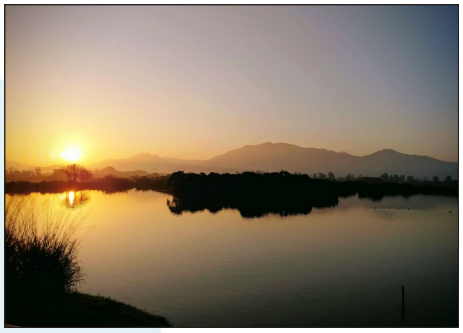
The Swire Institute of Marine Science

太古海洋科學研究所



Annual Report

2020

Gray speaking at the SWIMS "Topping out ceremony"

Director's Foreword

When writing the 2019 foreward I reflected on the challenging year 2019 had been for Hong Kong, little was I to know the events that 2020 would bring! The COVID-19 pandemic has obviously had huge ramifications on everyone's lives and changed how we interact: 2020 has been an academic year spent on virtual meetings as everyone has scrambled to try and maintain research programmes and indeed daily life. As a consequence this years SWIMS annual report is rather terse, with few conferences to report on and very few 'real life' international collaborations. Despite this we have maintained high levels of research excellence in publications as well as research grants with SWIMS researchers bringing in ~HK$23 million; including a prestigious Collaborative Research Fund grant for MarineGEO led by Dave and a Sustainable Fisheries Development Fund to Rajan – congratulations to their teams! We can also celebrate the creation of a Joint Laboratory with The Institute of Oceanology, Chinese Academy of Sciences, Qingdao which will significantly enhance our research collaborations in China.

This year also saw some major changes in SWIMS personnel with the retirement of long serving staff Cheung Ming; Simon, Wong Kam-kin and Chan Kit-ping. We shall certainly miss their experience and long term commitment to SWIMS and wish them all the best on their retirements. We are very pleased to welcome new appointments Alan, Chui Yiu-lun; Amy Chik Lai-kwan and Chan Yik-kei to the SWIMS family! There was also a well-earned promotion for Kenny, who has moved with his team to take up a Chair and Directorship of the State Key Laboratory in Marine Pollution at City University. We wish Kenny all the best and look forward to future collaborations.

Inevitably, the COVID situation severely impacted SWIMS expansion, with issues related to supply of materials, Government permitting etc. Thanks to the contractors and architects who worked hard to try and keep the expansion on track we held the "Topping out ceremony" in December and we shall be moving back to a newly expanded SWIMS in mid 2021.

Finally, it is worth reflecting that despite the great pressures placed on everyone, we have still been able to move forward. As I write this the finishing touches are being applied to SWIMS expansion, including a state-of-the-art new aquarium facility and so, although 2021 is inevitably bringing huge challenges, there is much to look forward in terms of restarting research at SWIMS.

Gray A Williams

Conferences and Collaborations

This is a unique report as it is the last before we move back to the newly expanded SWIMS in 2021. As we have been based on HKU campus we were unable to offer any outreach experiences or opportunities for visitors during 2019. Add to this the restrictions imposed by the COVID-19 pandemic many, if not almost all our normal activities were curtailed, cancelled or became 'virtual'. The annual University Consortium for Aquatic Sciences conference between SWIMS and Xiamen University, where our sister laboratory D-SMART is based was, for example, postponed to 2021 as were most exchange trips. The Ocean Park Conservation Foundation University Student Sponsorship programme did, however, provide research experiences for two of our students, Shu Kai Yip and Tsz Ching Wong who went to Guangxi and Sichuan to study Chinese White Dolphins and Bryde's whales, and pandas respectively.

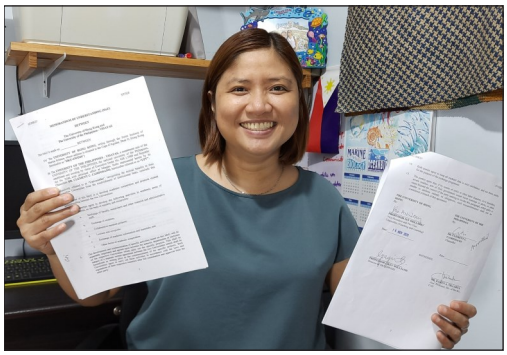
Unfortunately, most conferences or workshops were inevitable postponed and many are being cancelled or becoming virtual meetings as the long term ramifications of the pandemic are being realised. We did, however, manage to extend our collaborative network with new MoUs, linking up with one of our alumni, Karen Villarta and the University of the Visayas, Philippines and also a new project with Prince Songkla University, Thailand.

Shirley and her partner Kelly from HKUST at base camp in Longxi-Hongkou National Nature Reserve

Bryde's whale feeding on fish at the sea surface

New Joint Laboratory

In November 2020, SWIMS and the Institute of Oceanology, the Chinese Academy of Sciences (IOCAS), Qingdao held a virtual ceremony to launch the Joint Laboratory of Marine Ecology and Environmental Sciences. Officiated by Prof Alfonso Ngan (Acting Vice-President and Pro-Chancellor, Research); Prof Matthew Evans (Dean Faculty of Science); Dr Chen Heng (Director, Department of Educational, Scientific and Technological Affairs of the Liaison Office of the Central People's Government in the HKSAR) Prof Che Chi-Ming (Chemistry Department) and Ms Winnie Law (China Affairs Office) from Hong Kong and Professor Fan Wang, Director of IOCAS and his team in Qingdao the Joint Laboratory will facilitate scientific research in marine biodiversity and global change; marine biogeochemistry and environmental change; marine ecosystems and ecological disasters; and marine resources and ecological restoration. This is a very important milestone in SWIMS development and will further cement its position as a regional leader with colleagues in China.



Karen Villarta with the MoU between SWIMS and thr University of the Visayas, Philippines

The two teams signing the Joint Laboratory agreement from Hong Kong (left) and Qingdao (right)

Staff Research

Gray, Richard and Liam on the shores at West Coast National Park, S Africa

Gray A Williams

Gray's year got off to a good start, working with Richard Greenfield and Liam Connell measuring heart rates of limpets along the South West coast of South Africa as part of Liam's PhD. Spectacular shorelines and collecting some great data – 2020 was looking good! But soon after that trip, the COVID pandemic struck and all our proposed overseas research projects had to be placed on hold, or managed remotely. As a result we reverted to working on local species, kicking off the ECF funded territory wide rocky shore biodiversity survey and continuing work on survival strategies of high shore species.

Bayden sampling biodiversity on a restored subtidal oyster reef

Bayden Russell

This year started with a short sabbatical for Bayden to the University of British Columbia, Canada, to work with Dr Katie Marshall and Prof Chris Harley on the physiological effects of marine heatwaves on subtidal species and how this may lead to ecosystem restructure under climate change. Having to race back to Hong Kong to avoid border closures because of COVID, Bayden then focused on local research, expanding his groups oyster reef restoration projects. His Lab also celebrated the first PhD completion from the Marine Futures Laboratory! Well done Dr Jay Minuti!

The iMEco Lab having a good time together

Stefano Cannicci

Stefano's iMEco Lab achieved a lot of success in 2020! All iMEco Lab students safely continued their good work through the pandemic and new collaborators joined the group. Laura, Ying and Rebekah submitted and successfully defended their theses on various aspects of mangrove ecology and anthropogenic impacts exerted on these forests. Laura, Pedro and Ying also had their first papers accepted for publication. The Lab also welcomed a new RA, Mandy, an undergraduate research student; Angie, and Lyle, who joined as a Post-doctoral SRA to manage the newly funded ECF project on the impact of micro- and macroplastics on HK mangroves.

Kenny Leung

Despite the COVID-19 pandemic, Kenny's team research continued with good progress. Field experiments on seawalls demonstrated that increased habitat complexity via eco-engineering could enhance marine biodiversity, supporting its application in ecological restoration. Racliffe Lai obtained his PhD this year and his research article published in *Environmental Science: Nano* was selected as a "hot paper" by the editors. After serious consideration, Kenny decided to embark on a new challenge in his career. In August 2020, he returned to his *alma mater*, City University of Hong Kong where he was promoted to Chair Professor and Director of the State Key Laboratory of Marine Pollution, which is dedicated to advance science and technology for protecting the marine environment.

Kenny and his team celebrating with Racliffe who passed his PhD

V. ThiyagaRajan

Rajan's group has managed to continue their research despite the COVID-induced global lockdown. This year, we successfully cultured 2nd generation oysters in our mainland oyster hatchery to study transgenerational plasticity (TGP) and adaption potential in response to ocean acidification (OA) - thanks to our mainland students and collaborators. This year also brought three major grants (from RGC, Government and Industry) totaling over 10 million HKD to identify OA-tolerant TGP mechanisms, develop new oyster strains using big data and machine learning and for knowledge exchange through establishing an oyster hatchery. Rajan's collaborators have completely sequenced and annotated the Hong Kong oyster genome - which will, for sure, make his groups research journey towards "big-data driven molecular breeding" highly productive in 2021.

Thanks to Lee Kum Kee's hatchery in Zhanjiang for supporting research on oysters and ocean acidification

Moriaki Yasuhara

Moriaki started an Associate Editorship for the *Journal of Paleontology*, a flagship journal of the US Paleontological Society in 2020. His major discovery that the decline of tropical marine diversity is already widespread and will get worse with the business -as-usual IPCC scenario was published in *PNAS*. He also published "Time Machine Biology" a perspective paper emphasizing the importance of using paleo data to better understand past, present and future biodiversity and its drivers. PhD student Skye Tian published her first paper in *Quaternary Science Reviews*, and PhD graduate Ruby Chiu also published an important paper on latitudinal diversity gradients. Moriaki also welcomed new PhD student, Kyawt "Kk" Aye, to his Lab.

Moriaki at a EPD-UST-HKU meeting on Hong Kong marine deoxygenation

Dave's entire team on the HKU Centennial Campus

David Baker

2020 was a big year for the Baker Lab - we welcomed 2 new students Emily Chei and Roísín Hayden, and celebrated the promotion of Shelby to RAP which was underpinned by our CRF award to support MarineGEO. It was also a big year for departures with Archana, Inga, Jane, Jon, and Vicki all being conferred their PhDs. New ventures in entrepreneurship are brewing with student-led startup venture - archiREEF, Ltd. and IsoFoodTrace.

Benoit at HKU

Benoit Thibodeau

2020 was Benoit's 6th and last year as a SWIMer as he will move to CUHK in 2021 to take up an Assistant Professor position. He is thankful for the great collaborations and friendships developed at SWIMS over these years. In the last year, Yvonne Yau graduated from his lab and published an impactful paper on the effect of atmospheric deposition on hypoxia in Chinese waters. Benoit was also awarded a GRF grant to study large scale oceanic processes in relation to climate change.

Chrsitelle mentored the teams participating in the Ocean 3C's Symposium

Christelle Not

Christelle and her team continued to work on both paleoclimate reconstruction and plastic pollution. The lab made progress on the development of paleo proxies using the trace element content of marine ostracods in both Hong Kong waters and the Arctic Ocean. Christelle welcomed the first graduate students (Mandy, Coco and Hamsun) of the lab to work on plastic pollution. As in previous years, lab members were actively involved in several local and international outreach events on either paleoclimate or plastic pollution.

JD Gaitan-Espitia

2020 was a challenging year for all of us. However, some positive outcomes were achieved for our group. We received two new members in the lab through the HKPF scheme (Coskun) and the Robert Whyte Memorial Postgraduate Fellowship (Hester). Moreover, through the HKU Summer Research Fellowship, Jaimie Dwi joined our group. As co-PI, JD was awarded an Australian Research Council grant (~3M HKD) and a Chilean Antarctic Research grant (~1M HKD) to study the evolution of seaweeds in changing oceans.

JD working at his iBeer Lab

Celia Schunter

This year, despite having to undergo quarantine, Celia and her students managed to join a cruise in New Caledonia to run a project on fish in extreme pH fluctuating environments. Celia's team now has lots of fascinating projects up and running, from smaller fishes including model organisms like zebrafish, to coral reef fishes such as cleaner wrasses, all the way to big commercial fishes like groupers. The renovation of our molecular facility on campus is finally finished so we are focusing on the genetics and the molecular processes these fishes use to deal with environmental change. Celia and her team are looking forward to the new aquarium facility at SWIMS to start new mechanistic studies on HK fishes.

Celia catching fish using SCUBA in New Caledonia

Sean Crowe

Research in the Crowe lab in 2020 continued with a focus on ocean deoxygenation, past and present as well as extending into new areas with emerging programs on mangrove microbiomes and the marine Plastisphere. Deep time research centred on the reconstruction of seawater sulfate concentrations across the last 500 million years, and this work is uncovering new connections between dynamics in seawater sulfate, climate perturbations, and mass extinctions. Research on the mangrove microbiome is identifying microbial community processes that underpin blue carbon storage, while analyses of biofilm formation on marine plastics are generating new knowledge of key microbe-plastic interactions in the oceans.

Hamsun Chan sampling mudflat microbial communities at Mai Po

Jed investigating vegetation-wildfire-landslide dynamics on the Sai Kung peninsula, Hong Kong

Jed Kaplan

Fortunately Jed's computer-based research was largely unaffected by the events of 2020. This year saw the purchase and installation of a new high performance computing cluster that we will use for earth system modelling. Some of our first experiments have been to simulate the dynamics of the terrestrial biosphere for the Last Glacial Maximum and over the next century. We have also been busy in the preparation of new global datasets of lightning strokes, topography, high resolution climate, and soils. We started on a new project to study how climate change could increase the frequency and intensity of wildfires (hill fires) in Hong Kong, and are hoping to attract funding for this in 2021.

Nicole, Howard and Kayla surveying and collecting sediment cores from Mai Po wetlands

Nicole Khan

Nicole's group grew in 2020 with the arrival of two new PhD students who will begin projects to address knowledge gaps in the Holocene relative sea-level evolution of the Pearl River Delta (Howard Yu) and western Australia (Kayla Murai). Field trips were taken to Mai Po Wetlands in Hong Kong and coastal lagoons and marshes of southwestern Australia to collect sediment archives for these projects. Nicole was also involved in knowledge exchange throughout the year through her work with China Water Risk to communicate coastal flooding risk to the financial sector across Asia and as a contributing author to the upcoming IPCC AR6 report.

Philip and his group hiking from the MacLehose trail starting point

Philip Li

Philip's team grew with the arrival of two Postdocs and two PhD students in 2020. Research in Philip's Lab focuses on metagenome mining-guided and synthetic biology-enabled discovery of natural products. In 2020, he got a seed fund for SIRS from URC and an ECS fund from RGC. His team has established an integrated discovery approach of microbial natural products by the combination of AI-aided genome mining and synthetic biology. Applying this approach to the marine microbiome can not only tremendously increase the chance of identification of new drug leads but also unlocks the unknown chemical language encoded within the microbiome in shaping the ocean ecosystem.

Shelby McIlroy

As a newly minted Research Assistant Professor Shelby continues to have a leadership role in MarineGEO research. 2020 marked the completion of the ECF funded marine biodiversity assessments, and the launch of the RGC-CRF experiments to understand links between local stressors, biodiversity loss and human health risks. As a new staff, Shelby had the opportunity to join the team of SWIMS faculty designing the state-of-the-art aquarium systems being installed in 2021. Going forward she will build her lab and research in three areas: microbial ecology; biodiversity and environmental change; and species range expansions.

Shelby heading out for MarineGEO fieldwork at Tung Ping Chau

Post Doctoral Fellows

Tommy Hui

Tommy has designed field-based loggers to quantify both the tide and wave action on rocky shores. Measuring these key environmental drivers is fundamental to understand community structure, as tide measurements are critical to inform activity periods of rocky shore animals, and wave force measurements enable physical classification of the wave exposure gradient on different shores. Accurate field measurements of these variables are, however, challenging particularly in exposed, wave-swept environments. Using both compact capacitance sensors and accelerometers, Tommy has devised two different loggers to measure water level and wave force and the importance of these physical measurements will be assessed for driving spatio-temporal variation on Hong Kong's rocky shore biodiversity.

A deployed wave-logger on the rocky shore at Lung Kwu Tan

Ashley Hemraj

Ashley completed his long-term experiments investigating the effects of rate of change and severity of ocean acidification on the fitness, physiology and genetic responses of a copepod, over multiple generations. In addition, he completed a meta-analysis to understand the importance of environmental and evolutionary history on the response of copepods to ocean acidification and warming worldwide. Ashley also finished an experiment investigating the influences of hypoxia and ocean acidification on oyster physiology and immunology in collaboration with Dr Laura Falkenberg (Chinese University of Hong Kong). Finally, he published a manuscript on nonadaptive metabolic depression of marine gastropods exposed to heatwaves and collaborated on a successful GRF grant.

Final experimental bottles of Ashley's multi-generational experiment with copepods

Isis (left) in the field for the global network project on microbiomes

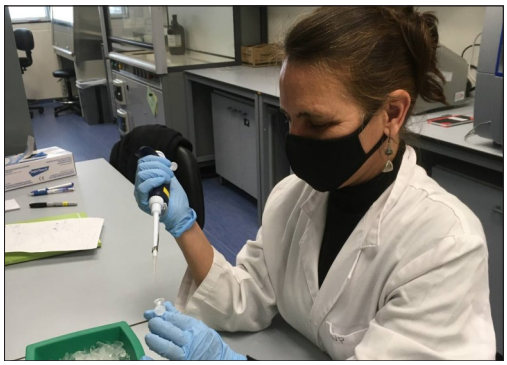
Isis Guibert

Isis launched the first network project in collaboration with the Smithsonian Institution, titled: "The Good, the Bad, & the Ugly: Carbon storage, eutrophication effects, and emergent health risks in the global marine sediment microbiome". This project will investigate the coastal microbiome and its impact on ecosystem functioning. To do so, 53 partners will be involved to conduct a worldwide experiment along a latitudinal gradient. In other projects, her research on six species of giant clams provided an unique insight on their trophic niche, and Isis is continuing her research on the effect of thermal stress on giant clams analysing lipid data and is also working for the MarineGEO project for which ARMS were deployed this summer.

Jing-Liang on the cliffs around SWIMS with a spectacular sea view

Jing-Liang Kang

This year, Jing-Liang analyzed brain RNA-sequencing data of six coral fish species from CO_2 seeps and control sites in Papua New Guinea to investigate the molecular response and potential genetic variances to ocean acidification. The results show that fish mostly deal differently with elevated CO_2 but there are also common responses across species. While this study is based on tropical fishes from coral reefs, he also started a project on the impacts of natural elevated CO_2 on four triplefin fish species from temperate ecosystems to be able to compare responses across ecosystems.



Natalia working in the molecular laboratory to extract DNA of fish exploited by trawling

Natalia Petit-Marty

Natalia joined SWIMS in August 2019. She is an evolutionary biologist interested in the molecular mechanisms of adaptation. Especially, Natalia is interested in how the decline of the population size of species might affect their capacity to adapt to future environmental conditions. During 2020 Natalia worked on a project that has, as a final goal, the development of a practical tool to evaluate the adaptive potential of species. For that, she collected samples of different species of exploited fish species in the South China Sea and has been working in the laboratory extracting and amplifying their DNAs.

Research Assistants

Yuanyuan Hong

Microfossil Ostracoda are known as a sensitive indicator for anthropogenic impacts. Our knowledge of the autoecology of indicator species, however, remains limited and lacks robust statistical support and comparison with environmental data. Yuanyuan has studied ostracods to reveal the natural-baseline biological community before human-induced environmental modification in Hong Kong. She analysed environmental data and applied regression models to reveal relationships between species distributions and environmental factors, and identify indicator species. Her next step will focus on establishing an AI deep learning-based automatic identification system for ostracods.

Yuanyuan taking sediment samples at Lai Chi Wo

Martin Cheng

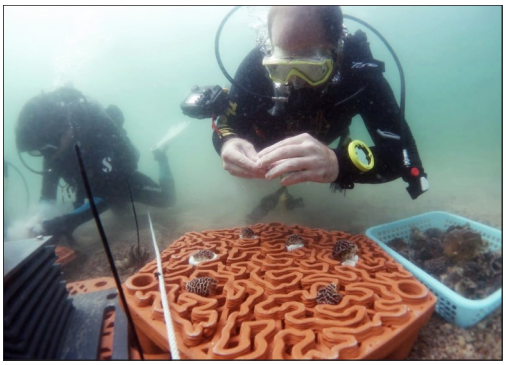
The commercially important New Zealand greenshell mussel, *Perna canaliculus*, was chosen for selective breeding to improve mussel quality by Cawthron Institute in New Zealand. Groups of mussels with different genetic pedigrees were obtained and underwent physiological testing. Recently, Martin Cheng has been working with Cawthron using their physiological data to develop Dynamic Energy Budget models for the selected mussel groups. By applying the developed models, the effects of genetic differences and environmental variations on performance (ie, growth rate and reproductive fitness) of mussels will be simulated to provide information to help improve aquaculture practices.

Martin leading an outreach class introducing coastal ecology to the public

Li Cheuk Wing

The FishBase project is entering its Phase II starting from December 2020 and LiCheuk continues to work on data mining, sorting, evaluation and encoding, with special emphasis on data from Hong Kong and China. In Phase I (Nov 2018 to Oct 2020) of the project, she located/collected more than 130 publications with greater than 1600 records encoded into database tables. These tables include species-specific information on country, occurrence, common name, L-W relationship, L-L relationship, growth, population characteristics, spawning, maturity, fecundity, food items, diet composition, predators and abundance. From the recent project, 244 out of 335 marine invertebrate species recorded were new to Hong Kong on SeaLifeBase with 69 of the 215 country records for fish being new records on FishBase.

Yvonne and LiCheuk attending the virtual 21st FishBase Consortium Annual Meeting



Transplanting corals onto 3D-printed reef tiles in the Hoi Ha Wan Marine Park

Phil Thompson

Phil is both a MarineGEO research assistant and co-leads a coral restoration experiment in Hoi Ha Wan using 3D-printed reef tiles. Using Autonomous Reef Monitoring Structures (ARMS) we are quantifying cryptic biodiversity in coastal habitats. Hong Kong represents a small marine footprint with large water quality gradients resulting in multiple habitat types across a small spatial scale, each with unique species assemblages with implications for ecosystem functioning. MarineGEO utilizes ARMS to compare patterns of biodiversity across sites. We have also deployed ARMS within the coral restoration site in Hoi Ha to test whether diverse assemblages of restored coral species correlate with higher biodiversity than restored monocultures.

Jay conducting a biodiversity survey in the oyster habitat in Tai Tam, Hong Kong

Jay Minuti

This year Jay completed her PhD, titled "Physiological response & recovery capacity of key grazers to climate change", on research both at SWIMS and as a visiting placement student at the Sydney Institute of Marine Science. Jay is continuing working at SWIMS as a Postdoc with Bayden in the Marine Future's Laboratory, working to assess the biodiversity associated with remnant oyster reef habitats. Jay will be using remote sensing and other field sampling techniques to map the remaining oyster habitat in Hong Kong and help to catalogue the reef associated species to enhance oyster restoration efforts in the region.

Valerie in the field at Double Island counting mobile rocky shore species

Valerie Hickey

Valerie joined the SWIMS team in October 2020 as a Research Assistant with Gray's group. Prior to arriving in Hong Kong, she finished her MSc in Marine Biology at UCC Ireland completing her research project on coral energy dynamics at NUS Singapore. Since arriving she has been in the field carrying out biodiversity surveys as part of the ECF project "A baseline evaluation of Hong Kong's rocky shore biodiversity". This thirty-one month project is the first detailed spatio-temporal analysis of rocky shore community dynamics and aims to contribute to Hong Kong's BSAP for conservation and mitigation planning.

Sarah Lau

Sarah has just submitted her PhD investigating the survival strategies of high shore littorinids. To reveal the secrets of these snails which makes them among the most thermally tolerant marine invertebrates, Sarah is working on a new project examining the physiological adaptations of the littorinid snail *Echinolittorina malaccana*. This species shows metabolic depression which is believed to be a key strategy to survive prolonged, thermally challenging emersion periods. By sampling across latitudes and acclimating the animals in the laboratory, Sarah aims to investigate the inter-individual variation and plasticity of this response which will contribute to our understanding of how species cope with thermally extreme environments.

A mosaic of high shore oysters and Echinolittorina *snails on Thailand shores withstanding severe thermal stress*

Lyle Vorsatz

Lyle joined the iMEco Lab as a Senior Research Assistant in August 2020, after completing his PhD at Rhodes University in collaboration with the South African Institute of Biodiversity focusing on the role microhabitats within mangrove forests play in structuring the spatio-temporal distribution and thermal metabolism of fish and invertebrate larvae. He now leads and coordinates an ECF funded project assessing the composition, distribution and impacts of macro- and microplastics in mangroves across Hong Kong. Within this project the team aims to identify the drivers, accumulation rates and the impact that sediment smothering by anthropogenic debris have on keystone organisms that maintain ecosystem productivity.

Lyle conducting fieldwork in Hong Kong mangroves

Jonathan Cybulski

This year's major accomplishment for Jon was the publication of his first thesis chapter in *Science Advances*, which outlined changes in the Greater Bay Area's coral communities over the last 5000 years. The work, including both local and international collaborators, concluded that poor water quality driven by increased development and lack of proper sewage treatment is the regions greatest threat to the survival of corals. Jon has also been investigating coral physiology using stable isotopes, identifying the importance of heterotrophically obtained nitrogen for the coral holobiont. Jon will continue as a Postdoc fellow in the Stable Isotope Laboratory, after which he will move to Panama as the 2021 Smithsonian Tupper Postdoc Fellow.

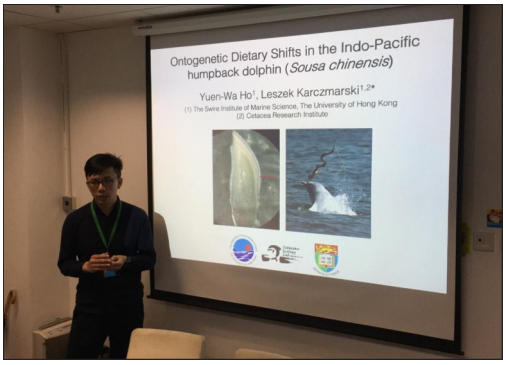
Jon speaking at the 2020 inaugural Conservation Paleobiology Symposium in Italy

Postgraduate Research

Taihun diving for a coral reef survey

Coral lipid biomarkers and stable isotope values in the Anthropocene

Taihun Kim finished his PhD thesis entitled "Coral lipid biomarkers and stable isotope values in the Anthropocene". He applied a variety of sophisticated biogeochemical proxies, namely stable isotope ratios, compound-specific isotope analysis (CSIA) and fatty acid (FA) profiles to investigate the human impacts on the nutritional physiology and biochemistry of coral reefs. Taihun's results will provide new insights into the mechanisms and limitations of coral metabolism, allowing for assessment of the overall health of coral reef ecosystems in the Anthropocene.



Derek presenting his research findings at the Ocean Park Conservation Foundation Hong Kong

Multi-faceted study of delphinid foraging ecology

Derek Ho recently completed his PhD study. Using stable isotope analysis of tooth dentine, he quantified the dietary pattern of Chinese white dolphins and found intriguing differences between sexes. While both sexes wean before the age of three, males wean sooner than females and as adults occupy a larger isotopic niche, consuming prey from a more depleted carbon source. Both sexes ingest a variety of non-food items, including microplastics, but rarely macroplastics. Using long-term acoustic data, he identified a soundscape feature that peaks at 2 kHz and represents a reliable predictor of dolphin's foraging habitats. Derek's study underscores the importance of viewing life strategies of marine mammals in the context of local environmental conditions.

Scott with field course students at one of his study sites, Pilanesberg National Park, South Africa

Spatial and socio-behavioural ecology of African elephants

Scott Chui completed his PhD investigating the socio-spatial ecology of African elephants. Using satellite-linked tracking data, computer simulations and resource modelling, he examined elephant movement and habitat use pattern's, revealing complex spatio-behavioural strategies driven by local ecological regimes. He also examined the social structure of an elephant population with a history of severe behavioural trauma, quantifying patterns of sociality using individual photo-identification techniques. He found that while the overall societal structures have been re-established, signs of previous behavioural disturbance remain detectable several decades later. Scott's findings underscore the importance of understanding the behavioural complexity of group -living mammals, and offer a framework that bridges their socio-demography, behaviour and spatial ecology.

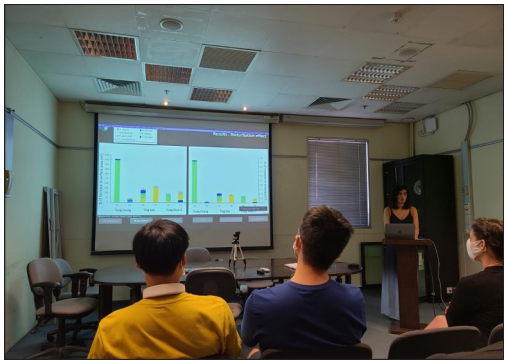
Ecological risk of zinc oxide nanoparticles

Zinc oxide nanoparticles (ZnO-NPs) are broadly applied in paints, cleaning and personal care products. Their broad application has raised the public's concern over their potential impacts on the marine environment. Racliffe Lai's study found that temperature and salinity of the environment could significantly modify the physicochemical properties and toxicity of ZnO-NPs towards a marine copepod, *Tigriopus japonicus*. Based on the response surface model, he predicts that ZnO-NPs would be most toxic at high temperature and low salinity (29 °C and 6 PSU). With the increasing stress from global climate change, this study has raised an alarm about existing regulations which seldom consider the influence of environmental parameters on chemical toxicity.

Racliffe collecting pearl oysters from a local fish raft for his experiments

Multiple roles of brachyuran crabs in wetlands: their importance for bioturbation and central role in the food web

This year Laura Agusto successfully defended and submitted her PhD thesis. The results of her thesis present broader implications for the understanding of the important roles that benthic macrofauna fulfil within coastal wetlands. She also highlighted considerations with regard to the use of generally accepted methods and practices within carbon budget assessments and food web investigations. Laura has since left SWIMS and started a Senior Management position within the Hong Kong based NGO and Charity: A Plastic Ocean Foundation.

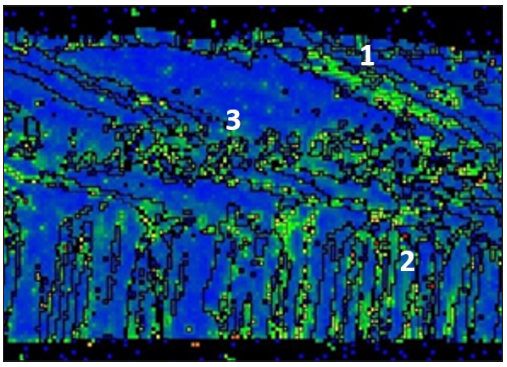


Laura defending her PhD thesis

The effect of elevated temperature and nitrate on the coral bacterial community

Shannon Hanson's latest research focuses on how elevated temperature and nitrate concentration affect the bacterial community within *Porites lobata* corals collected from Hong Kong. In a full factorial design, coral fragments were exposed to combinations of ambient/high temperature and nitrate concentrations for a period of ten days, after which the DNA of corals was extracted and sequenced. Shannon's experiment revealed elevated temperature and nitrate had a significant effect on bacterial community composition within coral fragments. Specifically increased variability between samples, an increase in bacteria associated with disease, and a more even structure indicated elevated nitrate caused *P. lobata* fragments to become stressed.

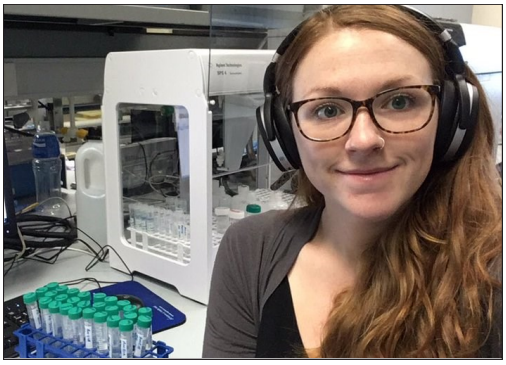
Experimental set-up to measure the effect of temperature and nitrate on the coral microbiome



Scanning Electron Microscopy - Electron Back scatter diffraction image of pediveliger oyster larval shell

Oyster biomineralisation in acidifying oceans

Kanmani is studying biomineralisation mechanisms in Hong Kong oysters (*Crassostrea hongkongensis*) under ocean acidification (OA). Because of her interest in knowledge exchange, she participated in the HKU three-minute thesis competition (3MT) and won the online people's choice award in June 2020. As part of her PhD research, she explored microstructure and crystallography of eyed-pediveliger oyster larval shells under OA. She discovered that the larval shells have a layer of prism like structure on the top (1), a column like layer at the bottom (2) with a junction layer where the two layers meet (3, see image).



Rebekah analysing heavy metal concentrations with the Inductively-Coupled Plasma Mass Spectrometer

Heavy metal contamination in Hong Kong mangroves

In November 2020, Rebekah Butler successfully defended her PhD thesis entitled "Heavy metal contamination in Hong Kong mangroves: Multiscale impacts on key ecosystem components". Her research promotes assessing the impacts of inorganic pollution at multiple scales of biological organisation to gain a deeper understanding of their influence on ecosystems. After gaining so much joy from demonstrating and teaching undergraduate students throughout her time at the University of Hong Kong, Rebekah has moved back to the UK to embark on a career in education completing a PGCE in Secondary Science with Biology at Middlesex University.

Jake and Prof Richard Greenfield (University of Johannesburg) during the Ecology and Evolution field course

Seasonal variation and oxidative stress in a tropical urchin living in a temperate world

Marine conditions in Hong Kong vary greatly between seasons. In summer, sea surface temperatures reach over 30°C, with winter temperatures below 15°C. Jake Dytnerski investigated how a dominant sea urchin, *Diadema setosum*, physiologically copes with these drastic seasonal differences. Contrary to predictions, he has demonstrated that urchins are not stressed in summer, but rather oxidatively stressed in winter. More surprising, lab experiments and assays showed that cold temperatures were not the cause of oxidative stress, but rather it may be increases in dissolved oxygen in the winter that cause the urchin's stress.

Coastal macrophyte ecology and climate variability

The productivity of marine macroalgae underpins coastal ecosystems, but is influenced by the environment and altered under climate change. Although summer temperatures likely cause the seasonal cycles of *Sargassum* algal forests in Hong Kong, Rhyn Cheung has shown that *Sargassum* can survive the summer heat with loss of biomass and drastically reduced growth. Hence, increasing sea temperature may not directly eliminate the species but reduce their growth season. Rhyn also found that under ocean acidification the decomposition of algal biomass was enhanced due to increased diversity of the associated microbial community.

Rhyn with a cuttlefish mantle found whilst surveying oysters in Tai Tam

Forensic methods, trade networks and impacts of predator removal

After extended transnational adventures and quarantines Vicki finally made it back to HK and passed her defense in November. Her thesis addresses major gaps and impacts regarding shark overexploitation by 1) developing forensic tools (using computer vision and isotopes) to improve monitoring for species and regions, 2) showing the global robustness and adaptability of shark trade networks which can often outpace local enforcement, and 3) building a nitrogen ODE model which simulates how shark biomass and the rate of exploitation can potentially drive shifts between stable and unstable states. Vicki is continuing to work broadly on other wildlife forensics projects as well as collaborations looking at chaos and critical transitions in ecology.

Shark cake!

Thermal physiology and distribution of intertidal crabs

Bimodal breathing brachyurans are widespread around the globe. These crabs are diverse and common in intertidal habitats, performing fundamental roles in the ecosystem. These unique organisms are interesting models for studying the adaptation of ectotherms transitioning to a more terrestrial lifestyle and their vulnerability to climate change. Pedro Jimenez's results show how crabs from different families, with different strategies and contrasting distributions, differ in their thermal performance and resilience to temperature increase. The results of his research unveils patterns of thermal adaptation of intertidal crabs and provide proxies for their vulnerability to climate change.

Pedro doing field work at Ho Chung mangrove

Yan with a lobster on his experimental fish raft

A cost-effective way to control biofouling on shellfish

Growth of unwanted marine organisms (i.e., biofouling) on pearl oysters negatively affects their growth and yield, while it is labour-intensive and costly to remove. Wa-Tat Yan, therefore, tested different biological methods for controlling this biofouling. Lobsters, *Panulirus homarus*, controlled the biofouling on culture cages, but they predated the oysters. Although purple sea urchins, *Heliocidaris crassispina*, could clean the biofouling on the oysters, they were not effective to control the biofouling on culture cages. Fortunately, Yan eventually found that immersion of culture cages with pearl oysters together in freshwater for one hour every week was the most cost-effective way to control biofouling, and transferred this important know-how to local shellfish farmers.

Kevin holding the rocky shore crab Eriphia ferox*, used in his mesocosm study*

Investigating the effects of ocean warming and marine heatwaves on *Eriphia ferox*: foraging, physiology, and the microbiome

Ocean warming and marine heatwaves pose a major threat to many species and ecosystem functions. Kevin Geoghegan used an experimental tidal system to investigate the effects of predicted future thermal stress on the physiology, microbiome and feeding behaviour of the predatory rocky shore crab *Eriphia ferox*. He found that metabolic demands increase with higher temperatures, but feeding - on the mussel *Septifer virgatus* - did not. That is, consumption does not keep pace with increased metabolic demands creating an energetic mismatch, which could negatively affect this important rocky shore predator as climate change gathers pace and extreme weather events become more frequent.

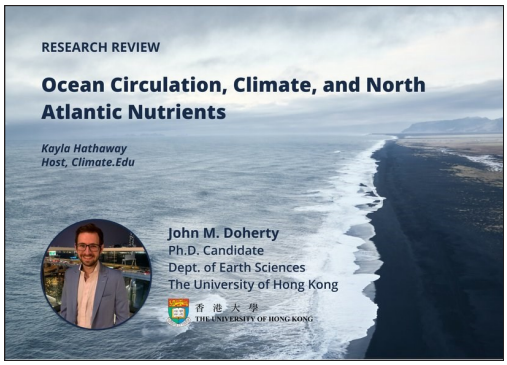
Ying with her MPhil certificate

Messy mangroves not so messy in Hong Kong

In 2020 Ying defended her thesis (via Zoom!) on anthropogenic marine debris (AMD) in mangroves, with a focus on Hong Kong. Her results highlighted that more research is needed in the area and Hong Kong is on the low end of plastic pollution (despite what our eyes may think!). Together with Stefano and Christelle she also successfully submitted her first major paper reviewing AMD studies in mangroves globally in the journal *Environmental Pollution*.

Reconstructing North Atlantic nutrient circulation

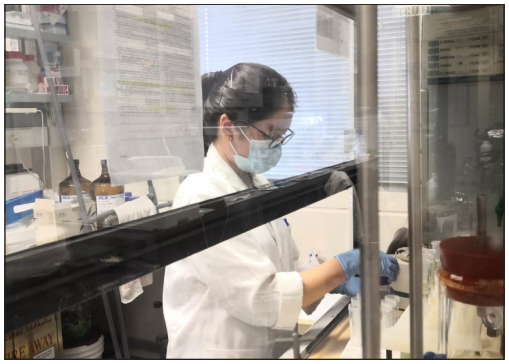
John completed the third year of his PhD on understanding past circulation patterns and nutrient supply in the North Atlantic. This year, he presented at the Goldschmidt geochemistry conference and was a co-author on a publication involving trace elements in Arctic ostracodes. Results from this study indicate that low-calcium samples may be unreliable for paleoceanographic reconstructions, which will help facilitate more accurate paleoclimate research in this globally important region. John also appeared on Cimpatico TV's Climate.edu program to discuss some of his recent work on North Atlantic oceanography and joined the Association of Polar Early Career Scientists (APECS) as a council member.



John appeared on Cimpatico TV to discuss his research

Assessing ecological risks of retinoic acids

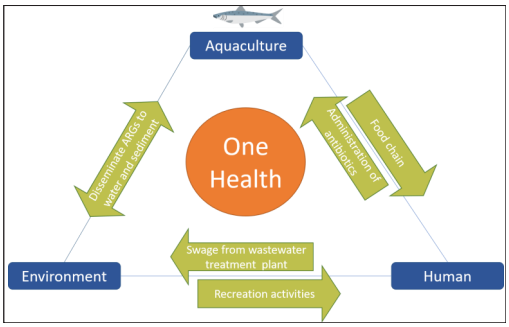
Katie Yeung continued her PhD assessing ecological risks of retinoic acids (RAs) in coastal marine environments. She investigated the concentrations of RAs in marine waters during harmful algal blooms which were considered as one of the major sources of RAs, and found that 13-*cis*-4-oxo-RA was the predominant form of RAs. She then examined toxic effects of RAs on nine marine species including algae, bivalves, gastropods, crustaceans, and fish embryos, which were the most sensitive species towards RAs. Using the data from both toxicity tests and field investigations, Katie will evaluate the ecological risks of RAs in local coastal marine ecosystems.



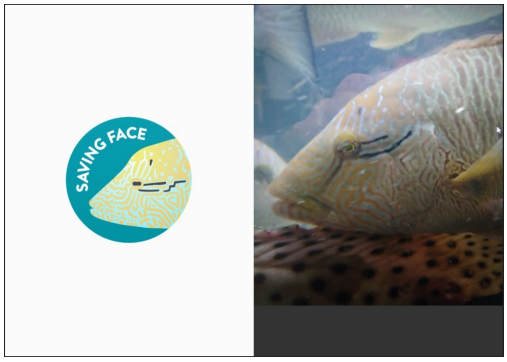
Katie extracting RAs from samples collected during a red tide incident

ARGs and associated microbiota in fish gut

Qi Huang applied metagenomics to reveal the profile of antibiotic resistance genes (ARGs) in the guts of four common marine fish. A total of 16 ARG types, 116 subtypes and 492 genes were discovered. Multidrug, tetracycline, beta-lactam, kasugamycin, and bacitracin were the major ARG types in the fish gut, while the abundance of aminoglycoside was the highest in the Japanese threadfin bream, *Nemipterus japonicus*. There was also a significant correlation between ARGs and the microbial community, indicating that gut microbiomes might have an influence on ARGs in fish guts.



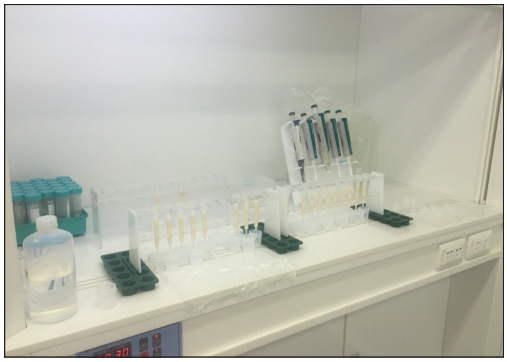
Interaction of antimicrobial resistance among aquaculture, the environment and humans



Interface of the mobile app, Saving Face*, where users can record and recognize individual humphead wrasse*

Application of facial recognition techniques on humphead wrasse to combat illegal trade

Humphead wrasse, *Cheilinus undulatus*, is a reef fish that is popular in luxury seafood markets in Hong Kong and mainland China. Hong Kong is the trading hub of this huge, long-lived but threatened and CITES-protected species. Loby Hau has been collaborating with local mobile application developer companies, Corvidae and Clear Robotics Ltd., to develop AI models for facial recognition of wrasse individuals, and a tailor-made mobile application intended to assist enforcement by local government officials against illegal trade and support research in this species.



Oliver's chemical purification of Th and Pa isotopes using column chromatography

Driving mechanisms of sedimentary ^{230}Th and ^{231}Pa variability in the Western Arctic Ocean

The long-lived particle-reactive radionuclides ^{230}Th and ^{231}Pa are useful tracers for oceanic and sedimentary processes. Distributions of excess ^{230}Th and ^{231}Pa (the fraction of ^{230}Th and ^{231}Pa produced in seawater and transferred to sediments) concentrations in Arctic Ocean sediment cores exhibit strong temporal variabilities, but the mechanisms responsible for this remain poorly understood. Oliver Xu's study demonstrates that the sedimentary ^{230}Th and ^{231}Pa variability in western Arctic cores was mainly controlled by changes in lateral transport of these isotopes (and associated sediments) over glacial-interglacial cycles. Oliver's work allows us to better understand sedimentary environments and glaciation history of the Arctic area.

Max during the preparation of ostracod samples to determine trace elements in their shells

Alternative E/Ca ratios as proxies to reconstruct ocean parameters in shallow marine environments

Max Rodriguez defended his PhD this year. Max investigated the distribution of element to calcium ratios (E/Ca) of ostracods of *Sinocytheridea impressa* and *Neomonoceratina delicata* and their correlation with environmental parameters. In the last year, he focused his attention on ostracod Mn/Ca, Zn/Ca and Ba/Ca ratios, which have been poorly studied in paleoenvironmental studies. The results of his thesis indicate that ostracod Mn/Ca, Zn/Ca and Ba/Ca ratios are likely controlled by the elemental concentrations in seawater. This provides a novel paleoenvironmental tool to study past hydrological changes of the Pearl River, ocean currents and anthropogenic contamination.

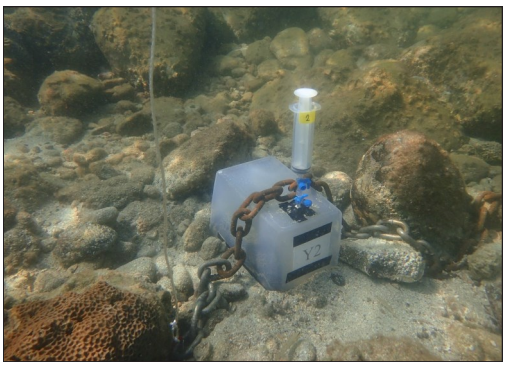
Enhancing coral restoration with 3D-printed terracotta reef tiles

Artificial reefs are man-made structures commonly used as a tool for ecological restoration, which enhances topographic rugosity to rehabilitate degraded marine habitats. More recently, 3D printing technology has been employed to engineer structures customized for the environmental challenges of specific locations. In collaboration with the School of Architecture, our research team developed an algorithm-based design of a 'reef tile' 3D-printed in terracotta - featuring sedimentation prevention, enhanced coral attachment, cost and time effective printing and assembly, and parameterized structural and textural complexity. Vriko Yu's thesis will evaluate coral performance with different assemblages, and the effects on biodiversity enhancement quantified by eDNA -based ecological assessment.

Vriko monitoring the health condition and growth of corals outplanted on the 3D printed reef tile

Ecosystem functions of sea cucumbers in Hong Kong

Cheryl Chu is studying the role of sea cucumbers in marine nutrient cycling, using *Holothuria leucospilota* as a model species. This year, Cheryl has experimentally demonstrated that sea cucumbers enhance nutrient turnover in eutrophic systems by reducing organic loading and enhancing the release of inorganic nutrients to the water column, but this rate is temperature dependant. For a more holistic understanding of the ecosystem functions of sea cucumbers, she will be mapping *H. leucospilota* populations in Hong Kong over large scales with a drone to allow estimates of the overall nutrient turnover rates by sea cucumbers in the region.



Cheryl's sampling equipment for nutrient analysis in Tolo Harbour

Thermal tolerance capacity of a high shore limpet

The tropical high rocky shore is a thermally challenging environment as rock temperatures can reach >60°C during summer low tides. Species living in this environment, therefore, are expected to have high thermal tolerance to withstand heat stress. Preliminary results from Adrian Wong's project, however, contradict this theory as the high shore limpet, *Lottia dorsuosa*, not only has lower thermal tolerance than other tropical intertidal species, but their lethal temperatures are also lower than the maximum rock surface temperature by ~16°C. Adrian is currently investigating the alternative strategies that this limpet must adopt to survive in this harsh environment.

Adrian collecting limpets for thermal tolerance trials

Antagonistic behaviour between Chiromantes haematocheir *and* Orisarma patshuni

Trophic ecology of terrestrial crabs of Hong Kong

Whilst many crabs of marine origin have adapted to live in terrestrial environments, they are much less well-known as compared to their relatives in mangroves. Christine Cheng investigates the ecology of native terrestrial crabs with a focus on their diet and behaviour. Results from her fieldwork show that the distribution of some terrestrial crabs is confined to coastal mangrove associate forests; while other species inhabit the banks of freshwater streams up to 500 meters from seawater. Using different laboratory techniques, Christine is working on the diet composition of these terrestrial crabs and will examine the roles of symbiotic microorganisms in their nutrition.

Ka Hei in Shui Hau mangrove searching for crabs

The terrestrial adaptation of semi-terrestrial crabs in Hong Kong

Terrestrialization is an important evolutionary event and the transition to the terrestrial habitat performed by true crabs is still an ongoing process. Ka-Hei Ng has been studying the physiological performances of semi-terrestrial crabs as well as their associated microbiota that may have an effect on their adaptation towards the terrestrial environment. Organ-specific microbes were found in three different populations of *Chiromantes haematocheir*, a semi-terrestrial crab, suggesting a consistent host-microbe interaction exists within this species. Further research will be done to study the evolutionary effect of this interaction.

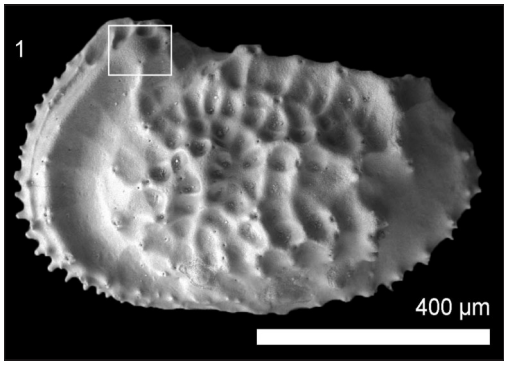
Alison filtering water samples from Hoi Ha Wan for environmental DNA

Tracing the flow of nutrients through the acroporid coral holobiont

The carbon and nitrogen budgets of the coral holobiont are supplied through a combination of autotrophy, via photosynthetic carbon fixation, and uptake of dissolved nitrogen from the surrounding seawater performed by endosymbiotic microalgae; and heterotrophy, through direct feeding of the coral host. To determine which nutrient sources are utilized by *Acropora*, and the extent to which these resources are shared between coral hosts and their algal symbionts, Alison Corley ran a feeding experiment exposing *Acropora* sp. to isotopically-labelled auto- and heterotrophic nutrient sources. Alison has also begun a separate project comparing spatial and temporal variation in environmental DNA community composition between water and sediment samples from Hoi Ha Wan Marine Park.

Understanding the Paleocene-Eocene Thermal Maximum (PETM) ecosystem perturbations

In the past year, Skye Tian focused on one of the most important hyperthermal events in Earth's history, the Paleocene-Eocene Thermal Maximum, as a partial analog to ongoing global warming to understand how marine ecosystems may respond to future anthropogenic changes. Using fossil ostracods as models, Skye studied two sediment cores from Maryland, eastern USA and revealed an interesting perturbation-recovery pattern of the local shallow-marine ecosystem during the PETM. Local extinction at the PETM onset was possibly caused by extremely warm subtropical surface waters and local diversification after the PETM was unexpectedly high with the reappearance of pre-PETM Lazarus species and introduction of post-PETM species.



SEM picture of PETM ostracod from Salisbury Embayment, Maryland

Transgenerational inheritance of OA effects in edible oysters

Hong Kong oyster larvae have been shown to acclimate through non-genetic (eg, DNA methylation patterns) ways to ocean acidification (OA) threats within a single generation. This year, James Lim found that linking various life history stages is crucial to assess OA-induced carry-over capacity of a commercially important edible oyster, *Crassostrea hongkongensis* in the natural environment. Outplanted juveniles with parental OA exposure had better survival and growth than juveniles without parental exposure regardless of their larval exposure history. Substantial evidence from differential methylation and transcriptomic expression, which include identified related gene sets and pathways, strongly supported the improved phenotypic traits.

James preparing larval metamorphosis assays for a transplantation OA experiment in Zhanjiang, China

Unravelling the mechanisms underlying bacterial responses to environmental challenges

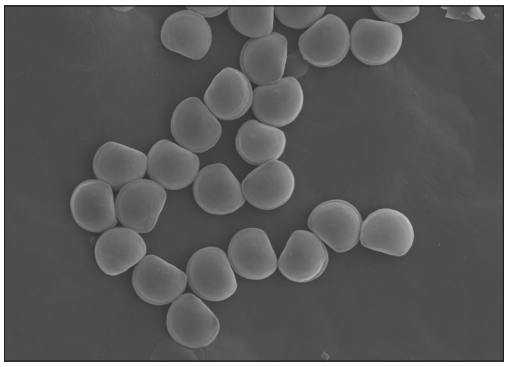
Bovern Arromrak is an evolutionary biologist and is interested in understanding the ecology and evolution of microorganisms to environmental challenges. His research investigates the dynamic interactions within and between microbes and multicellular organisms at different biological levels. One of the major findings from his current research is that bacterial physiology (ie, at lag, exponential or stationary phase) influences their capacity to utilize different nitrogen sources available for them. The question Bovern is now addressing is why are they not using them (ie, certain nitrogen sources) when no alternatives are available?

Bovern reviewing the intriguing bacterial growth curves in his experiment

Chiu conducting field work at the eco-enhanced shore at Ma Liu Shui

Boosting ecological values of seawalls via eco-engineering

Seawalls have homogenous surfaces and lack complex habitats for marine organisms to inhabit, forage and avoid predators. Without shade and water retention, organisms on seawalls often suffer from heat and desiccation stress, leading to low biodiversity. Eco -engineered features like eco-panels, tidal pools, and oyster baskets provide diverse habitats that may mitigate these problems. Chi-Chiu Lo has been testing if installation of these eco-features on seawalls can boost biodiversity and ecosystem services. Additionally, he has examined the relationship between temperature and bivalve biofiltration rates through meta-analysis, indicating profound impacts of global warming on this essential ecosystem service.



Hong Kong oyster larvae observed under a Scanning Electron Microscope

Evolutionary development of oyster shells: a proteomics and microstructural view

Alessia Carini's PhD thesis focuses on the effect of ocean acidification on the very first bivalve larval shell formation using shell proteomics and microstructural analyses. Shell matrix proteins play key roles in biologically controlled mineralization. However, the effects of ontology and environmental stressors on shell proteomes remain unknown. Alessia has designed a protocol for preparing larval shells prior to shell proteomic analysis. In addition, she has run an experiment with Portuguese oysters supported by the Conchologists of America Society to investigate the effects of ocean acidification on the interplay between shell proteome and microstructure.

Sandra at the main building of HKU

Molecular mechanisms of cooperative behaviour between a cleaner wrasse and client fish

Sandra Ramirez's research aims to understand the molecular mechanisms of cleaning behaviour in marine fish and how environmental changes affect this cooperative interaction. She studies the interaction of the cleanerfish, *Labroides dimidiatus,* and its client, *Acanthurus leucosternon,* and analysed differential gene expression patterns in different brain regions with and without species interactions. Most of the molecular responses occur in the Hindbrain and Forebrain, involving hormone systems and behavioural gene activation during the interaction of both species. The next step in Sandra's studies is to understand how this behaviour might be affected by changes in environmental conditions related to climate change.

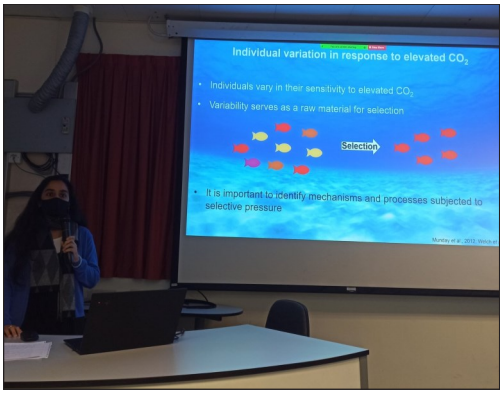
Impacts of mercy releases on local populations and the ecosystem

The hybrid grouper, a crossbreed between the Tiger grouper (*Epinephelus fuscoguttatus*) and Giant grouper (*E. lanceolatus*), is frequently being released into the wild through religious practises. It is speculated that this introduced species could have already established its own population and impact the local ecosystem. A comprehensive sitings report on natural hybrid grouper occurrence over the past year demonstrated that the hybrids can be found all over Hong Kong, especially in the Port Shelter area. Arthur Chung is analysing the gut content of hybrids with metabarcoding tools and comparing them with other local *Epinephelus* spp., so as to build a complete ecological profile of the hybrids in the natural environment.

Arthur preparing to sample hybrid groupers

Acidifying oceans and its impact on fish

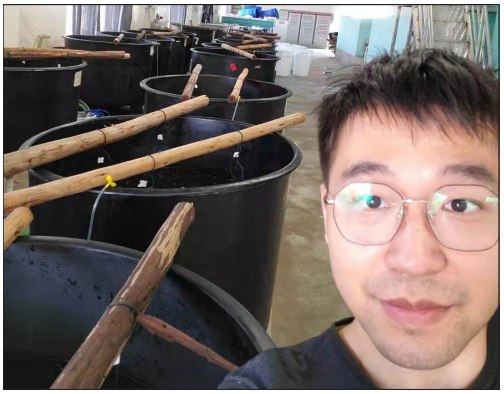
Sneha Suresh is studying the molecular responses of fish to ocean acidification and the influence of parental effects in enabling future generations to acclimate to acidifying oceans. Her research on the spiny damselfish shows that although there is limited potential for within-generation acclimation to ocean acidification, previous parental exposure has a positive influence on the molecular response of their offspring. She presented these results at the First Italian Conference on Marine Evolution in 2020. Sneha is also studying molecular processes enabling fish to inhabit naturally occurring CO_2 seeps. She is currently analysing over 2,000 genes that were differentially expressed in gobies from Vulcano Island, Italy to determine molecular pathways of long-term acclimation.



Sneha defending her PhD proposal at her qualifying seminar

Immunological responses of oysters to ocean acidification

Increasing anthropogenic CO_2 has been causing irreversible impacts on coastal carbonate chemistry including ocean acidification (OA). OA can disturb the dynamic interaction between microbiota and marine hosts. Therefore, Xin Dang is interested to study how OA alters host-pathogen interactions and immune responses in oysters. He found that the Hong Kong oyster exhibited immune tolerance to OA, with a pronounced role of autophagy in maintaining immune defense against pathogen infection. Currently, he is working on transgenerational inheritance of such OA induced immune response pathways, which will illustrate the orchestrated microbe-animal interactions under OA.



Xin studying oyster responses to ocean acidification in the hatchery at Zhanjiang, China

Zhenzhen defending his qualifying seminar

Does irradiance modulate thermal plasticity in marine phytoplankton?

Temperature and light are the main environmental factors that control phytoplankton dynamics. The interacting effects of these factors influence phytoplankton energy flux and their overall metabolic rate. Part of Zhenzhen Li's PhD research aims to understand the eco-physiological mechanisms underpinning changes in phenotypic plasticity in phytoplankton as a result of natural variation in temperature and light. His results indicate that thermal plasticity follows a generalist-specialist trade-off between the maximum growth rate and the breadth of performance and suggest that the ecological niche of phytoplankton is determined by the interaction of multiple environmental factors across the water column.

Laetitia (right) undertaking winter fieldwork with Hamsun at Ting Kok

Carbon storage dynamics in Hong Kong mangroves

This year Laetitia Allais conducted winter and summer field sampling with the help of her lab mates. Laetitia has been investigating the role of geochemical, biological and physical controls on the carbon storage capacity in Hong Kong coastal wetlands. She worked in the lab for isotope analyses, and microbial DNA extraction and analyses. Her findings so far have shown that mangrove sites from the western part of Hong Kong tend to store more carbon and show more ecological complexity than those from the east, and she is looking forward to completing all her fieldwork and sample analysis soon.

A hall-effect sensor on the shore to detect movement in rock oysters

Thermal stress strategies of intertidal bivalves

Under intense heat stress, intertidal animals show various strategies to survive. Unlike mobile species such as limpets and snails, intertidal bivalves lack the ability to move and hide from heat stress and therefore must adopt other strategies to survive during emersion. Benjamin Chiu has been recording the daily shell movement of bivalves using non-invasive hall-effect proximity sensors to identify their 'behavioural' strategies to survive the hot emersion periods on tropical shores. Ben will also examine inter-individual variation of other strategies (such as metabolic depression) to understand the relative contribution of these strategies to the success of bivalves on tropical shores.

Behavioural and molecular responses of aquatic animals to climate change

Jade Sourisse investigates climate change driven molecular changes occurring in freshwater and marine organisms, with regards to behaviour. Environmental factors, such as ocean acidification can alter animal behaviour, however little is known about what molecular reactions change in the brain. Jade's project focuses on model species, the sea hare, the zebrafish and the anemonefish to investigate how climate change is influencing brain expression and describe the molecular basis of behaviour. She will conduct experiments to assess behavioural changes and analyse brain imaging and molecular data to evaluate the molecular mechanisms under near-future aquatic conditions.

Jade removing a bat from the lab in the Coiba National Park Smithsonian field station, Panama

Spatial and temporal variation of Hong Kong rocky shore assemblages

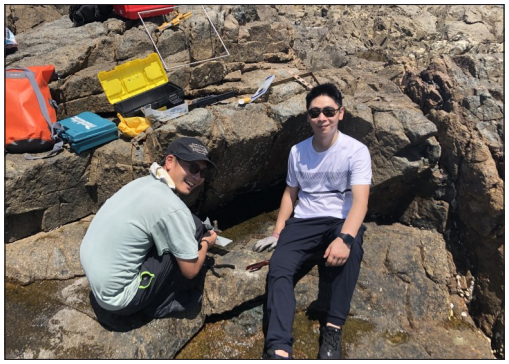
Species assemblages on Hong Kong rocky shores show a great spatial and temporal variation because of the salinity gradient from the western to the eastern coasts; the long and complicated coastline of Hong Kong; and the seasonal changes of environmental parameters and supply-side ecology. To investigate the spatial and seasonal variation of rocky shore assemblages, Jackson Lau and his colleagues have been surveying 24 rocky shores in Hong Kong in the dry season, and will repeat the survey in the wet season. He is also collecting monthly data at three sites to study temporal changes of midshore assemblages. With these data, he aims to discover the pattern and the major contributors of assemblage variations using different statistical approaches.

Jackson searching for field sites on Double Island

Ecosystem functioning in oyster reefs

Oyster reefs are one of the most productive coastal habitats in estuarine areas in terms of biofiltration, habitat and food provisioning. Yet, over 85% of natural oyster reefs have been lost globally due to over-harvesting, pollution, and coastal development. Due to the increase in awareness of the importance of oyster reefs, there has been a major push in Hong Kong to restore oyster reefs, and hence the functions they provide. Khan Cheung's research aims at gaining a mechanistic understanding of the constituents of a healthy and functioning oyster reef and seeks to derive a set of best management practices to guide future oyster reef restoration programs.

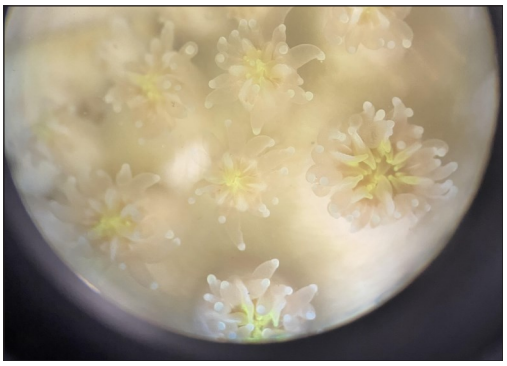
Khan deploying an unmanned aerial vehicle for taking photographs of oyster reefs



Yifei (right) with Martin in between field work at Cape d'Aguilar

Utilizing IT tools to study marine ecology and biodiversity

Yifei Gu's work combines computational methods with biology approaches. He has been working as a Research Assistant to develop an online educational application, the Virtual Rocky Shore Sampling Unit (VRSSU) to help students understand sampling methodologies and accuracy on rocky shores. Upon completion, he proposed a research project to investigate the role of small scale environmental heterogeneity on the distribution and survival of intertidal snails and will apply to the joint PhD position between HKU's Faculty of Science and Northeastern University, USA.



Bleached Galaxea *polyps under the microscope*

Competition in the coral microbiome

As the global occurrence of coral bleaching continues to rise, there is a growing need to understand the processes that structure and regulate coral-algal symbiosis. Not only do coral symbionts provide their host with ~85% of their energetic requirements, some species have been shown to bestow additional benefits, such as a higher thermotolerance. Using induced bleaching and reinfection experiments, Róisín Hayden is currently investigating how these algal symbionts compete for dominance in the coral microbiome and the impact this may have on the host.

Coral colonies found at Bluff Island in Hong Kong

Trophic plasticity of corals in response to seasonal nutrient fluxes

Emily Chei is studying coral trophic plasticity as a mechanism to tolerate anthropogenic stress. Corals rely on their symbiotic algae for resource acquisition, but heterotrophy may be an important compensatory mechanism when facing disturbances. By using δ15N and δ13C stable isotope values and the analytical tool SIBER, she is examining trophic strategies of seven coral genera found in Hong Kong where seasonal differences cause fluxes in turbidity, nutrient inputs, and salinity. Emily is also running a long-term sampling project using corals to track changes to dissolved inorganic nitrogen (DIN) in the marine environment.

Biomineralization and crystal orientation of proteins in oyster shells

Ocean acidification (OA) alters the biomineralization process in several shellfish species including edible oysters, particularly their shell matrix proteins. Shall matrix proteins assemble complex microstructures and determine the orientation of crystals within oyster shells, however the interplay between proteins-crystals under OA is yet to be revealed. Yang Li is investigating the regulation of shell microstructure, shell matrix proteins and related functions in oysters under OA, using both coastal and estuarine oysters. This research will provide novel insights into shell-specific protein functions in biomineralization processes and adaptive molecular mechanisms of oysters under OA.

Yang collecting oyster shell samples in the hatchery at Zhanjiang, China

The ecology and evolution of emerging diseases in marine organisms

Marine organisms can host a diversity of parasites and pathogens that modulate ecological and evolutionary processes through mass mortality events. In Hester He's project, she will assess the ecological drivers and potential evolutionary outcomes of host-pathogen interactions in marine organisms. As part of this project, she will explore the underlying mechanisms that explain host susceptibility and tolerances to outbreaks, and the interplay of these threats with climate change. With the rapid increase of emerging diseases driven by anthropogenic pressures, this information will provide important insights for aquaculture practices and management/conservation efforts.

Hester, the new postgraduate student of JD's Lab

Holocene sea-level change along the China coast

Howard Yu's research aims to generate new Late Holocene sea-level reconstructions from the South China Coast using microfossils (foraminifera, diatoms) preserved in intertidal sediment archives. He will also test the reliability of novel proxies (identification of foraminifera through their signature in environmental DNA) to infer past sea-level and environmental changes in tidal flats and mangroves. Finally, he will synthesize sea -level data from across the South China coast and integrate these data with statistical and geophysical models to decipher the driving mechanisms of sea-level change across the coast.

Howard (right) and Kayla doing field work at Sha Kiu, Deep Bay

Mériadec with Hong Kong behind him

Reconstruction of the western North Atlantic intermediate water temperature over the last 7,000 years

The Atlantic Meridional Overturning Circulation (AMOC) plays a key role in global climate and variation in the AMOC can have a significative influence on climate. To improve our understanding of the impact of the AMOC on the global climate, Mériadec Le Pabic is analysing δ18O, δ15N and Mg/Ca records from benthic foraminifera species collected in two sediment cores collected from the Laurentian Channel (Canada) and the North Atlantic Ocean. Mériadec will reconstruct parameter variations of water mass (temperature and salinity) over the last 7,000 years which are associated with variations in AMOC strength.

Kayla during sediment core collection in Mai Po

Holocene sea-level variability in Western Australia

The best response to sea-level rise and climate change is a combination of strategies to adapt in coastal areas. Therefore, it is crucial to generate a unified database of past and contemporary sea-level change to produce records for ecological and geological issues for future applications. Kayla Murai's project includes a standardized compilation of relative sea-level reconstruction of Western Australia. The aim of her study is to interpret paleoenvironmental change and to understand the mechanisms of past coastal variability that may influence future responses to climatic change. The evaluation of these sea-level indicators (carbonate platforms, coral reefs, and foraminifera) will provide insight to historical sea levels during the past 8,000 years.

Coco examining plastic waste in a mangrove at Shui Hau

Monitoring plastic degradation in the natural environment

Understanding plastic degradation is crucial to evaluate the retention time of plastic waste in the environment, as well as its fragmentation rate into detrimental smaller pieces identified as microplastics. During Coco Cheung's MPhil, she aims to study the *in situ* degradation behaviours of some common plastic polymers including PET, PE, PVC, PP, PS and EPS, as well as some environmentally friendly plastics in Hong Kong's natural environments. The role of environmental stressors such as UV radiation, temperature and moisture will be investigated and physical and chemical modifications of the plastic polymers examined.

Members and potential functions of the "Plastisphere"

Due to the prominence of plastic waste and microplastic in the ocean, a unique niche known as the "Plastisphere" has emerged, where the composition and behaviours of microorganisms vary from the surrounding environment. However, whether a specific community exists on plastic surfaces and their potential functions are still unknown. Hamsun Chan is now investigating the bacterial community on different plastic types and in different environments. With a better understanding of the bacteria that selectively attach to plastic, new methods to separate different plastic types or to recover plastic waste from the ocean may be developed in the future.

Hamsun collecting plastic samples in mangroves

Fate of plastic in mangrove forests: from bigger to smaller

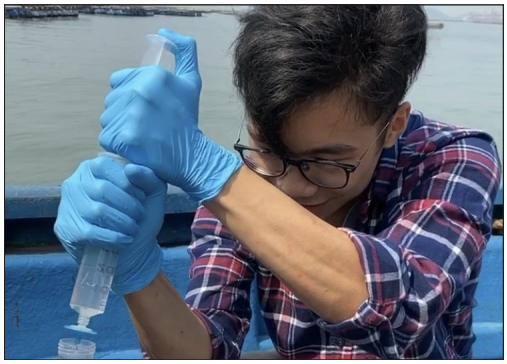
Marine plastic pollution has been recognised as one of the top environmental issues to tackle in recent decades. Whilst marine coastal habitats are considered as a major plastic reservoir, mangrove forests and mudflats are still relatively underexplored. Mandy So's research focuses on quantifying the microplastic abundance and distribution across mangrove forests and their fauna in Hong Kong. She is particularly interested in the role of mangrove crabs in plastic fragmentation and the related formation and fate of microplastics.

Mandy collecting sediment samples in the mangrove

Fishponds as biodiversity hotspots: implications for management and restoration of wetlands

Fishponds in Hong Kong are critical for biodiversity, offering habitat and food to native and migratory birds, as well as breeding ground and roosting site for amphibians, reptiles, mammals, and insects. However, fishponds are facing major threats resulting from land reclamation, infrastructural development and rapid urbanization, pollution/water quality, and changes in cultural practices. In his PhD research, Simon Tse proposes to develop a comprehensive functional analysis of fishponds under different management strategies in order to provide essential tools and information for planning and decision-making processes of wetland conservation in Hong Kong. He will use novel ecological and molecular approaches to study this particular wetland system.

Simon doing fieldwork



Henry taking water samples for nutrient analyses

Microbial responses to ocean deoxygenation

Henry Cheung is particularly interested in microbiology, biogeochemistry, and oceanography. His current research focuses on microbial responses to declining oxygen concentrations in the ocean, aiming to gain information about the capability of microorganisms to thrive in both modern and ancient anoxic conditions. His research acquires ecophysiological data coupled with parallel genomic and transcriptomic studies to track the adaptive mechanisms of microorganisms. Henry's goal is to understand how microbes influence, and are influenced, by the environment.

Research Opportunities

The Laurence Caplin Scholarship in Marine Biology

Established in memory of Laurence Caplin by his widow, Mrs E Caplin and daughter, Mrs J Woodford, to bring young people to SWIMS to undertake research in marine biology with a resident staff member.

The Intertidal Trust Fund

Established in 1982 with profits from the book 'The Seashore Ecology of Hong Kong', grants from the Intertidal Trust Fund can be made to overseas students and scientists who wish to undertake research on intertidal ecology at SWIMS.

Cape d 'Aguilar Trust Fund

Established in 1995 with profits from the book 'An Introduction to the Cape d'Aguilar Marine Reserve, Hong Kong', grants from the Cape d'Aguilar Trust Fund can be made to local or overseas students and scientists who wish to undertake marine biological research on the Cape d'Aguilar Marine Reserve at SWIMS.

Higher Degrees (M.Phil / Ph.D)

Students who are interested in undertaking a research postgraduate degree (M.Phil or Ph.D) in marine biology and ecology should directly contact SWIMS academic staff for more information regarding individual projects.

Along with the Academic Block the SWIMS Residence Blocks are also being upgraded

Student Research Assistantships/Internships

Undergraduate students holding a permanent Hong Kong identity card are encouraged to apply to work as volunteer student research assistants during the semester breaks/summer holidays. Undergraduate students from both local and overseas institutions who are enrolled in a degree programme, which requires the completion of an internship, may also contact us to discuss how we can facilitate that requirement. Interested students should contact SWIMS Secretary, Ms Sylvia Yiu.

SWIMS Publications (Jan - Dec 2020)

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Editorial Board Member, *Journal of Thermal Biology*
Subject Editor, *Zoological Studies*

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Scientific Committee Member, bioDISCOVERY, Future Earth
Member, Global Ocean Oxygen Network (GO2NE), IOC-UNESCO
Member, State Key Laboratory of Marine Pollution (SKLMP)
Editorial Board Member, *Global and Planetary Change*; *Marine Micropaleontology*; *Open Quaternary*
Associate Editor, *Journal of Paleontology*; *Palaeoworld*; *Marine Biodiversity; Paleontological Research*
Editor, *Plankton and Benthos Research*
Scientific Committee Member, 5th World Conference on Marine Biodiversity
Advisory Board Member, the NSF-funded project: FossilSketch: Developing a Digital Sketching Application That Delivers Personalized Feedback to Improve Student Learning and Engagement in Micropaleontology. NSF EHR DUE: IUSE 1937827
Author of United Nations World Ocean Assessments chapters

Conferences and Workshops

Sean Crowe

Keynote Speaker; Goldschmidt Meeting, 21-26 Jun 2020 (Online), Hawaii, USA.

Jonathan Cybulski

Oral Presentation; Conservation Paleobiology Symposium, 3-4 Feb 2020, Bologna, Italy. (Selected as one of the top student presenters)
Invited Speaker; TedX TinHau TED Countdown Event, 17 Oct 2020, The Fringe Club, Hong Kong.

JD Gaitan-Espitia

Invited Speaker; Annual Meeting Chilean Evolution Society, 11-13 Mar 2020 (Online).
Invited Speaker; APECS Iberoamerica, 10 Jun 2020 (Online).

Isis Guibert

Poster Presentation; Microbiome Bioinformatics with QIIME2 (BIOF89) - MarineGEO Hong-Kong: Taking the pulse of the ocean, 10 Jan 2020, National Institute of Health, Bethesda, USA.

Nicole Khan

Invited Oral Presentation; European Geosciences Union General Assembly, 4-8 May 2020 (Online).
Session Convener: Geological Society of America Annual Meeting, 26 -30 Oct 2020 (Online).

Kenny Leung

Participant/Chair; Gordon Research Conferences Training Session for 2021 Chairs, 8 Jan 2020, Singapore.

Invited Speaker; Webinar Series of the Environmental Management of Hong Kong, 29 Jun 2020, Hong Kong.

Invited Speaker; Symposium on Carrying Capacity and Ecological Process cum 2020 Coastal Research Consortium's Research Progress Meeting, 7-8 Nov 2020 (Face-to-Face and Online), Zhuhai, China.

Invited Keynote Speaker; Symposium on the Health Protection of the Ocean and Its High-quality Sustainable Development cum 1st Forum of Qingdao Hong Kong Marine Environment and Ecology Joint Research Centre for Young Scientists and Postgraduates, 25-26 Nov 2020 (Online), Hong Kong and Qingdao, China.

Natalia Petit

Oral Presentation; International Symposium on Marine Sciences, 1-3 Jul 2020 (Online).

Oral Presentation; REMAR Workshop, International Symposium on Marine Sciences), 1-3 Jul 2020 (Online).

Bayden Russell

Invited Talk; The Norwegian Institute of Marine Research, 30 Oct 2020 (Online), Tromso, Norway.

Invited Talk; 37th International Conference on Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education (ASCILITE), 30 Nov-1 Dec 2020, Armidale, Australia.

Invited Talk; International Conference on Learning and Teaching, 2-4 Dec 2020, The Education University of Hong Kong, Hong Kong.

Celia Schunter

Oral Presentation; EPIMAR – 1st EPIgenetics in MARine Biology Congress, 6-9 Oct 2020 (Online).

Oral Presentation; EVOLMAR 2020 – Marine Evolution - 1° Italian Congress, 23-25 Nov 2020 (Online).

Benoit Thibodeau

Invited Talk; American Geophysical Union-Japanese Geophysical Union Joint Meeting, Online Meeting, 13 Jul 2020 (Online).

Moriaki Yasuhara

Invited Award Lecture; Paleontological Society of Japan Meeting at the University of Tokyo, 7-9 Feb 2020, Tokyo, Japan.

Invited Lecture; Ecological Society of America Annual Meeting, 3-6 Aug 2020 (Online), Salt Lake City, USA.

Workshop; GO2NE (Global Ocean Oxygen Network) Annual Meeting, 31 Aug & 1 Sep 2020 (Online).

Invited Lecture; International Humboldt Day Event, 15 Sep 2020 (Online).

Invited Lecture; Research Grants Council Symposium, 10 Nov 2020 (Online), Hong Kong.

Discussion Panelist; TMSoc (The Micropalaeontological Society) Microfossil Geochemistry Workshop, Panel Discussion on Taphonomy and Diagenesis, 10 Nov 2020 (Online).

Invited Lecture; SEGG Research Seminar at University of Portsmouth, 19 Nov 2020 (Online), Portsmouth, UK.

Invited Plenary Lecture & Discussion Panelist; 5th World Conference on Marine Biodiversity (WCMB) & Panel Discussion: Advice for Early Career Researchers in Marine Biodiversity Science, 14-16 Dec 2020 (Online), Auckland, New Zealand.

Postgraduates

Bovern Arromrak

Oral Presentation; Marine Biology from Malaysia Perspectives, 26 Nov 2020 (Online).

Arthur Chung

Oral Presentation; 2020 Workshop on Population and Speciation Genomics, 19-31 Jan 2020, Cesky Krumlov, Czech Republic.

Oral Presentation; IUCN Grouper Fishery Monitoring and Assessment Workshop, 10-11 May 2020 (Online).

Alessia Carini

Oral Presentation; Molluscan Forum - The Malacological Society of London, 19 Nov 2020 (Online), Natural History Museum, London, UK.

Coco Cheung

Participant; MICRO2020 - Fate and Impacts of Microplastics: Knowledge and Responsibilities, 23-27 Nov 2020 (Online).

Alison Corley

Oral Presentation; The 1st Conservation Paleobiology Symposium, 3-4 Feb 2020, The University of Bologna, Italy.

John Doherty

Oral Presentation; Goldschmidt 2020, 21-26 Jun 2020 (Online), Hawaii USA.

Shannon Hanson

Oral Presentation; Goldschmidt 2020, 21-26 Jun 2020 (Online), Hawaii USA.

James Lim

Participant; EPIMAR – 1st EPIgenetics in MARine Biology Congress, 6-9 Oct 2020 (Online).

Invited Awardee; The CCGame Project eSymposium, 18 Jun 2020 (Online). Hong Kong Baptist University, Hong Kong,

Award: Most Valued Player (2nd place) in the United Nations SDG International eTournament, 6-10 Jan 2020, Hong Kong Baptist University, Hong Kong.

Kanmani Rajan

Finalist and Online People's Choice Award; HKU Three-minute Thesis Competition, 23 Jun 2020 (Online).

Finalist; HKU Visualise Your Thesis Competition, Aug 2020 (Online).

Sandra Ramirez

Oral Presentation; EVOLMAR 2020 – Marine Evolution - 1° Italian Congress, 23-25 Nov 2020 (Online).

Jade Sourisse

Oral Presentation; EVOLMAR 2020 – Marine Evolution - 1° Italian Congress, 23-25 Nov 2020 (Online).

Sneha Suresh

Participant; EPIMAR – 1st EPIgenetics in MARine Biology Congress, 6-9 Oct 2020 (Online).

Oral Presentation; EVOLMAR 2020 – Marine Evolution - 1° Italian Congress, 23-25 Nov 2020 (Online).

Acknowledgements

Mr. Pat Healy and Ms. Tina Chan, The Swire Group of Companies
Prof. Xiang Zhang, President and Vice-Chancellor, HKU
Prof. PKH Tam, Provost and Deputy Vice-Chancellor, HKU
Dr. SJ Cannon, Executive Vice-President, HKU
Prof. IM Holliday, Vice-President and Pro-Vice-Chancellor, HKU
Prof. Alfonso Ngan, Vice-President and Pro-Vice-Chancellor, HKU
Prof. Matthew Evans and staff, Faculty of Science, HKU
Prof. Richard Saunders and staff, School of Biological Sciences, HKU
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Ms. SSM Lo and staff of Finance and Enterprises Office, HKU
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For donations to research at SWIMS:
The Swire Group
Faculty of Science, HKU
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Visitors to SWIMS

As we have moved out of SWIMS due to the expansion, no formal visitors were recorded for 2020.

Many thanks to all the following for their cheerful and excellent help: Ms. Cheung Cheuk Yiu, Mr. Léonard Pons, Ms. Christy Hung Yuen Ching & Mr. Aaron Tsang.

Student Graduations

Ph.D

Minuti, Jay Joan (2020) - Physiological response & recovery capacity of key grazers to climate change.

Lai, Weng Seng (2020) - Quantitative hazard assessment of engineered zinc oxide nanoparticles: Insights into their regulation

M.Phil

Yau, Yu Yan (2020) - Tracing atmospheric nitrogen deposition and its impact on Hong Kong and Chinese coastal ecosystem.

Luo, Yuying (2020) - Messy mangroves: Anthropogenic marine debris in mangroves globally, with an investigation on Hong Kong mangrove debris and its effect on the faunal community

Staff Training

Mr. Kong Chi Kau has attended the training course on Safe Use of Mobile Aluminum Towers at Occupational Safety & Health Council on 23 July 2020.

View down to the Residence Blocks (red roof tops) and onwards to Waglan Island

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