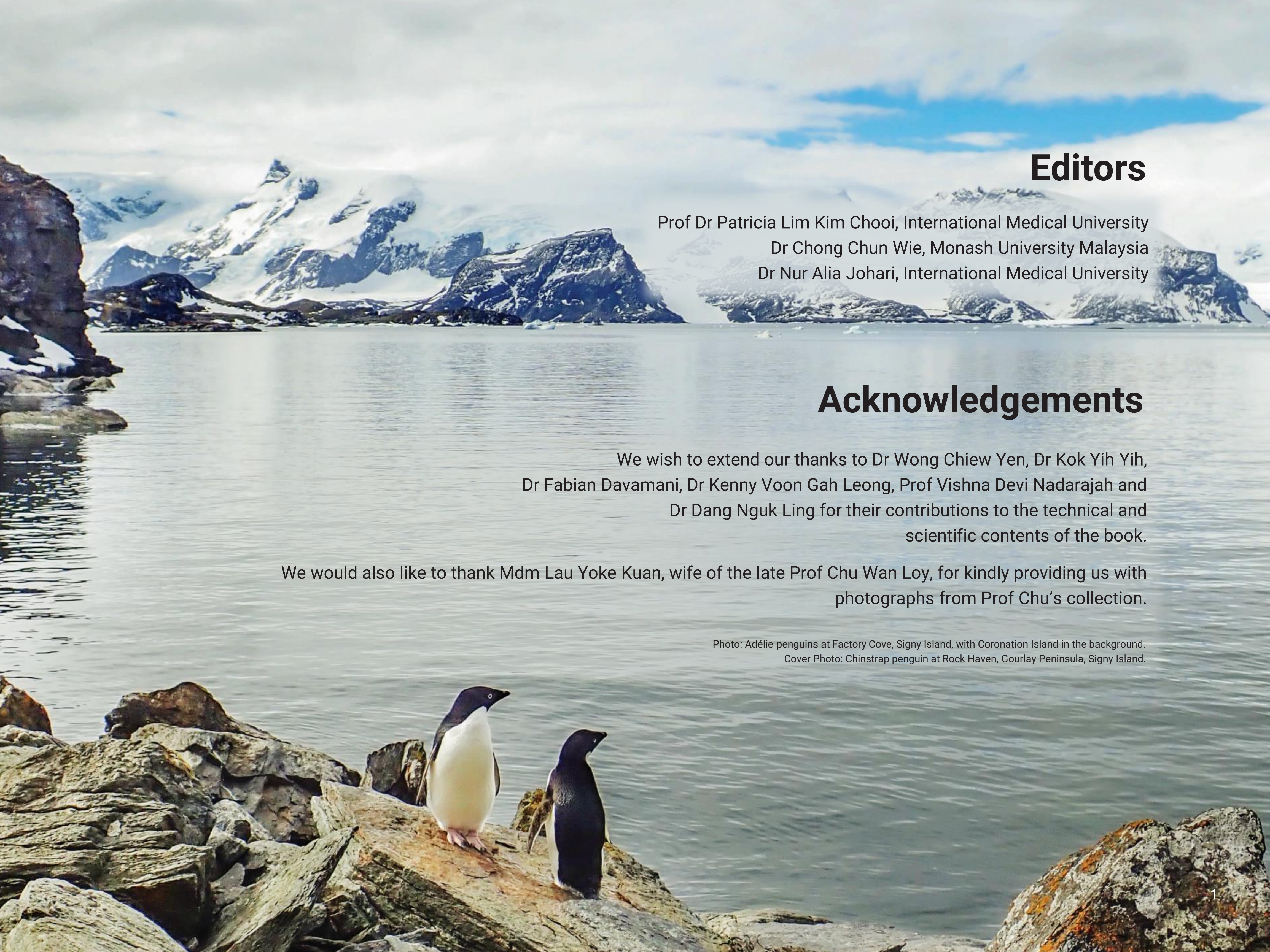
INTERNATIONAL MEDICAL UNIVERSITY
MALAYSIA

Polar Research in the International Medical University



Editors

Prof Dr Patricia Lim Kim Chooi, International Medical University
Dr Chong Chun Wie, Monash University Malaysia
Dr Nur Alia Johari, International Medical University

Acknowledgements

We wish to extend our thanks to Dr Wong Chiew Yen, Dr Kok Yih Yih, Dr Fabian Davamani, Dr Kenny Voon Gah Leong, Prof Vishna Devi Nadarajah and Dr Dang Nguk Ling for their contributions to the technical and scientific contents of the book.

We would also like to thank Mdm Lau Yoke Kuan, wife of the late Prof Chu Wan Loy, for kindly providing us with photographs from Prof Chu's collection.

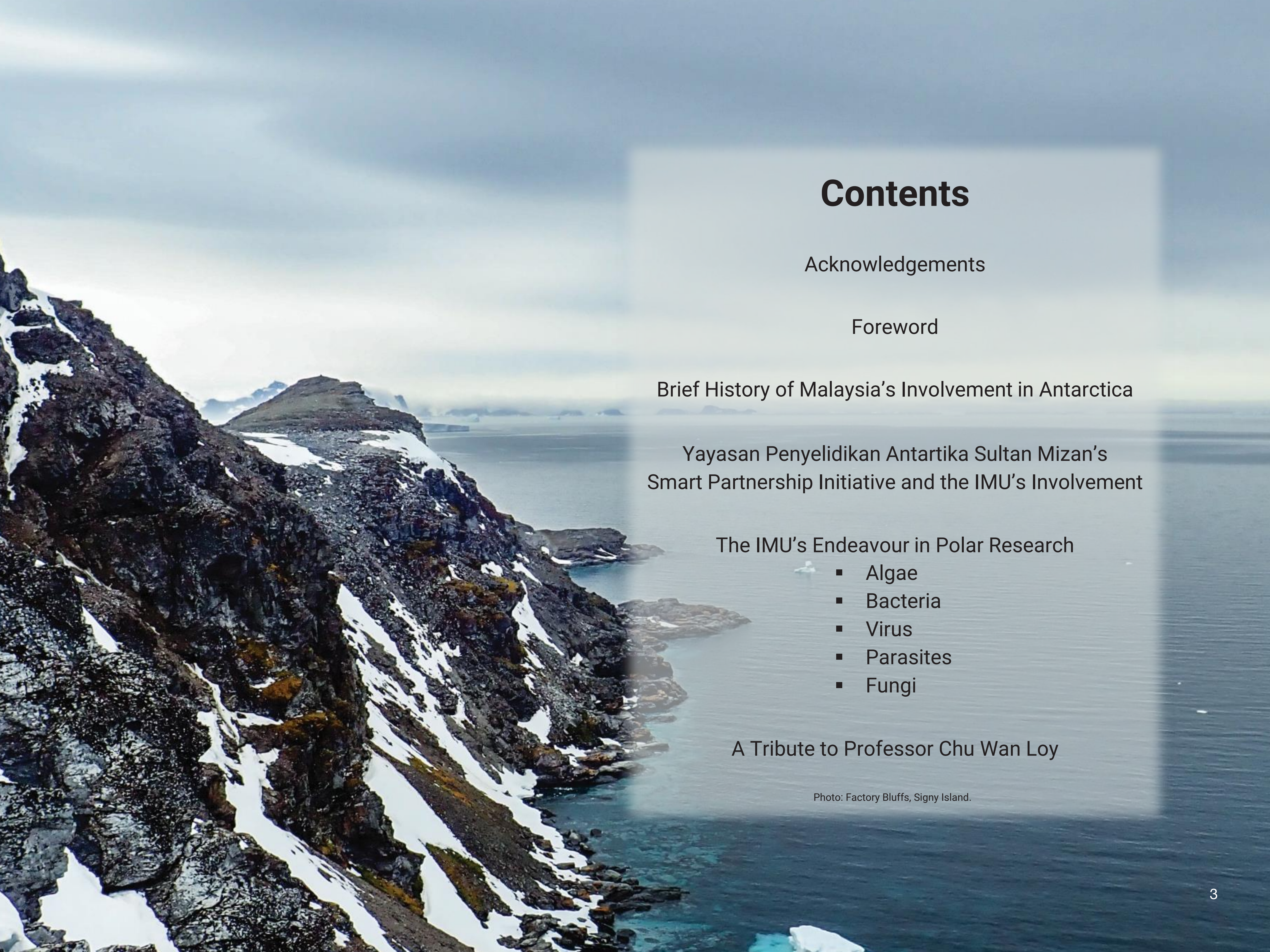
Photo: Adélie penguins at Factory Cove, Signy Island, with Coronation Island in the background.
Cover Photo: Chinstrap penguin at Rock Haven, Gourlay Peninsula, Signy Island.

Foreword

The vast, white expanse of the ice-covered Antarctic continent, seemingly devoid of life. When such images come to mind we often forget about the extraordinary abundance of life just beneath the ice, particularly microorganisms, surviving and playing a fundamental role in the functioning of the Antarctic ecosystems. The abundance and diversity of microbial life in such extreme aquatic and terrestrial environments have intrigued scientists for over a century. However, amidst the silence and solitude of the Antarctic we have begun to see dramatic changes in the environment, with climate change and the significant impacts of human activities in the region becoming ever more apparent in recent years.

The International Medical University's (IMU) foray into polar research first began with Prof Chu Wan Loy's passion for tropical and polar algae research. Scientists from the IMU have since joined in the exploration and study of these extraordinary organisms, expanding into research on bacteria, viruses, parasites and fungi. Research efforts include how these microorganisms contribute to the maintenance and delicate balance of the Antarctic ecosystem and their responses to the changing climate. In this book, we describe the IMU's endeavour in polar research, in memory of Prof Chu's vision and dedication to not only scientific exploration, but also education and a shared effort to understand the consequences of global warming.

Photo: Hiking to Tioga Hill, the highest point (279 m) on Signy Island. Dr Nur Alia Johari (right) with a British Antarctic Survey field guide.



Contents

Photo: Factory Bluffs, Signy Island.

Brief History of Malaysia's Involvement in Antarctica

Antarctica is the coldest and windiest continent, located at the southernmost part of the globe. Despite being approximately 10,000 km apart, Malaysia's interest in Antarctica can be traced to nearly 40 years ago. In 1983, the then Prime Minister of Malaysia, Tun Dr Mahathir Mohamad drew the attention of the world by raising the "Question of Antarctica" in the United Nations General Assembly (UNGA). It is the first official diplomatic initiative that debated the exclusivity of the Antarctic Treaty System (ATS) represented only by the developed nations. Tun Dr Mahathir called for the opening of the ATS to allow underdeveloped and developing countries to participate in the decision-making process regarding Antarctica and to share the resources of the continent.

Malaysia's position on Antarctica shifted in the 1990's, especially after the signing of the Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol) in 1991. The agreement specifies the protection of the Antarctic environment and prohibits all activities relating to mineral resources except scientific exploration. Malaysia was active in advocating the protection of Antarctica, for instance, expressing concern over the overharvesting of krill and the illegal, unreported and unregulated (IUU) fishing off the Antarctic coast.

Photo: Adélie penguins at the Gourlay snowfield, Signy Island.


In comparison to diplomatic and political involvement, Malaysia's scientific endeavour in Antarctica started relatively late in 1997. The breakthrough came when New Zealand offered the use of Scott Base in Antarctica in 1997 for Malaysia to undertake research. This became the catalyst for the Malaysian Cabinet to commission the Academy of Sciences Malaysia (ASM) to develop the Malaysian Antarctic Research Program (MARP). MARP was established in 1998 and the young Antarctic program was given a big task to focus on climate change and biodiversity in Antarctica.

The first Malaysian scientific field research in the Antarctic was undertaken on 13 to 25 October 1999 in Scott Base, Antarctica. MARP received an injection of MYR10 million under the 8th Malaysian Plan (2000-2005) to develop resilient and innovative researchers in Antarctic Science. During this period, the MARP started extensive international collaborations with Antarctic research bodies such as Antarctica New Zealand (ANZ), Australian Antarctic Division (AAD), British Antarctic Survey (BAS), Instituto Antártico Argentino (IAA), South Africa National Antarctic Program (SANAP), Korea Polar Research Institute (KOPRI), and National Centre for Antarctic and Ocean Research (NCPOR), India. The bilateral agreements with national programmes have facilitated the logistic arrangements for field work in Antarctica and technology transfers which both benefited the development of Antarctic research in Malaysia.

Photos: (Top) BAS Twin Otter VP-FBC aircraft refuelling at Sky-Blu Field Station, Eastern Ellsworth Land; (Middle) RRS James Clark Ross (background) and the ship's cargo tender during 2019/20 summer season station opening, Signy Research Station, British Antarctic Survey; (Bottom) The Gourlay huts on Signy Island.

Malaysia's efforts in Antarctic research have been recognised internationally. In 2004, MARP was admitted as an Associate Member of the Scientific Committee of Antarctic Research (SCAR) at the 28th SCAR Meeting at Bremerhaven, Germany. MARP has also been invited to become a consultative member of the Joint Committee on Antarctic Data Management (JCADM), an arm of SCAR responsible for the collation and dissemination of scientific information gathered by all research under SCAR. MARP is also a member of the Asian Forum on Polar Science (AFOPS) and has contributed significantly in the International Polar Year (IPY 2007/2008) not only in the form of research, but also through outreach and education.

Twenty eight years since "Question of Antarctica", Malaysia finally acceded to the Antarctic Treaty System as a Non-Consultative member, the same year when His Majesty, The Yang di-Pertuan Agong, Tuanku Mizan Zainal Abidin visited Antarctica. Sultan Mizan also facilitated the establishment of the Sultan Mizan Antarctic Research Foundation or Yayasan Penyelidikan Antartika Sultan Mizan (YPASM) in June 2012 to promote and develop national and international collaborations in the research and conservation of polar regions, especially in the Antarctic continent. On 15 August 2016, Malaysia finally acceded to the Madrid Protocol, five years after signing the Treaty. This marked a great progress in Malaysia's endeavour in Antarctic research, policy and conservation.

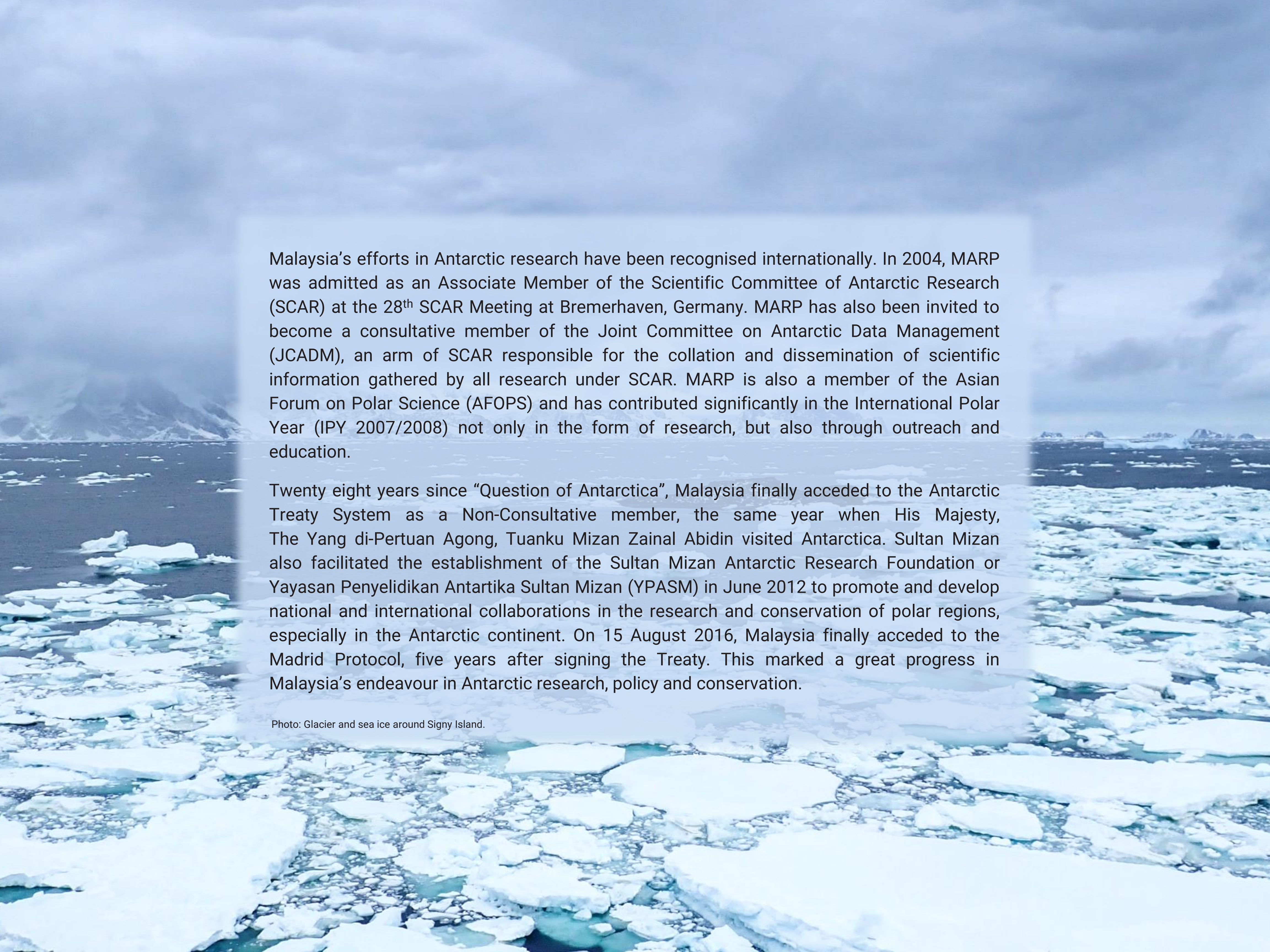


Photo: Glacier and sea ice around Signy Island.

Yayasan Penyelidikan Antartika Sultan Mizan's Smart Partnership Initiative and the IMU's Involvement

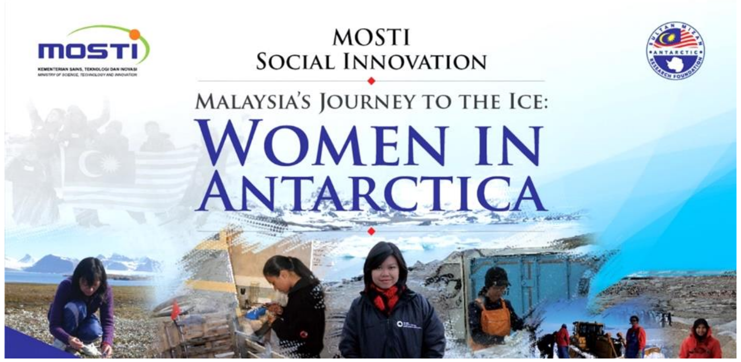
Yayasan Penyelidikan Antartika Sultan Mizan (YPASM) or Sultan Mizan Antarctic Research Foundation was established in 2012 to spur the participation of Malaysian scientists in Antarctic research, strengthen the research capacity and to sustain Malaysia's presence in Antarctica. The foundation was approved by the Cabinet and registered as a Company Limited by Guarantee and not having share capital, under the purview of the Ministry of Environment and Water (KASA) in June 2012.

With strong commitment to Antarctic research and conservation, Ke Bawah Duli Yang Maha Mulia Al-Wathiqu Billah Tuanku Mizan Zainal Abidin Ibni Al-Marhum Sultan Mahmud Al-Muktafi Billah Shah, Sultan of Terengganu graciously accepted the role of Patron of the foundation during the launching ceremony of YPASM in Kuala Terengganu, 19 July 2012.

Photo: Adélie (left) and Chinstrap penguins (right) at Gourlay Peninsula, Signy Island.

Since operation, YPASM has played an important role in connecting Malaysian researchers with scientific communities in the regions and globally. The foundation provides a fellowship scheme for Malaysian young Polar researchers to conduct short research attachment at established Polar institutions, as well as research grants to support the continuation of Polar research in Malaysia. It is noteworthy that IMU researchers are among the inauguration recipients of the YPASM Antarctic fellowship. Other than scientific research, the foundation also organises education and outreach programmes such as polar science camps, sharing sessions, contests and exhibitions for students and the public to nurture the interest in polar science.

Shortly after the setting up of YPASM, the Smart Partnership Initiative was introduced. The founding 8 members include Universiti Sains Malaysia, Universiti Malaysia Sabah, University of Malaya, Universiti Teknologi Mara, Universiti Kebangsaan Malaysia, Universiti Malaysia Terengganu, Universiti Putra Malaysia and the IMU. Each participating university is obliged to contribute MYR55,555 to YPASM annually for five years with a matching grant of MYR388,885 from YPASM offsetting more than half the overall costs.



Dr Wong Chiew Yen sharing her experiences in Antarctic research as part of the 'Malaysia's Journey to the Ice - Women in Antarctica' programme organised by YPASM.

IMU staff and students with fellow Malaysian polar researchers at the 7th SCAR Conference, Kuala Lumpur in 2016.

The IMU is proud to be the only Private University in the Smart Partnership. From 2016 to 2020, the IMU has contributed MYR277,775 to YPASM in the first cycle as a commitment for the Smart Partnership for Polar Research. In return, a total amount of MYR499,500 has been awarded to four recipients from the IMU; three from the Institute for Research, Development and Innovation (IRDI) and one from the School of Health Sciences (SOHS).

The first cycle of the Smart Partnership has ended in 2020. To continue IMU's endeavour in Antarctic Science, the IMU's Management Committee has approved the renewal of the Smart Partnership for another five years (2021-2025).

Under the new proposal by YPASM for the Smart Partnership Initiative, each participating university will contribute MYR62,500 per year for five years (amounting to MYR312,500 after five years). YPASM will match the contribution by the university on a 1:1 ratio, making the total available fund to be allocated under this initiative for a university to amount to MYR125,000 per year or MYR625,000 for five years.

List of IMU recipients for YPASM fellowship and research grant since 2016

Recipient	Faculty	Type and Year of Research Support	Project Title	Total Funding (MYR)
Dr Dang Nguk Ling	IRDI	Fellowship Scheme 2016	Phylogenetic study on microalgae isolated from pristine and heavy metal-impacted site on Signy Island, Antarctica.	49,500
Dr Nur Alia Johari	IRDI	Research Grant 2018	Molecular evaluation of biogeography of functional redundancy theory in Antarctic rhizosphere prokaryotic communities.	150,000
Dr Nur Alia Johari	IRDI	Berth Support to Antarctica 2019	Molecular Evaluation of Biogeography and Functional Redundancy Theory in Antarctic rhizosphere Prokaryotic Communities.	150,000
Dr Wong Chiew Yen	SOHS	Research Grant 2020	Phytoremediation Potential of Antarctic Microalgae on Diesel Hydrocarbons.	150,000
			Grand Total	**499,500**

Dr Dang Nguk Ling.

From L-R: Dr Chong Chun Wie, Dr Mai Chun Wai, Prof Datuk Dr Lokman Hakim Sulaiman and Dr Nur Alia Johari at the 8th Malaysian International Seminar on Antarctica (MISA8) 2019, Universiti Putra Malaysia.

The IMU’s Endeavour in Polar Research

Being a medical university, the IMU's involvement in Antarctic research may have raised a few eyebrows. It is easy to forget that the health of the environment that we are living in, as well as the health of the animals that share the same space with us are important elements of overall public health. The notion that the environment can influence human health is not new. For instance, the ancient Greeks had defined health as a state of dynamic equilibrium between the internal and the external environments. Furthermore, throughout the ancient civilisation, the management of pollutants such as human waste had been the priority in the planning and establishment of human settlements (e.g. construction of bathroom, latrines, water drains). Additionally, the strong associations between disease, seasonality and climate are regularly observed. For example, water-borne diseases such as cholera, leptospirosis and typhoid fever are generally more prevalent during the rainy season.

With the recognition of the inter-relationships between climate, animals and humans in health, there is an increasing emphasis on "One Health". Based on the WHO, "One Health is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes". In line with this approach, the IMU's researchers had embarked on the journey to deepen our understanding on the impact of environmental changes on the biota of Antarctica, and to search for clues of their potential link to human health. The Antarctic is a perfect natural laboratory to study the impact of environmental perturbations due to its simple ecosystems, and the fact that it is among the regions that experience a faster rate of warming.

IMU's research on Antarctica can be briefly categorised based on the studied organisms. Work has been conducted on the five groups of microoorganisms, namely algae, bacteria, viruses, parasites and fungi.

Photo: An Antarctic fur seal looking out over Elephant flats, Signy Island.
Photo (previous page): View of a large glacier in South Georgia, as seen from the RRS James Clarke Ross, March 2020.

Algae

The IMU's foray into research on Antarctic algae began with two flagship projects awarded by the Ministry of Science, Technology and Innovation (MOSTI) in 2014, under the Antarctic Flagship Programme led by Prof Dato' Dr Azizan Abu Samah, University of Malaya. Under the flagship projects, a number of IMU undergraduate and postgraduate research projects were developed and funded, including studies on Antarctic bacteria, parasites, viruses and fungi.

The first project titled 'Biomarkers of Polar and Lower Latitudes Microbes in Relation to Heavy Metal Stress' (MYR819,902) was led by Prof Chu Wan Loy, under the Flagship Programme theme 'Diversity and Adaptation of Microbes: A Cross Latitudinal Study'. The project aimed to assess the effects of heavy metals on oxidative stress response and metabolomic profiles of microalgae isolated from Signy Island, Antarctica. Although Antarctica is known to be the last pristine continent on earth, it is not free from heavy metal contamination. The major source of heavy metal pollution in Antarctica is mainly due to anthropogenic activities, especially near research stations.

Prof Chu Wan Loy on field in Antarctica for the collection of algae from sea ice and glaciers in 2001.

Dr Chan Kok Keong

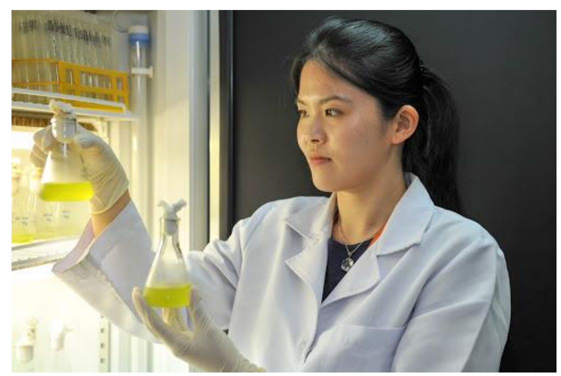
To collect samples for the project, Dr Chan Kok Keong was a member of the project team that joined the expedition to Signy Research Station, Antarctica, organised by the British Antarctic Survey (BAS) in 2015.

Dr Chan successfully collected soil samples from various locations with biological contamination, namely those with prolonged human activities, heavy metal contamination and wildlife (penguin, seal and giant petrel) activities.

The microorganism profiles of the contaminated locations were then compared with those of pristine sites on the sub-Antarctic Signy Island. A collection of soil microalgae was subsequently established from the samples collected during the expedition. Morphological characterisation and phylogenetic studies on the microalgae have been conducted. Selected microalgae from the collection have also been used for toxicity testing of heavy metals such as copper and lead.

Dr Chan collecting samples at Three Lakes Valley, Signy Island.

Antarctic fur seals on Signy Island. A rare blonde variant surrounded by more common brown fur seals.



Dr Dang Nguk Ling completed her PhD titled 'Effects of heavy metals on oxidative stress response and metabolomics profiles of Antarctic algae' in 2020 under Prof Chu's supervision as part of Prof Chu's YPASM flagship project.

Dr Wong Chiew Yen

The second project was led by Dr Wong Chiew Yen, titled 'Physiological and genomic responses of microalgae to climate changes across a global gradient' (MYR827,600) under the theme 'An Integrated Approach: Microbes and Response to Climate Change'. The project was in collaboration with Prof Chu, Prof Phang Siew Moi and Prof Lim Phaik Eem (University of Malaya), Prof Pete Convey (BAS) and YPASM.

One of the seriously debated environmental issues today is the impact of climate change, particularly related to increased temperature and ultraviolet radiation (UVR). The elevated anthropogenic greenhouse gases are expected to lead to an increase in the average global surface temperatures over the next century ranging anywhere from 1.8 to 4.0°C (IPCC, 2007). Increasing levels of UVR have been reported in many parts of the world including Antarctica and the adjacent geographic regions (southern parts of South America and Australia), as well as the Arctic region.

Changes in the global environment, especially global warming and ozone depletion, which results in the increase of UVR and temperature can have far-reaching impacts on organisms especially microalgae in the Antarctic, affecting their physiological processes and productivity. Such impacts on microalgae are of particular interest as they form the basis of the food webs in the Antarctic ecosystem. Thus, the research project focused on comparing the physiological response of microalgae from different geographical regions to the effects of increased temperature and UVR.

Dr Wong in Casey Station, Antarctica (top) collecting snow algae and (bottom) conducting a UVR field experiment.

In addition, the application of transcriptomics approaches on microalgae exposed to UVR and temperature provides insight on the relevant genes and genetic responses that are involved in responding to environmental stress. This information is fundamentally important for the understanding of algal adaptation to climatic and environmental changes. The objectives of this project are closely aligned with the aims of the recently-approved Scientific Committee on Antarctic Research (SCAR) International Scientific Research Program, Antarctic Thresholds – Ecosystem Resilience and Adaptation. This project therefore provides a timely and important opportunity to place Malaysian Antarctic research firmly in the mainstream of the international research priorities identified by SCAR.

As part of the flagship project, IMU Master in Medical and Health Sciences student Aniqah Zulfa joined the YPASM Malaysian Antarctic Scientific Expedition in 2016 to Antarctica from December 2015 till February 2016 to collect samples for the isolation of algae for the study titled ‘Effects of Ultraviolet Radiation on cell proliferation, oxidative stress and antioxidant enzyme activities of *Chlorella* isolates’.

Dr Wong assessing algae samples in the IMU Research Lab.

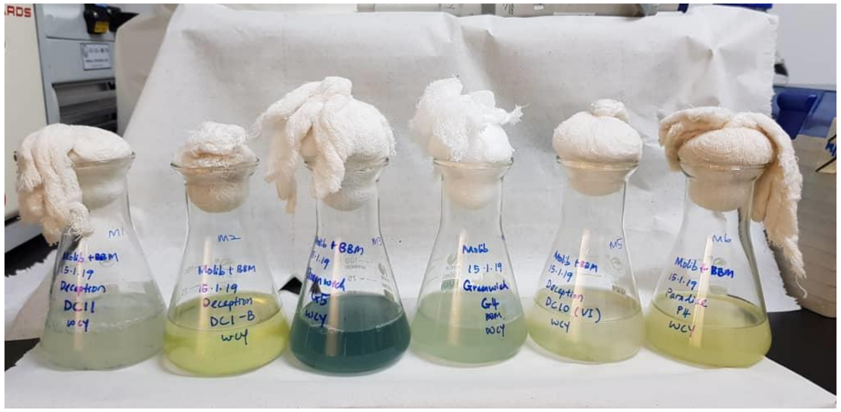
Collecting samples for isolation of Arctic microalgae in Ny-Ålesund, Norway.

Aniqah Zulfa (second from left) with the Malaysian Antarctic Scientific Expedition Team 2016 from USM, UiTM, UM and UMT.

YPASM Research Grant 2020: Phytoremediation Potential of Antarctic Microalgae on Diesel Hydrocarbons

The latest (at time of writing) research grant for Antarctic research was awarded to Dr Wong Chiew Yen under the Smart Partnership Initiative. In collaboration with Prof Chu and Dr Kok Yih Yih (IMU), A/Prof Dr Siti Aqlima Ahmad (UPM), Prof Pete Convey (BAS), A/Prof Dr Azham Zulkharnain (Shibaura Institute Technology, Japan) and Dr Claudio Gomez-Fuentes (Universidad de Magallanes, Chile/ Centro de Investigación y Monitoreo Ambiental Antártico) (CIMAA), the project will run from 2020 and aims to identify the degradation potential of microalgae isolated from Antarctica.

Hydrocarbon pollution in Antarctica is derived from various origins such as catastrophic oil spill events, chronic fuel leakage and from local effluent, and has contaminated some of Antarctica's near-to-pristine land over the past few decades. The hydrocarbon composition of diesel is known to be toxic and harmful to terrestrial and marine ecosystems and biota, further exacerbated due to its persistence. Despite increasing knowledge about contamination in Antarctica due to increased human pressure, clean-up (remediation) of polluted sites is still in its infancy, in part owing to the extreme environment. Remediation through application of physical machinery would be laborious and costly due to the harsh conditions, as well directly damaging to the fragile terrestrial ecosystems, whilst remediation using chemical dispersants is itself a potential environmental hazard and should be critically considered.

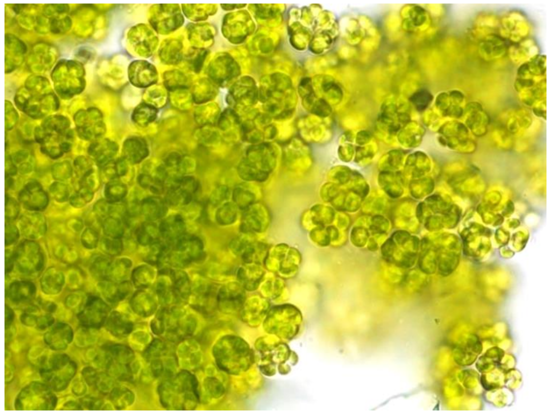


Preliminary testing for phytoremediation using Antarctic microalgae.

Dr Wong demonstrating laboratory techniques for the project to students at Universiti Putra Malaysia (UPM).

Phytoremediation is now emerging as a sustainable technique for the treatment of organic and inorganic contaminants. The ability of Antarctic freshwater algae to remediate diesel hydrocarbons in an axenic state has not been thoroughly studied, alone or in combination with characterisation of the abiotic factors that limit algal growth. Such studies have the potential to take advantage of the cold-adapted physiology of native Antarctic microbes in developing realistic and practicable remediation approaches, as well as helping to address the limitations imposed by the Antarctic Treaty System which bans the import and introduction of non-native microbes to the Antarctic environment.

The project aligns with the Integrated Science to Inform Antarctic and Southern Ocean Conservation (Ant-ICON) proposal for the next generation of SCAR programmes, which includes a large element of identifying and mitigating/providing policy advice pertinent to human impacts on Antarctic ecosystems. This project will also contribute to enhancing Malaysia's footprint in polar research, in line with the aspiration of the country to attain consultative status within the Antarctic Treaty.

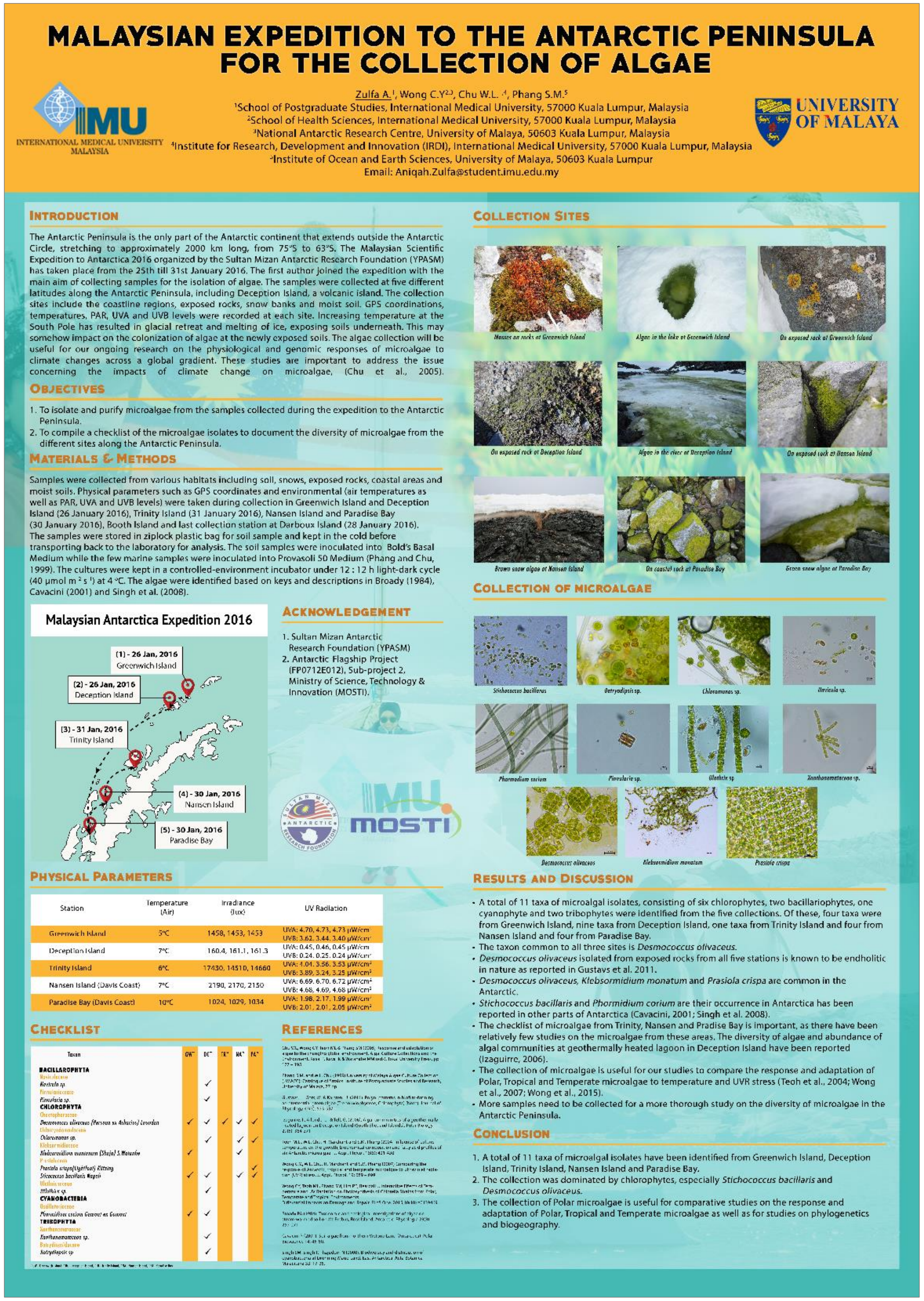


Gloeobotrys sp., a terrestrial algae found in the soil.

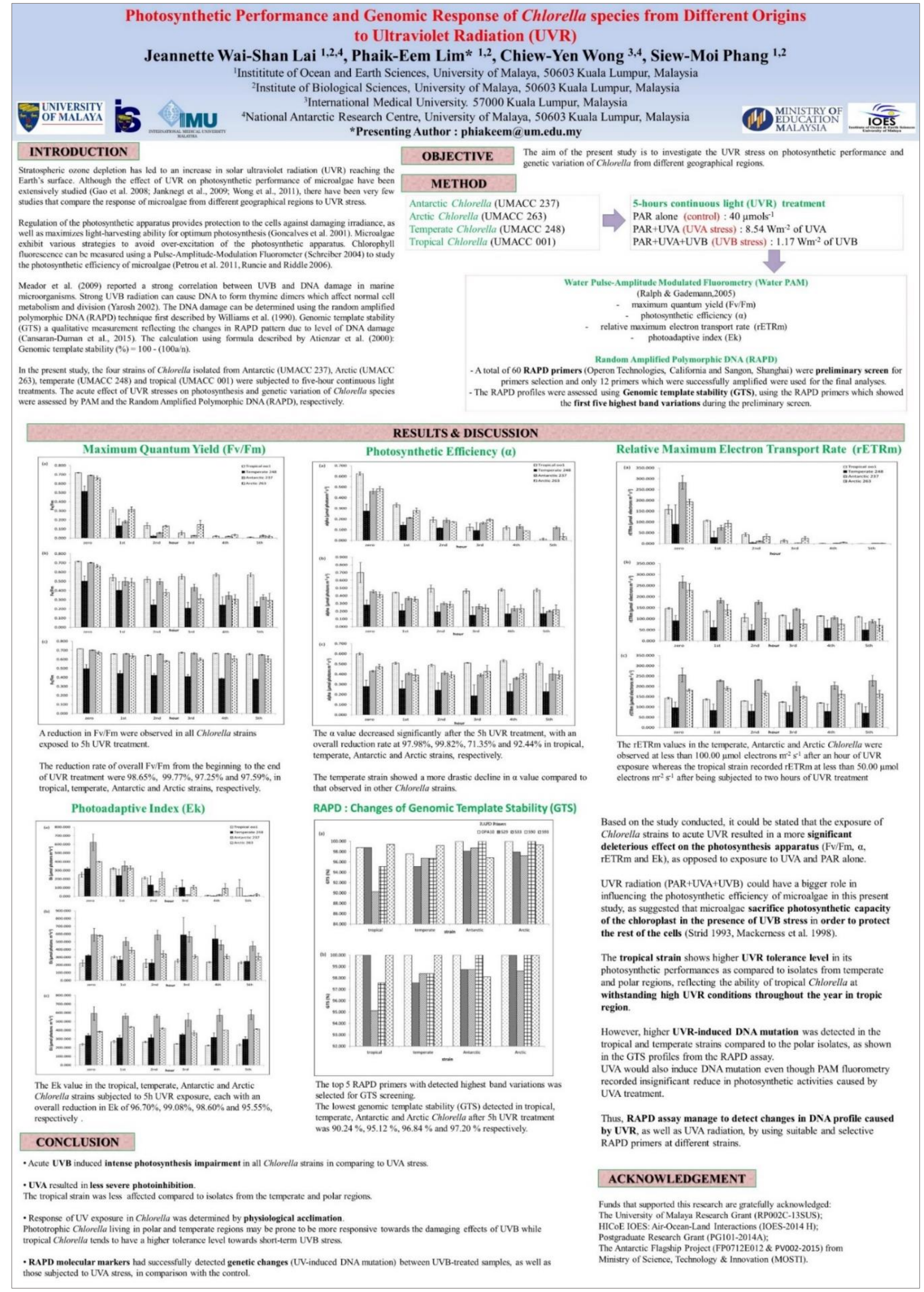
Algae in Antarctic ice.

Microalgae isolated from Antarctica.

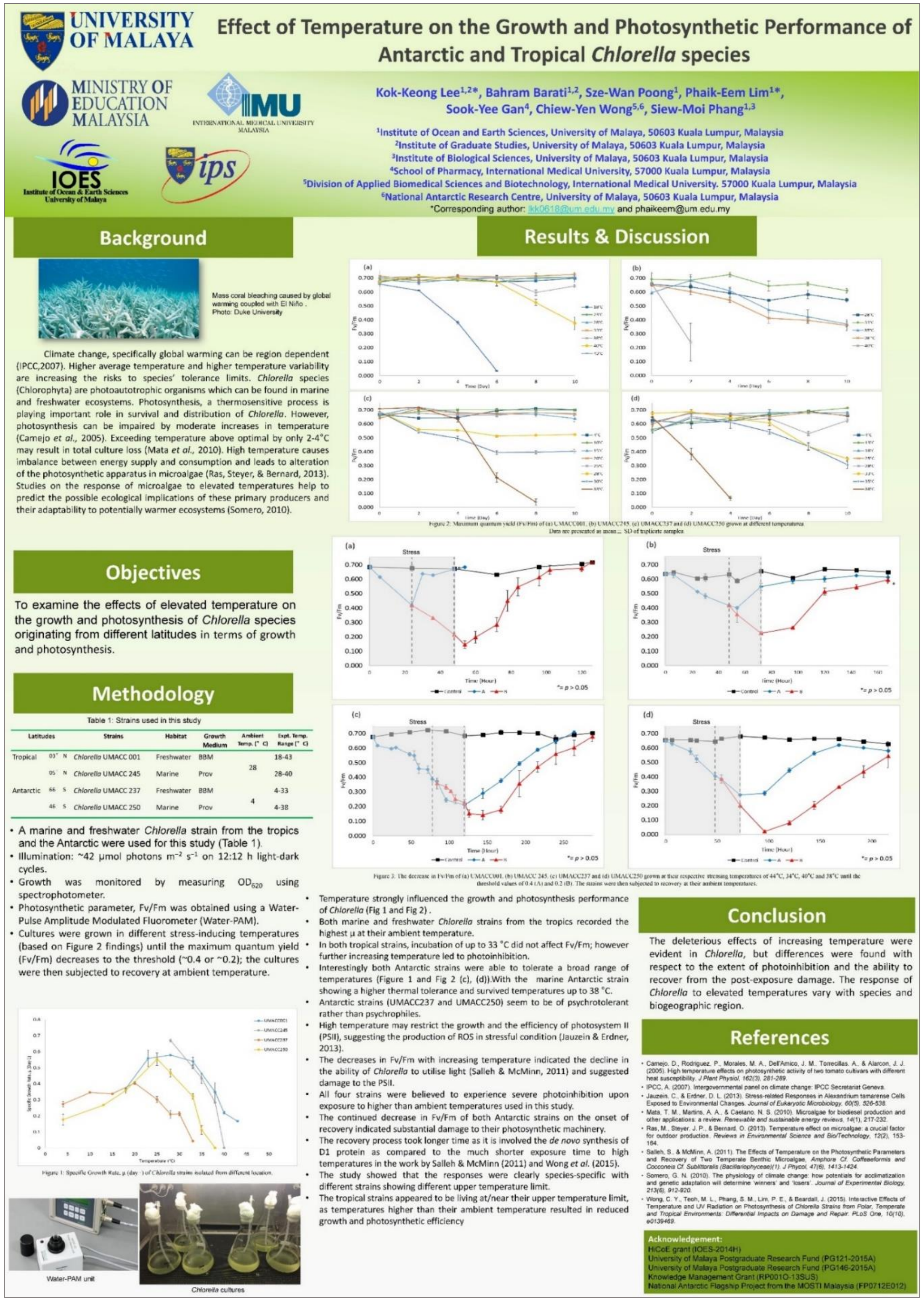
Algae Research Posters



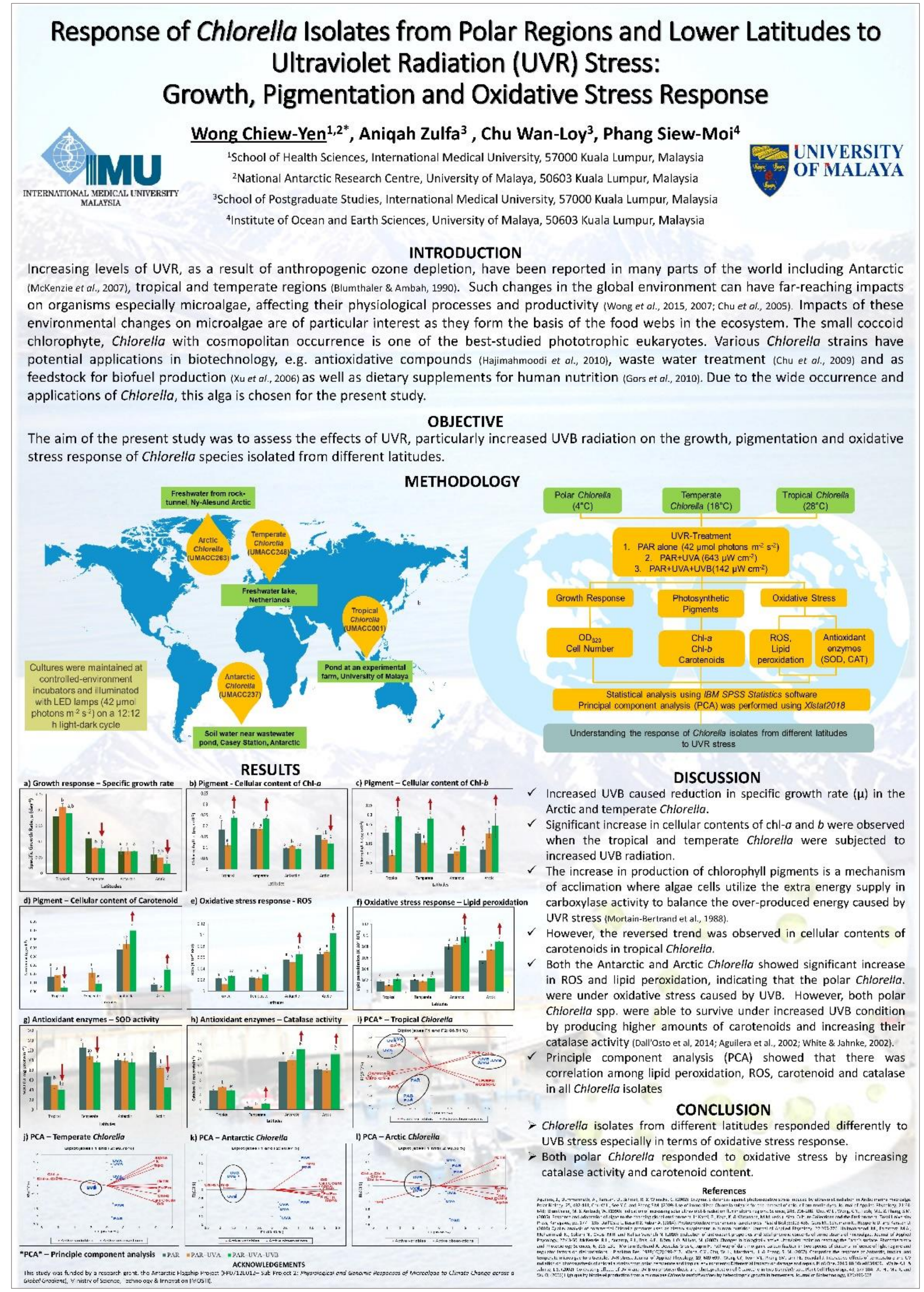
Abdul Latif AZ, Wong CY, Chu WL and Phang SM. Malaysian expedition to the Antarctic Peninsula for the collection of algae. XXXIV SCAR Biennial Meeting and Open Science Conference, Kuala Lumpur, *Malaysia*, 22-26 August 2016.



Lai JWS, Lim PE, Wong CY and Phang SM. Photosynthetic performance and genomic responses of *Chlorella* species to ultraviolet radiation (UVR) stress across different geographical gradient. XXXIV SCAR Biennial Meeting and Open Science Conference, Kuala Lumpur, *Malaysia*, 22-26 August 2016.



Lee KK, Barati B, Poong SW, Lim PE, Gan SY, Wong CY and Phang SM. Effect of temperature on the growth and photosynthetic performance of Antarctic and tropical *Chlorella* species. XXXIV SCAR Biennial Meeting and Open Science Conference, Kuala Lumpur, *Malaysia*, 22-26 August 2016.



Wong CY, Zulfa A, Chu WL and Phang SM. Response of *Chlorella* Isolates from Polar Regions and Lower Latitudes to Ultraviolet Radiation (UVR) Stress: Growth, Pigmentation and Oxidative Stress Response. 8th Malaysian International Seminar on Antarctica, Universiti Putra Malaysia, *Malaysia*, 18-20 June 2019.

Publications

1. Chu WL, Dang NL, Kok YY, Yap KSI, Phang SM and Convey P (2019). Heavy metal pollution in Antarctica and its potential impacts on algae. Polar Science. 20, pp.75-83.

2. Lai WSJ, Lim PE, Wong CY, Phang SM, Beardall J (2019). Photosynthetic response and DNA mutation of tropical, temperate and polar *Chlorella* under short-term UVR stress. Polar Science. 20: 35-44.

3. Poong SW, Lee KK, Lim PE, Wong CY, Phang SM, et al. (2018). RNA-Seq mediated transcriptomic analysis of heat stress response in a polar *Chlorella* sp. (Trebouxiophyceae, Chlorophyta). Journal of Applied Phycology. DOI:10.1007/s10811-018-1455-9.

4. Poong SW, Lim PE, Phang SM, Wong CY, Pai TW, et al. (2018). Transcriptome sequencing of an Antarctic microalga, *Chlorella* sp. (Trebouxiophyceae, Chlorophyta) subjected to short-term ultraviolet radiation stress. Journal of Applied Phycology. 30:87-99. DOI: 10.1007/s10811-017-1124-4.

5. Lee KK, Lim PE, Poong SW, Wong CY, Phang SM, et al. (2017). Growth and photosynthesis of *Chlorella* strains from polar, temperate and tropical freshwater environments under temperature stress. Chinese Journal of Oceanology and Limnology. DOI: 10.1007/s00343-018-7093-x.

6. Pearce DA, Alekhina IA, Terauds A, Wilmotte A, Quesada A, Edwards A, Dommergue A, Sattler B, Adams BJ, Magalhães C and Chu WL (2016). Aerobiology over Antarctica–a new initiative for atmospheric ecology. Frontiers in Microbiology. 7, p.16.

7. Wong CY, Teoh ML, Phang SM, Lim PE & Beardall J (2015). Interactive effects of temperature and UV radiation on photosynthesis of *Chlorella* strains from polar, temperate and tropical environments: Differential impacts on damage and repair. PLoS ONE,; 10(10): e0139469. DOI: 10.1371/journal.pone.0139469. (SCI IF: 3.234).

8. Teoh ML, Phang SM, & Chu WL (2013). Response of Antarctic, temperate, and tropical microalgae to temperature stress. Journal of Applied Phycology. 25(1), 285-297.

9. Chu WL (2012). Biotechnological applications of microalgae. International e-Journal of Science, Medicine & Education (IeJSME), 6(Suppl 1): S24-S37.

10. Chong GL, Chu WL, Rofina Yasmin Othman, Phang SM (2011). Differential gene expression of an Antarctic *Chlorella* in response to temperature stress. Polar Biology. 34(5): 637-635.

11. Wong CY, Teoh ML, Phang SM & Chu WL (2011). Effect of ultraviolet radiation (UVR) on the tropical microalgae *Chlorella vulgaris*. Malaysian Journal of Science. 30(1):3-15.

12. Teoh ML, Chu WL, Phang SM (2010). Effect of temperature change on the physiology and biochemistry of algae: a review. Malaysian Journal of Science. 29(2): 82-97.

13. Chu WL, Lim SL, Teoh ML, Wong CY & Phang SM (2009). Influence of nitrogen source on the growth and biochemical composition of an Antarctic *Chlorella*. ASM Science Journal. 3(2):178-183.

14. Phang SM, Chu WL, Wong CY, Teoh ML, Tan KP, et al. (2008). A checklist of microalgal isolates from Ny-Ålesund, Svalbard. In: Azzolini R, (Ed.) Polarnet Technical Report PTR-1/2008. Scientific and Technical Report. The Journal of the CNR's Network of Polar Research. ISSN 1592-5064. 11-14.

15. Wong CY, Chu WL, Marchant H & Phang SM (2007). Comparing the response of Antarctic, tropical and temperate microalgae to ultraviolet radiation (UVR) stress. Journal of Applied Phycology. 19:689-699.

16. Wong CY, Chu WL, Marchant H & Phang SM (2004). Growth response, biochemical composition and fatty acid profiles of four Antarctic microalgae subjected to UV radiation stress. Malaysian Journal of Science. 23(2): 103-118.

17. Teoh ML, Chu WL, Marchant H & Phang SM (2004). Influence of temperature on the growth, biochemical composition and fatty acid profiles of six Antarctic microalgae. Journal of Applied Phycology. 16(6): 421-430.

18. Phang SM & Chu WL (2004). The University of Malaya Algae Culture Collection (UMACC) and potential applications of a unique *Chlorella* from the collection. Japanese Journal of Phycology. 52 : 221-224.

Chapter of book

1. Phang SM, Chu WL and Rabiei R (2015). Phycoremediation. In: The Algae World (pp. 357-389). Springer, Dordrecht.

2. Wong CY (2013). Field experiment on the effect of solar ultraviolet radiation on microalgae. In: Azizan Abu Samah, Convey P, Siti Aisyah Alias, Smykla J (eds) Antarctica: Malaysia's Journey to the Ice. Malaysia Antarctic Research Centre (NARC) & Malaysian National News Agency (Bernama), pp 190-193.

3. Chu WL, Wong CY, Teoh ML & Phang SM (2005). Response and adaptation of microalgae to the changing global environment. In: Fumie Kasai (ed.) Microalgae Culture Collections and the Environment, pp. 177-195.

Antarctic algae isolates

1. A total of 22 unialgal from Signy Island (soil microalgae) successfully isolated and deposited in Research Lab, IMU.

2. A total of 6 unialgal from Antarctic Peninsular successfully isolated and deposited in Research Lab, IMU.

Bacteria

Vegetation of Signy Island. Clockwise from top: *Deschampsia sp.,* or tussock grass, amongst moss vegetation at Deschampsia Point; *Chorisodontium* sp. with dark brown patches of *Andreaea* sp. and white epiphytic lichens; *Sanionia* sp., one of the most abundant mosses in maritime Antarctica.

The cold and arid conditions of Antarctica have restricted the development of higher plants on the terrestrial ecosystems. Although sporadic prevalence of cryptogamic plants such as mosses and lichens can be detected in limited biology hotspots during summer, the vast majority of Antarctica is barren or covered by permafrost. In such a unique setting, microorganisms such as bacteria play a vital role in ensuring the functioning of the ecosystems. What drives the assembly of the bacterial community and how bacteria responds to environmental perturbations are therefore among the key fundamental questions that need to be addressed to enable ecological simulation and the design of proper conservation strategies. Indeed, these form part of the key research questions highlighted by the Scientific Committee on Antarctic Research (SCAR) Antarctic and Southern Ocean Science Horizon Scan.

In support of the SCAR Horizon Scan initiative, researchers from the IMU had initiated a research project to evaluate the distribution and interaction of microbial communities in the rhizosphere, titled 'Molecular evaluation of biogeography and functional redundancy theory in Antarctic rhizosphere prokaryotic communities' (2019-2022, MYR150,000). Rhizosphere is the area around the plant root (plant-root-soil interface) where numerous biogeochemical processes take place, pathogenic and beneficial microorganisms interact, and which constitutes a major influence on plant growth and health. Using this unit habitat as a model, the project also seeks to evaluate the validity of bacterial biogeography and functional redundancy theories by comparing bacterial community composition and rhizosphere functions across a large selection of regions in Antarctica.

A view of the landscape of Signy Island in maritime Antarctica, with a complex geology and range of terrestrial habitats providing a wide diversity of ecosystems.

Collection tubes marking bank forming mosses *Polytrichum* sp. & *Chorisodontium* sp., a drier habitat, next to *Deschampsia sp.* grass (bottom right).

The moss *Sanionia* sp. (right) lifted up to reveal the rhizosphere just beneath, next to the green algae *Prasiola* sp. (bottom left).

Antarctica also constitutes an ideal natural laboratory to test these theories, without effects of external human influences, allowing identification of major drivers of bacterial diversity, function and change. The research will be the first to assess microbial functions at a continental spatial scale, and the first to link functional diversity to the underlying chemistry through nuclear magnetic resonance (NMR) and metabolomics. Findings will serve as baseline data for future assessments of the impact of changing environmental conditions, and inform ecological forecasting; how ecological populations and ecosystems will change in the future in response to environmental factors such as climate change. These include effects on crop yield and potential risks of pathogenic bacteria in the rhizosphere to animals and humans in the future.

Dr Nur Alia Johari

Dr Nur Alia Johari is the principal investigator and was the field expeditioner of the project. She joined the Summer 2019/2020 expedition with the British Antarctic Survey (BAS) to Signy Research Station. Despite being one of the smaller BAS stations, Signy Island (60°43'0"S, 45°36'0"W), is one of the most isolated, requiring travel to and from aboard the RRS James Clark Ross.

The expedition lasted for 14 weeks where Dr Alia collected rhizosphere soil samples across the island. The plant species beneath which the soil samples were collected from were noted, comprising of various mosses and lichens as well as the only two flowering plants native to Antarctica, namely *Deschampsia antarctica* and *Colobanthus quitensis*. The soil samples were successfully tested and shipped to the UK and subsequently Malaysia for analysis.

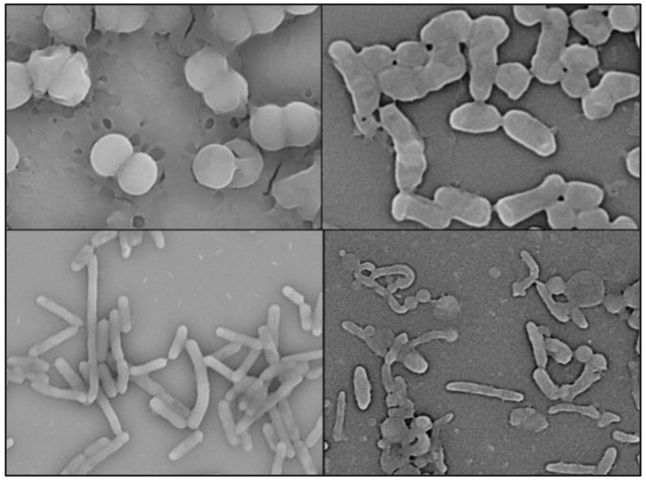
The research is funded by YPASM under the Smart Partnership Programme, and is in collaboration with Prof Pete Convey (BAS), Prof David Pearce (University of Northumbria), Dr Nicole Trefault (Universidad Mayor, Chile), Dr Chong Chun Wie (Monash University, Malaysia), Dr Mai Chun Wai (IMU), Dr Ivan Yap (Sarawak Research and Development Council) and Dr Cindy Teh (University of Malaya).

Dr Alia on Signy Island. Clockwise from top: Hiking over Knife Point with Orwell Glacier in the background; travelling on a snowmobile on the island's ice-cap; collecting soil samples at Skua Terrace on the west coast.

Dr Fabian Davamani

Separately, the footprint of IMU's Antarctic research is also evident in the area of bacterial biofilms, heavy metal resistance, and antibiotic resistance. Previous and existing research work under Prof Chu's flagship project were led by Dr Fabian Davamani, and have focused on the genomics of Antarctic bacteria and the production of biofilms, which provide a survival advantage to persist under harsh Antarctic conditions.

Dr Fabian developed in-house media to grow Antarctic bacteria from soil samples collected from Signy Island. His group is also currently studying both the phenomics (physical and biochemical traits) of Antarctic bacteria and creating heat maps to understand their metabolism. Advanced genomics approaches such as whole genome sequencing of Antarctic bacteria were also employed to provide further insights into the molecular evolution, antibiotic resistance, psychrotolerance and the diversity of the Antarctic bacteria. Through the annotation of the genomic sequences, Dr Fabian's research team sought to identify strains that might lead to the discovery of novel bioactive compounds with medical applications.



Samples of Antarctic biofilms grown at low temperatures (psychrophilic).
Clockwise from top left:
Psychrobacter sp,
Rodococcus sp,
Flavobacterium sp,
Sporosarcina sp.

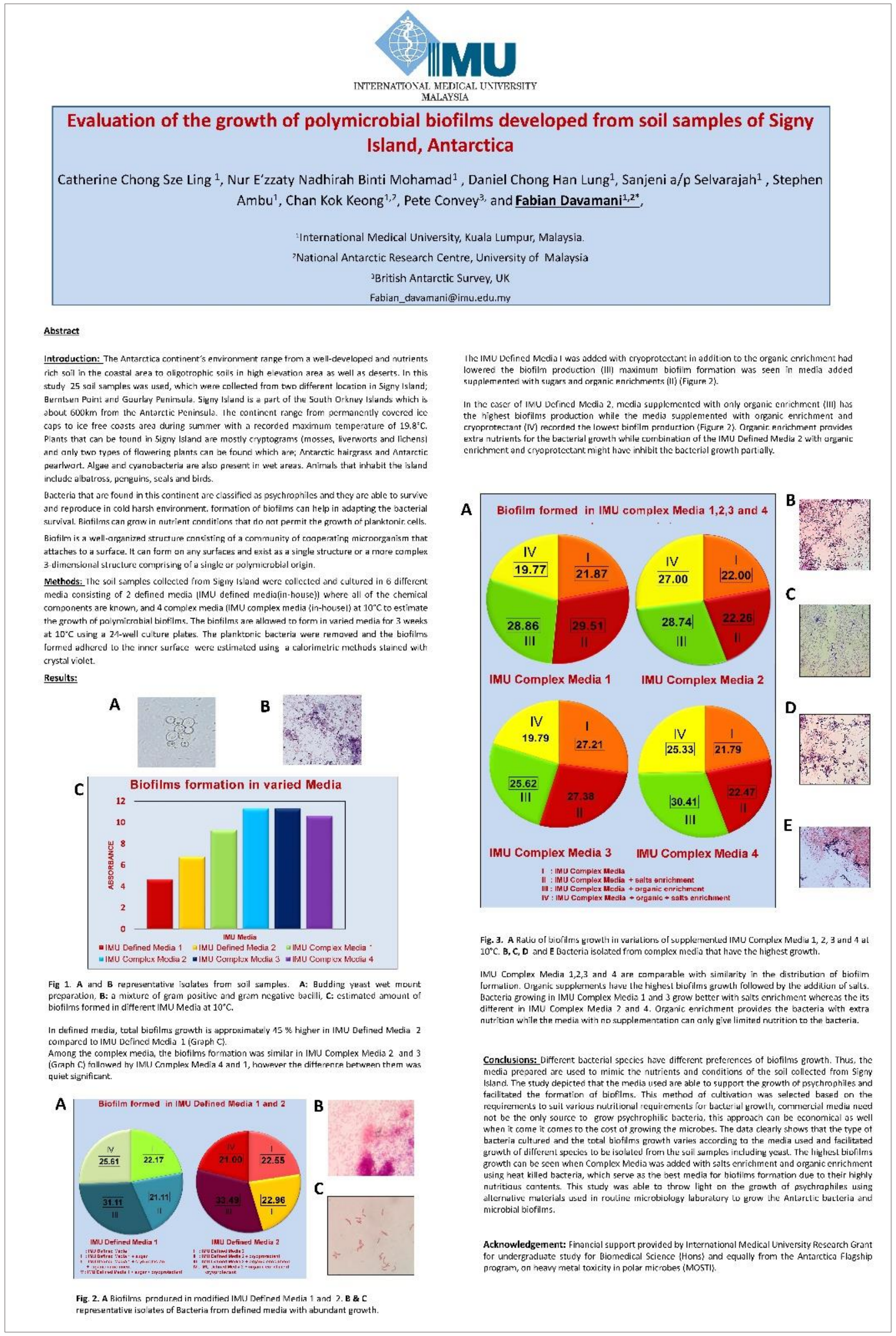
Antarctic bacteria isolates

Dr Fabian's work has led to the submission of Antarctic bacteria isolates to the National Center for Biotechnology Information (NCBI):

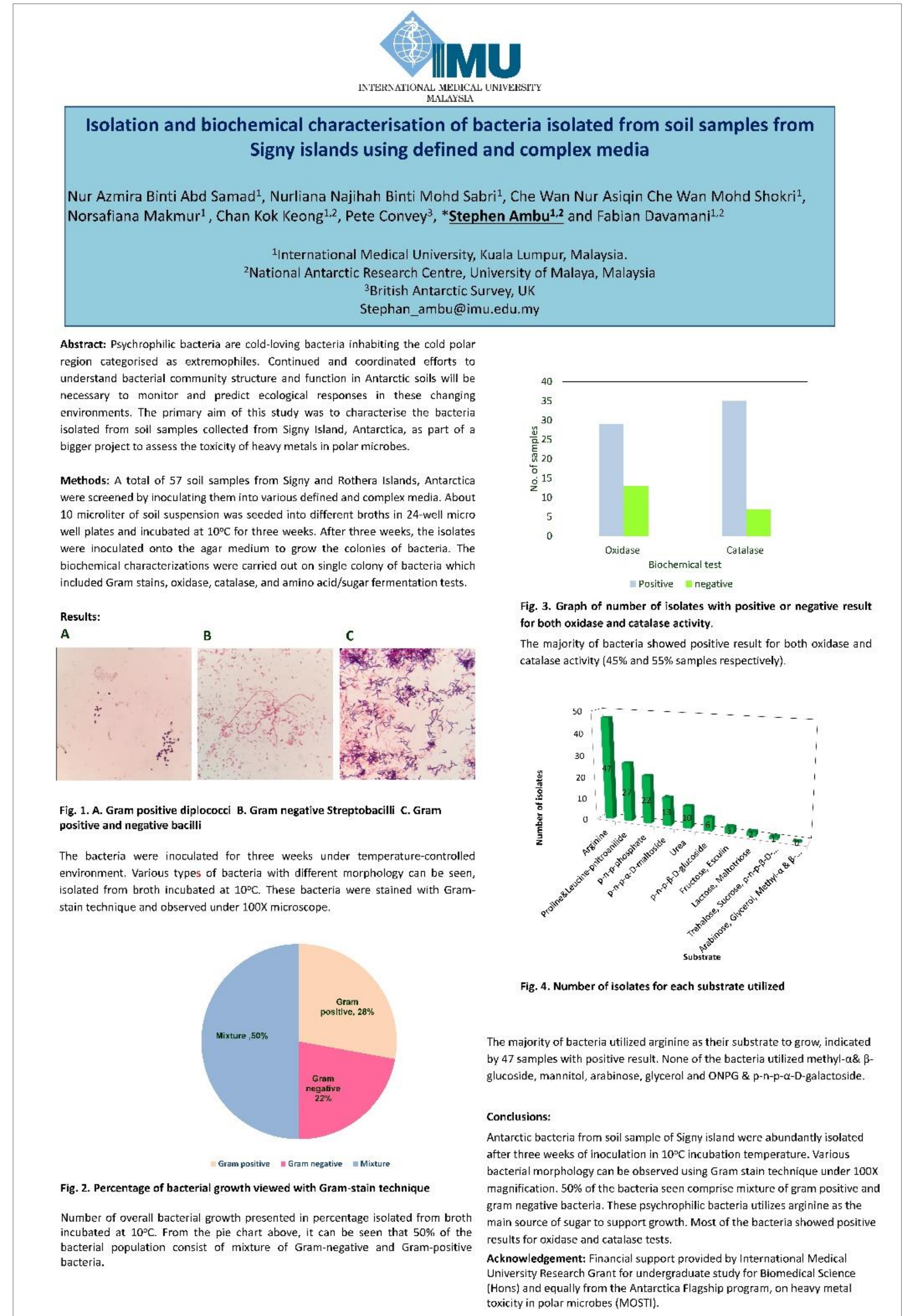
1. *Arthrobacter* sp.
2. *Rhodococcus* sp.
3. *Flavobacterium* sp.
4. *Cryobacterium* sp.
5. *Psychrobacter* sp.
6. *Sporosarcina* sp.

Conference presentations

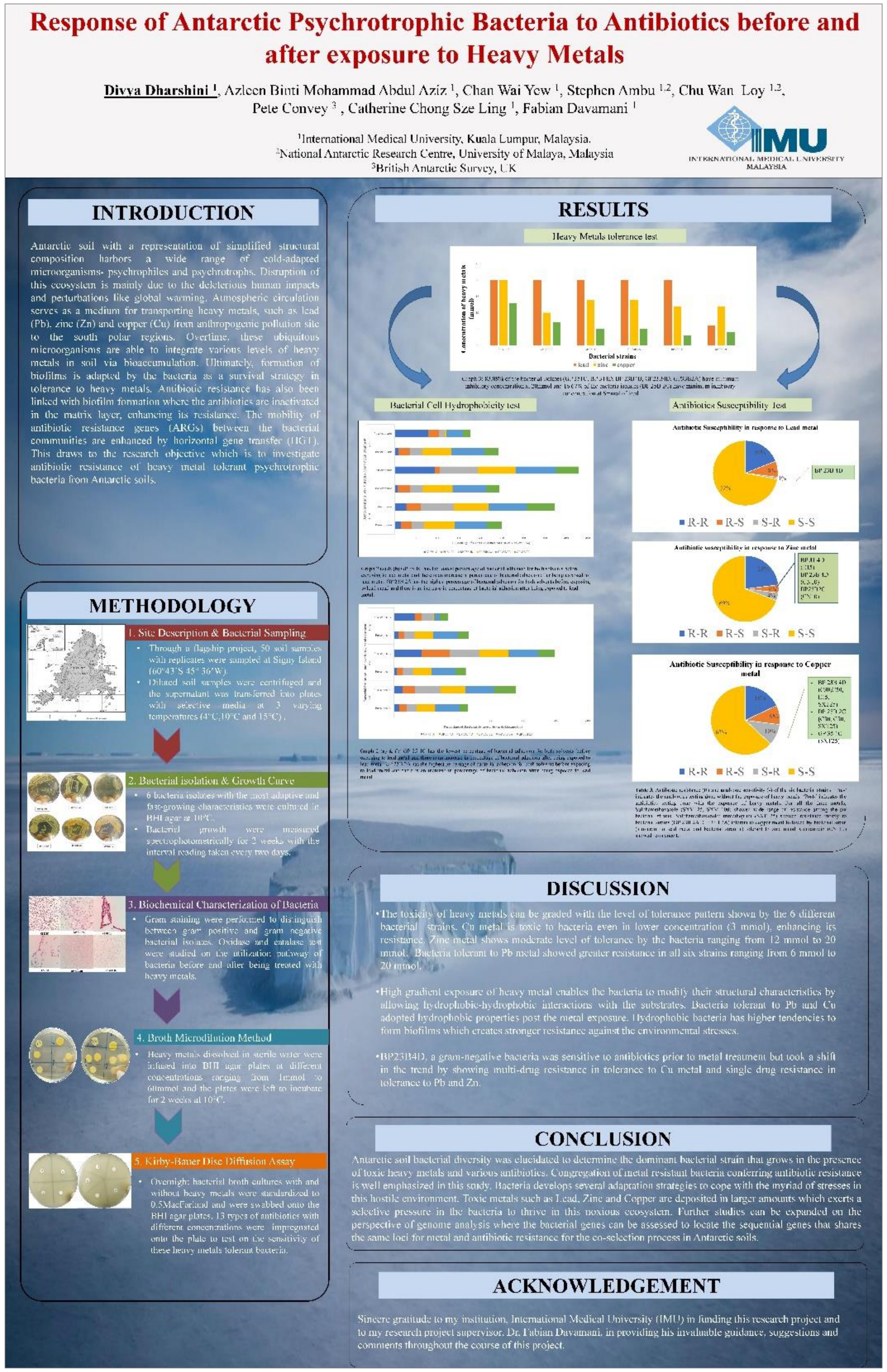
Davamani F, Chong CSL, Chong DHL, Mohamad NENB, Selvarajah S, Ambu S, Chu WL, Convey P. Exploiting temperature and nutritional conditions for Poly microbial biofilm formation from Antarctic soil samples. 8th Malaysian International Seminar on Antarctica - Polar regions in the Global Climate System. Kuala Lumpur, *Malaysia*, 18-19 June 2019.



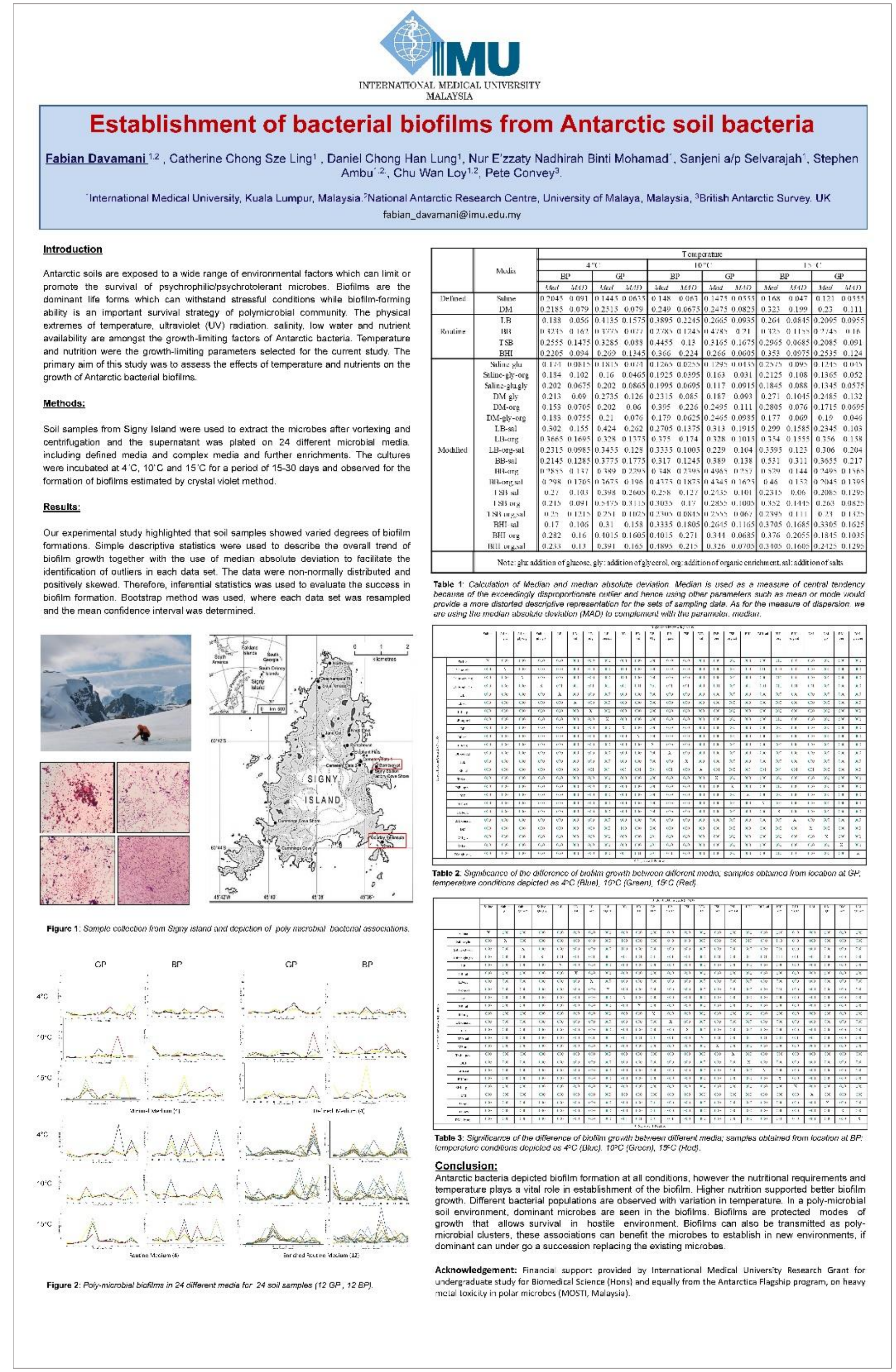
Davamani F, Chong CSL, Mohamad NENB, Chong DHL, Selvarajah S, Ambu S, Chan KK and Convey P. Evaluation of the growth of polymicrobial biofilms developed from soil samples of Signy Island, Antarctica. 36th SCAR open science conference. KLCC, Kuala Lumpur, *Malaysia*, 22-26 August 2016.



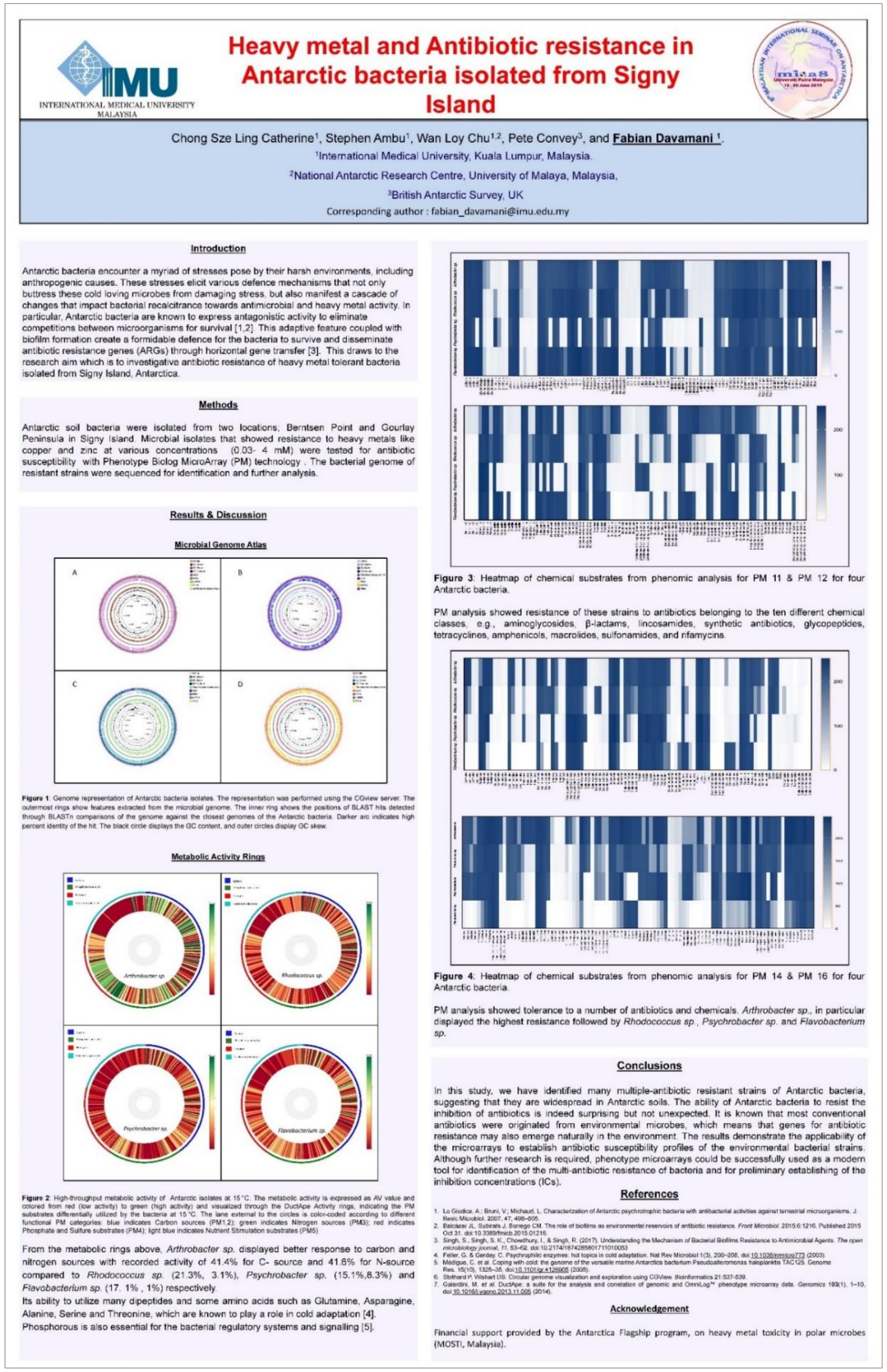
Ambu S, Davamani F, Abd Samad NAB, Mohd Sabri NN, Che Wan Mohd Shokri CWNA, Makmur N, Chan KK and Convey P. Isolation and biochemical characterisation of bacteria isolated from soil samples from Signy Islands using defined and complex media. 36th SCAR open science conference. KLCC, Kuala Lumpur, *Malaysia*, 22-26 August 2016.



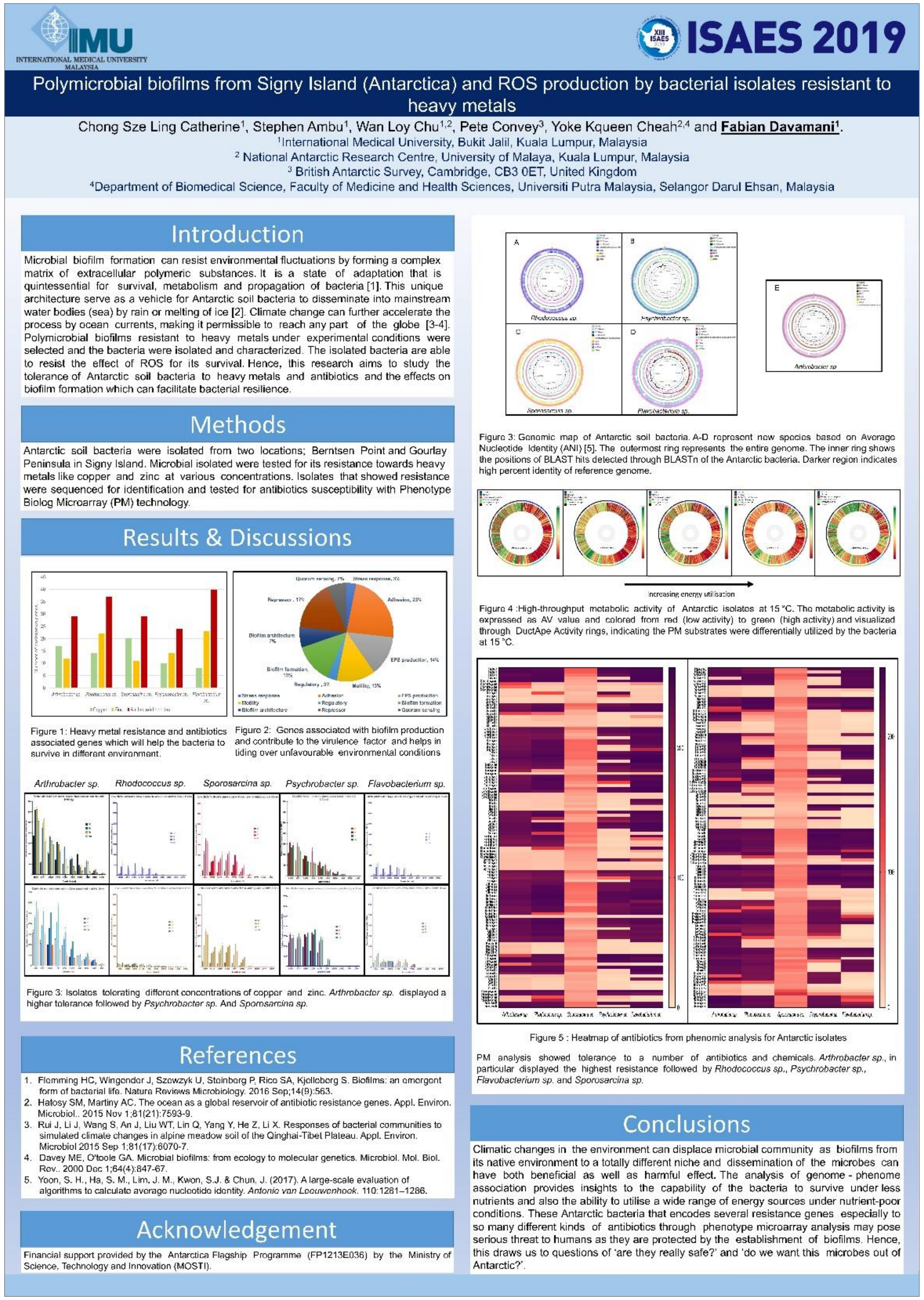
Dharshini D, Mohammad Abdul Aziz AB, Chan WY, Ambu S, Chu WL, Convey P, Chong CSL, Davamani F. Response of Antarctic Psychrotrophic Bacteria to Antibiotics before and after exposure to Heavy Metals. Australian Society for Microbiology Annual Scientific conference 2018. Brisbane, *Australia*, 1-4 July 2018.



Davamani F, Chong CSL, Chong DHL, Mohamad NENB, Selvarajah S, Ambu S, Chu WL, Convey P. Establishment of bacterial biofilms from Antarctic soil bacteria. Australian Society for Microbiology Annual Scientific conference 2018. Brisbane, *Australia*, 1-4 July 2018.



Chong CSL, Ambu S, Chu WL, Convey P, and Davamani F. Heavy metal and antibiotic resistance in Antarctic bacteria isolated from Signy Island. 8th Malaysian International Seminar on Antarctica -Polar regions in the Global Climate System. Kuala Lumpur, *Malaysia*, 18-19 June 2019.



Chong CSL, Ambu S, Chu WL, Convey P, Cheah YK and Davamani F. Polymicrobial biofilms from Signy Island (Antarctica) and ROS production by bacterial isolates resistant to heavy metals. XIII International Symposium on Antarctic Earth Sciences (ISAES 2019). Incheon, *Republic of Korea*, 22-26 July 2019.

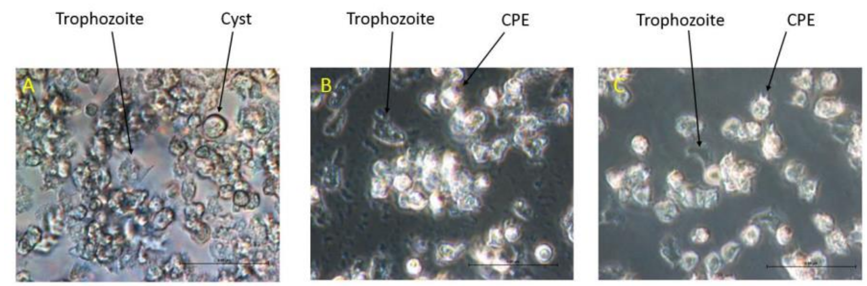
Virus

Dr Kenny Voon

The IMU's research work on Antarctic viruses is led by Dr Kenny Voon Gah Leong. Dr Kenny Voon's lab focuses on investigating the role of mimivirus in Antarctica, with the project titled 'Isolation and molecular characterisation of giant amoebal viruses from soils in Signy Island'. The project aims to isolate giant amoebal viruses from soils in Signy Island and perform molecular characterisation of these isolates.

He is intrigued by how the mimivirus is so ubiquitous that it could be discovered in different parts of the world, including Antarctica. With the success of isolating mimivirus from soils in Malaysia, his team used a similar approach to isolate and detect mimivirus from Antarctica, particularly soil samples from Signy Island. The genome of isolated mimivirus will be sequenced to be compared with those that were discovered from different regions. Much of the knowledge about the roles of viruses in the natural environment comes from studies of marine microbial communities.

Viruses play an important role in infecting and degrading heterotrophic microbes which later lead to increases in net respiration, the release of carbon dioxide and nutrient recycling in the world's oceans. However, the role of mimivirus in the natural environment remains to be explored.



Light micrograph of *A. castellani* at 400X magnification; A shows the negative control; B shows the *A. castellani* after being passaged on with samples from Berntsen Point; C shows the *A. castellani* after being passaged on with samples from Gourlay Peninsula, Signy Island.

Publication

Ooi ZQ, Hong KS, Thum EY, Ong SL, Voon K, Chong CW. The Discovery and Quantification of Mimivirus and Marseillevirus in Signy Island, Antarctica. Polar Biology (in preparation for submission).

Parasites

Prof Patricia Lim

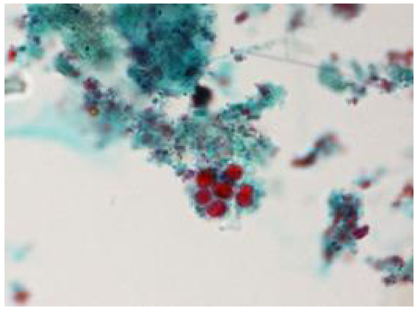
Research projects under Prof Chu's flagship grant also included work on parasites, led by Professor Patricia Lim Kim Chooi. The project titled 'Identification of parasites in soil samples collected from Signy Island, Antarctica' aimed to examine soil samples collected from various sites in Signy Island using direct smear and a concentration technique as well as identify the parasites and parasitic stages using morphological methods.

Prof Patricia's team examined a total of 135 soil samples obtained from five locations on Signy Island (South Orkney Islands, maritime Antarctic), namely North Point and Gourlay Peninsula (penguin rookeries), Pumphouse (relic coal-powered pump house), Jane Col (barren high altitude fellfield) and Berntsen Point (low altitude vegetated fellfield close to current research station).

They found that approximately 10% of the soil samples (14/135) from three out of the five study sites had parasites which included Diphyllobotridae spp. eggs, *Cryptosporidium* sp., an apicomplexan protozoa (gregarine), *Toxoplasma gondii*, helminths (a cestode, *Tetrabothrius* sp., and a nematode larva) and mites. Two of the three sites with parasites are penguin rookeries (North Point and Gourlay Peninsula) while the third site (Pumphouse Lake) has human activity. Some of the parasite species found in the soil samples appear to be distinctive but there were also parasites such as *Cryptosporidium* and *Toxoplasma gondii* that have a global distribution and are potentially pathogenic.

Publication

Lim PKC, Lee XC, Mohd Nazmi NMA, Tang YY, Wong SF, Mak JW, Convey P (2018). Parasites in soil samples from Signy Island, Antarctica. Tropical Biomedicine. 35(4): 1007-1016.



Toxoplasma gondii oocyst.

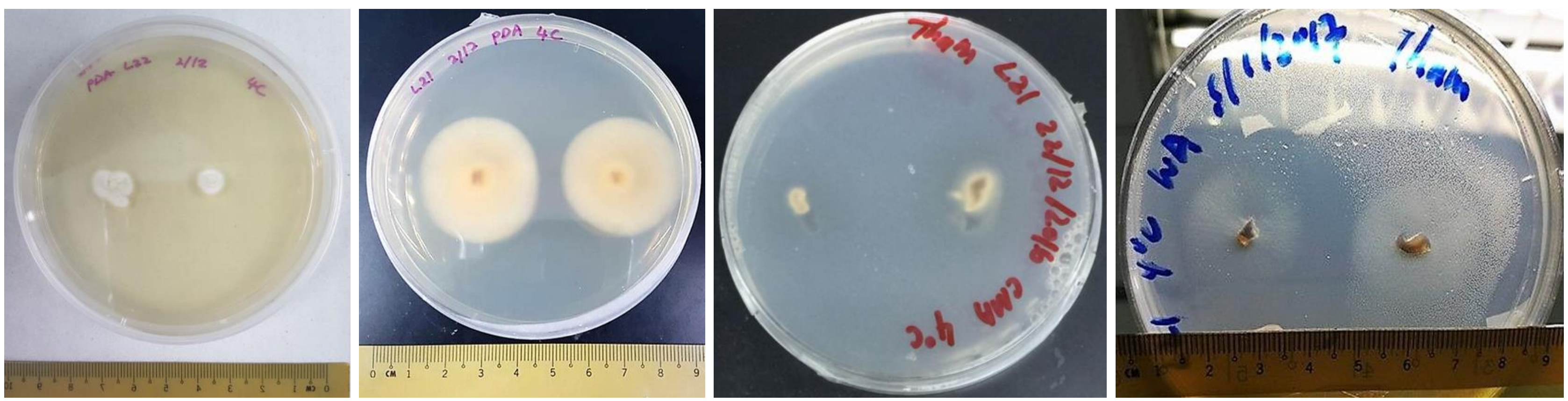
Gregarine.

Cryptosporidium oocyst.

Fungi

Dr Carolina Santiago

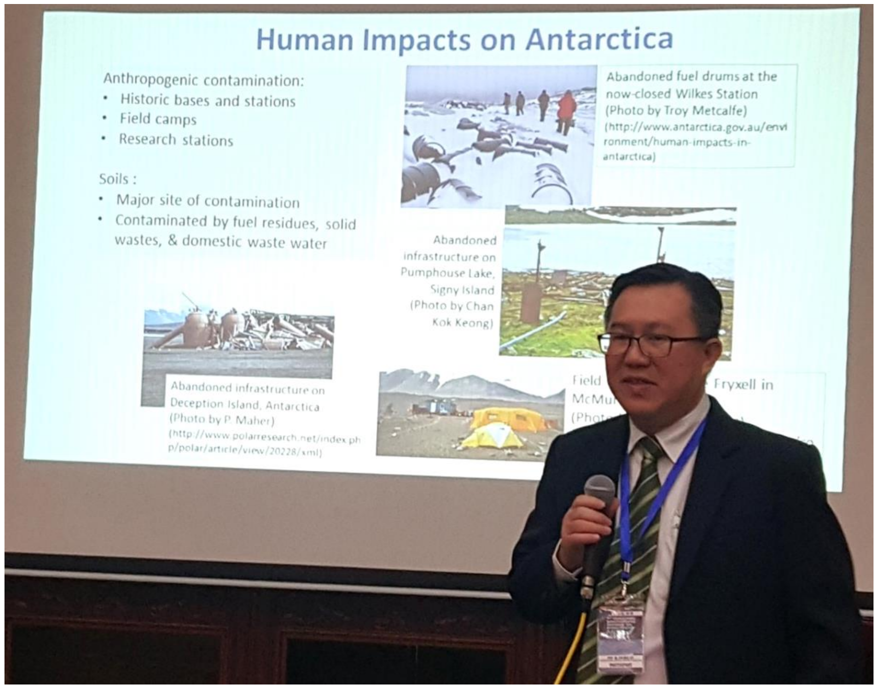
For research on fungi, Dr Carolina Santiago studied the effect of Antarctic fungal alkaloid extracts on indole production in antibiotic resistant *Escherichia coli* strains. The objective of her research was to investigate the activity of alkaloid extract on indole production in antibiotic resistant *E. coli* strains. According to her research, alkaloidal extract from a *Phoma* sp. isolate coded as L21 was found to reduce production of a bacterial signalling molecule, indole in antibiotic resistant *E. coli* strains. The compounds from this extract were deemed to have a potential application in overcoming antibiotic resistance exhibited by bacteria.



Phoma sp. isolate L21 (from left to right): Grown on potato dextrose agar (PDA) culture media; with colony growth at 4°C for 14 days; grown on corn meal agar at 4°C for 14 days; grown on water agar at 4°C for 14 days.

A Tribute to Professor Chu Wan Loy

31 July 1964 to 15 June 2020



Prof Chu presenting his research findings on the human impacts on Antarctica at the 7th Malaysian International Seminar on Antarctica (MISA7) 2017, Universiti Malaysia Terengganu (UMT).

Professor Chu Wan Loy - A humble, kind, passionate and brilliant scholar who has made significant contributions in education and research, particularly in the field of algae research.

As an educator, Prof Chu was enthusiastic and contributed significantly to undergraduate medical education in various roles – as a lipid biochemist, as respiratory system coordinator in medicine, in curriculum review for medicine and as a programme director for medical biotechnology. For medical biotechnology, his particularly significant contribution was bringing medicinal plants into the curriculum.

Prof Chu served as the Dean, School of Postgraduate Studies (SOPG), IMU from 1 October 2013 till 15 June 2020 and was the Deputy Director, Research, Institute for Research, Development and Innovation (IRDI), IMU from 18 September 2012 till 31 December 2018.

As Dean, School of Postgraduate Studies, Prof Chu made important contributions as follows:

1. Introduction of postgraduate diplomas and certificates to SOPG, previously there were only masters programmes;
2. Introduction of Online Distance Learning (ODL) postgraduate programmes;
3. Reviewing the programme to be more flexible to adult learning and improved governance of programmes;
4. Shortening the masters programme to a minimal one year programme.

Prof Chu's first trip to Antarctica

Prof Chu's illustrious research journey on algae began when he worked on tropical algae for his PhD under the supervision of Prof Phang Siew Moi at the University of Malaya in the 1990s. It was Prof Phang who encouraged him to continue research in this field and he was one of two successful Malaysian researchers who was offered a berth by the Australian Antarctic Division (AAD) to go on a reconnaissance voyage to Casey Station, Antarctica in 2000.

This was his first trip to Antarctica and due to several delays, Prof Chu managed to stay on Casey Station for only four days but the experience and the journey were memorable for him. He collected the first set of Antarctic polar algae samples on soil, snow and glaciers from several sites including a penguin rookery and this collection formed the basis of numerous studies on responses and adaptation of Antarctic algae to global warming and UVR stress. Such studies are important to understand the consequences of environmental changes such as global warming and the widening hole in the ozone layer and their impact on Antarctica.

The MV Polar Bird, an ice-strengthened ship chartered by the AAD for the voyage.


Prof Chu on board the MV Polar Bird.

Sub-Antarctic and Arctic expeditions

Prof Chu subsequently made two more trips to collect samples for the isolation of sub-Antarctic and Arctic algae:

7 April – 12 May 2005
Expedition to Marion Island, sub-Antarctica under the South African National Antarctic Program (SANAP).

24 July – 15 August 2007
International Polar Year (IPY) Research Cruise to the Bering Sea (sub-Arctic) and Chukchi Sea (Arctic).

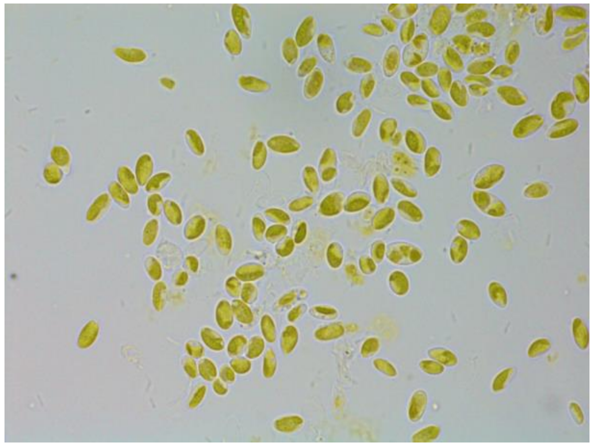
Prof Chu, with a view of penguins from the MV Polar Bird.

Prof Chu with the ship's cook on board the MV Polar Bird.

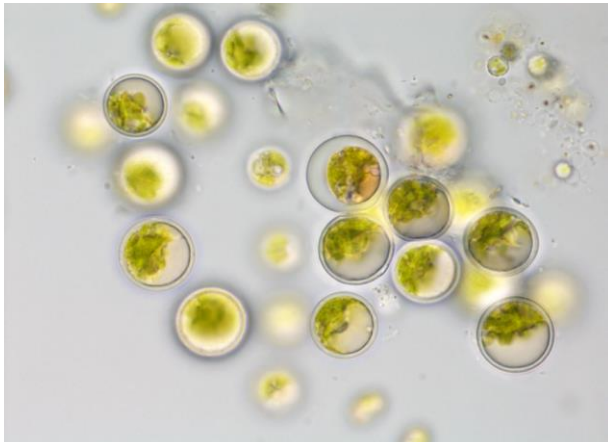
Arctic ice.

Micro-algae cultures

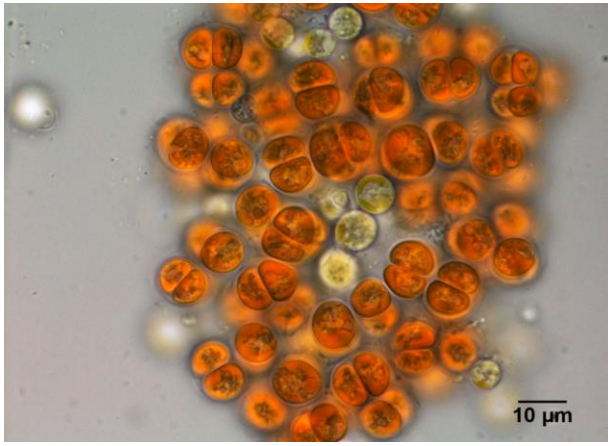
Prof Chu successfully cultured a large number of micro-algae from his Antarctic and Arctic collections at the Research Laboratory in the IMU. This is a significant contribution as his micro-algae cultures served as research materials for many research projects, which not only brought in several research grants and generated numerous publications but trained a large number of undergraduate and postgraduate students at the IMU.



Coccomyxa gloeobotrydiformis.



Chlorella sp.



Desmococcus olivaceus (old cells filled with carotenoids).

Pseudanabaena sp.

Prof Chu representing the IMU in Antarctica.

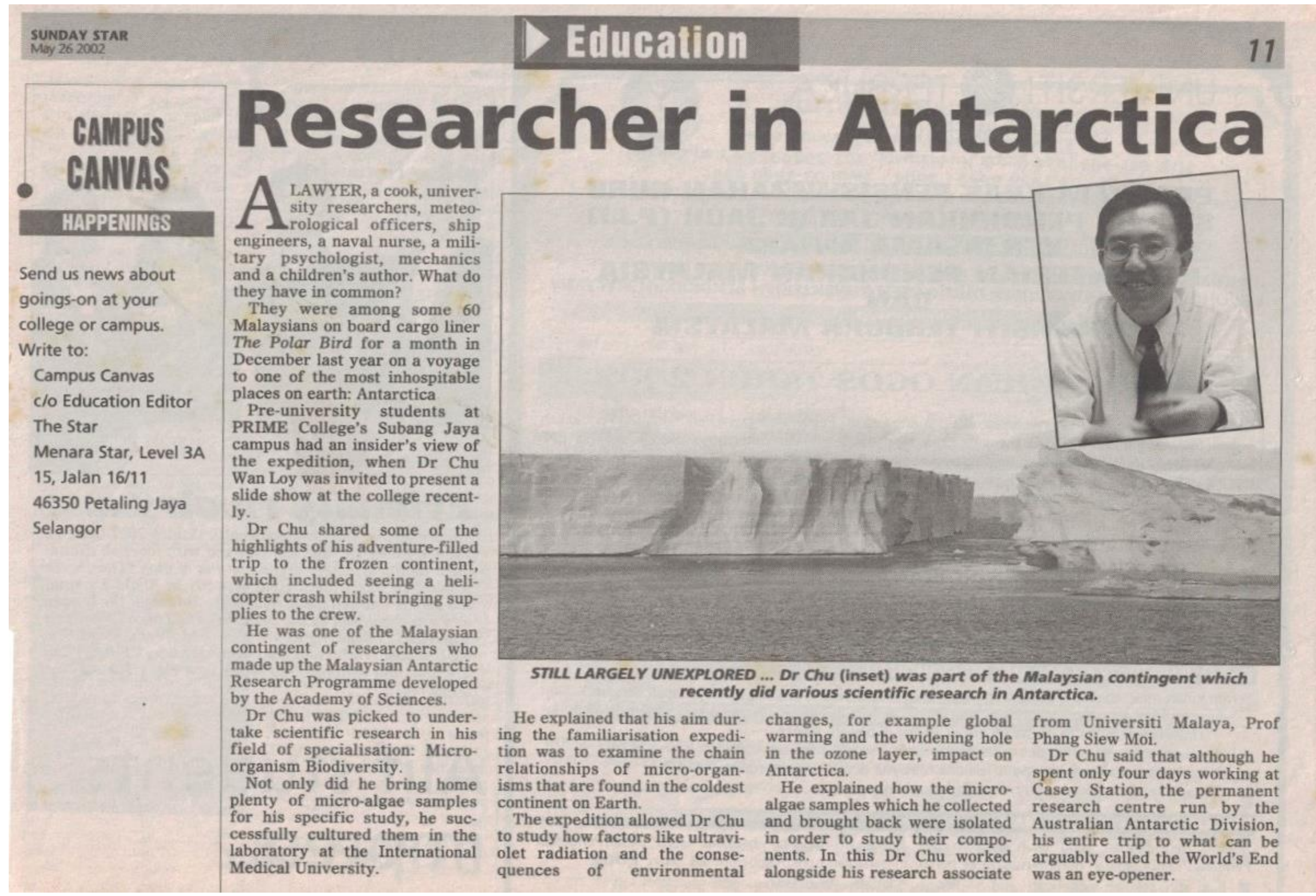
Prof Chu's Contributions to Research and Publications

Prof Chu's passion for algae research is indescribable and his contributions to the fields of micro-algae and polar research are reflected in his outstanding international reputation and many awards and honors.

He was a Research Associate with the Algae Research Laboratory & Institute of Ocean and Earth Sciences (IOES), University of Malaya and a member of the Malaysian Antarctic Research Taskforce. His collaborating research partners included University of Malaya, Institute for Medical Research (IMR), Cancer Research Initiatives (CARIF), Monash University, Australian Antarctic Division, University of the Western Cape (South Africa).

His research excellence can be evidenced by his success in securing 20 external and 27 IMU internal research grants on algae research. Prof Chu has published more than 50 scientific papers and book chapters, and presented over 70 papers at both local and overseas conferences.

Prof Chu was invited by PRIME College in 2002 to share highlights of his Antarctic trip with Pre-University students.



SUNDAY STAR
May 26 2002

Education

11

CAMPUS CANVAS

HAPPENINGS

Send us news about goings-on at your college or campus.
Write to:
Campus Canvas
c/o Education Editor
The Star
Menara Star, Level 3A
15, Jalan 16/11
46350 Petaling Jaya
Selangor

Researcher in Antarctica

A LAWYER, a cook, university researchers, meteorological officers, ship engineers, a naval nurse, a military psychologist, mechanics and a children's author. What do they have in common?

They were among some 60 Malaysians on board cargo liner *The Polar Bird* for a month in December last year on a voyage to one of the most inhospitable places on earth: Antarctica

Pre-university students at PRIME College's Subang Jaya campus had an insider's view of the expedition, when Dr Chu Wan Loy was invited to present a slide show at the college recently.

Dr Chu shared some of the highlights of his adventure-filled trip to the frozen continent, which included seeing a helicopter crash whilst bringing supplies to the crew.

He was one of the Malaysian contingent of researchers who made up the Malaysian Antarctic Research Programme developed by the Academy of Sciences.

Dr Chu was picked to undertake scientific research in his field of specialisation: Micro-organism Biodiversity.

Not only did he bring home plenty of micro-algae samples for his specific study, he successfully cultured them in the laboratory at the International Medical University.

STILL LARGELY UNEXPLORED ... Dr Chu (inset) was part of the Malaysian contingent which recently did various scientific research in Antarctica.

He explained that his aim during the familiarisation expedition was to examine the chain relationships of micro-organisms that are found in the coldest continent on Earth.

The expedition allowed Dr Chu to study how factors like ultraviolet radiation and the consequences of environmental changes, for example global warming and the widening hole in the ozone layer, impact on Antarctica.

He explained how the micro-algae samples which he collected and brought back were isolated in order to study their components. In this Dr Chu worked alongside his research associate from Universiti Malaya, Prof Phang Siew Moi.

Dr Chu said that although he spent only four days working at Casey Station, the permanent research centre run by the Australian Antarctic Division, his entire trip to what can be arguably called the World's End was an eye-opener.

Prof Chu with the Algae team at the IMU Convocation on 14 June 2015. From left to right: Dr Kok Yih Yih, Dr Dang Nguk Ling, Prof Chu Wan Loy, Ms Chin Yin Yien, Dr Tan Boon Keat.

Prof Chu (standing, 10th from right) with IMU colleagues during the IMU ASPIRE 1 workshop, 2010.

Prof Chu - Teacher, Scientist, Mentor and Friend

As a teacher, Prof Chu was a walking encyclopedia for his most passionate subject - microalgae. He always wanted to do his utmost best for all his students and worked relentlessly to get his postgraduate students to complete their theses on time. So many students are indebted to Prof Chu for his guidance, advice, tutelage and mentorship. Prof Chu has supervised/ co-supervised a total of 11 PhD, 18 Master and 35 undergraduate students in their research.

Prof Chu will be remembered as an extremely creative and brilliant scientist who was able to address the biological questions he so passionately pursued with his broad background in biological principles and quantitative analysis.

Remembering Prof Chu

To his colleagues and friends, Prof Chu was much more than an outstanding scientist. He will be remembered as a dedicated mentor who always gave credit to his team and was always there to listen and advise. One of Prof Chu's favourite quotes was "'The glory is for a day, but the science is forever", this is how he would like the science and its impact to be remembered.

He will be remembered as a wonderful colleague who gave freely of his time, advice and expertise. He is remembered for his love for Korean drama, good food and coffee where he shared many wonderful and happy moments with others.

Prof Chu (right) with Emeritus Professor Mak Joon Wah (middle) and Prof Leong Chee Onn, 2010.

Prof Chu with Prof Peter Pook, Deputy-Vice Chancellor (Academic), Deans and Department Heads, 2018.

And he will be remembered for serving the IMU with great distinction in many capacities, including his long tenure as the Dean of School of Postgraduate Studies.

Prof Chu's achievements and success in life are largely attributed to two important family members, his beloved mother and his wife who have served as his pillars and provided him with much love and support.

Another important pillar in his academic and research career is Emeritus Professor Mak Joon Wah, former Pro-Vice Chancellor (Research) and Director, IRDI, who nurtured and guided him throughout his career at the IMU, particularly in his roles as Dean, School of Postgraduate Studies and Deputy Director, Research in IRDI.

Picture Credits

Dr Carolina Santiago
pg 30

Dr Chan Kok Keong
pg 13

Dr Chong Chun Wie
pg 5

Dr Dang Nguk Ling
pgs 9, 13, 38

Derren Fox, BAS
pg 2

Dr Fabian Davamani
pgs 24-27

International Medical University
pgs 9, 13, 31, 38-39

Dr Kenny Voon
pg 28

Dr Kok Yih Yih
pg 35

Mdm Lau Yoke Kuan
pgs 12, 17, 33-34, 36-37

Martin McCallum, BAS
pg 23

Dr Nur Alia Johari
Cover photo; pgs 1, 3-7, 10-11, 13, 21-23, 40

Prof Patricia Lim Kim Chooi
pg 29

Dr Wong Chiew Yen
pgs 8, 9, 14-19, 32

YPASM
pg 7

Photo: Equipment and fuel secured to a boulder at Khyber Pass, Signy Island, Antarctica.