorella vulgaris, Chlorella* sp. (*ivoai*), *Chlorella miniata* and *Chlorella* sp. (*2f5aia*) were found to have comparable tolerance to water-borne tetra-bromodiphenyl ether (BDE-47), a model polybrominated biphenyl ether (PBDE), at a very high contamination level (100 μg L-1). In practice, wastewater generated from industry is often co-contaminated with heavy metals. The effects of different levels of heavy metals (copper and nickel in a mixture) on toxicity and removal of BDE-47 at 10 μg L-1 by *S. capricornutum* and *C. vulgaris* were investigated. Growth and photochemistry of both species treated with BDE-47 alone started to show decreases from Day 4 onwards and heavy metals at low level (0.1 and 0.01 mol L-1 Cu and Ni, respectively) did not pose additional toxicity. However, medium and high levels of heavy metals, 5 and 10 times of the low level, respectively, were very toxic to microalgae, especially *C. vulgaris*, irrespective to

whether BDE-47 was spiked or not. The removal of BDE-47 was not affected by heavy metals with up to 70% BDE-47 removed by both species in six days. The accumulation of BDE-47 in *S. capricornutum* increased while transformation decreased significantly at medium and high levels of heavy metals. On the contrary, BDE-47 was mainly accumulated in *C. vulgaris* with little transformation, which was comparable at different heavy metal levels. These results indicate that the toxicity, accumulation and transformation of PBDEs were affected by heavy metals, the metal effect was concentration dependent as well as species-specific.

MEASURING SOLAR UV RADIATION WITH EBT RADIOCHROMIC FILM

Yu P

Ultraviolet radiation (UV) wavelengths are in-between the visible light spectrum and the x-ray spectrum. It is emitted from the sun in three main defined wavelengths, UV-A (315–400 nm), UV-B (280–315 nm) and UV-C (100–280 nm). Today, it is known that all forms of UV radiation are detrimental to humans causing effects such as skin cancer and degenerative effects for our eyes like cataracts. UV radiation also has impact on the ecosystem. For example, it can slow the growth of certain species of ocean algae that provide food for larger organisms, and it can impair phototactic behavior of certain marine organisms. The effect of UV produced by the sun is becoming more significant as the earth's ozone layer is thinning, allowing more UV light to hit the earth's surface. Recent observations suggest that atmospheric ozone levels for March (2011) in the Arctic were approaching the lowest levels. This was described as the first "artic ozone hole". The present work proposed a convenient and cost-effective method for UV radiation dosimetry with the use of a radiochromic film called Gafchromic EBT. The film changes from a clear color to blue color when exposed to UV radiation and results have shown that the color change is reproducible within ±10% at 5 kJ m–2 UV exposure under various conditions of solar radiation. Parameters tested included changes in season (summer versus winter exposure), time of day, as well as sky conditions such as cloudy skies versus clear skies.

DESIGN OF HIGH EFFICIENT NIOBIUM AND TANTALUM OXIDE NANOPARTICLES AS PHOTOCATALYSTS FOR THE DEGRADATION OF ORGANIC POLLUTANTS IN WATER UNDER VISIBLE LIGHT

Wang RW, Qiu YF, Wang L, Leung CF, Liu GJ, Lau TC

The presence of organic pollutants in water has become a serious problem and is threatening the natural environment as well as human health. Removal of these pollutants by photocatalytic degradation using sunlight has attracted great interest in recent years. Although TiO2 has been widely used as photocatalyst for degradation of pollutants in water, it is only efficient under UV light. In this project, we have designed a series of micro/nano oxides of Nb and Ta; these oxides have been doped with various metals and non-metals in order to increase the photocatalytic efficiency and to shift the band-gaps to the visible light region. The photocatalytic activity of these materials has been evaluated by photodegradation of various dyes and organic pollutants such as Orange G (OG), Bisphenol A (BPA) and pentachlorophenol (PCP) under visible light irradiation. Our results show that the visible light (>399 nm) photocatalytic activities of some of our samples are higher than those of Degussa TiO2 P25.

Abstracts of the three 2011 IRSF projects

DEVELOPMENT OF NOVEL TECHNOLOGY FOR EARLY DIAGNOSIS AND MONITORING OF IMMUNOTOXIC POLLUTANTS IN MARINE ENVIRONMENT

Au DWT

Impairment of immune system reduces the ability of an organism to defend itself against pathogens, resulting an adverse impact on fitness and survival success of individuals. Endocrine disruptive chemicals (EDCs) are present in large quantities and widespread in the marine ecosystems. The mammalian immune system has been found to be sensitive to environmental estrogens. Immune commpetence of vertebrates can be compromised more readily by EDCs as compared to their long term consequence on reproductive success. However, to date, there is a lack of monitoring technology for early diagnosis of immunotoxic effects in marine organisms. There is an urgent need to develop novel and sensitive tools for early detection and monitoring of immunotoxicants and their effects in marine vertebrates. A longstanding barrier to progress in biomarker development for ecotoxicology has been the inability of most sub-organismal responses (including molecular and biochemical changes) to indicate significant effects at the population level. Current strategy is to employ a two-step approach to tackle this challenge: i) formulate a conceptual framework to predict —adverse outcome pathway‖ (AOP) which represents a sequence of events that begins with a molecular initiating event, spans multiple levels of biological organization, and ends with an adverse outcome at the level of an individual; ii) develop biologically based, quantitative extrapolation models that allow us to apply cell- or tissue-level data to individuals, and individual-level data to entire populations. In the present study, attempt will be made to develop a conceptual adverse outcome pathway (AOP) and biologically-based, quantitative dose response models for predicting environmental estrogens induced immunotoxic effects, using the marine medaka as model organism. Experiments will be conducted to determine dose-response, sensitive life stage and lifelong impacts of estrogen agonist, 17α-ethinylestradiol (EE2), on immune competence in marine medaka. A battery of molecular, cellular and histological endpoints will be used to assess change in immune function and competence in marine medaka upon short-term and long-term exposure to EE2. The ultimate goal is to identify novel immune biomark-

ers that gain both predictive and diagnostic credibility through their links to both the initiating event and the adverse outcome, which are useful for early diagnosis and monitoring of immuntoxicants in marine environment.

DEVELOPMENT OF A METABOLOMICS PLATFORM FOR THE ASSESSMENT OF IMPACTS OF ENVIRONMENTAL CONTAMINANTS ON THE CENTRAL NERVOUS SYSTEM (CNS) AND THE HYPOTHALAMIC-PITUITARY-GONADAL (HPG) AXIS USING MARINE MEDAKA (*ORYZIAS MELASTIGMA*)

LAM MHW

The metabolome represents the top level of the "omics" in a biological system and is more closely related to the phenotype of the biological entity than its genome and proteome. Metabolites are the downstream products of gene expression. It gives an instantaneous snapshot of biochemical abundances or absolute concentrations of metabolites, and is becoming an increasingly popular tool for toxicological studies to understand the relationship between environmental stresses and disease susceptibility; for identification of useful biomarkers of disease and exposure to environmental contaminants/toxicants; and for elucidation of biological pathways / molecular mechanisms of toxicity. Neurotransmitters are endogenous chemicals that allow the transmission of signals from one neuron to the next across synapses. They, and their metabolites, are also produced by some glands, such as the pituitary and the adrenal glands. They are vital to the functioning of the central nervous systems, and the neural-hormonal regulations, of higher animals. Our research group has already developed the analytical protocol for the quantification of 47 neuro-transmitters in the brain tissue of marine Medaka (*Oryzias melastigma*) using the LC tandem triple quadrupole mass spectrometer (LC-MS/MS) of SKLMP.

A special derivatization technique using dansyl chloride for the derivatization of the neurotransmitter analytes so as to improve their chargeability, and hence their detection sensitivity by the mass spectrometer, was developed in order to achieve pg/g-lipid levels of detection limits for these analytes. With such a high sensitivity, our method is able to establish the pro-

file of neuro-transmitters in the brain of individual fish. This has greatly enhanced the correlation capability of the neuro-transmitters metabolome of *Oryzias melastigma* with any external stimuli and environmental stresses. We have already applied our metabolomic profiling capability for neuro-transmitters in *Oryzias melastigma* to study the potential neurotoxicity of selected polybrominated flame retardant, namely BDE-47, and have observed the up-regulation of the synthesis and catabolism of a number of polyamine-based neuro-transmitters upon BDE-47 exposure. We would like to further our study with food-borne exposure of marine Medaka to a series of toxicants known to affect the CNS and the hypothalamic-pituitary-gonadal (HPG) axis, e.g. mercury, paralytic shellfish poisoning toxins, brevetoxin, ciguateria toxins, bisphenol-A, tetrabromobisphenol-A and the various hydroxyl and methoxyl metabolites of BDE-47, in order to identify individual and/or groups of neuro-transmitters that have shown special up- or down-regulation in their synthesis or catabolism. Their potential to be specific biomarkers for these toxicants will be explored.

QUANTIFICATION OF POLY- AND PERFLUORINATED COMPOUNDS (PFCS) AND SPECIES IDENTIFICATION OF SHARK FINS PURCHASED FROM HONG KONG SEAFOOD SHOPS

Murphy MB

Shark populations are declining around the world, largely due to overfishing and the global shark fin trade. In contrast to many other marine predators, there is a lack of information on the contaminant status of sharks, particularly with regard to poly- and perfluorinated compounds (PFCs), which are used as surface protectors and surfactants both industrially and in manufactured products. Some PFCs have been shown to be persistent and toxic, and thus these chemicals are of global concern. Unlike many organic contaminants, PFCs tend to partition to protein-rich tissues. As such, they can be detected in bird feathers, which are composed primarily of keratin; in this project, a method will be developed based on the method for feathers to measure PFCs in shark fins, which are composed of the structural protein collagen, using acid digestion, solid-phase extraction and high performance liquid-chromatography tandem mass spectrometry (HPLC-MS-MS). Shark fins are readily available in Hong Kong, which is the largest market in the global fin trade; shark fin soup is also commonly consumed locally. In this project, shark fins will be purchased from seafood shops around the city in collaboration with the marine conservation group BLOOM and analyzed for concentrations of shortand long-chain PFCs, and a hazard assessment will be carried out to determine the hazard of shark fin consumption to humans due to PFCs. Individual fins will also be identified at the species level using DNA extraction and sequencing in order to get more information on the species involved in the global shark fin trade, and to relate PFC exposure and accumulation to trophic level and species. By combining ecotoxicology and conservation biology, this project will provide data with relevance to both environmental and human health.

Abstracts of the five 2011 SCRF projects

ASSESSING THE IMPACTS OF ORGANIC AND METAL POLLUTION ON SYMBIOTIC MICROBIAL COMMUNITIES IN MARINE CORALS AND SPONGES BY METAGENOMICS AND TRANSCRIPTOMICS APPROACHES

Qian PY, Wang WX, Wu RSS, Qiu JW, Lee OO, Chiu JMY

Corals and sponges are two major groups of marine benthos around the world. Apart from providing shelter, protection from currents and predators, and areas for breeding, spawning, feeding and resting for fish and other species, they are of great conservation values and also important sources for antibiotics and drugs. Indeed, many potential pharmaceuticals are not directly produced by the corals and sponges, but the symbiotic micro-organisms therein (Faulkner et al., 1999). Despite their great ecological and economic values, the diversity and abundance of corals and sponges in the world experienced a tremendous decline over the last 30 years, mainly because of pollution, global climate changes, habitat destruction, and emerging diseases. In Hong Kong, coastal development and reclamation and pollution from sewage, heavy metal and other industrial wastes pose serious threats on corals and sponges. It has been estimated that about 90% of coral communities in Hong Kong is subject to a high degree of threats from pollution, yet only few works have been carried out to evaluate the impacts of pollution on corals and sponges. It has been well documented that the well being of corals and sponges rely on their symbiotic microorganisms. We hypothesize that that environmental stress may affect the structure and function of these symbiotic microbes, therefore affecting the well being of corals and sponges. In this project, experiments are designed to examine the impacts of selected organic and metal pollutants on the composition and function of these symbiotic microbes, and relate this to the health of corals and sponges. The result of this study will provide a thorough understanding on the relationships between pollution, symbiotic microbial communities and their coral and sponge hosts, which remained poorly known.

HEALTH RISK ASSESSMENTS OF RESIDENTS IN THE PEARL RIVER DELTA EXPOSED TO BROMINATED FLAME RETARDANTS (BFRS)

Wong MH, Wang HS, Man BYB, Wu SC, Lam PKS, Wong CKC, Jones PD, Giesy JP

The concentrations of polybrominated diphenyl ethers (PBDEs) and novel brominated flame retardants (nBFRs) such as methoxylated (MeO-) and hydroxylated (OH-) PBDEs in the environment and humans have been increasing in recent years all over the world. This is particularly the case in the Pearl River Delta (PRD), which is a global power house producing a large amount of electronic products. As important environmental endocrine disruptor chemicals, these organobrominated compounds have the potential to cause serious thyroid hormone disruption, neurotoxicity and adverse developmental effects in humans. However, our knowledge about the intakes, body accumulation and potential transgenerational exposures to these BFRs, especially nBFRs, is very limited. We hypothesize that (1) PBDEs and nBFRs could accumulate in human bodies via inhalation and food ingestion, especially fish consumption, and (2) The accumulated PBDEs and nBFRs in the maternal body can be biotransferred to the next generation via transplacental transport and breast feeding. The major objectives of the present proposal are to develop validated methods for the analysis of nBFRs, investigate their occurrences in foodstuffs, indoor dust and human tissues and to evaluate the associated health risks. This proposed project comprises 6 parts: (1) Determination of average daily intakes of BFRs for residents in the PRD, via consumption of fish and other food products available in the region; (2) Determination of average inhalation intakes of BFRs for residents in PRD, by measuring BFRs in indoor dust samples; (3) Measuring the transfer of BFRs through the intestinal barrier using the Caco-2 cell line model, the transport of BFRs across human cultured alveolar A549 cell monolayers and their tissue distribution in an animal model; (4) Assessing human health risks of oganobromine compounds in human blood and breast milk samples, and the correlation of BFRs concentrations between daily intakes and human body burdens; (5) Determining transgenerational exposure of BFRs to newborns in the region via placental transfer and breast feeding; and (6) Reviewing the current issues and providing guidance concerning food consumption for local residents, especially for sensitive populations such as pregnant woman, women of childbearing age, and infants, with regards to BFRs.

INTERACTIVE EFFECTS OF CLIMATE CHANGE AND HYPOXIA ON FISH SEX DETERMINATION: ESTROGEN SYNTHESIS AND MASCULINISATION

Kong R, Wu RSS, Yu R

Episodes of aquatic hypoxia (< 2 mg O_2 L^{-1}), along with elevated water temperatures are likely to be exacerbated as climate change progresses. Recent studies by our group have demonstrated for the first time that hypoxia disrupts fish sex differentiation, leading to a male-biased sex ratio in the zebrafish and Japanese medaka. Coincidentally, in many fish species exposure to elevated water temperature also leads to male-biased sex ratios. Under climate change, increased frequency of hypoxic episodes and warmer waters are likely to intensify such sex change events. Such shifts in the operational sex ratio are likely to have dire consequences for reproduction and recruitment of fish assemblages inhabiting small lentic waterbodies, potentially leading to losses in biodiversity and fisheries productivity. Despite this emerging threat, the question of how hypoxia and elevated temperature interactively alter fish sex differentiation and hence sex ratios remains unexplored.

One of the mechanisms known to disrupt sex differentiation is interference with sex hormone synthesis. Recent findings in our lab suggest that the inhibition of estrogen synthesis might be a crucial cause of hypoxia-induced masculinisation (the development of male sexual characteristics in a genotypic female). Curiously, inhibition of estrogen synthesis has also been widely observed in masculinised fish as a result of heat treatment, indicating both hypoxia and elevated temperature may share common mechanisms of action on sex differentiation.
Ovarian aromatase (cyp19a) is the steroidogenic enzyme that converts androgens to estrogens. Decreases in cyp19a gene expression can be a major cause of reduced estrogen synthesis under hypoxic and heat conditions, however, the mechanism underlying this gene suppression remains elusive. The transcription factor hypoxia inducible factor-1 (HIF-1) is the master regulator of a broad range of genes responsible for oxygen homeostasis. Intriguingly, HIF-1-mediated gene expression is upregulated not only by hypoxia but also high temperature, implying its critical role in adaptive responses to both stresses (including repression of energy-consuming reproductive processes). As suggested by a recent study using mammalian cancer cells, a possible mechanism of how HIF-1 suppresses cyp19a gene expression could be via depletion of the estrogen receptor (ER), a key transcriptional activator of cyp19a,

although this possibility has not been tested in vivo or in fish thus far. Through understanding the responses and effects of hypoxia-and heat-induced HIF-1 on cyp19a gene expression and estrogen synthesis, this study will establish a novel molecular link between climate change and altered sex ratio in fish populations.

ESTABLISHING THE GREEN LIPPED MUSSEL PERNA VIRIDIS AS A UNIVERSAL MARINE MODEL ORGANISM AND POLLUTION BIOMONITOR FOR ECOTOXICOLOGY AND ENVIRONMENTAL GENOMICS

Leung K, Lam PKS, Wong CKC, Chan LL

The green-lipped mussel *Perna viridis* is widely used as a sentinel species in marine pollution monitoring and ecotoxicological studies in Asia-Pacific region. This species is considered as a subtropical equivalent biomonitor of the temperate *Mytilus* species. In order to elucidate pollutant effects on this common biomonitor species and provide early warning signals of pollutant-mediated stresses, it is prerequisite and essential to understand the toxic mechanisms at molecular level and identify a suite of reliable exposure- and effect-related biomarkers for diagnostic purpose. Global analyses of the expression levels of genes and their products (i.e., RNA and proteins) are increasingly employed in marine model organisms (e.g., copepods, medaka fish, and mussels Mytilus species) to achieve such goals. Despite the important role of *P. viridis* in environmental and toxicological studies, its genomic resources are currently extremely limited when compared with their temperate counterparts, *Mytilus* species. Such an obstacle has significantly hindered the further development of *P. viridis* as a universal model species for ecotoxicological, genomic and proteomic studies. Therefore, this proposed study we will first establish a comprehensive and representative putative transcriptome database for *P. viridis* using the next generation sequencing technology. With the help of bioinformatics, the outcomes of this study will significantly improve our genomic knowledge of *P. viridis*. The analysis will cover three main organs, i.e., hepatopancreas, adductor muscle and gills, which are commonly used in biomonitoring. The established tissue-specific transcript databases will provide a novel and important “back-bone” resource for genome-wide association studies of *P. viridis* which will enable us to uncover the toxic mechanisms, establish concentration-dependent biomarker responses, and develop advanced pollution

monitoring tools. Secondly this proposed study will further address the molecular toxic mechanisms of selected trace metals (e.g. cadmium and copper), persistent organic pollutants (e.g. triphenyltin and PBDE) and nano-particles (e.g. nano metal oxides and carbon nanotubes) in *P. viridis* upon waterborne and/or dietary exposure. The results of this study will also help us to underpin the toxic response pathways for various groups of pollutants, from which we will identify a suite of reliable biomarkers for further development of gene-based biosensors and ELISA-based protein-arrays. These advanced diagnostic tools can be used to provide rapid effect-based biomonitoring of marine pollution and screening for new chemicals in the near future. Given the popularity and increasing importance of *P. viridis*, this work will make significant visible impact and contribution to the advancement of marine pollution research in the region.

SOURCES AND BIOACCUMULATION OF MERCURY AND CADMIUM IN THE PEARL RIVER ESTUARY (PRE) AND HONG KONG COASTAL WATERS

Li XD, Wang WX

Toxic metals are among the major contaminants in marine ecosystems. Metal contamination has become a major environmental problem in many parts of the world. In the Pearl River Estuary (PRE) and Hong Kong coastal water, two metals are of major concern in the marine environments, namely mercury and cadmium. It is well known that mercury (especially its organic form: methylmercury) is biomagnified at the top of marine food chains (such as in marine fish). Recent evidence has also shown that cadmium can be biomagnified in marine benthic food chains (e.g., intertidal rocky shores). The biomagnification of these two metals in predatory marine fish and gastropods can present significant health risks to human through seafood consumption in Hong Kong and the South China coastal regions. Although metal pollution has been recognized in Hong Kong for several decades, the understanding of the biological and environmental behaviors of mercury and cadmium still remains very poor. The mechanisms on how different marine organisms handle metals and how such handling affects metal toxicity are extremely challenging research topics. Such complexity is further augmented by the very complicated but unique hydrographic conditions in the subtropical Pearl River Estuary and Hong Kong coastal waters. This proposed research project will aim to study (1) the sources and geochemical behavior of mercury and cadmium in the PRE and Hong Kong waters; (2) the biological fates and food web dynamics of mercury and cadmium in the subtropical region; and (3) the bioaccumulation of mercury and cadmium in the top predators of these food chains under different hydrographical conditions/exposure histories, and the assessment of seafood safety issues in the study area. The proposed research will increase our understanding of mercury and cadmium pollution in coastal environments, and will provide scientific advice to regulatory agencies and industries for better management of toxic metals in the marine environment.

Collaborative Research

CIGUATERA FISH POISONING: RECENT ADVANCES AND EMERGING THREATS

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Ciguatera fish poisoning (CFP) is a foodborne illness caused by consumption of reef fishes contaminated by a variety of ciguatoxins (CTXs). CTXs are a group of natural marine toxins consisting of more than 20 extremely potent congeners — the lethal potency of the most toxic CTX, Pacific-CTX-1 (P-CTX-1), is 100 times greater than that of tetrodotoxin. It affects more than 25,000 people annually. In the past, CFP was localized in endemic regions such as the tropical atoll island countries in the Pacific. Recently, however, cases of CFP have increased globally, probably due to 1) greater international trade and consumption of coral reef fish; 2) increased proliferation of the CFP causative benthic dinoflagellate, *Gambierdiscus* spp., as reefs continue to degrade due to coral bleaching processes/events, ocean acidification and global warming. Much of the problem in avoiding CFP is due to the normal appearance, smell and taste of fish contaminated with CTXs coupled with the lack of a sensitive and reliable method for detecting ciguateric fish and diagnosing CFP in seafood consumers. Hong Kong has become a main center not only for the import of live coral reef fishes for domestic consumption, but also for the distribution of these fishes to mainland China. At present, there is no system in place in Hong Kong that identifies the source of imported reef fish, and all imports are potentially contaminated since the distribution of ciguateric fishes is sporadic. To protect human health and minimize economic losses by the fisheries industry due to CFP, our research group has developed a rapid analytical method for the quantification of CTXs in fish blood. This method has the advantages of being less-destructive and allows for repeated sampling for continuous monitoring. After consumption of ciguateric fishes (ciguatoxicity ≥ 0.1 ng/g P-CTX-1 equivalents), a number of neurological, gastrointestinal and cardiovascular disorders have been reported in previous studies, yet there is limited information

available concerning the chronic exposure of P-CTXs to mammals. Our preliminary result showed that chronic exposure of P-CTX-1 impaired affective components of visceral pain memory in rat. The absence of signs of intoxication and overt pathology in ciguateric fishes suggests that the carrier species are immune to the effects of CTXs. However, only certain toxic-resistant species, such as the groupers *Cephalopholis argus, Epinephelus spilotoceps* and moray eel, *Gymnothorax undulatus*, have been found to contain high levels of P-CTX-1 equivalents and still appear in the highly ciguateric areas revealed in our previous field studies. In addition, dominance of herbivores is a frequently observed pattern in ciguateric areas. These observations suggest that CTXs could cause damage to resistant species and lead to depletion of sensitive species. Whether CTXs create adjustment or imbalance within coral reef food webs warrants further investigation.

OBSERVATIONAL STUDY OF COUPLED SHELF-BAY CIRCULATION AND ASSOCIATED NUTRIENT TRANSPORT IN MIRS BAY (HONG KONG)

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The oceanic circulation, particularly the interactive bay-shelf circulation in Mirs Bay plays an important role in marine ecosystem in Hong Kong waters. To better understand the hydrodynamics and the associated nutrient transport between the bay and the adjacent shelf waters, members of SKLMP from Hong Kong University of Science and Technology and City University of Hong Kong have jointly conducted a five-day interdisciplinary field survey in Mirs Bay during upwelling season in July 2011. We have sampled hydrographic, nutrients and chlorophyll along four cross-bay and one along-bay transacts with total 25 sampling stations in the bay, during both ebb and flood tides. Besides these mapping surveys, we, for the first time, conducted a time-series mooring of current, temperature, salinity, chlorophyll and O2 of the water column in the bay. The field data clearly shows that the circulation in the Mirs Bay is not isolated from the adjacent shelf processes. With a deep central channel in the bay and unique shelf/coastline topography in the adjacent shelf waters, Mirs Bay is closely influenced by the intrusion of dense and nutrient rich deep shelf waters, induced by the frictional bottom Ekman layer and by the amplified cross-isobath shoreward transport at the lee of the coastal promontory due to Hong Kong Island. The intrusive nutrient rich deep waters surface in the bay and subsequently transport to the rest part of Hong Kong waters by the shelf circulation. Both shelf and bay circulations, and thus the shoreward nutrient transport, are highly time- and space-dependent governed by variable wind and tidal forcing as well as by the local intrinsic hydrodynamics.

Other Achievements

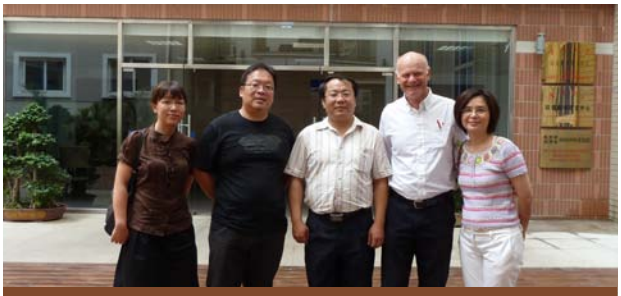
Cheng Shuk Han, Chen Xueping, Li Li, Lin Chun Chi, Lee Cheuk Man, Hui Jasper Jun, Cheung Sally Ho Yee, Cheng Hoi Lam Helen. Transgenic Fish for High-Throughput Biomonitoring of Toxicants. Bronze Prize. Korea International Women's Invention Exposition 2011.

Lam Paul, Lam James, So MK, Yeung Leo, Geochemistry of PFCs in China southeastern coastal region and relevant risk assessment (我国东南沿海海域全氟化合物地球化学特征及其生态健康风险评估), Second Class Natural Science Award, Ministry of Education, December 2011, PR China.

Academic Exchange Activities

Date	Activities
Mar 2011	Mr Xu Bing Dong, the Vice Director of Science and Technology Bureau of Xiamen City, and Prof Zhu Yong Guan, the Director General of Institute of Urban Environment (IUE), Chinese Academy of Sciences, visited SKLMP as an important event in the Programme of Fujian Provincial Delegate, which was led by Ms Sun Chun Lan, the Governor of Fujian Province. An agreement for establishing a Joint Research Centre of Urban Environment was signed by Prof Lam PKS and Prof Zhu Yong Guan, on behalf of SKLMP and IUE, respectively.
Apr 2011	Dr Leo Chan and Dr James Lam, invited by Prof Yu Hong Xia, the Vice Director of Environmental Protection Department of Jiangsu Province, paid a visit to Nanjing. Prof Yu and the experts from Nanjing University expressed great interests in launching a collaborative project under the 12th five-year-plan scheme concerning water pollution in the Taihu Lake Watershed, after they took a field trip around the lake.
Jul 2011	SKLMP co-organised the International Symposium on Toxicity Assessment (ISTA 15) was held at the City University of Hong Kong, Hong Kong, from 3 to 8 July 2011.
Jul 2011	Prof Wen Xiao Bo, the Vice President of Shantou University, visited SKLMP for an academic exchange on the safety of aquacultural products. As a consequence, a joint proposal concerning a new type of high-quality fish feed has been submitted to Innovation Technology Fund of Hong Kong.
Nov 2011	Prof Hu Min, the Director of State Key Joint Laboratory of Environmental Simulation and Pollution Control invited Dr Leo Chan and Dr James Lam to give two presentations regarding up-to-date progress of our research on harmful algal toxins and emerging chemicals at Peking University.
Dec 2011	The Director of Croucher Foundation, Mr David Foster visited SKLMP.
Dec 2011	SKLMP co-organised the International Conference on Deriving Environmental Quality Standards for the Protection of Aquatic Ecosystems (EQSPAE – 2011) with The University of Hong Kong.

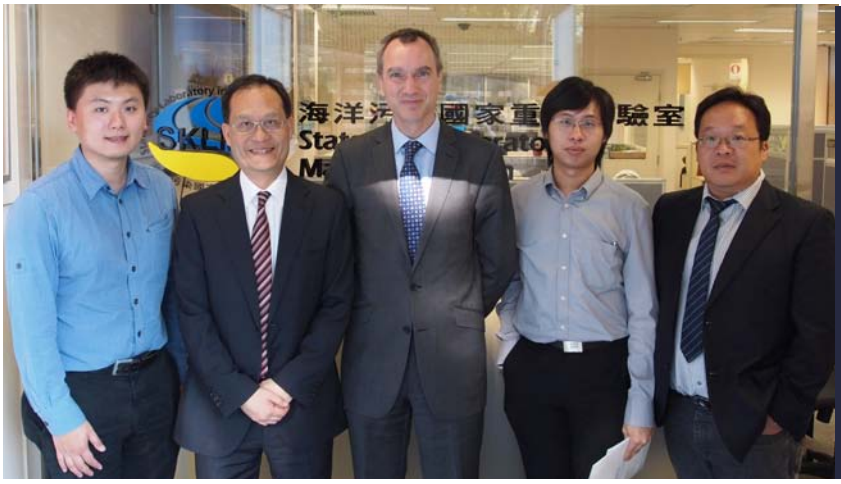
Date	Activities
Dec 2011	SKLMP co-organised the Chinese First Workshop on Environment and Human Health with the Institute of Urban Environment, Chinese Academy of Sciences.



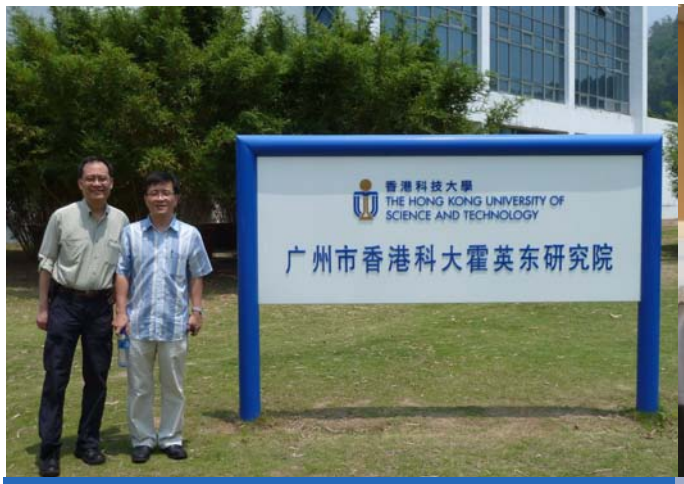
Publication workshop for Xiamen University, with Prof. Charles Sheppard, the editor of Marine Pollution Bulletin, in the summer of 2011

Cruise for Observational study of Coupled Shelf-Bay Circulation and Associated Nutrient Transport in Mirs Bay (HK)

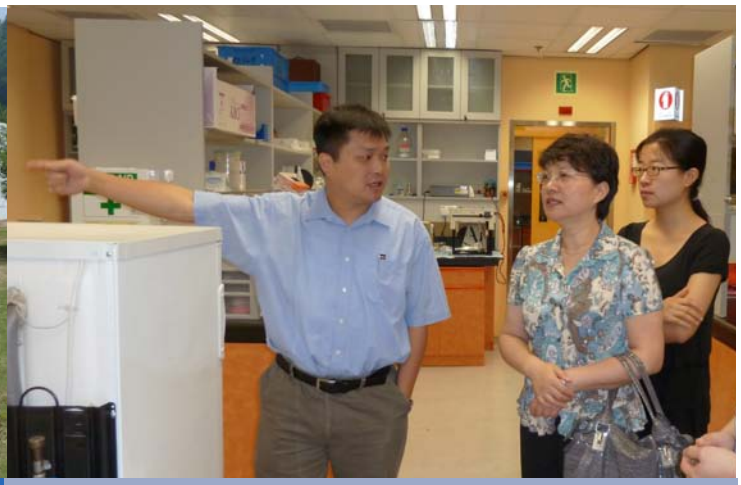
Collaborative Research Project: 2011 Sampling trip in Marakei Island of Republic of Kiribati



The Director of Croucher Foundation, Mr David Foster visited SKLMP.



Visit HKUST Fok Ying Tung Graduate School in Nansha



Prof Yu Hong Xia, the Vice Director of Environmental Protection. Department of Jiangsu Province visit SKLMP.

Visit Nanjing University for exploring a collaborative project under 12th five-year-plan scheme concerning the water pollution in the Taihu Lake Watershed

Major Equipment

New Facilities

- Ultra Performance Liquid Chromatography – Triple Quadrupole Tandem Mass Spectrometer (LC-MS/MS) (Agilent UPLC + 3200Qtrap AB Sciex)

- Ultra Performance Liquid Chromatography – Triple Quadrupole Tandem Mass Spectrometer (LC-MS/MS) (Agilent UPLC + 5500Qtrap AB Sciex)

- Flow Cytometer (BD FACSCanto II)

- Flow Cytometer (BD FACSAria III)

Existing Facilities

Atomic Absorption Spectrophotometer (AAS) (Shimadzu AA-6501S)
Atomic Force Microscope for Biological Imaging (Veeko Bio-Scope II)
Autoclave (AMSCO)
Biophotometer (Eppendorf)
Capillary Electrophoresis System (Beckman Coulter P/ACE)
Centrifuge (high speed) (Beckman Avanti J25I)
Centrifuge (refrigerated) (Beckman J2-MC)
Centrifuge (ultra-) (Beckman Optima L70)
CHNS Analyzer (Perkin-Elmer PE2400II)
DNA Microarray System (Parkard BioScience ScanArray 4000)
DNA Sequencer (ABI Prism 377)
Environmental Scanning Electron Microscope (Philips X130 ESEM - FEG)
Flow Cytometer (BD FACSAria III)
Flow Cytometer (BD FACSCanto II)
Flow Cytometer (with facstation) (BD FACSCahbur)
Fluorescent Confocal Laser Scanning Microscope (Carl Zeiss LSM 510)
Fluorescent Confocal Laser Scanning Microscope (Lecia SPE)
Freeze-Dryer (FTSYSTEMS Dura-Dry)
Gas Chromatograph - Flame Ionization Detector (GC-FID) (Agilent 6890N GC)

Gas Chromatograph -Electron Capture Detector (GC-ECD) (Agilent 6890N GC)
Gas Chromatograph – Mass Spectrometer (GC-MS) (Agilent 6890N GC + Agilent 5973 MSD)
Gas Chromatograph – Mass Spectrometer (GC-MS) (Shimadzu GCMS-QP2010)
Gel Documentation XR System (Bio-Rad)
GeneAmp in situ PCR System 1000 (Perkin-Elmer)
High Performance Liquid Chromatograph – Triple Quadrupole Tandem Mass Spectrometer (LC-MS) (Agilent 1100 HPLC + AB SCIFX MS)
High Performance Liquid Chromatograph with Diode Array Detector HPLC-DAD (Waters 600S HPLC + Waters 996 DAD)
High Performance Liquid Chromatograph with Fluorescent Detector (HPLC-FL) (Waters 600E HPLC + Waters 472 FL)
High Performance Liquid Chromatograph with Post-Column Derivatization and Fluorescent Detection (Waters 600 HPLC + Waters PCD + Waters 474 FL)
High Performance Liquid Chromatograph with UV Detector (HPLC-UV) (Waters 2695 HPLC + Waters 2487 UV)
Incubator (hydridization) (FINE PCR COMBI-D24)
Incubator (with heating & cooling function) (Digitherm DT2-CO2-CE)
Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES) (Optima 2100DV)
Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) (Perkin-Elmer Elan 6100 DRC^{plus})
Ion Chromatography (Dionex GP-40)
Laser Confocal Fluorescent Microscope (with multi-photon excitation capability) (Lecia SP5)
Micro-Centrifuge (refrigerated) (Beckman Coulter Microfuge 22R)
Micro-Centrifuge (Thermo Durafuge 200)
Microarraying System (Perkin-Elmer DBC0001D)
Micromanipulator (Nikon Arisaige)
Microtoxicity Analyzer (Microbics 500)
Microwave Digestor (CEM MARS Xpress)
Multi Imaging System (Bio-Rad)
Nuclear Magnetic Resonance Spectrometer (300 MHz) (Varian)
PCR Machine (DNA Engine Alpha Unit, Dual, MJ Research, PTC-200 Peltier thermal cycler)
Real Time PCR Fast System (ABI 7500)
Real Time PCR System (ABI 7300)
Spectrofluorometer (Horiba JobinYvon FluoroMax-3)

Spectrofluorometer (with fluorescent lifetime measurement capability) (Horiba JobinYvon Fluorolog-TCSPC)
Stable Gas Isotope Mass Spectrometer (Delta V Advantage)
Total Organic Carbon Analyzer (TOC) (Shimadzu TOC-5000A)
Transmission Electron Microscope (Philips Tecnai 12)
Ultra filtration System (autoclayable benchtop lap system with pump) (GE Healthcare Quixstand AE P/N: QSM-04SAP/50)
UV-visible Spectrophotometer (Hewlett Packard)
Walk-in Environmental Chamber (Conviron CMP-3244)
X-ray Fluorescence Microanalyzer (Spectro MIDEX M)

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Editors: Shengchun Wu, Leo Chan, James Lam, Jiajun Wu, Xiaomin Li

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