Proceedings of the Fraser's Hill Symposium 2020

DECEMBER 2020

WWF-Malaysia is collaborating with UKM for the protection of the Fraser's Hill Forest Complex

PROCEEDINGS OF THE FRASER'S HILL SYMPOSIUM 2020

FRASER'S HILL FOREST COMPLEX:

TOWARDS ACHIEVING STATE PARK STATUS

16 - 17 December 2020

Editorial and Production Team

Carell Cheong (WWF-Malaysia);
Siti Zuraidah Abidin (WWF-Malaysia);
Cheng Yean Ni Munisha (WWF-Malaysia);
Raja Muhammad Zuha Raja Kamal Bashah (UKM);
Norela Sulaiman (UKM)

Authors and contributors

Abdul Latiff Mohamad
Abdul Rahim Abdul Samad
Ahmad Fitri Zohari
Aliaa Athirah Adam Malek
Amir Sadiq Abd Rahman @ Ragam
Amran Hamzah
Azira Muhamad
Badrul Munir Md Zain
Carell Cheong
Chan Teck Ling (Eddie)
Choong Chee Yen
Connor William Butler
Daniel Chin Zhi Hao
Elangkumaran Sagtia Siwan
Farah Shafawati Mohd Taib
G. Balamurugam
Haja Maideen Kader Maideen
Haris Hafizal Abd Hamid
Hong Chern Wern
Intan Sofiatul Ilyana Mohamad
Izfa Riza Hazmi
Johari Jalinas
Lailatul Nadhirah Asri
Malcolm Soh Chu Keong
Mohd Hariri Arifin
Mohd Razif Mamat
Muhammad Naqiuddin Johari
Muhammad Zuber Azhar
Nada Badruddin
Nik Norhazrina Nik Mohd Kamil
Norela Sulaiman
Norhayati Ahmad
Norizan Mohd Mazlan
Nur 'Aqilah Mustafa Bakray
Nur Khairunnisa Salleh
Nur Syamina Jamaluddin
Raja Nor Azlina Raja Ahmad
Ruth Kiew
Salmah Yaakop
Sarah Nadira Hurairah
Siti Norhafizah Ahmad Tarmidzi
Siti Nurhidayu Abu Bakar
Surin Suksuwan
Wee Suk Ling
Zulfahmi Ali Rahman

Citation

WWF-Malaysia & UKM. (2021). Proceedings of the Fraser's Hill Symposium 2020. WWF-Malaysia, Petaling Jaya, Selangor, Malaysia.

ISBN 978-967-0237-59-6

Publishing office

WWF-Malaysia, 1, Jln PJS 5/28 A, Pusat Dagangan Petaling Jaya Selatan, 46150 Petaling Jaya, Selangor, Malaysia.

Tel. +6 03-7450 3773

Design by WWF-Malaysia

Printed by Percetakan Imprint (M) Sdn Bhd

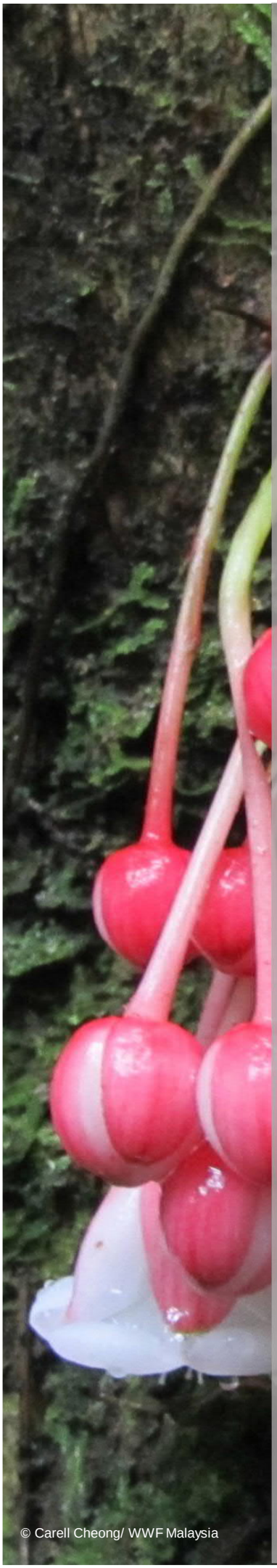
Visit our website at wwf.org.my

Cover photograph: © Shariff Mohamad/WWF-Malaysia. The smooth cascading falls of Sungai Merah, Gunung Semangkok amongst huge natural boulders, accentuates the importance and vulnerability of water provisioning service of the Fraser's Hill Forest Complex.

For more information

Carell Cheong
Protected Areas Manager
ccheong@wwf.org.my

Dr. Raja Muhammad Zuha Raja Kamal Bashah
Senior Lecturer, UKM
rmzuha@ukm.edu.my



CONTENTS

SECTION I

SECTION II

APPENDICES

FOREWORD

By Associate Professor Dr. Norela Sulaiman, Chairperson of Fraser's Hill Symposium 2020

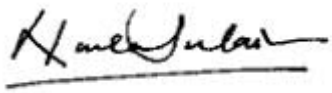
First and foremost, as Chairperson of the inaugural Fraser's Hill Symposium, I would like to sincerely thank the organizing committee, which managed to successfully put together and run a smooth virtual symposium on December 16th and 17th, 2020 despite the COVID-19 pandemic. I hope that the partnership between Universiti Kebangsaan Malaysia and WWF-Malaysia continues beyond this event.

What brought us together to organise the Fraser's Hill Symposium was our shared interest in the Fraser's Hill Forest Complex, a vital water catchment forest along the Titiwangsa Mountain Range which supplies water to Pahang and is the source of Pahang River, the largest river system in Pahang. It is also rich in biodiversity and provides a range of crucial ecosystem services that various sectors are reliant on, be it agriculture, industry or domestic use.

However, the biological diversity and ecosystem services of Fraser's Hill Forest Complex are at risk due to an increasing number of threats, namely the illegal collection of plants and invertebrates such as orchids and spiders, pollution, climate change and unsustainable tourism activities. We are at a critical juncture now, as the highland ecosystem of the forest complex is fragile and sensitive to changes. So far, it has often been taken for granted that Fraser's Hill and its surrounding forests will remain intact and continue to harbour its natural wonders, but if firm and swift action is not taken to conserve it, it may undergo irreparable damage.

The Fraser's Hill Symposium was organised not only in the hopes of providing researchers the opportunity to present their studies, many of which have been conducted within the Fraser's Hill Forest Complex, but to urge for the establishment of a state park encompassing the entirety of the forest complex and the implementation of good management practices. Thus, the theme of this symposium, "Fraser's Hill Forest Complex: Towards Achieving State Park Status".

We are now in the right place and at the right time to protect Fraser's Hill Forest Complex. I am confident that through the exchange of ideas and insights during the Fraser's Hill Symposium, all participants will be able to gain and share knowledge that will go a long way towards the conservation of Fraser's Hill Forest Complex. Thank you for your support and may we be able to meet at another Fraser's Hill Symposium in the near future.



Associate Professor Dr. Norela Sulaiman
Chairperson of Fraser's Hill Symposium 2020

FOREWORD

By Ms. Sophia Lim, Executive Director/CEO WWF-Malaysia

On behalf of WWF-Malaysia, I would like to express our sincere appreciation to our co-organisers, Universiti Kebangsaan Malaysia, for the time and effort they have made in working with us to make this event happen. It was a lengthy journey, turning an in-person symposium into a virtual one, but I hope everyone involved was able to enjoy the fruits of their labour. I would also like to extend our heartfelt thanks to Tourism Pahang and Entomological Society of Malaysia for their support of the event.

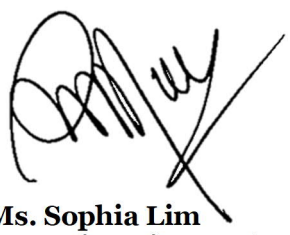
As most of you probably know, the Fraser's Hill Forest Complex spreads nearly 83,000 hectares across the Titiwangsa Mountain Range, comprising six forest reserves, state land forest and the Fraser's Hill Town Board. As a key biodiversity area, it is home to rare and endangered species such as the melanistic leopard, dhole, Sunda pangolin and clouded leopard, in addition to being recognised as an Important Bird Area. In parts of it, due to higher elevations, you can find montane forests that contain natural treasures different than what you would typically find in the country's lowland tropical forests, such as unique flora species that thrive in the cooler climate.

Besides its value as a biodiversity hotspot, Fraser's Hill Forest Complex is also an important water catchment area, where the headwaters of several rivers form. These rivers then flow into Pahang River, benefiting various users, from the indigenous communities that inhabit the forest all the way to the downstream users populating the towns.

For these reasons and many more, WWF-Malaysia has envisioned a bright future for Fraser's Hill Forest Complex: one where it is protected and sustainably managed as a state park, whereby visitors can experience its beauty and majesty for generations to come. This is why the symposium's theme was "Fraser's Hill Forest Complex: Towards Achieving State Park Status" – we wished to connect with experts who have conducted studies within Fraser's Hill Forest Complex and provide a platform for them to showcase their work. Indeed, we had an impressive line-up of speakers who are well-known in their respective fields, such as fauna, flora, economy, geology, ecotourism, and sustainability to share their work throughout the two days, and the participants asked many thought-provoking questions.

This journey towards achieving state park status is a multi-stakeholder process, requiring many different types of information relevant to the different stakeholders. Therefore, the journey would need to be inclusive and collaborative in order to achieve its objectives. I, as well as the FHS organising committee, believe that this symposium has been a positive step in bringing the right people and organisations together and building momentum towards the establishment of a state park in Fraser's Hill Forest Complex.

So, to all speakers and participants, thank you for taking part in the first Fraser's Hill Symposium. It is our hope that what was shared during the symposium will plant the seeds towards the foundation of a state park and inspire more research to be conducted in the Fraser's Hill Forest Complex, as there is so much more to learn. Together possible.



Ms. Sophia Lim
Executive Director/CEO WWF-Malaysia

ACKNOWLEDGEMENT

WWF-Malaysia, in collaboration with Universiti Kebangsaan Malaysia, wish to acknowledge the support of the following who had made possible the successful execution of the Fraser's Hill Symposium 2020.

Donors
The Entomological Society of Malaysia (ENTOMA)
WWF-Malaysia individual donors

Keynote speaker
Professor Emeritus Dato' Dr. Abdul Latiff Mohamad (UKM)

Plenary speakers
Dr Ruth Kiew (FRIM)
Professor Badrul Munir Md Zain (UKM)
Dr Siti Nurhidayu Abu Bakar (UPM)
Mr Daniel Chin Zhi Hao (ERE)

Panellist & Moderator
Mr Surin Suksuwan (ProForest)
Professor Dr Amran Hamzah (UTM)
Dr G. Balamurugan (ERE)
Ms Norizan Mohd Mazlan (WWF-Malaysia)

Chairpersons of the parellel sessions
Ms Norizan Mohd Mazlan (WWF-Malaysia)
Dr Nurul Wahida Othman (UKM)
Dr Raja Muhammad Zuha Raja Kamal Bashah (UKM)
Dr Nur 'Aqilah Mustafa Bakray (UKM)

Rapporteurs
Ms Zurinah Yaakop (WWF-Malaysia)
Ms Syahaneem Othman (WWF-Malaysia)
Nur Fazrina Mohd. Ani (WWF-Malaysia)
Dr Izfa Riza Hazmi (UKM)
Dr Shamsul Khamis (UKM)

Zoom Webinar Hosts & Co-Hosts
Ms Zurinah Yaakop (WWF-Malaysia)
Dr Hong Chern Wern (WWF-Malaysia)
Ms Nur Fazrina Mohd. Ani (WWF-Malaysia)
Ms Syahaneem Othman (WWF-Malaysia)
Ms Cheng Yean Ni Munisha (WWF-Malaysia)

Participants
ERE Consulting Group Sdn Bhd
Forest Research Institute Malaysia
Iktisas Planners Sdn Bhd
Malaysia Genome Istitute
Perbadanan Kemajuan Bukit Fraser
Persatuan Alam dan Warisan Bukit Fraser
PLANMalaysia@Pahang
ProForest
The Habitat Foundation
TREKS Events Sdn Bhd
University of Southamptom
University of Western Australia
Universiti Kebangsaan Malaysia
Universiti Putra Malaysia
Universiti Teknologi Malaysia
Universiti Teknologi MARA
WWF Malaysia

ORANISERS

SUPPORTED BY

EXECUTIVE SUMMARY

The first Fraser's Hill Symposium, organised by WWF-Malaysia and Universiti Kebangsaan Malaysia (UKM), was held on 16th and 17th December 2020 with an attendance of over 70 participants from the academia, government agencies, environmental NGOs and consultants. Conducted amidst the ongoing COVID19 pandemic, the symposium was executed virtually with all participants, speakers and presenters engaged in the 2-day event from the safety of their home or office.

Both WWF-Malaysia and UKM have greatly benefited through this collaboration as it has enabled both parties to share knowledge and expertise and has forged greater rapport and understanding for future collaborations.

In her opening speech, the Head of UKM's Fraser's Hill Research Center, Associate Professor Dr. Norela Sulaiman set the scene of the symposium's theme to accelerate the exchange of ideas and scaling up good practices and the emergence of fresh energy and noble partnership to sustain our efforts towards achieving state park status for Fraser's Hill.

Professor Emeritus Dato' Dr. Abdul Latiff Mohamad in his keynote address, stressed that in our pursuit, we have to ensure integrity, authenticity and sustainability and protection of its value, whether at the national, state or local level to ensure a better future for the local communities, biodiversity and ecosystems.

Four themes were highlighted at the plenary sessions. On sustainability aspects, Daniel Chin of ERE Consulting Group emphasised on shared responsibilities between all stakeholders and stressed on the importance of preserving ecological, economic and social values to enable a conducive partnership between the government, public and private sectors. Dr Siti Nurhidayu Abu Bakar of Universiti Putra Malaysia reiterated in the Ecosystem Services plenary that unsustainable land-use changes can cause 'Too Little, Too Much' syndrome, in which water produced by the forest can be disrupted by the alteration of forest structure and hydrological functions. This can already be seen in Malaysia, where water becomes very scarce annually during hotter, drier season and big flooding events occur almost every year during the rainy season. With better forest management and understanding of the crucial function of forests as water catchment areas, these disasters can be mitigated. In the Flora plenary, Dr Ruth Kiew of FRIM, explained that Fraser's Hill meets the three IUCN criteria that qualify it as an Important Plant Area, namely (1) in its extremely high species richness, (2) presence of threatened species, and (3) endangered habitats such as the rivers, streams and the cloud forest on the mountain peaks. The current count of more than 1,300 species of vascular plants (Kiew & Aliaa Athirah, in prep.) represents about 14% of the total flora in Peninsular Malaysia and 43% of the montane flora that grows above 1000 m elevation. A holistic approach needs to be taken to protect the surrounding forest that forms the Fraser's Hill Forest Complex in view of rising temperatures that have resulted from the increasing destruction of forest cover and to mitigate the effects of global warming. In the Fauna plenary, Professor Dr. Badrul Munir Md Zain of Universiti Kebangsaan Malaysia, shared about the advantage of certain methods of studying primates such as metagenomics and metabarcoding as well as whole-genome sequencing. This information is expected to help in defining primate species according to management units based on genetics and thereby providing better justification for the protection of certain primates and their habitat.

It was evident from the 36 research papers presented at this symposium, that the Fraser's Hill Forest Complex should be protected and conserved – for its many values of biodiversity, cultural, tourism (both ecotourism and heritage), the provisioning and regulation of important ecosystem services. However, there are also evident threats to the forest complex, the COVID-19 pandemic being one of the prevalent threats, threatening to diminish the economic resilience and tourism potential. And being one of the key destinations in Pahang, Fraser's Hill cannot be decoupled from tourism.

To truly protect and conserve the landscape, it does not stop at just establishing the state park. Equally, if not more important are the measures taken to manage it effectively and having good governance to fulfil its objectives. In order to do this, the availability of different types of information would be needed. For example,

while biodiversity related information would be key for the park authority, revenue streams for the state and its benefits to the local economy and communities might be of higher priority for the state government. Therefore, in the efforts towards establishing a state park, specific studies need to be conducted to generate the relevant information required by various parties. Subsequently, it is also important to articulate the justifications for protecting the Fraser's Hill Forest Complex – not just locally, but also at the state and national levels.

This journey towards achieving a state park status for the Fraser's Hill Forest Complex is just the beginning. There is a substantial knowledge gap on the biological diversity; economic valuation; cultural significance; and social impact on the local and indigenous communities – this we have learned. The Fraser's Hill Symposium 2020 has provided the focus and stimulation for all to work diligently and collaboratively to ensure that we achieve its theme, that is "Fraser's Hill: Towards Achieving State Park Status".

NEVER DOUBT THAT A SMALL GROUP OF THOUGHTFUL, COMITTED CITIZENS CAN CHANGE THE WORLD;

INDEED, IT IS THE ONLY THING THAT EVER HAS.

- MARGARET MEAD

BACKGROUND

How it all began

It has often been mentioned that Fraser's Hill is very biodiverse and rich in providing ecosystem services for the benefit of mankind; and therefore rendering it vital to be protected and conserved – but, how exactly so? What biodiversity do we have there? What are the ecosystem services that are generated from the landscape? And what are their economic and social values? The quest to answer these questions and subsequently, how do we utilise these ecosystem services responsibly and sustainably for the long-term benefit of our future generations became the catalyst for the inaugural Fraser's Hill Symposium (FHS) which was held from the 16th to 17th December 2020.

Background of the Fraser's Hill Forest Complex and Vision

The landscape known as Fraser's Hill Forest Complex (FHFC) is identified by WWF-Malaysia following the contiguity of (mostly) forest blocks that make up the bounaries of six permanent reserved forests, state land and the Fraser's Hill Town Board as well as considering the altitudinal range of areas with more than 300 m above sea level (asl). Located in the district of Raub in the state of Pahang, it encompasses a total area of 82,895 hectares (ha). The six permanent reserved forests within the forest complex are Batu Talam, Sungai Sia, Rotan Tunggal, Rotan Tunggal (Tambahan), Sempam and Teranum. The forest complex is large and contiguous, bordering the Titiwangsa Range on the west and the Selangor State Park in the south-west. It functions as an important water catchment forest and it is the origin of the head waters for five of the major tributaries (Sg Lipis, Sg Liang, Sg Sempam, Sg Teras and Sg Teranum) to Sungai Pahang.

Within the forest reserve, 89% or 73,700 ha has been gazetted as water catchment forest or soil protection forest or both under the National Forestry Act, 1984. Furthermore, based on the Pahang State Structural Plan 2050, this forest complex is identified as an Environmentally Sensitive Area (ESA) Rank 1 where development, agriculture or logging is not allowed except for ecotourism, research and education. However, even with such designation the forest complex still faces conservation issues such as unsustainable land use changes.

The Fraser's Hill Forest Complex is relatively unknown and under-explored, apart from areas within the Fraser's Hill Town Board. A rapid search among scientific journals of the following keywords: Fraser's Hill, Batu Talam, Ulu Teranum and Sungai Sia, found close to 80 articles published between the years 1970 to 2019. This works out to an average of less than two articles a year. The articles range from tourism, zoology and the environment, and the bulk of the research were conducted within the FHTB. Factors such as the availability of forest trails that provide easy access to the forest as well as the existence of the Fraser's Hill Research Center may be attributed to this. Established in 1990 by Universiti Kebangsaan Malaysia (UKM), the research center is located near the Jeriau waterfall, encompassing an area of 45 ha. Among the research field available for the university's undergraduate and postgraduate students include bio-engineering, hydrology, botany, ecology, soil, flora and fauna. This has enabled concentrated and continuous work to be conducted within the Fraser's Hill Town Board.

However, the wider forests, located to the north (Batu Talam and Sungai Sia Forest Reserves) and the south (Tranum Forest Reserve) of the Fraser's Hill Town Board have been sorely neglected from research activities. The horizon for new scientific discoveries thus lies in the relative unstudied Fraser's Hill Forest Complex. Thus, it is hoped that the symposium will stimulate the Fraser's Hill Forest Complex as a hub for scientific research by conferring a cohort of scientists to present their research on the forest complex as well as inspire future research to be conducted among scientists, the academia and related government agencies. Three objectives were set to be achieved, they are:

a) To create an avenue or platform for scientists to present or showcase their research based on past studies on the Fraser's Hill Forest Complex,
b) To garner interest and enthusiasm among researchers to conduct more research in the Fraser's Hill Forest Complex,

c) To network and share management recommendations from the studies conducted among the scientists, academia and government agencies.

Collaboration with Universiti Kebangsaan Malaysia (UKM)

The establishment of the UKM Fraser' Hill Research Center since 1990, became the obvious choice of an academic partner for this symposium. Given their studies, experience and expertise in this field, UKM, notably their Fraser Hill Research Center, had played an important role towards the success of the FHS. What was impressive from day one of the first meeting in October 2019 was that WWF-Malaysia had met with nothing but enthusiasm and commitment from a whole team of 20 lecturers and research officers. The outcomes of the first meeting include the formation of a committee for the symposium, tentative budget and fees discussion as well as the theme of the symposium and its research categories. The venue and date of the symposium was also decided by the committee to be on 2nd to 4th April 2020 at Shahzan Inn, Fraser's Hill.

With monthly meetings held to make decisions and updates on the progress, the committee members, comprising of members from WWF-Malaysia and UKM worked jointly in their respective portfolios to put everything in place. Publicity and communications were integral in the call for abstracts; budget and costings were worked out for logistics and meals; the secretariat was in constant contact with researchers, plenary speakers, panellists and keynote speaker; and the scientific committee members worked diligently to review all the 36 extended abstracts received from the participants.

The COVID-19 Pandemic

The COVID-19 pandemic threw a spanner in the works of the Fraser's Hill Symposium. The onset of the Movement Control Order in March 2020 and the uncertainty of the pandemic situation in the country left the organisers with no other alternative but to postpone the FHS to a later date. Converting to a virtual symposium was not an option then, as there were many issues, such as availability of strong internet connection and technical uncertainties of the participants and presenters. When Malaysia entered the recovery stage in July 2020, the FHS organizing committee met and finally decided for the symposium to be held physically from the 16th to 17th of December 2020 (Wednesday to Thursday), with strict adherence to the Malaysian Government's Standard Operating Procedures (SOP) for organising conferences.

However, the coming months did not shed any diminishing signs in the virus infection risks and the country was still battling the emergence of new infection clusters in different parts of the country. In early November 2020, with the symposium date just one and a half months away, the organising committee decided that the symposium will be conducted virtually.

The Inaugural Fraser's Hill Virtual Symposium

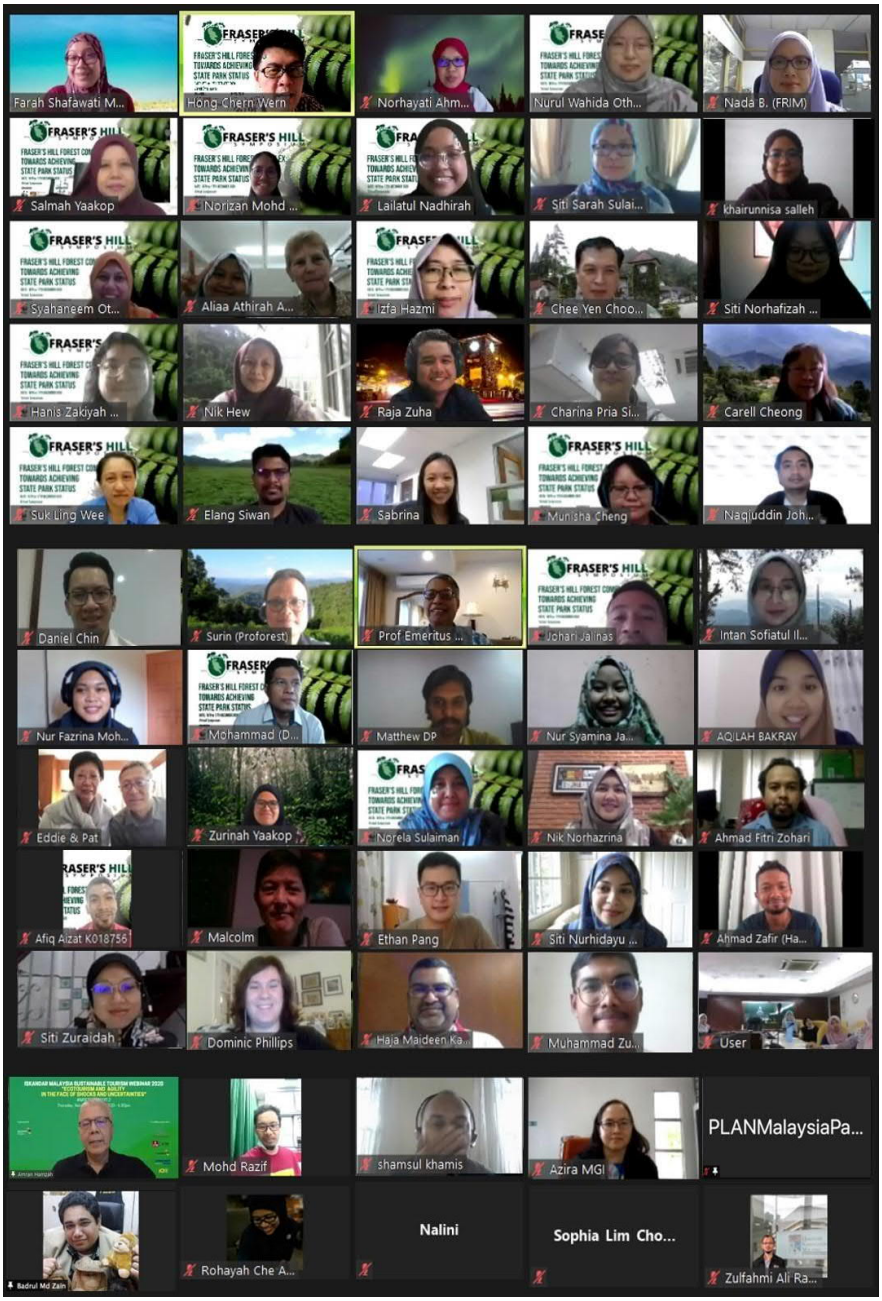
In order to maintain a zero-risk event and to overcome technical and connectivity hitches, all speeches, presentations, plenary speeches and a panellist session were pre-recorded via a web conferencing software program - Zoom, to be relayed during the two days of the symposium. Each presenter was still required to be present online as question and answer sessions were organised after the presentation sessions. As such, it took the organiser four weeks to contact all presenters, pre-record their presentations and assemble all recordings. This could only be achieved through the dedication and commitment of each and every member of the committee and the kind cooperation of the keynote speaker, plenary speakers, panellists and all presenters.

The committee conducted two dry-run sessions before the symposium day to mitigate any possible technical hitches or failure. This was crucial as the symposium was run on parallel sessions and participants had the option to log in for any of the sessions at any time. Active interaction between the participants and presenters during the question and answer session was encouraged online so as not to dilute the essence of networking during the symposium.

The Fraser's Hill Virtual Symposium finally commenced on 16th December and ended smoothly on 17 December 2020 after fourteen months of planning and postponements. Attended by more than 70 participants from the academia such as Universiti Kebangsaan Malaysia, Universiti Putra Malaysia, Universiti Teknologi Malaysia, Universiti Teknologi Mara, University of Southampton, University of Western Australia and the Malaysian Genome Institute; from government agencies such as Forest Research Institute Malaysia (FRIM), Perbadanan Kemajuan Bukit Fraser and PLANMalaysia@Pahang; from non-government organisations such as WWF-Malaysia, ProForest, Habitat Foundation, Persatuan Alam & Warisan Bukit Fraser and Treks Events; and from consultancy firms such as ERE Consulting group and Iktisas Planners.

Conclusion

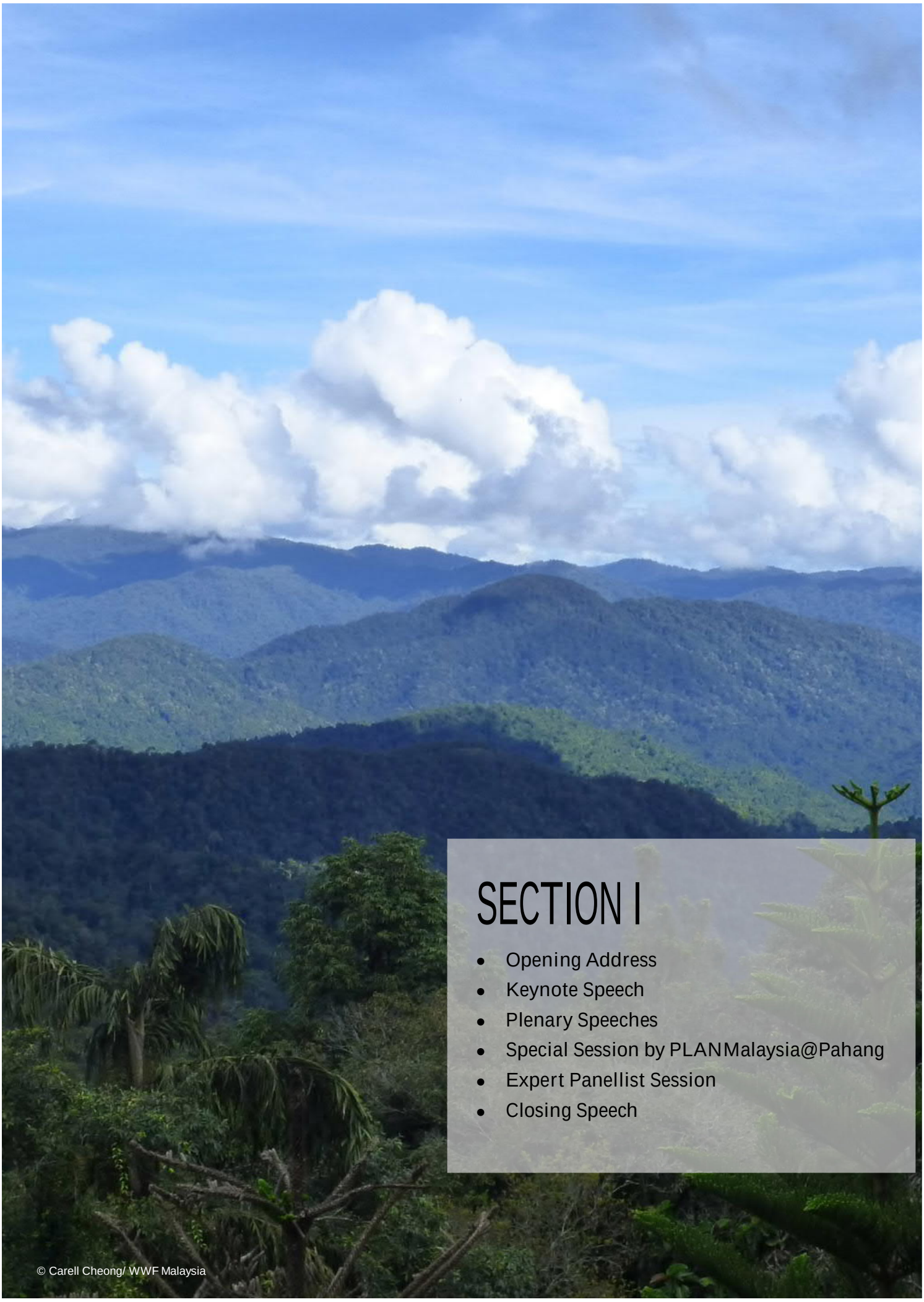
The symposium has provided the platform for researchers and vested parties to share their work and insights. This has created an impetus for all of us to come together and collaborate further. Let us be assured that there will be many more Fraser's Hill symposiums to come and possibly, even a scientific expedition into the wider Fraser's Hill Forest Complex. By then, we can all meet up and work together again.



Group photo of participants of the virtual 2020 Fraser's Hill Symposium
© WWF Malaysia

ABBREVIATIONS

AMAP	Adaptive Management Advisory Panel
CIPD	Centre for Innovative Planning and Development
DNA	Deoxyribonucleic acid
DOE	Department of Environment
ECER	East Coast Economic Region
EIA	Environmental Impact Assessment
ENTOMA	The Entomological Society of Malaysia
ERE	ERE Consulting Group Sdn Bhd
ESA	Environmentally Sensitive Area
FHFC	Fraser's Hill Forest Complex
FHS	Fraser's Hill Symposium
FHSP	Fraser's Hill State Park
FHTB	Fraser's Hill Town Board
FR	Forest Reserve
FRIM	Forest Research Institute Malaysia
FSC	Forest Stewardship Council
GEF	Global Environment Facility
GoM	Government of Malaysia
HCV	High Conservation Value
ICCFS	Improved Connectivity in the Central Forest Spine
IUCN	International Union for Conservation of Nature
JPN	Jawatankuasa Perancang Negeri
KEP	Forest Research Institute of Malaysia Herbarium
KSAS	Kawasan Sensitif Alam Sekitar
LAC	Limits of Acceptable Change
MPFN	Majlis Perancang Fizikal Negara
NGO	Non-Governmental Organisation
NPBD	National Policy on Biological Diversity
PBN	Pihak Berkuasa Negeri
PBPT	Pihak Berkuasa Perancang Tempatan
PBT	Pihak Berkuasa Tempatan
PERHILITAN	Department of Wildlife and National Parks Peninsular Malaysia
PRF	Permanent Reserved Forest
RKK	Rancangan Kawasan Khas
RSNP	Rancangan Struktur Negeri Pahang
RSPO	Roundtable on Sustainable Palm Oil
RTD	Rancangan Tempatan Daerah
TWG	Technical Working Group
UKM	Universiti Kebangsaan Malaysia
UNDP	United Nations Development Programme
UPM	Universiti Putra Malaysia
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
WCPA	IUCN World Commission for Protected Areas
WWF-Malaysia	World Wide Fund for Nature - Malaysia



SECTION I

- Opening Address
- Keynote Speech
- Plenary Speeches
- Special Session by PLANMalaysia@Pahang
- Expert Panellist Session
- Closing Speech

OPENING ADDRESS

By Associate Professor Dr. Norela Sulaiman, Chaiperson of Fraser's Hill Symposium 2020

Assalamualaikum and good day. Welcome to the Fraser's Hill Symposium 2020. It is my pleasure to welcome all participants to the Fraser's Hill Symposium 2020 webinar.

As we all know, we are in the midst of a crisis like no other. The pandemic has sent shock waves to the nation and across the globe. We, in Asia are not excluded from the danger of COVID-19. In this virtual conference room, let me first and foremost express my sincere thanks to all the organising committee members for making this webinar conference a success, co-organised by WWF-Malaysia and Universiti Kebangsaan Malaysia.

The Fraser's Hill Symposium is aimed to provide researchers the opportunity and platform to showcase their studies specifically those conducted at the Fraser's Hill Forest Complex. Encompassing nearly 83,000 ha, the Fraser's Hill Forest Complex is comprised of six forest reserves, the Fraser's Hill Town Board, and state land forest. Not only is it important for its water catchment forest, which supply water to Pahang (being the source of two large river systems, which is Sungai Pahang and Sungai Selangor) it is also rich in biodiversity and the provider of many ecosystem services.

We are at a critical juncture, as the highland ecosystem is fragile and sensitive to changes. It has often been taken for granted that Fraser's Hill and its surrounding forest will remain intact and continue to harbour its rich biodiversity. However, these biological diversity is being threatened by illegal collections of plants and invertebrates, such as orchids, and spiders; pollution; climate change; and unsustainable tourism activities.

The objectives of this conference are to offer an avenue for researchers to present their studies on the Fraser's Hill Forest Complex; to garner interest and enthusiasm among researchers to conduct more research in Fraser's Hill Forest Complex; and last but not least, to network and share management recommendations from the studies conducted among researchers, academia, and government agencies.

Ladies and gentlemen, in conclusion I hope that our discussion can be visionary and very pragmatic at the same time. I believe by participating in this webinar, we are in the right place and the right time. Together, let us accelerate the exchange of ideas of good practices. I am confident that you will find new ideas, fresh energy, and noble partnership in support ofachieving state park status. I wish you all a very successful webinar. Thank you.

KEYNOTE SPEECH

Bukit Fraser, Pahang: Journey towards a National Heritage Site and State Park

By Prof. Emeritus Dato' Dr. Abdul Latiff Mohamad[1]

To all the participants of the Bukit Fraser Seminar, I am very honoured and it's a privilege for me to have been invited by the organisers, namely WWF-Malaysia, UKM, and in particular, the community of Bukit Fraser, to discuss a proposal to make Bukit Fraser either a National Heritage Site or possibly a State Park. I will discuss with you what I consider a journey that can be taken by all of us to realise our vision to make Bukit Fraser something to be proud of.

I will discuss by looking briefly at the concept of World Heritage Sites as envisaged by UNESCO and go into the National Heritage Site, which is propagated by Jabatan Warisan Negara which comprises historical, cultural, geological and natural sites. Then, I will go directly into the candidature of Bukit Fraser as a National Heritage Site, looking at the potential, the values, possible threats and the challenges on the management of the site.

As an introduction, Peninsular Malaysia has a few historical hill resorts, and of course you and I know Bukit Fraser in Pahang is one of them. This hill resort has been developed by the colonial masters during the colonial days for their own recreation and they chose the hill for the reason you and I know, the temperature on the hills are cooler than down here, which is why Bukit Fraser had the privilege of being chosen as one of the hill resorts by the British. And as we all know, Bukit Fraser to me is just an outcrop of granitic formation with a very cool ambience but for my concern, it is the flora and the fauna on Bukit Fraser that has scientific and conservation values.

As you know, we have four UNESO World Heritage Sites in Malaysia; Mount Kinabalu in Sabah, and Gunung Mulu in Sarawak. In Peninsular Malaysia, there are only two sites, one is World Heritage Site, Penang, and another in Melaka, representing the cultural historical ports of the colonial days and the latest on the scene is Lenggong World Heritage Site, which is a cultural archaeological site proposed by Malaysia to highlight the discovery of the Perak Man.

There are a few sites in Malaysia which aspire to be the UNESCO World Heritage Sites for example the Royal Belum State Park, is proposing the area of 117,500 ha in Ulu Perak as a natural site. And FRIM, Forest Research Institute Malaysia is proposing as a cultural site. In its proposal, the whole campus of FRIM is an artificial forest, been man-made after the land was devastated from tin mining and now, after about 98 years it is like a forested site. So FRIM is going under cultural because the forest is not natural. And in Sabah, I understand that the conservation areas of Danum Valley, Maliau Basin and Imbak Canyon have proposed to UNESCO World Heritage Site as a natural site candidate. Gunung Niah National Park is thinking of going under a mixed site, which is cultural and natural. The reason why it is a mixed site is because Gunung Niah has some archaeological artifacts that they want to take forward as a gift to the world community as a mixed site. And I am made to understand also that the kusta or leprosy site at Sungai Buloh may be thinking likewise to go under cultural site, and I hope there are more sites in Malaysia: Sabah, Sarawak, and Peninsular, which should aspire to be categorised as a World Heritage Site.

In the home front, for the National Heritage Site, FRIM at Kepong and Royal Belum State Park has already been declared as a National Heritage Sites 2012, and now we have proposals from 14 more sites for consideration. But as you and I understand, this consideration must go through the respective state government or the respective state agency, authorities for approval before these sites can be taken by Jabatan

[1] This is an edited transcript of the speech given during the symposium.

Warisan Negara to declare, proclaim and gazette as a National Heritage Site. And I think Bukit Fraser is a candidate in this aspect.

You may wonder what constitutes a natural site. Well, you and I can guess it is a landscape or seascape with rich components of flora and fauna or biodiversity. It can represent an ecosystem or community diversity, habitat, niche, hill, forests, and it should contain something unique particularly with respect to flora and fauna, and normally we would look at the high content of endemic species, which make the site valuable in terms of its scientific value and also conservation value. Why do you need it to be a National Heritage? There must be something to be protected and conserved for humanity, community and our country. If you look at Figure 1, the picture on the left is Danum Valley, which I have said, aspires to be a World Heritage Site. The picture on the top right is Maliau Basin, also aspires to be a nomination from Sabah. And the picture on the bottom right, is a picture from Taman Negara. Taman Negara which straddles Pahang, Terengganu and Kelantan also aspires to be a UNESCO World Heritage Site and as you know Taman Negara is rich with biodiversity, undisturbed and covers a very big area; itcan easily qualify as a National Heritage Site.

Figure 1. Left: Danum Valley; Top right: Maliau Basin; Bottom right: Taman Negara

As I said earlier, 14 sites have been considered as candidates for the National Heritage Site, namely Perlis State Park in Perlis, Gunung Stong State Park in Kelantan, Setiu Wetlands in Terengganu, Bukit Bauk Urban Forest in Dungun Terengganu, the Merbuk Mangroves in Kedah, Ulu Muda Forest Reserve in Kedah, Matang Mangroves in Perak, which is a world renowned mangrove habitat, Bukit Larut Forest Reserve in Perak, a 50 ha plot in Pasoh Forest Reserve in Negeri Sembilan (simply because we all know how many species, how many genera, how many families of trees there are in the 50 ha plot, so it is really a valuable site), Air Hitam Forest Reserve in Selangor (which is a forest reserve in UPM), Tanjung Tuan in Melaka, and even Bukit Nenas Urban Forest (an area about 9.8 ha in Wilayah Persekutuan) because of the value they give to science and conservation.

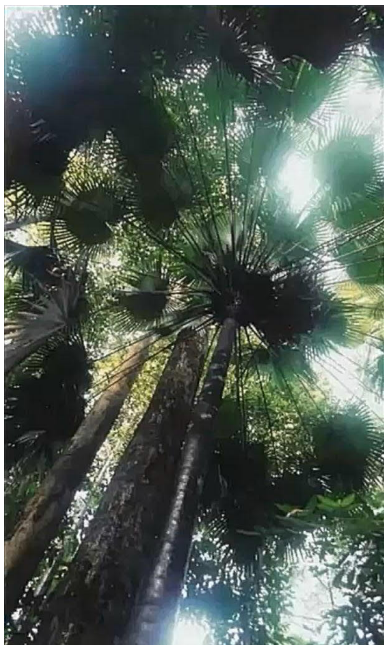


Figure 2. Livistona endauensis which is endemic to Peninsular Malaysia.

Just look at Taman Negeri Perlis or Perlis State Park. Perlis has beautiful limestone forests on the east, bordering Thailand, which is situated in the Nakawan Range, where about 50% of the area has now been gazetted as Perlis State Park. The other 50% to the south of Kuala Perlis are yet to be considered as a state park, but we consider the limestone flora and fauna in Perlis State Park are worth considering to be a National Heritage.

If you look at this picture (Figure 2), you will be wondering what it is. It is Livistona or Serdang, an endemic species to Peninsular Malaysia and is only found in Taman Negara Endau Rompin, Taman Negeri Rompin, right up to Bukit Bauk Terengganu and it can be proposed as a World Heritage object or even a National Heritage object because it is beautiful andit has conservation and scientific value.

Now let us move to Bukit Fraser. In the last decade, I have witnessed Universiti Kebangsaan Malaysia conducting a few scientific expeditions to generate information on biodiversity, and all these information are published in a couple of proceedings, books and even coffee table books; we now know the uniqueness, the particular flora and fauna of Bukit Fraser. Lately Universiti Putra Malaysia under the leadership of Professor Dr. Rusea Go, together with Selangor Forestry Department organised a similar

expedition, but on the Selangor side. On top of that, as some of you know, Dr Norela Sulaiman is the coordinator of the field research centre, the only one in Bukit Fraser and it is established by UKM at Jeriau Valley.

So, Bukit Fraser as a National Heritage Site, has its value to think about. It's a good candidate because 2,804 ha is quite big and the highest point, the Pine Tree Hill, it's quite high, 1,460 m a.s.l, so it is quite cool, and the vegetation is lower montane forest. Historically, it has been botanised as early as the last century and we have got so much information. Dr Ruth Kiew now at FRIM, had more than 20 years ago, compiled the flora of Bukit Fraser and in her small book, she has listed 120 families, more than 400 genera and close to 1000 species. That indicates to us it is very rich with flora. Unfortunately, we do not have a similar list for the fauna. But I am sure some of you may know the number for specific categories of animal.

Just to illustrate, there are four families which are considered large. Looking at the orchids (Orchidaceae), Professor Dr Rusea Go has got the actual number, but I think it is more than 148 species; the coffee family (Rubiaceae) nearly 80 species; the senduduk family (Melastomataceae) 46 species; and the medang family (Lauraceae) 42 species. If we look at the largest genera, you find many figs (Ficus), more than 30 species; the orchids (Bulbophyllum) more than 26 species; the berangan (Lithocarpus) and the kelat (Syzygium), nearly 20 species; and another orchid (Eria), more than 17 species. In other words, we have a rich biodiversity there.

Figure 3. Pterisanthes pulchra, found only in Bukit Fraser.

We have compiled the list, and currently we think there are 47 species which are endemic to Bukit Fraser. Well 47 is not big, but these are examples of those endemic species found endemic to Peninsular Malaysia and found in Bukit Fraser.

Figure 3 is one example. It is a wild grape. Some of you who have been to Bukit Fraser may have seen this. It is a beautiful vine where the lower side of the leaf, golden yellow and the dorsal side is a deep green. This is Pterisanthes pulchra, and it is found only on Bukit Fraser, around the Jeriau Valley and Gunung Semangkok and not anywhere else in the whole world. Just imagine this illustrates the uniqueness.

During the expedition conducted last year, led by Professor Dr. Rusea Go, we were given this gift (Figure 4a), a climber, Kadsura japonica, a beautiful berry like fruit on Gunung Semangkok. And again, one of the saprophytic Balanophora fungosa (Figure 4b), found along the Warisan trail on Bukit Fraser. If you look at other flora, the ferns, the mosses, the liverworths, and the lichens, I think we have accounts and lists of these categories of plant that have been generated through the various expeditions, and I think we can vouch for this.

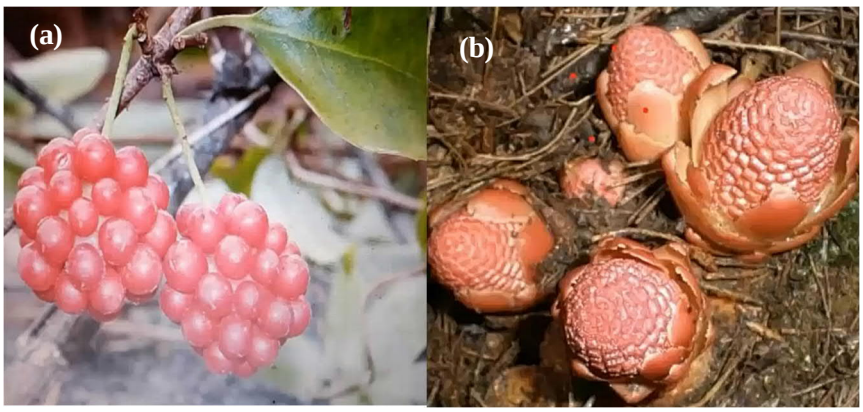


Figure 4. (a) Kadsura japonica, found on Gunung Semangkok. (b) Balanophora fungosa found along the Warisan trail in Bukit Fraser.

I would like to point out some noteworthy plant species. One that comes to my mind is what we call Trig Oak, Trigonobalanus verticillate, a Fagaceae. In Malaysia, this species only occurs on Mount Kinabalu in Sabah, Bario Highlands in Sarawak, and Jeriau Valley in Bukit Fraser. Its relatives are found in Papua New Guinea and Colombia, South America. Just imagine that Jeriau Valley in Bukit Fraser has got this very ancient Trig Oak and it is not found anywhere else in Peninsular Malaysia.

With regard to the fauna, I do not have the actual number for this, but I am sure some of you, the participants of this seminar and other scientists out there know that we have got the top predator and their prey in the area. The bird life in Bukit Fraser is so well known among birders, and every year they have the Bird Race and I think Bird Life International had already designated Bukit Fraser as one of the Important Bird Areas in Malaysia. The reptiles and amphibians are also rich, and I am sure Professor Norhayati Ahmad of UKM knows the number. And insects as I said, everybody knows it is one group of fauna which we know very little about. But I am sure in Bukit Fraser, if you were to set up the trap one night, you may be able to count hundreds or even thousands of wild insects and not to mention other vertebrates. So, we also have accounts of the fauna that have been generated through our expeditions.

Well, a beautiful picture (Figure 5), just to show that when we were camping at the Jeriau Valley, in our UKM research centre, we were told that this top predator Panthera tigris jacksoni had visited us one night, and I believe it is still there. And if you have the predator, you probably have the prey.

Figure 5. Panthera tigris jacksoni

As the value and benefits of the flora and fauna, you and I know that these are the components which contribute to ecosystem services, biological resources, social and aesthetic benefits and cultural values.

Let's look at the attributes of Bukit Fraser. Of course, you and I know that the land belongs to the state. But the forest is under the jurisdiction of the Pahang Forestry Department; the wildlife is under the jurisdiction of PERHILITAN; and I think Jabatan Pengairan dan Saliran looks after the water catchment areas for the supply of water. The good thing about Bukit Fraser is, it has a body to manage it, Perbadanan Kemajuan Bukit Fraser, and there are also many private properties, as well as civil organisations there. In other words, the stakeholders must be informed of the aspiration and our desire to make Bukit Fraser as I have said earlier, a National Heritage Site.

Nevertheless, we have to understand that Bukit Fraser is just a piece of land with a hill, so, there will be geological changes. The landscape will change because of socioeconomic developments, and lately there are changes made on Bukit Fraser. There might be landslides; there might be phenomena of climate uncertainties; land use change may occur; forest and their exploitation might occur; there might be new housing development or hotel developments; and the establishment of social amenities, especially for local tourism. These, we must take into consideration.

The good thing about Bukit Fraser, is that it is a historical resort site. The geology is granitic; the area is still very pristine with very little disturbance. It has lower montane vegetation, high species diversity, as I said earlier, for the plants alone we think there are 47 species, and it has been protected and conserved by the community all these while, because the community loves Bukit Fraser and that is why the aspiration came into this discussion today.

Now, where should Bukit Fraser head for? The National Heritage Site or the State Park? You can go for either or you can go for both. And I think if you go for either or both, it is a big win for biodiversity, it is also a big win for the local community. To go for the National Heritage Site, we must go to the state agency, or an NGO can propose this, but again through the state because the land belongs to the state. If we want to be Bukit Fraser State Park, we have no choice but to go through the state forestry department, which can take it to the state authority or state department for approval. So Perbadanan Kemajuan Bukit Fraser has a role to play here to facilitate our desire to bring up Bukit Fraser either as a National Heritage Site or a Bukit Fraser State Park, and the Exco is in the position to either agree with the proposal or otherwise. And as you realise we have a few models for this in our country, we have "Perbadanan" or a municipality or even the state department can take this matter up.

Well, to propose Bukit Fraser as a National Heritage Site or even a state park, we have to ensure its integrity, in other words, you cannot spoil it. And we must safeguard its authenticity, making sure things have not changed as it was before. We must protect its value, either at the national level or state level, or even at the local level. We must determine the values, either tangible or non-tangible. We must write a very short brief,

and we must be able to see it working, we must have what we consider a conservation management plan, in other words to ensure its integrity, authenticity, and sustainability. And we must promote it after this, either as a National Heritage Site or a state park, in order to sustain the interest of the community.

I am sure most of you who are listening and participating in this seminar will be asking yourself - heritage for what? Why do we want to go for a National Heritage Site, in this case, Bukit Fraser? We answer this question through the uses or through the functions or even attributes that the site qualifies. And if you combine all these uses, functions, attributes, you can justify a candidature for the National Heritage Site or state park on this aspect. And in the case of Bukit Fraser, as I have discussed earlier, it has a very high biodiversity, it comes to my mind a cultural site, because it was developed by the colonial masters, and it has got historical values, and also aesthetic values, and its wilderness is second to none. And if you justify its functions, it will amalgamate very well to justify the candidature.

Now, look at the journey, as I said just now, the state or the state agency, or even the Bukit Fraser Development Corporation, or even any NGO or individuals, may prepare the brief, a very short four-page brief to talk about the site, to explain its attributes and as to why we need to propose Bukit Fraser as such. And these agencies or individuals may take it to the State Exco or state government for approval, and once they have given the green light, we can send it to Jabatan Warisan Negara, which is a Federal agency, which looks after the National Heritage Sites. And under the Jabatan Warisan Negara, it has a committee looking after the natural sites and a committee that will discuss the proposal. After the committee discusses this, and agrees to this, then we may propose to Jabatan Warisan Negara to get the last agreement from the state in order to proclaim it as a Heritage Site.

I need to acknowledge the organisers of the seminar, especially the chairperson of the seminar, representing UKM is Dr Norela Sulaiman and Dr Shamsul Khamis; WWF-Malaysia, also part of the organising committee; and there are many individuals who have made my presentation possible. And lastly, I would like to thank Dr Raja Muhamad Zuha and the rest, and apparently this recording is made by Dr Raja Zuha, whom I must thank very much.

So, thank you all for listening to my discussion, and I hope some of you will get the benefit from the discussion, and after this we shall or we may sit down to discuss the journey to take the candidature of Bukit Fraser to the highest authority in Pahang state government, and then I can help to facilitate with Jabatan Warisan Negara and hopefully one day we may be able to see Bukit Fraser either or both as National Heritage Site or even a Pahang State Park. Incidentally, Pahang has got only one state park now, Taman Negeri Rompin, so hopefully Bukit Fraser can be the second. Thank you very much for your listening pleasure. May god bless you, happy holiday, thank you. Wabillahitaufik walhidayah wassalamualaikum warahmatullahi wabarakatuh.

SUMMARY OF PLENARY SPEECHES

Dr Ruth Kiew is currently the co-ordinator of Flora of Peninsular Malaysia at the Forest Research Institute Malaysia (FRIM). Dr. Ruth had traveled to the United States to speak on the fate of South Asia's endangered tropical forests and to accept the botanic equivalent of the Nobel Prize: The David Fairchild Medal for Plant Exploration from the National Tropical Botanical Gardens, an American group dedicated to plant preservation and discovery. She is also one of the world's great experts on tropical begonia.

Professor Badrul Munir Md Zain is a professor in Environmental Science and Natural Resources from the Faculty of Science and Technology at Universiti Kebangsaan Malaysia. He received his PhD from Columbia University. He has a wide range of research interest which includes mammal taxonomy, genomics, DNA sequencing, genetic diversity, population genetics and molecular phylogenetics.

Dr Siti Nurhidayu is the receipient of the Newton Mobility Grant (2018-2020) on sediment quantification in forest and oil palm catchments and the editor of the Malaysian Forester journal. She is also the project leader for Asia Pacific forest adaptation to climate change Malaysia Phase 2 project. Her research interest includes hydrological processes impacted by forest activities, water yield and water quality, erosion quantification and modelling, as well as catchment modelling.

Mr Daniel Chin is currently an environmental consultant at ERE Consulting Group Sdn Bhd. He conducts field assessments and provides ecological inputs for EIAs as well as stakeholder engagements. He received his MSc in Sustainable Development Management from Sunway University and his area of interest is social aspects to improve Protected Area Management. He is directly involved in the preparation of 3 management plans for the Johor National Parks Corporation (Pulau Kukup, Tanjung Piai, and Gunung Ledang). Besides that, he contributed to the inputs for the introduction materials for the NPBD 2016-2025 as well as took part in the LAC study for the Royal Belum State Park.

FLORA

ARE ECOTOURISM AND BIODIVERSITY CONSERVATION COMPATIBLE AT FRASER'S HILL? A BOTANISTS' PERSPECTIVE

By Ruth Kiew
Corresponding author email: ruth@frim.gov.my

Fraser's Hill meets the three IUCN criteria that qualify it as an Important Plant, namely (1) in its extremely high species richness, (2) presence of threatened species, and (3) endangered habitats (streams and the cloud forest on Pine Tree Hill). Dr Ruth Kiew, in her current study, found Fraser's Hill (in an area of about 2,800 ha.) has a count of 1300 species of vascular plants (Kiew & Aliaa Athirah, in prep.). This represents about 14% of the total flora in Peninsular Malaysia and 43% of the montane flora that grows above 1,000 m elevation. In addition, about 20% of the flowering plants and 5% of ferns are endemic in Peninsular Malaysia. Its forest has high endemism with 37 hyperendemic species known only from Fraser's Hill, and a large number, almost 90 species, for which Fraser's Hill is the type locality (Kiew & Aliaa Athirah, in prep.). In accordance with Target 6 of the Malaysian National Strategy for Plant Conservation, 50% of Important Plant Areas should be protected (Saw et al., 2009) and Fraser's Hill should certainly be among them.

Dr Ruth brought to the attention of endangered habitats such as in Pine Tree Hill where global warming is likely to be a major threat because rising temperatures will directly impact on cloud formation that is vital to maintain the moist conditions necessary for the survival of its summit flora. Although covering a small area, Pine Tree Hill is extremely biodiverse with many rare and endangered species. The small cap of upper montane forest on Pine Tree Hill is unlike lower montane forest because it hardly regenerates when disturbed or cleared. Unfortunately, its rare pitcher plants and orchids have been the target for collection and their populations drastically reduced. Throughout Peninsular Malaysia, upper montane forest is an endangered habitat. Because flora and fauna on mountain peaks cannot migrate any higher, studies in America on the avifauna warn of the phenomenon of the 'escalator to extinction'.

Habitat destruction and fragmentation is the greatest threat to the integrity of biodiversity at Fraser's Hill, not only to plants but also to birds and wildlife in general. Positive initiatives should be taken to safeguard the integrity of the forest and especially populations of endangered species and threatened habitats, while making nature accessible to visitors. It is imperative to guard against any further deterioration, not open up any new areas, but instead to rehabilitate facilities standing idle. Eco-tourism needs to be managed so that it is not over-developed beyond its carrying capacity (Lim, 1995). Degrading forests and especially clearing even small areas will result in ecological damage that is expensive if not impossible to repair.

Dr Ruth has proposed four aspects of management recommendations to balance commercialisation with safeguarding biodiversity. They are (1) Ecotourism – Interpretation; (2) Maintain the biodiversity of the roadside and trails; (3) Commercial vs. scientific collecting and (4) Environmental education. While four sites at Fraser's Hill were pinpointed as of especial biodiversity conservation importance (Kiew, 1998), in fact a holistic approach needs to be taken to protect all the surrounding forest that forms the Fraser's Hill Forest Complex in view of rising temperatures that are the result of increasing destruction of forest cover and to mitigate the effects of global warming. The whole area, not only the Township and its surroundings, but also the water catchment areas of the rivers that flow down to Raub that lie within the six Permanent Reserved Forests, namely Batu Talam, Sungai Sia, Rotan Tunggal, Rotan Tunggul (Tambahan), Sempam and Teranum, need strict and permanent protection coupled with enforcement. It is timely that Fraser's Hill and the six permanent reserved forests be securely gazetted at least with the status of State Park.

Reference:

Kiew, R. 1998. The Seed Plant Flora of Fraser's Hill, Peninsular Malaysia with Special Reference to its Conservation Status. Forest Research Institute Malaysia, Research Pamphlet No. 121, pp. 1-121.

Kiew, R., & Aliaa Athirah, A.M. (in prep.) The Flora of Fraser's Hill, Peninsular Malaysia with Special Reference to its Conservation Status.

Lim, L.C. 1995. Carrying capacity of Fraser's Hill. WWF, Kuala Lumpur

Saw, L.G., Chua, L.S.L., & Abdul Rahim, N. (eds.). 2009. Malaysia National Strategy for Plant Conservation. Ministry of Natural Resources and Environment, Putrajaya and Forest Research Institute Malaysia, Kepong. 61 pp.

THE NEGLECTED PRIMATES OF PENINSULAR MALAYSIA AND PRIMATES SIGHTING AT FRASER'S HILL

By Badrul Munir Md Zain
Corresponding author email: abgbadd@ukm.edu.my

Even though Malaysia is blessed with 25 species of primates, out of which, 13 are found in the Peninsula, Professor Dr Badrul drew attention to some neglected or understudied primates of Peninsular Malaysia. They are the:

a) Stumped tailed macaque (Macaca arctoides), a rare species confined to the north of the Peninsula at the Nakawan Range;
b) Slow loris (Nycticebus), being nocturnal and arboreal it is a single polymorphic species that has high variation among different populations, causing the taxonomy of this group to remain unresolved. To date, this group has been threatened by habitat loss and illegal trading.
c) Gibbons, being aboreal and living in primary forests as well as having the ability to travel rapidly from one tree to another is a major factor in the complexity of studying this primate group. The three species of gibbons present in Peninsular Malaysia, are the White-handed gibbon (Hylobates lar), Agile gibbon (Hylobates agilis), and Siamang (Sympalangus syndactylus). The group is also threatened with extinction because of the loss of habitat and illegal trading.

Professor Dr Badrul's survey found that the Fraser's Hill area is suitable as a primate conservation area as it has intact forests and has the potential to become a primate tourism destination (Abdul-Latiff et al., 2019). The five primate species documented in Fraser's Hill are the Long-tailed macaque (Macaca fascicularis); Pig-tailed macaque (Macaca nemestrina); leaf monkeys are represented by Dusky leaf monkey (Trachypithecus obscurus) and White-thighed leaf monkey (Presbytis siamensis). Siamang (Symphalangus syndactylus), a gibbon, was also seen and its vocalisation was heard from the forest canopy (Kawabe, 1970).

Primates of Fraser's Hill. Photo credit: Eddie Chan, Md-Zain and Ridwan Rahman

As a way forward to bridge the knowledge gaps, Professor Dr Badrul recommends that a systematic survey covering the entire range of species should be undertaken in the future to assess the current status of these neglected species. Data on dietary, home range and activity patterns are important for understanding their behaviour in their natural habitat. The use of technology such as camera traps, infrared cameras, drones and telemetry is also needed to provide a resolution for assessing the status of these species. In addition, molecular approaches using faecal DNA analysis can also be used to determine the genetic structure and the phylogenetic relationship. Furthermore, advanced molecular methods such as Next Generation Sequencing using faecal samples are also capable of defining the diversity of microbiomes, diets, parasites, and viruses in these primates.

Reference:

Abdul-Latiff, M.A.B., Najmuddin, M.F., Haneef, S.K., Nabil, A., Shahrool-Anuar, R., & Md-Zain B.M. 2019.Transforming ranging behaviour of Schlegel's Banded Langur (Presbytis neglectus) into PrimaTourism product. IOP Conference Series Earth and Environmental Science 269. DOI:10.1088/1755-1315/269/1/012005

Kawabe, M. 1970. A preliminary study of the wild siamang gibbon (Hylobates syndactylus) at Fraser's Hill, Malaysia. Primates 11(3): 285-291.

ECOSYSTEM SERVICES

THE FORGOTTEN FOREST PRODUCT: WATER

By Siti Nurhidayu Abu Bakar
Corresponding author email: sitinurhidayu@upm.edu.my

Malaysia is blessed with high rainfall with an average annual rainfall of 2,400 mm in Peninsular Malaysia, 2,360 mm in Sabah and 3,830 mm in Sarawak. This provides the source of water especially during the monsoon season where the availability for continuous base flow is important for various purposes such as irrigation, hydroelectric, recreation, transportation and industrial. Selangor often experiences frequent water disruptions compared to the other states in Malaysia. As there are many development projects that may not have a proper Environmental Impact Assessment (EIA), uncontrolled and unmanaged developments often lead to the destruction and degradation of water catchment forests. Based on public opinion, there is an urgent call for the protection of water catchment areas and the need to work towards gazetting new water catchment forests.

Dr Siti Nurhidayu stressed the importance of understanding the ecosystem services provided by a healthy landscape as natural habitats provide a wide range of benefits from carbon sequestration and storage, to water supply, climate regulations and many more. One of the important ecological processes provided by the tropical forest is the hydrological cycle. During dry seasons, the runoffs are sustained by persistent precipitation at areas of high elevation. While discussing highland areas like Fraser's Hill, there is a need to understand its importance, and the added moisture input from clouds. By combining these factors, it will result in higher residue for a given amount of rainfall. Flows from cloud forest will also tend to be more stable during extended periods of low rainfall. Concerns have often been expressed that if the cloud forests are converted to other land use, it could result in a significant decline in the overall dry season flow.

The potential consequences from any changes in landscape can be divided into upstream and downstream. At upstream, changes in landscape will affect tree growth due to the lack of nutrients (erosion and topsoil removal) and will later affect its production. Besides that, water yield will be affected where the long-term water supply to the reservoir will be reduced, especially during dry seasons. There will also be a flashy response, which is, the time taken for water to flow from upstream to downstream would be faster. Other effects upstream would be the reduced storage capacity of the reservoir due to sedimentation. As for the downstream, the most prominent consequences will be low water availability during the dry season, which will affect agriculture activities, industrial areas as well as domestic users. Apart from that, the cost for water treatment will also increase to remove sediments, and there will also be an increase in flood frequency and duration. Another consequence of landscape change is that it will affect downstream fisheries due to changes in water quality. All these consequences are likely to be more extreme in the future due to climate change such as higher temperature, more extreme rainfall events and prolonged drought periods.

For highland forest areas, once it is gone, it will be difficult to restore to its original natural state. More research on the hydrological process in highland areas especially in Fraser's Hill is needed as well as attention is needed to focus on the protection and the management of natural forests for the provision of clean water. All stakeholders must work together towards the protection of the water catchment areas by finding the balance between economics and environmental sustainability by looking at alternative sources of income to achieve conservation.

What We Need to Get a Fraser's Hill State Park?

By Daniel Chin Zhi Hao
Corresponding author email: czh@ere.com.my

The Fraser's Hill Forest Complex is by no means an ambitious effort to advocate for the creation of a state park around Fraser's Hill. Continuous research activities have enhanced the conservation value of the rich and diverse landscape around Fraser's Hill. While the present goal is to eventually establish and gazette a state park, various aspects need to be fully in place for this goal to be fully realised and implemented.

Mr Daniel Chin highlighted the fact that establishing a state park requires a Shared Vision to be formed, one that serves both the state and local community. This Shared Vision must be agreed amongst important stakeholders that have direct and indirect roles in the Fraser's Hill Forest Complex. A Shared Vision also comes with Shared Responsibility. Related stakeholders need to come together to acknowledge the various roles and responsibilities and form a working framework. As such, the formation of a single management entity is the best way forward to streamline coordination between all stakeholders. This will ensure that the management of the envisioned state park is in line with the Shared Vision.

The establishment of a state park will also require some form of development. To this end, development needs to be in line with the Shared Vision. Development proposals should aim to preserve and enhance the values of the Fraser's Hill Forest Complex. This may include the biological, sociological, cultural, and historical aspects. At the same time, development needs to recognise and respect the physical and ecological limits of the Forest Complex. Development proposals need to be clearly assessed and deliberated before being approved to avoid causing severe environmental issues. Finally, managing a state park will require investments into sustainable partnerships. Management entities need to recognise and build benefiting partnerships between interested parties to achieve the goals of developing and protecting the Fraser's Hill State Park.

SPECIAL SESSION by PLANMalaysia@Pahang

Summary of the speech

The symposium was made richer through the presentation made by the Deputy Director of PLANMalaysia@Pahang, Y.M Raja Nor Azlina Raja Ahmad. Entitled “Rancangan Struktur Negeri Pahang 2050” (or Pahang State Structural Plan 2050), this special session enlightened the participants on the spatial planning process in Malaysia at the federal, state, district levels and finally at the most micro level, i.e. the special area plan. Y.M Raja Nor Azlina also shared the cronology of the preparation for the Pahang State Structural Plan 2050 and includes the various local and international policies that has been taken into account in developing the structural plan. With the vision “Pahang Cemerlang 2050”, the structural plan consists of four main thrusts, 33 policies and 98 strategies. She further explained that Raub district where Fraser’s Hill is located, falls within the highland tourism zone area as well as the agricultural zone area. The plan also recommends for the development of a Special Area Plan for the management of environmentally sensitive areas including cloud forests which encompass Fraser’s Hill, Genting Highlands and Cameron Highlands, as well as a Special Area Plan for Fraser’s Hill State Park.

The full speech was given in Bahasa Malaysia (Malay language) and is transcripted as below:

Rancangan Struktur Negeri Pahang 2050

By Y.M. Raja Nor Azlina Raja Ahmad

Rancangan Struktur Negeri Pahang (RSNP) 2050 merupakan kajian semula kepada RSN Pahang 2020 yang telah diwartakan pada 22 November 2007. RSN 2050 disediakan mengikut Seksyen 11, Akta 172 iaitu Akta Perancangan Bandar dan Desa. RSN Pahang adalah satu dokumen yang menggariskan dasar-dasar dan cadangan pembangunan guna tanah dan fizikal bagi seluruh negeri Pahang menjelang tahun 2050.

Di Malaysia, hierarki pembangunan fizikal bermula dengan kajian Rancangan Fizikal Negara yang mana ia dirunding dengan Pihak Berkuasa Negeri (PBN), diluluskan oleh Majlis Perancang Fizikal Negara (MPFN), dan disediakan oleh ibu pejabat PLANMalaysia. Manakala, di peringkat negeri, Rancangan Struktur Negeri diluluskan oleh Jawatankuasa Perancang Negeri (JPN), di persetujui oleh PBN, dan disediakan oleh PLANMalayia@Negeri. Hierarki yang ketiga adalah Rancangan Tempatan Daerah dan proses adalah sama seperti RSN. Terakhir, adalah Rancangan Kawasan Khas (RKK), yang mana WWF-Malaysia mencadangkan kajian dibuat untuk Bukit Fraser adalah terjatuh di hierarki yang keempat iaitu Rancangan Kawasan Khas.

Mengikut kronologi penyediaan RSNP 2050, kajian ini telah dimulakan dengan beberapa proses iaitu daripada laporan tinjauan yang telah dibuat pada 8 Disember 2016; kemudian laporan draf, dan kemudian publisiti kepada orang awam selama sebulan, iaitu pada November 2017. Draf RSNP 2050 mendapat kelulusan daripada JPN pada 13 Mac 2018 dan telah angkat kepada MPFN pada tahun 2018 dan di setuju oleh PBN pada 18 Oktober 2018. Pada 14 Mac 2019, RSNP 2050 telah siap diwartakan.

Dalam membuat laporan RSNP, dasar-dasar peringkat antarabangsa, peringkat nasional dan peringkat negeri juga dipertimbangkan. Di peringkat antarabangsa, dasar-dasar yang diambil kira adalah seperti Sustainable Development Goals, Pembangunan Segi Tiga Indonesia-Malaysia-Thailand (IMT-GT) dan Brunei Darussalam-Indonesia-Malaysia-Philippines East Asian Growth Area (BIMP-EAGA). Dasar peringkat nasional termasuk Rancangan Malaysia Ke-11, Rancangan Fizikal Negara Ke-3, Dasar Perbandaran Negara Ke-2, Dasar Perancangan Fizikal Desa Negara, Rancangan Fizikal Zon Pesisiran Pantai Negara, Pembangunan Jajaran Lebuhraya, Central Forest Spine: Pelan Induk Rangkaian Ekologi, Dasar Teknologi Hijau dan Program Transformasi Ekonomi. Dasar peringkat negeri juga diambil kira seperti Wilayah Koridor Ekonomi, Rancangan Tempatan Daerah dan Rancangan Kawasan Khas serta pelan-pelan strategik negeri.

Visi bagi Negeri Pahang adalah Pahang Cemerlang 2050 dan pembentukan visi ini berasaskan kepada Rancangan Malaysia Ke-11, Rancangan Fizikal Negara Ke-3, Plan ECER, Plan Strategik Negeri dan Pembangunan Bandar Bersempadan. Ia mengandungi 4 teras, iaitu teras spatial seimbang, teras maju, teras sejahtera, dan teras lestari, yang melibatkan 33 dasar dan 98 strategi.

Negeri Pahang berkeluasan 3.596 juta hektar, meliputi 11 daerah dan 12 pihak berkuasa tempatan (PBT). Daerah Raub, yang mana Bukit Fraser berada, ialah satu daripada 11 daerah negeri Pahang. Penduduk pada tahun 2015 adalah 1.6 juta dan dianggarkan pada tahun 2050 penduduk negeri Pahang akan meningkat sehingga 2.57 juta. Guna tanah di negeri Pahang terdiri daripada tepu bina yang meliputi 3.08%, pertanian merupakan 37.66%, dan hutan adalah guna tanah yang terbesar iaitu 57.18%, diikuti oleh badan air, sungai dan lain-lain, 2.08%.

Dalam Pelan Strategik Spatial 2050, di Daerah Raub, Bukit Fraser terjatuh dalam kawasan zon pelancongan tanah tinggi dan ia merupakan nodus pelancongan utama negara dan juga negeri. Zon pelancongan utama telah dibahagikan kepada 3 zon di negeri Pahang iaitu zon tanah tinggi, zon semulajadi dan zon persisiran pantai/pulau. Sebelah Kuantan, Pekan, Rompin telah dizonkan sebagai zon persisiran pantai/pulau, manakala zon tengah sebagai zon semulajadi yang meliputi Jerantut, Temerloh, Bera, Muazam Shah dan Maran. Zon di sebelah Bentong, Raub, Cameron Highlands adalah zon tanah tinggi dan ia termasuk Raub di mana Bukit Fraser berada di sini.

Seterusnya dari segi pembangunan ekonomi, terdapat 5 paksi pembangunan utama ekonomi negeri Pahang iaitu melibatkan 5 paksi utama iaitu yang pertama Kuantan-Gambang-Gebeng-Pekan, kedua Temerloh-Mentakab, ketiga Bentong-Karak-Bukit Tinggi, keempat Cameron Highlands, dan kelima Kuala Rompin-Tioman. Raub tidak termasuk dalam paksi pembangunan ini, tetapi ia akan menerima limpahan daripada paksi yang ketiga iaitu Bentong-Karak-Bukit Tinggi, yang mana ia merupakan zon pelancongan utama dan nodus pelancongan utama negara.

Daerah Raub mempunyai keluasan 226,891 hektar dan penduduk pada tahun 2020 dianggarkan seramai 105,490. Kawasan guna tanah hutan yang monopolinya adalah sebanyak 61.06%, di ikuti tepu bina sebanyak 1.43%, pertanian 36.45%, badan air 0.57% dan pengangkutan 0.49%. Bandar utama di daerah Raub adalah bandar Raub, manakala bandar tempatan dan pusat penempatan utama melibatkan Bukit Fraser, Cheroh, Mukim Dong, Mukim Sungai Ruan, Tranum, dan Batu Malim. Penduduk yang dianggarkan untuk daerah Raub pada tahun 2050 adalah seramai 136,317.

RSNP 2050, daerah Raub di fasarkan sebagai Lembah Tani Lestari, memandangkan kawasan pertanian yang luas di daerah Raub. Daerah Raub telah mempunyai Rancangan Tempatan Daerah (RTD) Raub 2003-2015, yang telah diwartakan pada 6 Disember 2007. Fungsi RTD adalah menterjemahkan dasar-dasar RSN; panduan fizikal bagi daerah dan Pihak Berkuasa Perancang Tempatan (PBPT) berkaitan melalui peta cadangan guna tanah; menyediakan garis panduan bagi kawasan pembangunan; mengenal pasti projek utama daerah; dan menyediakan garis panduan pelaksanaan.

Dalam RSNP 2050, terdapat satu bab berkaitan dengan Bukit Fraser iaitu dalam projek-projek “high impact”, iaitu di mana dasar yang disasarkan dalam RSNP adalah untuk memperkasakan Bukit Fraser sebagai destinasi ekopelancongan yang mampan. Terdapat juga beberapa cadangan dan tindakan yang perlu dilaksanakan oleh agensi-agensi yang terlibat termasuk menaik taraf infrastruktur dan utiliti seperti jaringan jalan raya, bekalan air, bekalan elektrik dan sistem pembetungan. Pemuliharaan dan pemeliharaan kawasan menarik Bukit Fraser melibatkan kawasan-kawasan antaranya, The Paddock Fraser’s Hill, Bird Interpretive Center, Kompleks Sukan Bukit Fraser, Kelab Golf Diraja Bukit Fraser, Hemmant Trail Fraser’s Hill dan lain-lain.

Terdapat beberapa cadangan RSN Pahang 2050 yang khusus di Bukit Fraser. Untuk Teras Spatial, dalam sektor guna tanah, fizikal dan penempatan, adalah dicadangkan untuk membuat RKK Pengurusan Kawasan Sensitif Alam Sekitar (KSAS) Tanah Tinggi (Cloud Forest) yang meliputi Bukit Fraser, Genting Highlands, Cameron Highlands. Selain itu, terdapat juga cadangan untuk membuat RKK Kawasan KSAS Bukit Fraser (Taman Negeri Bukit Fraser). Selain Bukit Fraser, secara spatial, ia juga dicadangkan kawasan Bandar Raub, iaitu Sungai Ruan dan Bukit Fraser akan diperkembangkan berasaskan sempadan bandar dan pembaharuan

semula (urban renewal, infill dan brownfield). Manakala dari sektor pelancongan dalam Teras Maju, terdapat cadangan pelaksanaan kajian laluan basikal dan pejalan kaki terutama di Bukit Fraser, Pusat Bandar Raub dan kawasan agro pelancongan bersesuaian untuk mengukuhkan fungsi Daerah Raub sebagai zon pelancongan tanah tinggi. Bagi cadangan ketiga yang berkenaan dengan Teras Lestari yang meliputi sektor alam sekitar, terdapat cadangan untuk mewartakan Bukit Fraser sebagai Taman Negeri Pahang iaitu Warisan Alam Sekitar untuk burung burung dan lain-lain seperti flora dan fauna; dan pemeliharaan Rezab Hidupan Liar Bukit Fraser dan penyelidikan. Ia juga dicadangkan untuk memastikan kelestarian kawasan KSAS terutama kawasan tanah tinggi, empangan dan loji rawatan air dan punca bekalan air yang melibatkan Bukit Fraser. Seterusnya, cadangan jalan baru, iaitu naik taraf Jalan Persekutuan 55 (Raub-Bukit Fraser-Kuala Kubu Bharu), dan juga cadangan untuk membuat inventori bangunan warisan yang termasuk Balai Polis Bukit Fraser, Ye Olde Smokehouse dan menara jam Bukit Fraser.

Reference:

JPBD Pahang. 2019. Rancangan Struktur Negeri Pahang 2050. Jabatan Perancangan Bandar dan Desa Negeri Pahang, Kuantan, Malaysia.

EXPERT PANELLIST DISCUSSION

To complement the multitude of presentation from experts from each focus areas, an expert panellist discussion was organised on the second day of the symposium. An esteemed line-up of panellist were invited to share their thoughts, insights and experiences based on four questions. A summary of the responses and the discussions that took place during this session can be found below:

Biography of the Panellists

Mr Surin Suksuwan is currently the Southeast Asia Regional Director at Proforest. He is a biodiversity conservationist and sustainability consultant and has worked over 20 years in various organisations including WWF-Malaysia and Proforest. Currently, he is a member of the IUCN World Commission for Protected Areas (WCPA) and the Malaysian Nature Society. In Proforest, he leads a team in Southeast Asia in the planning and implementation of various projects in sustainable production and supply of agricultural risk assessment; supply chain mapping; HCV assessment; certification pre-assessment (RSPO, FSC, etc); and capacity building programmes.

Professor Dr Amran Hamzah, is a professor in tourism planning at Universiti Teknologi Malaysia and a director at the Centre for Innovative Planning and Development (CIPD). He is also an elected Regional Councillor of IUCN. He is notable for his role in championing community-based tourism since the 1980s. Professor Dr Amran is committed to play a big role in community-based tourism due to his respect for the desire and perseverance of rural communities in striving for economic progress without scarifying their community values and lifestyle.

Dr G. Balamurugan is the Managing Director of ERE Consulting Group Sdn Bhd. Over the past 30 years, Dr Bala has been actively involved in environmental and natural resources planning and management in the region. He is directly involved in large-scale planning projects such as the National Physical Plan for Peninsular Malaysia, the National Policy on Biological Diversity and Sustainability Policy for the state of Johor. He has served as advisor to a wide range of government agencies, private sectors, and NGOs across Asia. He has published widely and is frequently invited to speak at conferences and seminars on environmental and natural resources planning.

This session was moderated by Ms Norizan Mohd Mazlan, WWF-Malaysia's Head of Conservation Peninsular Malaysia. A civil engineer by training and specializing in water and wastewater treatment and services. Her role focuses on forests and freshwater project management in Peninsular Malaysia which entails providing policy directions, thought leadership and guidance to internal staff and as well as external stakeholders. Norizan was the WWF-Malaysia representative at the National Steering Committee for the Central Forest Spine Masterplan, the UNDP-GEF-GoM Improved Connectivity in the Central Forest Spine (ICCFS) Masterplan project, the National Steering Committee for the National Mangrove and Coastal Vegetation Replanting Project, a member of the ICCFS Adaptive Management Advisory Panel (AMAP), Core group member of the 12th Malaysian Plan (12MP) and Technical Working Group (TWG) for Natural Resources.

Discussion 1: How useful can the knowledge gained from scientific studies on biodiversity, sustainability and the economics of the FHFC help in protecting it?

Dr Bala: We have done a huge amount of biodiversity, sustainability, environmental studies throughout the country, and that knowledge so far has not really stopped biodiversity degradation. However, was the knowledge gained merely for scientific purpose or was there a practical value to help the people in power to protect Fraser's Hill. Hence, there is a need to pause and ask ourselves whether we are doing the right kind of research and acquiring the right kind of knowledge. The biodiversity might interest the scientists but may be of little interest to the decision makers. In short, what we need to do is to find information and knowledge that will be useful for the Pahang state government to cajole them to protect Fraser's Hill.

Surin: It is not just information, as a whole, but what kind of information and for whom, is important. The move to setup a state park or to improve the protection for Fraser's Hill should be a multi stakeholder process. In this sense, different kinds of information would be of use to different groups. From the state government's point of view, they will be more interested in the social and economic aspects and the tourism values as well. Whichever agency that is going to be entrusted with the management of the protected area, need to somehow improve the long-term viability of a protected area in terms of the economics of it. There is a need to know what are the aspects that need to be promoted in a sustainable way for tourism purposes, and what potential revenue streams that can be generated sustainably from having the area protected as a state park. A major gap that needs to be filled in terms of knowledge is the economic value and the benefits to local communities.

Norizan: Protecting an area could be considered as reducing the land bank for a state and under the Federal Constitution, the land and water is the state's mandate. One of the things that we really need to look at is what can actually generate revenue sustainably. As ecotourism has been taunted as possibly one of the revenues, perhaps Prof Amran, would like to share some of his experiences on any areas in Malaysia, both Peninsular, and Sabah, Sarawak, that have really shown a difference and what were the things that made it happen?

Prof Amran: If we want local communities to be active joined custodians, ecotourism must be made economically viable for them to have an economic reason for doing so. Malaysia has yet to optimise the economic revenue from ecotourism to plough it back into conservation. This can be done through opening up this revenue stream for tourism concessions because ecotourism in Peninsular Malaysia is under the jurisdiction of government agencies who are basically not trained in visitor management as managing ecotourism is different from managing a conservation area, requiring different scheme sets. The concept of tourism concessions which is gaining popularity, where well qualified investors create wonderful tourism experiences based on the forest, and tourists will not mind paying a premium. The concessions can then easily reinvest some of the money back into conservation. Citing an example, Sabah Parks have provided avenues for tourism concessions. Basically, they do not have to worry about managing conservation, and they have professionals managing ecotourism. In the event of a disaster, as in the earthquake in 2015, Sabah Parks was able to mobilise their money through the trust funds within weeks to make all the necessary repairs and reopened the park. This is an economic aspect that we have yet to unlock.

Discussion 2: In your opinion, what is unique or special about Fraser's Hill to justify it as a state park and what are the threats you see it facing?

Surin: The montane ecosystem of FHFC is relatively rare within our protected area system especially within national parks and state parks. Peninsular Malaysia does not have that many parks that encompasses mountainous areas, and because of its location within the main range, there are some unique features. Some of the plant species reached their southernmost range at Fraser's Hill. They may be found in mainland Asia, in Thailand, northern Peninsular Malaysia, but their range end somewhere around Fraser's Hill, so that's quite unique. There are also few endemic plant species that are only found in Fraser's Hill and nowhere else. And from the fauna point of view, Fraser's Hill provides very rare opportunities to see some of these wildlife up-close. And Fraser's Hill is probably one of the few areas in Malaysia where you can see the siamangs relatively easily.

Dr Bala: The threats facing Fraser's Hill is a matter of perspective, be it threats to biodiversity, or lifestyle or even its heritage values; and depending on who you are asking this question, you may get different answers. COVID 19 is an important game changer, because the tourism industry has been hit very badly and we cannot detach Fraser's Hill from tourism. The Federal Government and most state government revenues streams have been badly hit, so they too are looking for avenues to generate more revenue. So, given this scenario, you'll find increasing number of states, seeking to develop more and more land, and Fraser's Hill is no exception. The second threat, which is also an advantage, is that Fraser's Hill is so close to Klang Valley and people in Klang Valley are desperate for recreational avenues as it does not have sufficient recreational spots. As a result of this, you'll expect greater and greater pressure for development in Fraser's Hill in the coming years, caused by expansion of population in Klang Valley, and the drop in revenue for the state government caused by COVID19.

Prof. Amran: The main reason for the creation of a protected area should be for it to function in terms of ecosystem services, and the role of Fraser's Hill or the forest complex as a water catchment area is very crucial. From that point of view, the damage to Fraser's Hill had been done a long time ago with the construction of the 18-hole golf course at Jeriau Valley and the few resort hotels to maximise the economics of scale which was not appropriate for Fraser's Hill. So instead of focusing on that kind of ecotourism, Malaysian ecotourism should really explore our potential as a special interest tourism. If we can do that and build the values and thereby attract high value tourist, then it would be different.

Norizan: As ecotourism is supposed to be low impact, there needs to be a limit, so that it doesn't detrimentally affect the ecotourism hotspots or even the area. How does that happen and what are the measures that can be planned for in order to recover high end tourism?

Prof. Amran: The application of Carrying Capacity and Limits of Acceptable Change must be used as a tool to help the formulation of management strategies and if they are not put into the bigger picture, carrying capacity will be quite useless.

Discussion 3: Basing on the theme of this symposium, 'Fraser's Hill Forest Complex: Towards Achieving State Park Status', we would like to hear your thoughts on this in terms of whether it is achievable and the associated gaps.

Surin: In the Malaysian context, it depends very much on the political will of the state government, because there are examples whereby a state park can be established relatively quickly, because there is a buy in from the state government. But there are also proposals for state parks that have been sitting around for decades. As far as Fraser's Hill is concern, of interest to most conservationist and people is, how big the state park would be and where is it. Because it is not just a matter of having a state park for the sake of having one, but will it actually serve the purpose and is it going to achieve the objective of protecting the biodiversity and the catchment values?

Dr Bala: Advocacy to create a state park should not stop after its creation, rather, it should continue on how the park would be managed, where the money is coming from and where the capacity is coming from. Maintaining the state park is probably a bigger challenge than just creating a state park. Yes, for Fraser's Hill, it is achievable, but all the advocacy work that is being done now, it should not just focus at merely creating the park, but how we are going to manage the park and thereafter. I think that is an important angle of advocacy work.

Prof Amran: With political will, anything is possible, but is there a real appetite or desire from the state government, which is almost similar to political will? If the state park is established, and continues to be the same structure without good governance introduced, then it would not achieve anything. Good governance can be interpreted in many ways, such as transparency and accountability and whether it leads to a collaborative management approach. It needs to be inclusive where you empower local communities and

indigenous communities. This will be a really positive outcome of transformation towards good governance of natural resources.

Discussion 4: What is the future direction such as the key steps needed by the respective stakeholders to take forward the management recommendations of these researches in order to achieve the state park status?

Dr Bala: There is a need to understand the success factors of parks that were gazetted quickly as oppose to those who are taking a very long time and some of these underlying factors might help us to speed up the gazettement process for Fraser's Hill. It is also incumbent upon us to demonstrate the value and the benefits to the country as a whole, for Fraser's to become a state park. We have yet to articulate the benefits of a state park to the state government and society at large and more effort should be put into it.

Norizan: Everyone has pointed out to the kind of research; and why and how we can actually benefit the state, in terms of managing it. Information such as total economic valuation and cost-benefit analysis as well as the value of the ecosystem services such as water provisioning is not very well studied.

Surin: It will make sense to document the research through a proceeding and share it with the relevant authorities and the Malaysian public to increase awareness on the importance of the area and why we should gazette it. There is also a possibility that there is already something else that actually captures the attention of the state government and basically convinces them to move forward, or maybe they have already decided that they want to gazette Fraser's Hill as state park but more importantly as I have mentioned earlier, it is a matter of convincing them, what kind of area, what is the size of area and where the boundary should be. Maybe some of the research outputs can help to answer some of these questions.

Prof Amran: It is very crucial that all these findings be published and articulated well. Less is more, in terms of convincing the policy makers that this is the value and threats of the forest complex. Fraser's Hill complex means different things to different people, and we need to convince them to be on the same page. The way forward should include looking at the different models of state parks that have been developed in this country; the politics of gazetting a state park; and compensations for the land that has been gazetted; and finally the partnership between federal and state governments. We should not run away from the very challenging politics of establishing a state park in the country.

Norizan: It is one thing to gazette the state park, but we must not lose sight of what is needed to maintain it, manage it effectively and provide good governance to fulfil its state park objectives of protection and conservation.

Different types of information would suit different stakeholders. For example, a park manager would be interested in the biodiversity information, whereas the state government would be interested in revenue streams for the state and its benefits to the local economy and communities. Therefore, if we were to focus on jumping over the first hurdle and gazetting FHFC as a state park, the types of studies to be conducted should take into account what the state government and what the federal government would require - as Dr Bala mentioned, put ourselves in the government's shoes. There is also the matter of articulating our case well and highlighting the benefits of protecting Fraser's Hill – not just locally, but also to the state and at the national level.

This journey towards achieving state park status is a multi-stakeholder process, and therefore the process needs to be inclusive and collaborative in order to achieve its objectives.

CLOSING SPEECH

By Ms. Sophia Lim, CEO/Executive Director WWF-Malaysia

A very good afternoon to you Ladies and Gentlemen. I am Sophia Lim and I am very honoured to be here with you today at the closing of the first-ever 2020 Fraser's Hill Virtual Symposium. It has been a lengthy journey, turning an in-person symposium into a virtual one, but now, from the safety of our homes, I hope everyone involved is able to enjoy the fruits of their labour and make the most of the symposium.

As you know, the Fraser's Hill Forest Complex, spanning an area of almost 83,000 hectares, is relatively unknown and under-explored scientifically. Nonetheless, we know that what's hidden is a treasure trove of rare, endangered, endemic and possibly even new species waiting to be found. The forest complex is not only magnificent and highly biodiverse but provide ecosystem services beneficial to many. By researching and documenting these services, we hope it can contribute towards justifying the need for the conservation of the forest complex. Hence, the theme of this symposium is Fraser's Hill: Towards Achieving State Park Status. I am confident that once we are able to perceive the intrinsic value of biodiversity and ecosystems, and how it underpins the growth of economy and social well-being, it will be an eye-opener for everyone including the Pahang State government.

We are aware that there has been many studies done within the Fraser's Hill Town Board by our partners of this symposium - Universiti Kebangsaan Malaysia, other universities and researchers. One of the purposes of this symposium was to create a platform for them to showcase the findings of these studies. We also hope this symposium has triggered an interest and enthusiasm among researchers to conduct more studies in the wider forest complex. WWF-Malaysia and Universiti Kebangsaan Malaysia hope to work with the Forestry Department in the near future to conduct a scientific expedition into the interiors of the Fraser's Hill Forest Complex. There will be another symposium then and by that time, we hope it will be conducted face-to face with an opportunity for me to meet all of you in person.

I am thrilled to know of the many findings and new discoveries being showcased at this symposium such as:

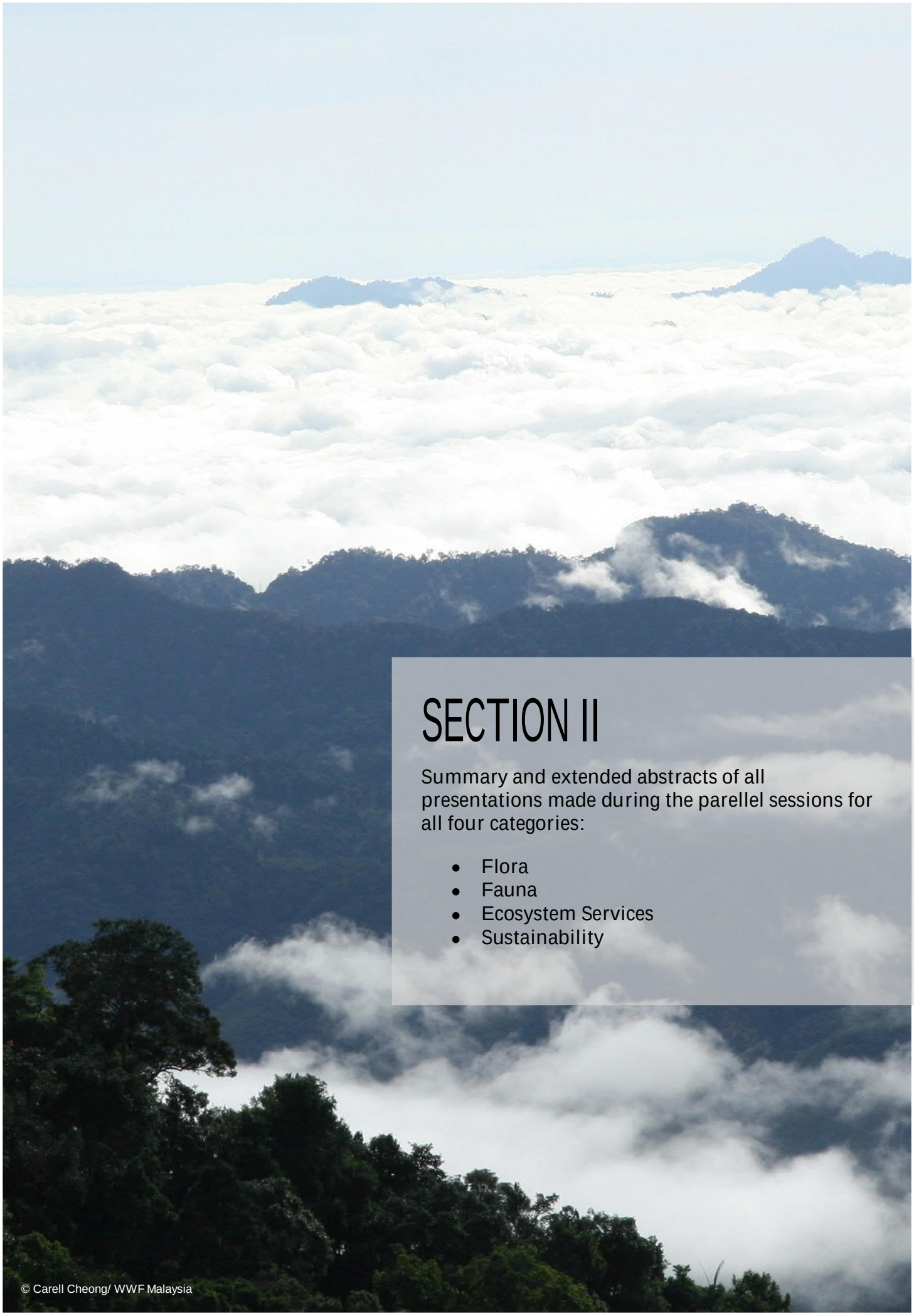
1. The discovery of a new micro-fungi species as a new record in Malaysia;
2. The discovery of 18 new records of moth species in Fraser's Hill;
3. Record of a new butterfly sub-species as an additional taxon in Fraser's Hill;
4. A total of 31 species of non-volant mammals were recorded by camera traps, where 10 species are listed as threatened under the IUCN Red List of Threatened Species;
5. Record of a dragonfly species as endemic to Fraser's Hill; and
6. Record of two new firefly species in Fraser's Hill.

Let me assure you that these records and discoveries will not end here as there is still a biodiversity treasure trove in the wider forest complex waiting for scientists like you to unveil.

After months and even years of research done at this amazing Fraser's Hill Forest Complex, seeing the forest complex's ecosystems and biodiversity thriving for perpetuity is an aspiration that all conservationists alike share. To all the presenters and plenary speakers and especially the keynote speaker, Prof. Emeritus Dato' Dr. Abdul Latiff Mohamad, my sincere gratitude for your time and contributions. To the expert panellists, Prof Amran, Dr Bala and Mr. Surin, thank you for your extremely salient views and suggestions on the way forward. Hopefully this will inspire more research that could translate into actionable plans by the governments. I thank you all.

As a conclusion, I would like to extend my heartfelt appreciation to our partner, Universiti Kebangsaan Malaysia, as well as our funder Entomological Society of Malaysia and with the support from Tourism Pahang. I would also like to thank the organizing committee members who had worked tirelessly to make this symposium a success.

Thank you. Please stay healthy and safe, everyone.



SECTION II

Summary and extended abstracts of all presentations made during the parellel sessions for all four categories:

- Flora
- Fauna
- Ecosystem Services
- Sustainability

FLORA

Summary of papers presented during the flora session:

FLORA01 – Managing the flora of Fraser's Hill to maximise its value as a visitor attraction
Kiew, R.

The author suggests that the roadside environment, because of the fast growing and aggressive nature of weeds, needs proactive management to keep weeds and aggressive aliens at bay but not at the expense of native flowers. Besides that, the author also suggests that there is a need for a simple pictorial guidebook to common flowers that enables a plant to be quickly identified and named with additional information like its origin or uses. This will enhance the value of the flora as an attraction for visitors and photographers because it will enable visitors to quickly identify and learn about the flowers and plants that they see and photograph at Fraser's Hill.

FLORA02 - A collection of Sapotaceae in Fraser's Hill, Pahang, Peninsular Malaysia
Jamaluddin, N.S. & Khamis, S.*

In this study, a total of eight species from three genera of sapotaceae have been recorded in Fraser's Hill. *Payena dasyphylla* is one of the identified species and is listed under the IUCN Red List as an endangered species. The huge year gaps in specimen collections at the herbarium may affect the geographic range data and species distribution information. The authors suggest that the flora inventory and efforts to pile up the specimens for herbarium collection should be extensive in Fraser's Hill. This study concludes by suggesting that the flora inventory needs to be prepared periodically to improve conservation measures and protect Fraser's Hill Forest Complex.

FLORA03 – Diversity of macrofungi in Fraser's Hill
Thi, B.K.*, Mustafa Bakray, N.A., Sanusi, M.S., Wan Azhar, W.M.A., Samsuddin, A.S., & Ahmad, M.F.

This study has shown that Fraser's Hill harbours many different macrofungi and among the collections of macrofungi, *Coniolepiota spongodes* from Agaricaceae was discovered as a new record in Malaysia. It is important that continuous efforts are made to study the diversity of macrofungi. A better understanding of macrofungi diversity is important to determine their potential and utilisation in the medicinal, biotechnology industry and various applications for future uses.

FLORA04 – Some noteworthy mosses from Fraser's Hill, Pahang, Peninsular Malaysia
Norhazrina, N.*, Syazwana, N., Munirah A., & Maideen, H.

Among the mosses found thus far in the Fraser's Hill area, many can be considered as rare and interesting. In this study, the authors reported a total of seven species which are rare and represent a second locality for these particular species in Peninsular Malaysia.

FLORA05 – Notes on the the tree fern genus *Diplazium Swartz* (Athyriaceae) of Fraser's Hill
Mohamad Khaduwi, N.A.*, Maideen, H., & Norhazrina, N.

This study has shown that there are ca. 27 taxa of *Diplazium* recorded in Peninsular Malaysia (Parris & Latiff 1997) in which more than half of the genus (ca. 19 taxa) can be found in Fraser's Hill (Maideen et al. 2001).

Four out of five species of *Diplazium* endemic to Peninsular Malaysia are located in Fraser's Hill, namely *D. angustipinna*, *D. insigne*, *D. kunstleri* and *D. procumbens*.

FLORA06 – Composition and diversity of sapling in Tranum Forest Reserve Fraser's Hill, Pahang, Malaysia
Zohari, A.F., Nizam, M.S., Talip, N.*, & Latiff, A.

This study on the species composition and diversity of saplings conducted in the upper hill dipterocarp forest at the Tranum Forest Reserve, Fraser Hill, Pahang have resulted in 269 individuals belonging to 91 species, 67 genera and 32 families. Saplings especially the dipterocarps, are important for their sustainability because they can grow to big trees. In addition, saplings also provide food resources for many species of insects, birds, and mammals. This study found that the upper hill dipterocarp forest at Tranum Forest Reserve has a high number of saplings.

FLORA07 - Gunung Ulu Semangkok, Selangor: Relevance of early botanical collection today
Aliaa Athirah, A.M*, & Kiew, R.

This study has shown that the flora of Gunung Ulu Semangkuk (GUS) comprises of 273 species of vascular plant in 175 genera and 79 families and 16 % of the species found are endemic to Peninsular Malaysia. Interesting floristic comparisons with Fraser's Hill are possible with early botanical records and shows that oak–laurel forest occur in both areas. Regardless of the similarity of species in both areas, Corybas sp. are not found in GUS. Cloud forest is a small niche with a diverse community which occurs on the summit of GUS. Now, GUS serves as a hiking spot for many nature enthusiasts making the flora habitat threatened by human activities. Conservation management efforts like visitor access control are urgently required to prevent the loss of flora habitat by physical disturbance.

Extended abstracts for all the papers listed above:

FLORA 01

MANAGING THE FLORA OF FRASER'S HILL TO MAXIMISE ITS VALUE AS A VISITOR ATTRACTION

Kiew, R.
Forest Research Institute Malaysia, 52109 Kepong, Selangor, Malaysia
Corresponding author email: *ruth@frim.gov.my*

Abstract

What are visitors supposed to do when they come to Fraser's Hill? One suggestion is that they enjoy the cool climate and natural ambiance and take the opportunity to amble along the roads or forest paths and observe and photograph the birds and flowers. While there are two bird spotters' guides specifically for Fraser's Hill (Strange, M. 2004; Davison et al., 2019), one guidebook for moths should you be out at night (Leong et al., 2005) and one for large toadstools (Thi et al., 2011), there is no information readily available about the flowers of Fraser's Hill although they are prime targets for photographers as they are colourful and don't fly away. But having snapped away, the photographer is left with the dilemma of finding a name for his/her photograph. I can't count the number of times I have been asked "What plant is that?' The answer? There needs to be a handy little book for the flowers of Fraser's Hill. An illustrated guide is particularly important in biodiverse Malaysia where the great majority of flowers do not have common names that can make them inaccessible to the general public. Who knows what the stunningly beautiful *Codonoboea quinquevulnera* looks like unless you see it illustrated. As the proverb says, "A picture is worth a thousand words".

Keywords: Guidebook, weeds, garden escapes, photography, strimming

Flowers and ferns of Fraser's Hill, an Illustrated Guidebook

The first question to ask is what should a guidebook include. With almost a thousand native species known from Fraser's Hill (Kiew, 1998), there is an obvious need to make a selection, but what should be included and what should be left out? I would choose strikingly visible plants from trees to palms to flowers to ferns and also things that fall onto the road, like schima flowers, acorns, wild chestnuts or the helicopter fruits of the wild walnut.

Many flowers that do attract the eye are not native species at all, they may be weeds or garden escapes. These flower almost continuously and, in the case of garden escapes, have been selected for their large and colourful flowers. Obviously, these should be included because they are most likely to be photographed. Information can then be provided as to their origin. Some of these aliens like lantana, snake weed, and white weed are popular with butterflies and so provide an added attraction for visitors and photographers.

.

While the majority of native plants do not have strikingly attractive flowers, or only flower at intervals or infrequently, like the saurauria and codonoboeas, a selection of native species should nevertheless be included on the off chance that the photographer can catch them in flower. So recognising that flowers and ferns are one of the features that make Fraser's Hill attractive as a hill resort, how can the flora be managed to maximise their attractiveness?

Managing the flowers of Fraser's Hill to maximise their attraction

Garden escapes and weeds - are they good or bad?

Weeds in Malaysia are in general light-demanding so are unable to penetrate into the deep shade of the forest. They occupy unstable habitats in full sun, like roadside verges, so they are highly visible and they tend to flower continuously. For example, these include many sorts of composite (sunflower) families. Weeds are therefore the most visible component of the flora at Fraser's Hills and need to be valued as a component of visitor attraction. Garden escapes by their nature means that they have been selected for their attractive flowers or foliage. At Fraser's Hill there is a 'tradition' of dumping garden waste on the opposite side of the road, where it may continue to grow but in general does not spread, nor can it compete with native species and escape into the forest. These are one of the attractive elements of the flora at Fraser's Hill and includes the

large flowered Mexican sunflower, angels' trumpets, morning glory, balsams and on rocks of retaining walls of the 'traditional' bungalow pretty herbs like the bearded begonia, Mexican fleabane, and pink knotweed.

A word on strimming

Strimming is the horticultural practice of cutting grass using a 'strimmer' that whirls a piece of plastic string around at high speed. It is light and very efficient in cutting turf down to ground level and being light can be raised to mow banks.

However, this practice has had a noticeable deleterious effect on the flora of Fraser's Hill. It is particularly serious when used within the forest where it decimates rare native plants that in general are slow growing and will not recover from regular and severe strimming. For clearing paths in forest, staff need to be trained to prune by hand.

Along roadsides, strimming should not be carried out too frequently, should not cut too close or cut the vegetation on roadside banks. Strimming too close cuts off the flowers of even low creeping plants like the lobelia, thereby greatly reducing the attraction of road-side verges to boring green grass. Some native species, like the orchid *Spiranthes*, naturally grows in sandy marginal places but is slow growing and will not survive strimming. Roadside banks are very species diverse and include attractive ferns, gingers, orchids and other mostly native flowers, so should obviously not be decimated.

This destruction of natural wayside vegetation by strimming has also had a deleterious effect on the avifauna as was pointed out by Noramly & Chin, 2001 who noted that "close-shaving of once fern-covered banks has ensured that birds are no longer welcome around roads of the hill resort".

What to do with aggressive aliens?

Aggressive alien plants require proactive management to keep them in check. At Fraser's Hill, two species are of great concern. Creeping Charlie, *Pilea nummulariifolia,* a creeping garden plant grown for ground cover, now forms dense carpets that spread aggressively into the forest and smothers native vegetation. It has apparently become established on roadsides after being discarded from gardens and has now become established in many places. In fact, every time I go to Fraser's Hill I see new patches, which suggests that it is now spread by fragments on the wheels of vehicles. These patches need to be actively managed and vigorously uprooted.

Another species that is cause for concern is the spiked pepper, *Piper aduncum,* an alien large bush or small tree that is very invasive. This has recently become much more common and in some places, forms thickets that prevent the regeneration of native species. This needs to be actively managed too and totally eliminated wherever it occurs as it is noticeably contributing to the deterioration of the quality of native vegetation.

Similarly, lantana needs to be kept in check but need not be eliminated completely because it has attractive flowers and is a useful addition to the roadside flora as a popular butterfly plant.

Conclusion

On the whole the forest is a stable environment and will look after itself needing a minimum of trimming (not strimming!) to keep the trails open. On the other hand, the roadside environment, because of the fast growing and aggressive nature of weeds, needs proactive management to keep weeds and aggressive aliens at bay but not at the expense of native flowers. In other words, while strimming is necessary, do not strim too close or strim up banks or strim too frequently. For the aggressive aliens, there needs to be a special programme to identify *Piper aduncum* and *Pilea nummulariifolia* and to totally exterminate them where found.

Part of the enjoyment of flowers and ferns is being able to name them. There is a need for a simple pictorial guidebook to common flowers that enables a plant to be quickly identified and named with additional information like its origin (if it is a weed) or uses. This will enhance the value of the flora as an attraction for visitors and photographers, because it will enable visitors to quickly identify and learn about the flowers and plants that they see and photograph at Fraser's Hill.

References

Cheong, C. 2013. *Fraser's Hill, a lush highland hideaway*. WWF Malaysia, Kuala Lumpur. 27 pp.

Davison, G. C. Foley & A. Hogg. 2019. *A Naturalist's Guide to the Birds of Fraser's Hill*. John Beaufoy, U.K. 1-179.

Kiew, R. 1998. *The Seed Plant Flora of Fraser's Hill, Peninsular Malaysia with Special Reference to its Conservation Status*. Forest Research Institute Malaysia, Research Pamphlet No.121, pp. 1-121.

Leong, T.M., P.V. Murphy, C.W. Gan, V. D'Rozario,& B.C. Strange. 2005. *Marvellous Moths of Fraser's Hill and other Highlands of Peninsular Malaysia, a Photographic Memoir*. Singapore.

Noramly, G. & A.Y. Chin. 2001. Avifauna of Fraser's Hill. In A. Latiff et al. (eds.) *Bukit Fraser: Persekitaran Fisikal, Biologi & Socio-ekonomi*. UKM. Pp. 181-192.

Strange, M. 2004. *Birds of Fraser's Hill, an Illustrated Guide and Checklist.* Nature's Niche Pte. Ltd. Singapore.

Thi, B., S.S. Lee & N. Zainuddin & H.T. Chan. 2011. *A Guidebook to the Macrofungi of Fraser's Hill*. FRIM, Kepong.

Postscript

Project to provide baseline data for the management of biodiversity to maximise bird populations by managing their plant food source.

It seems to be generally agreed that the birds are not as abundant as they used to be. One causal factor of this may be the gradual deterioration of the forest with a concomitant reduction in the plant food source, whether as a source of nectar, fruit, or foliage-munching invertebrates. For example, is the invasion of aggressive alien species like *Piper aduncum* displacing bird food plants?

While the identity of the avifauna is extremely well known, there is a surprising dearth of information about what birds eat. Figs are touted as an important food source. Thirty species have been recorded from Fraser's Hill with fruit size ranging from 0.5-10 cm diameter, something for every species of bird. But we have no information about the figs' phenology (fruiting seasons). And of course, they are no use for the nectiferous birds. Since bird spotting is usually along the roadsides, the plants they visit should be easy to collect and identify. Once this baseline data is available, it is then possible to ensure firstly that existing vegetation is not degraded, and secondly to try to encourage the establishment of bird-plants.

This is not a difficult project. It just requires good binoculars and camera, expert knowledge of bird identification and to learn how to collect plants to make permanent herbarium collections and deposit them in a herbarium where they can be expertly identified and be a permanent record. This should be carried out over at least one year to ensure that all seasonal variations are covered.

FLORA 02

A COLLECTION OF SAPOTACEAE IN FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA

Jamaluddin, N.S. & Khamis, S.*
Department of Biological Sciences and Biotechnology
Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor
**Corresponding author email: shamsulk@ukm.edu.my*

Abstract

This paper discusses Sapotaceae species in Fraser's Hill, Pahang, Peninsular Malaysia. The family can be found in various forest vegetation and is vital to stabilise the ecosystem. Various types of climbing mammals eat the fruits, while the flowers offer sweet nectar to bats. Although Sapotaceae takes a long time to colonise secondary forests, they are among the prominent families with big tree girth. In Fraser's Hill, plant checklists have been prepared by Burkill, Holttum, Kiew and Turner. However, these checklists require careful examination as current taxonomy trends have changed the concept of many species and families. This paper draws up a list of Sapotaceae species in Fraser's Hill by examining herbarium specimens and searching literature. A total of eight species from three genera have been recorded in Fraser's Hill. *Payena dasyphylla* is one of the identified species and is listed under the IUCN Red List as an endangered species. This study concludes by suggesting that the flora inventory needs to be prepared periodically to improve conservation measures and protect Fraser's Hill Forest Complex.

Keywords: Sapotaceae, Fraser's Hill, herbarium specimens

Introduction

Fraser's Hill is a favoured secluded highland in Peninsular Malaysia for local and foreign tourists to relax and rest. The vegetation in Fraser's Hill remains largely pristine and undisturbed by socio-economic development (Er et al. 2013; Shamsul et al. 2020). The forest is rich in biodiversity. As such, scientists have explored to understand its flora and fauna. According to Latiff (2009), a total of 36 endemic species in Peninsular Malaysia are found in Fraser's Hill. Previously, seed plants checklists in Fraser's Hill have been prepared by Burkill, Holttum and Kiew (Kiew 1992). Due to the changing species classification and taxonomic alignments, many of the concepts of species, genera and families have been altered.

As one of 12 designated megadiversity countries of the world, Malaysia carries a huge responsibility to conserve its natural resources. Preserved specimens collected from various locations in herbaria is one of the most effective conservation measures. A herbarium is a source of knowledge about the flora of a region or locality that provides materials for taxonomic, flora and anatomical studies and is even useful for studying the DNA, numerical taxonomy and others (Nesbitt, 2014). The Forest Research Institute of Malaysia and Universiti Kebangsaan Malaysia have developed a biodiversity website and database providing access to many forest resource collections containing bibliographic and herbarium collections (Suhaimi et al. 2001).

Sapotaceae is one of the families in Ericales (APG 2003) and consists of approximately 50 genera and 1000 species. Currently, in the Malesian region, there are an estimated 15 genera and 300 species (Wilkie, 2011). As mentioned by Turner (1995) there are 10 genera of Sapotaceae in Peninsular Malaysia. Sapotaceae could be found in tropical and subtropical regions with high humidity. Few genera could be found in dry and sub-dry regions (Chai & Yii, 2002). It is a versatile family that can survive in various forest types, such as on the summit of limestone hills, rocky seacoasts and montane forests (Ng 1972).

Although Sapotaceae takes a long time to colonise secondary forests, this family is one of the main families with big tree girths. The trees of Sapotaceae provide good food (fruits and flowers) for bats and small mammals such as monkeys, civets and squirrels (Ng 1972). This underscores the importance of Sapotaceae trees to stabilise the ecosystem. The aim of this paper is to draw up a list of Sapotaceae species in Fraser's Hill.

Materials and Methods

In this study, the data are obtained by examining herbarium specimens and searching the relevant literatures. The Universiti Kebangsaan Malaysia Herbarium (UKMB) and Forest Research Institute of Malaysia Herbarium (KEP) were visited to examine the historical collections. The conservation status of all species is checked from the IUCN Red List website (IUCN 2020).

Results and Discussion

Herbarium specimens

Based on more than 500 specimen collection of Sapotaceae from various genera examined at the Forest Research Institute Malaysia Herbarium (KEP) and Universiti Kebangsaan Malaysia Herbarium (UKMB), only 42 collections of Sapotaceae specimens were collected in Fraser's Hill which consists of five species as listed below.

Palaquium hexandrum (Griff.) Baill

1. Ulu Tranum FR, Abdul Manaf, 229976, 18/2/1951 (KEP)

Palaquium regina-montium Ng

2. Pine Tree Hill, 231243, 27/11/53 (KEP)
3. Pine Tree Hill, 76265, 17/1/54 (KEP)
4. Pine Tree Hill, Ng, 231248, 20/2/67 (KEP)
5. Pine Tree Hill, Ng, 231240, 29/3/67 (KEP)
6. Pine Tree Hill, Kochummen, 231237, 24/3/67 (KEP)
7. Pine Tree Hill, Kochumen, 231248, 24/4/67 (KEP)
8. Pine Tree Hill, Whitmore, 231251, 28/6/69 (KEP)
9. Pine Tree Hill, Ng, 231241, 10/7/67 (KEP)
10. Pine Tree Hill, Ng, 231255, 28/9/67 (KEP)
11. Pine Tree Hill, Ng, 231238, 7/11/67 (KEP)
12. Pine Tree Hill, Ng, 231239, 7/11/67 (KEP)
13. Hutan Pine, MK & RZ, 01908, 27/10/74(UKMB)
14. Bukit Fraser, Noraini, 06162, 11/12/75 (UKMB)
15. Gunung Berembang, Noraini, 04714, 11/12/75 (UKMB)
16. Pine Tree Hill, Pennington & Kochummen, 231253, 9/10/81 (KEP)
17. Roadside, Saw, 67657, 28/11/88 (KEP)
18. Pine Tree Hill, Wilkie, 188543, 7/3/2011 (KEP)
19. Pine Tree Pine Tree Hill, Wilkie, 188542, 7/3/2011 (KEP)
20. Pine Tree Hill, Wilkie, 188542, 7/3/2011 (KEP)

Pouteria firma (Miq.) Baehni

21. Path to Pine Tree hill, FRI1946, 20/2/67, (KEP 4043)
22. Path to Pine Tree hill, FRI1947, 20/2/67 (KEP 4044)
23. Path to Pine Tree Hill: Ridge forest FRI5586, 10/7/67 (KEP4047)
24. Fraser Hill, FRI9071, 15/3/68 (KEP 4040)

Pouteria glabra (Ridl.) I. M. Turner

25. Road to waterfall Frasers hill, Ng, FRI5987 (KEP 4054)
26. Path to Pine Tree Hill,17/1/54 (KEP 4061)
27. Path to Pine Tree Hill, Ng, FRI1943, 20/2/67(KEP)
28. Path to Pine Tree Hill, Ng, FRI5002, 29/3/67 (KEP 4059)
29. Path to Pine Tree Hill, Ng, FRI5003, 29/3/67 (KEP 4063)
30. Path to Pine Tree Hill, Ng, FRI5001, 29/3/67 (KEP 4051)
31. Path to Pine Tree Hill: Primary forest, Kochummen, FRI2308, 24/4/67 (KEP4060)
32. Path to Pine Tree Hill, FRI5588, 10/7/67 (KEP 4064)
33. Path to Pine Tree Hill: primary ridge forest, Ng, FRI5712, 28/9/67 (KEP 4053)
34. Frasers Hill, Benjamin, 7420, 26/10/1967 (KEP8534)

35. Path to Pine Tree Hill, Ng, FRI5821, 7/11/67 (KEP 4062);
36. Frasers Hill: primary hill side, 98151,11/12/68 (KEP 4056)
37. Road to waterfall Fraser's Hill, Ng, FRI5988, 8/3/68 (KEP 4052)
38. Frasers Hill, FRI 22213, 8/4/1976 (KEP 91414)
39. Ulu Jeriau rigde west of waterfall, Whitmore, FRI20418, 28/8/71 (KEP 4055)
40. Trail to Pine Tree Hill, Pennington & Kochummen, K.M. 10262, 9/10/81 (KEP4057)

Pouteria obovata (R. Br.) Baehni

41. Bukit Fraser, 00349, 27/7/70 (UKMB)
42. Fraser Hill, 10678, 27/7/70 (UKMB

There is only one specimen collection of *Palaquium hexandrum* (Fig. 1), commonly known as *Nyatoh jambak* because they have six stamens, which was collected from Ulu Tranum Forest Reserve by Abdul Manaf on 18/2/1951. However, according to Ng (1972), *Palaquium hexandrum* is a big-tree species distributed widely in Peninsular Malaysia. It is curious as to why there is only one specimen for this species available in the herbarium collection.

Figure 1. Herbarium specimen of *Palaquium hexandrum* collected on 18 February 1951

Palaquium regina-montium is a species endemic to montane forests and abundantly found and collected in the path of Pine Tree Hill, Fraser's Hill. The oldest specimen collection for *Palaquium regina-montium* was collected on 27/11/53. Wilkie retraced *Palaquium regina-montium* on 7/3/2011 at Pine Tree Hill because the previous most recent collection of herbarium specimens for this species was 23 years back which was collected by Saw at the roadside somewhere in Fraser's Hill on 28/11/88. A large number out of 19 collections were collected in Pine Tree Hill, however there is one collection in UKMB collected from Mount Berembang, Fraser's Hill on 11/12/75 by Noraini.

On the other hand, the collection for *Pouteria firma* was very little, which is four collections and collected in the year of 1967 and 1968. The current classification has changed and stated that *Pouteria firma* is one of the

synonyms for *Pleioluma firma* (Miq.) Swenson. Most likely this is one of the reasons why there was not much collection, yet further studies need to be conducted so that confusion among researchers can be reduced.

Kiew (1992) and Turner (1995) mentioned that *Pouteria glabra* or formerly known as *Planchonella glabra* was only found in Fraser's Hill, but currently the herbarium specimen collections showed that this species can be found in different localities. The oldest herbarium specimen collection for this species was collected on 17/1/54 and the most recent specimen collected by Pennington & Kochummen on 9/10/81. All the 16 specimen collections for this species was collected in three localities in Fraser's Hill which was at Ulu Jeriau, Pine Tree Hill and somewhere near the waterfall.

The finding of *Pouteria obovata* specimens collected from Fraser's Hill is a bit odd because this species is commonly found on rocky and sandy seacoasts and limestone hills (Ng 1972). Even though current classification states that *Pouteria obovata* and *Pouteria glabra* is the synonym name for *Planchonella obovata*, authors feel there is a need for further study about these two species as previous studies and herbarium collection for both species were mostly recorded from different ecological habitat.

Literature search

Henderson (1927) mentioned that three species were identified which are *Sideroxylon* sp., *Payena* sp. and *Sideroxylon firmum* (Miq.) Pierre ex Burck or the current name for this species is *Pouteria firma* (Miq.) Baehni. Kiew (1992) recorded four species in Fraser's Hill which are *Palaquium regina-montium* Ng, *Payena lucida* A. DC., *Pouteria firma* (Miq.) Baehni and *Pouteria glabra* (Ridl.) I. M. Turner. Her works are based on herbarium specimens, field collection and literature search. The authors believe that most of the herbarium specimens that she mentioned are the same specimens that we examined.

On the other hand, Shamsul et al. (2020) recorded four genera and six species in a 2-ha permanent plot at Jeriau Valley, Fraser's Hill. Out of six species, *Payena dasyphylla* (Miq.) Pierre and *Pouteria malaccensis* (C. B. Clarke) Baehni are only mentioned in their paper. Turner (1995) checklist for Sapotaceae in Peninsular Malaysia are the most recent checklist, however from his checklist, he mentioned only one species is specifically found in Fraser's Hill which is *Pouteria glabra*. Therefore, the authors managed to draw up eight species from three genera of the recorded and collected Sapotaceae species in Fraser's Hill (Table 1). Each of the species conservation status is checked in the IUCN Red List website (IUCN 2020).

Table 1. List of Sapotaceae species was collected from Fraser's Hill based on the UKMB and KEP herbarium collections and literature search and the conservation status.

Genus	Species	Location in Fraser's Hill	IUCN conservation status
Palaquium	*Palaquium hexandrum*	Ulu Tranum FR	Near Threatened
	Palaquium regina-montium	Pine Tree Hill	Near Threatened
Payena	*Payena dasyphylla*	Jeriau Valley, Fraser's Hill	Endangered
	Payena lucida	Not stated	Near Threatened
Pouteria	*Pouteria firma*	Pine Tree Hill & Jeriau	Least concern
	Pouteria glabra	Pine Tree Hill, Ulu Jeriau ridge west of waterfall & Road to waterfall Fraser's Hill	-
	Pouteria obovata	Not stated	-
	Pouteria malaccensis	Jeriau Valley, Fraser's Hill	Near Threatened

Conclusion

The study found that specimens in the UKMB and KEP herbarium are not the current collections as most of the collections were collected in the 20th century. The huge year gaps in specimen collections at the herbarium may affect the geographic range data and distribution information species. Therefore, the authors suggest that the flora inventory and efforts to pile up the specimens for herbarium collection should be extensive in Fraser's Hill.

Moreover, conserving the Fraser's Hill Forest Complex is very important as it has one species listed under the IUCN Red List as endangered species, which is *Payena dasyphylla*, and three species are listed as near threatened, which are *Payena lucida*, *Palaquium hexandrum* and *Palaquium regina-montium*. This study contributes to the Sapotaceae composition checklist in Fraser's Hill.

Acknowledgements

The authors would like to thank the Forest Research Institute Malaysia Herbarium (KEP) and Universiti Kebangsaan Malaysia Herbarium (UKMB) curator for their assistance. Special thanks to Prof. Emeritus Dato' Dr. Abdul Latiff Mohamad as internal reviewer and making this work possible.

References

APG (The Angiosperm Phylogeny Group). 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society* 141: 399-436.

Chai, P.P.K. & Yii, P.C. 2002. Sapotaceae In Soepadmo, E., Saw, L.G. & Chung, R.C.K. (pnyt.). *Tree Flora of Sabah and Sarawak* 4: 203-345.

Er, A.C., Sheau, T. C., Habibah, A., Sarmila M.S., & Zaimah, R. 2013. The Sustainability of Fraser's Hill as an Eco-destination. *International Journal of Business Tourism and Applied Sciences* 1(2): 109-115.

Henderson, M. R. 1927. Additions to the list of Fraser Hill plants. *Grads' Bull. Str. Settle*. 4:92-105.

IUCN-International Union of Conservation of Nature. 2020. *The IUCN Red List of Threatened Species.* (Online) http://www.iucnredlist.org/search (13 September 2020).

Kiew, R. 1992. *Checklist of Seed Plants at Fraser's Hill and Their Conservation Status*. Report of WWF Project No. MYS 213/91. WWF Malaysia.

Latiff, A. 2009. Flora of Bukit Fraser. Bukit Fraser: *Crown of the Titiwangsa Range* (Eds A. Latiff, M. Abdullah, N. Ahmad, J.H.). Fraser's Hill Research Centre and Fraser's Hill Development Corporation, Selangor.

Nesbitt, M. 2014. Use of herbarium specimens in ethnobotany. In Salick, J., Konchar, K. and Nesbitt, M. (Eds). *Curating Biocultural Collections: A Handbook*. 22: 313-328.

Ng. F.S.P. 1972. Sapotaceae. In Whitmore, T.C. (Eds.). *Tree Flora of Malaya Jilid 1*: 388-439.

Shamsul, K., Nik Norafida, N. A., Mat-Salleh, K. & Latiff, A. 2020. Tree Species Composition, Diversity and Biomass Estimation in Lower Montane Forest at Fraser's Hill, Pahang, Peninsular Malaysia. *The Malaysian Forester* 83 (1): 114 – 127.

Suhaimi, N. Mat Salleh, K. Itam, K. & Latiff, A. 2001. Biodiversity Databases for Malaysian Flora and Fauna: An Update. *IWS2001 Proceedings.*

Turner, I. M. 1995. A catalogue of the vascular plant of Malaya. *The Garden Bulletin Singapore* 47 (1 & 2): 1-157.

Wilkie, P. 2011. Towards an account of Sapotaceae for Flora Malesiana. *Gardens' Bulletin Singapore* 63(1&2): 145-153.

FLORA 03

DIVERSITY OF MACROFUNGI IN FRASER'S HILL

Thi, B.K.[1]*, Mustafa Bakray, N.A.[2], Sanusi, M.S.[1], Wan Azhar, W.M.A.[1], Samsuddin, A.S.[1], & Ahmad, M.F.[1]
[1]Mycology and Pathology Branch, Forest Biodiversity Division,
Forest Research Institute Malaysia (FRIM), 52109 Kepong, Selangor.
[2]Department of Biological Sciences and Biotechnology, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor.
**Corresponding author email: thibeekin@frim.gov.my*

Abstract

Fraser's Hill consists of hill and montane forest ecosystems with rich diversity of mosses, fungi, plants and insects. However, little study was conducted on the diversity of macrofungi in these forests. Therefore, efforts were made to explore the forests in Fraser's Hill and surveys were carried out from the year 2007 to 2010. The aim of this study is to collect and document the diversity of macrofungi of hill and montane forests in Fraser's Hill. A total of 374 collections from the order of Agaricales, Auriculariales, Boletales, Cantharellales, Dacrymycetales, Geastrales, Hymenochaetales, Leotiales, Polyporales, Russulales and Xylariales were made from the 20 expeditions conducted in Fraser's Hill. The highest macrofungi collection was from the order of Boletales and Russulales. Among these collections, *Coniolepiota spongodes* was discovered and newly recorded in Malaysia. Collections from these expeditions were gathered and recorded into FRIM's database. Dry voucher specimens were also kept systematically in the Fungarium in FRIM. It is important to document the diversity of macrofungi in Fraser's Hill. The information gathered will contribute to the knowledge of macrofungal diversity in Malaysia; and improve the global understanding on the diversity and distribution of macrofungi in the hill and montane forest ecosystems.

Keywords: macrofungi, diversity, montane forest, Fraser's Hill

Introduction

Fraser's Hill, located in the state of Pahang, is one of the popular highlands in Peninsular Malaysia. Fraser's Hill has altitudes that ranged from 1200 to 1505 meters above sea level and consists of lower montane forest, upper montane forest and ericaceous forest. It has rich biological diversity not only in ferns, mosses, orchids, plants but also birds, herpetofauna and other wildlife. The diversity of flora and fauna at Fraser's Hill are well studied. There are 952 plant species in 405 genera and 120 families documented from Fraser's Hill (Kiew 1998). Besides plants, 36 species of leaf beetle (Abdullah Muhaimin *et al*. 2019) and 280 bird species were also reported from Fraser's Hill (Davidson *et al.* 2019).

Macrofungi or larger fungi have visible structures or fruiting bodies and are commonly known as mushrooms. In Malaysia, only about 3,000 species of fungi have been documented and it is estimated that up to about 70% of the fungi in Malaysia are yet to be discovered and described. The documentation of macrofungi in tropical forests in Malaysia is still very much lacking, thus, it is important to obtain further information about its diversity. It is believed that the montane forest at Fraser's Hill has high diversity of macrofungi and is an excellent site for further exploration. Therefore, macrofungi surveys were conducted from the year 2007-2010 to document the diversity of macrofungi from the hill and montane forests in Fraser's Hill.

This paper presents the macrofungal diversity from the montane forests at Fraser's Hill. We hope that this information can contribute to a better understanding of the macrofungal diversity in montane forests of Malaysia.

Materials and Methods

Sampling and collecting sites

Macrofungi were collected along the road banks and eight main forest trails at Fraser's Hill. The trails are Abu Saudi Trail, Bishop Trail, Hemmant Trail, Mager Trail, Pine Tree Trail, Kindersley Trail, Rompin Trail and Maxwell Trail. Surveys were conducted from the year 2007 to 2009. The sampling of macrofungi was carried out twice a year, in the months of April and September for the year 2007 to 2010; and once every

month in the year of 2008 and 2009 except for the period when it was difficult in accessing Fraser's Hill, due to landslides during the rainy season.

Specimens collected were labelled with field numbers and photographed. Their habitats were noted and the corresponding locations including altitude were recorded using GPSmap 76CSx in the field. The collected specimens were kept in wax or aluminium foil paper packets, to prevent dehydration, before being brought back to the laboratory for description.

Macrofungi descriptions and identification

Fresh specimens were described based on their macroscopic characteristics; and the colour according to the Flora of British Fungi Colour Identification Chart (Anonymous 1969) and The Online Auction Color Chart (Anonymous 2004). Spore prints were prepared and the specimens were later dried at 45ºC in a ventilated portable dryer. The dried and labelled specimens are kept in the fungal herbarium at FRIM. Identification was made according to their macroscopic and microscopic characteristics using identification keys.

Results and Discussion

Macrofungal diversity

A total of 374 collections, with 104 species distributed in 33 families and 75 genera, were collected during the surveys conducted from the year 2007 to 2010 (Table 1). In addition to the collected members of the basidiomycota, members of the Ascomycota, i.e. *Leotia* sp. (commonly known as jelly baby fungi), *Xylaria* sp. and *Xylaria polymorpha* (commonly known as dead man's fingers) were also found growing on rotted wood in this forest. The collected macrofungi were grouped into 11 major orders: Agaricales, Auriculariales, Boletales, Cantharellales, Dacrymycetales, Geastrales, Hymenochaetales, Leotiales, Polyporales, Russulales and Xylariales. The findings from this study were also illustrated and published in Thi and Lee (2010) and Thi *et al.* (2011).

The largest number of macrofungi species collected between 2007 and 2010 were from the family of Boletaceae (14 species in 85 collections), followed by Polyporaceae (12 species in 17 collections) and Russulaceae (9 species in 110 collections). Both fleshy bolete fungi and polypore fungi were commonly encountered in Fraser's Hill. According to Hattori *et al*. (2007), polypores are species-rich in Malaysia where its diversity is high in lowland rainforest. Polypore fungi in montane forest at Fraser's Hill also showed high diversity in this study. The species of *Russula*, with 110 collections, were frequently observed along the trails and mossy banks during its blooming season, making it the highest collection in our collecting trips. Among these collections, *Coniolepiota spongodes* from Agaricaceae was discovered as a new record in Malaysia.

Table 1. Number of species and collections of macrofungi collected annually between 2007 and 2010 from montane forest at Fraser's Hill

Fungal families	Year				Total species (collection number)
	2007	2008	2009	2010	
ASCOMYCOTA					
Leotiales					
Leotiaceae	1(1)			1(1)	1(2)
Xylariales					
Xylariaceae	2(3)	1(1)			2(4)
BASIDIOMYCOTA					
Agaricales					
Agaricaceae	2(4)	1(2)	1(2)	2(2)	5(10)
Amanitaceae	1(1)	2(2)	2(2)		3(5)
Clavariaceae		1(2)			1(2)
Entolomataceae	5(13)	1(2)		1(1)	5(16)

Hydnangiaceae	1(2)	1(9)	1(5)	1(1)	1(17)
Hygrophoraceae	3(3)	2(9)	1(2)	2(2)	4(16)
Hymenogasteraceae		1(1)	2(2)	1(1)	3(4)
Inocybaceae	1(1)	2(2)	1(1)	1(1)	2(5)
Lyophyllaceae		1(1)			1(1)
Marasmiaceae	1(1)	2(2)		1(1)	4(4)
Mycenaceae	2(2)	2(3)	1(1)		3(6)
Physalacriaceae		1(1)	1(1)	1(2)	3(4)
Pleurotaceae	1(1)				1(1)
Psathyrellaceae	5(5)				5(5)
Tricholomataceae		1(2)			1(2)
Auriculariales					
Auriculariaceae		1(1)			1(1)
Boletales					
Boletaceae	2(22)	11(37)	6(23)	3(3)	14(85)
Calostomataceae					1(1)
Sclerodermataceae	2(2)	1(20)	1(7)	2(2)	2(31)
Gomphidiaceae		1(1)			1(1)
Cantharellales					
Cantharellaceae	1(1)	2(2)		2(3)	5(6)
Dacrymycetales					
Dacrymycetaceae				1(1)	1(1)
Geastrales					
Geastraceae		1(1)			1(1)
Hymenochaetales					
Hymenochaetaceae	1(1)	5(5)			5(6)
Polyporales					
Formitopsidaceae	1(1)				1(1)
Ganodermataceae		2(3)			2(3)
Meripilaceae	1(1)	1(1)			1(1)
Polyporaceae	8(11)	5(6)			12(17)
Russulales					
Auriscalpiaceae	1(1)				1(1)
Russulaceae	3(29)	4(55)	2(15)	2(11)	9(110)
Steraceae	1(3)	1(1)			2(4)
	46(109)	54(172)	19(61)	21(32)	104(374)

Conclusion

Fraser's Hill harbours many different macrofungi. It is important that continuous efforts were made to study the diversity of macrofungi. A better understanding of macrofungi diversity is important to determine their potential and utilisation in the medicinal, biotechnology industry and various applications for future uses.

Acknowledgements

The authors would like to thank Fraser's Hill Development Corporation for granting permission to conduct the research on macrofungi at Fraser's Hill. They would also like to thank the Department of Wildlife and National Parks for the invitation to join the expedition to Fraser's Hill in July 2008.

References

Abdullah Muhaimin M.D., Wan Nur Madihah W.A.H., & Salmah Y. 2019. The diversity and richness of leaf beetles (Coleoptera: Chrysomelidae) at Fraser's Hill, Pahang, Malaysia. *AIP Conference Proceedings* 2111, 060001.

Anonymous. 1969. *Flora of British fungi colour identification chart*. Edinburgh, London: Her Majesty's Stationery Office.

Anonymous. 2004. *The Online Auction Color Chart*. www.OnlineAuctionColorChart.com

Davidson, G. Foley, C. & Hogg, A. 2019. *A Naturalist's Guide to the Birds of Fraser's Hill and the Highlands of Peninsular Malaysia*, pp 176. Oxford: John Beaufoy Publishing Ltd.

Hattori, T, Noraswati, M.N.S. & Salmiah, U. 2007. Basidiomycota: diversity of Malaysian polypores, pp 55-68. *Malaysian Fungal Diversity*. Jones, E.B.G., Hyde, K.D. & Vikineswary, S. (eds.). Kuala Lumpur: Mushroom Research Centre, University of Malaya and Ministry of Natural Resources and Environment Malaysia.

Kew, R. 1998. *The seed plants at Fraser's Hill, Peninsular Malaysia with special reference to its conservation status*, pp 121. Research Pamphlet No. 121. Kepong: Forest Research Institute Malaysia.

Thi, B.K. & Lee, S.S. 2010. Macrofungi of Fraser's Hill: Part 1. *Conservation Malaysia* 11: 6-8.

Thi, B.K., Lee, S.S., Zainuddin, N. & Chan, H.T. 2011. *A Guidebook to the Macrofungi of Fraser's Hill*, pp 93. Siri Alam dan Rimba No. 14. Kepong: Forest Research Institute Malaysia.

FLORA 04

SOME NOTEWORTHY MOSSES FROM FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA

Norhazrina, N.[1,2]*, Syazwana, N.[1], Munirah A.[1], & Maideen, H.[1,2]
[1]*Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*
[2]*Bukit Fraser Research Centre, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*
**Corresponding author email: riena@ukm.edu.my*

Abstract

A total of seven species of mosses from Fraser's Hill that are considered as rare and interesting are discussed. These noteworthy species are *Actinodontium rhaphidostegum* (Müll. Hal.) Bosch & Sande Lac., *Atrichum undulatum* (Hedw.) P. Beauv., *Breutelia arundinifolia* (Duby) M. Fleisch., *Cyathophorum hookerianum* (Griff.) Mitt., *Distichophyllidium nymanianum* M. Fleisch., *Pogonatum camusii* (Thér.) A. Touw and *Rhodobryum giganteum* (Schwägr.)

Keywords: mosses, diagnostic characters, Fraser's Hill

Introduction

Many floristic studies on the mosses of Peninsular Malaysia have been carried out, especially in the state of Pahang where two of the famous and frequently visited hill stations are located, namely Fraser's Hill and Cameron Highlands. Fraser's Hill which was developed in the late 1919 has been well botanised since the early days. This area was visited by prominent botanists such as H.N. Ridley, I.H. Burkill and R.E. Holttum from the Singapore Botanical Garden. The report on the mosses of Fraser's Hill began with Dixon (1924), who recorded four species. Two years later, in a list of mosses in Peninsular Malaysia, 25 taxa in 18 genera and 13 families of mosses from Fraser's Hill were enumerated (Dixon 1926). A more comprehensive study of mosses in this hill was conducted by Tixier (1971), where 78 taxa in 50 genera and 26 families were recorded. In another publication, Noguchi (1973) enumerated 15 taxa of mosses in 12 genera and eight families based on H. Inoue's collections made in 1965 to 1966. Damanhuri and Nizam (2001) reported 108 taxa in 57 genera and 26 families of mosses from the area based on a study on the specimens kept in the Herbarium of Universiti Kebangsaan Malaysia (UKMB). In a coffee table book of Fraser's Hill, Damanhuri (2009) published some common pictures of mosses of Fraser's Hill. Recently, Damanhuri et al. (2015) listed 75 taxa of mosses in 41 genera and 19 families from areas known as Raub-Fraser's Hill corridor.

Among the mosses found thus far in the Fraser's Hill area, many can be considered as rare and interesting. In this paper, we reported a total of seven species which are rare and represent a second locality for that particular species in Peninsular Malaysia.

Materials and Methods

Moss specimens kept in UKMB Herbarium collected at Fraser's Hill in the past and present days have been examined. The diagnostic characters of those selected rare species were noted including information regarding collectors, altitudes, dates, and localities of each specimen collected. The microhabitats of all the moss species reported here such as tree trunks, buttresses, rotten logs, twigs, surfaces of rocks, soil and soil banks were noted. All information on the species reported by Tixier (1971) were taken from the literature.

Results and Discussion

1. ***Actinodontium rhaphidostegum*** (Müll. Hal.) Bosch & Sande Lac., Bryologia Javanica 2: 37. 160. 1862. Fraser's Hill: On trunks of tree-ferns in open areas along the road to Ye Olde SmokeHouse, ca. 1400 m alt., A. *Damanhuri & T.H. Wong 4060, 4065, 4070, 4079.*

   Fraser's Hill represents the second locality for this species in Peninsular Malaysia after Cameron Highlands, where it has been collected on tea plants. This particular species can easily be recognised by the oblong-lanceolate leaves, long acuminate apices, costa double, unequal in length and extending

beyond midleaf; laminal cells elongate-rhomboid to elongate-hexagonal, thin-walled and smooth. Seta erect, up to 6 mm long and smooth. Calyptra mitrate, laciniate at base, covering only the top of capsule. Operculum rostrate (Mohamed & Robinson 1991).
Distribution: Borneo, Indonesia (Celebes, Java), Peninsular Malaysia and Philippines.

2. ***Atrichum undulatum*** (Hedw.) P. Beauv., Prodrome des Cinquième et Sixième Familles de l'Aethéogamie 42. 1805. (Fig.1).
Fraser's Hill: On soil in an exposed area at the entrance of Bishop trail, ca. 1000 m alt., *N. Norhazrina 5481*.
This interesting species was recently found growing on the ground at just one locality in Fraser's Hill. The other locality where this species occurs is Cameron Highlands, where it can be seen colonising open places.
Atrichum can be separated without any difficulty from the genus *Pogonatum*, the other more common and widespread genus in Polytrichaceae recorded in Peninsular Malaysia, by the presence of multicelled lamellae confined only to the upper part of the costa. In species of *Pogonatum*, the lamellae are found only on the lamina of the leaf. Another distinct feature of this species that can instantly separate it from species of *Pogonatum* is the presence of teeth of the leaf lamina (Mohamed & Mohamed 1986). This species is mainly confined to the northern Hemisphere and Peninsular Malaysia seems to be its southernmost range extension in Asia.
Distribution: Algeria, Canada, Europe, Japan, Macaronesia, Peninsular Malaysia, Philippines and Tunisia.

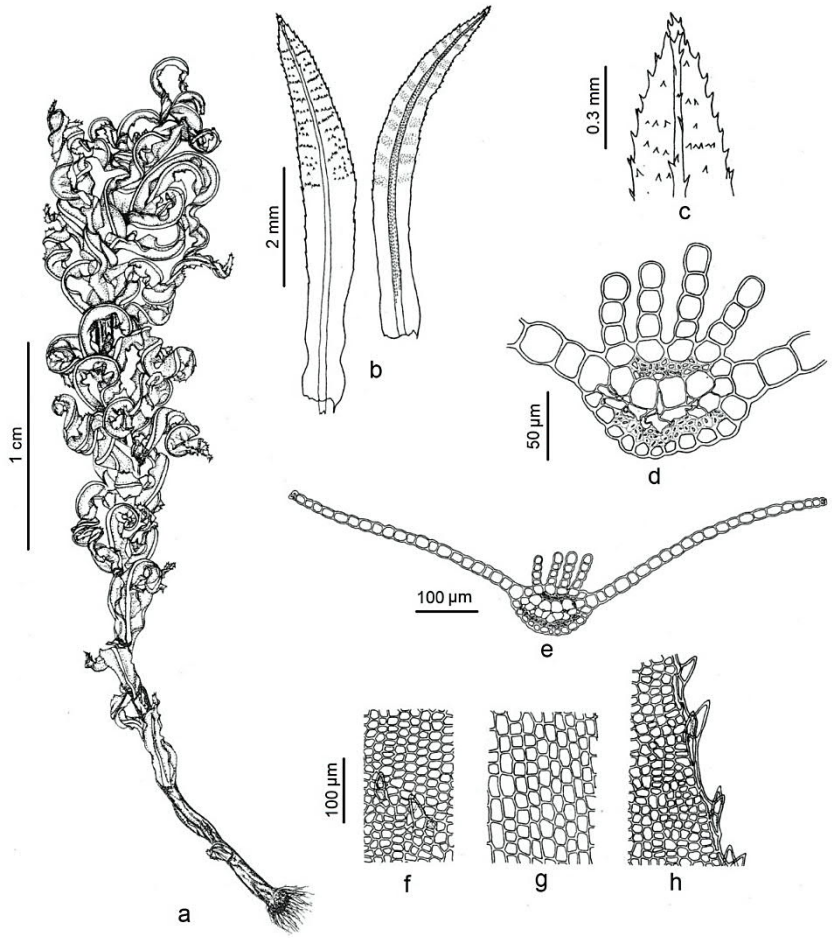


Fig. 1. *Atrichum undulatum* (Hedw.) P. Beauv. a) Plant (dry), b) leaves, c) apex, d) cross section of costa, e) cross section of leaf, f) upper laminal cells, g) basal lamina cells, and h) leaf margin.

3. ***Breutelia arundinifolia*** (Duby) M. Fleisch., Die Musci der Flora von Buitenzorg 2: 630. 120 (1904)
Fraser's Hill: On base of tree-fern in partial shade at Jeriau Waterfalls, ca. 1400 m alt., *A. Damanhuri s.n.*
This montane species was first reported in Peninsular Malaysia by Manuel (1981) based on specimens collected on the summit of Gunung Ulu Kali, Genting Highlands, Pahang. The presence of this species in Fraser's Hill was reported by Damanhuri and Nizam (2001) based on a single collection from Jeriau Waterfalls.
In the field, this species can be recognised at a glance, by the robust plant with squarrose widely spreading, bright yellowish-brown or golden-brown leaves distributed along slender strongly tomentose stems. Leaves linear-lanceolate, deeply plicate, glossy, margin serrate from apex to mid-leaf, costa thin, excurrent; laminal cells linear, almost rectangular near leaf apex; papillose alar cells large, hyaline, quadrate to rectangular.
Distribution: Borneo, China, Indonesia (Celebes, Java, Sumatra), Japan, Papua New Guinea, Peninsular Malaysia, Taiwan and United States of America (Hawai) (Virtanen 1997).

4. ***Cyathophorum hookerianum*** (Griff.) Mitt., Journal of the Proceedings of the Linnean Society, Botany, Supplement 1(2): 147 (1859)
Fraser's Hill: On tree trunks in an open area in evergreen forest, ca. 1400 m alt., *P. Tixier 4827* (as *Cyathophorella tenera*); On trunk of tree-fern, in full shade near Temerloh Bungalow, ca. 1400 m alt., *A. Damanhuri, A. Zainudin & M. Nizam 2000-42* (as *Cyathophorella burkillii*).
Prior to the discovery of *Cyathophorum hookerianum* in Fraser's Hill, this species was reported only from Cameron's Highlands where it grows epiphytically in moist, shady valleys.
This species is characterised by robust, dull green, flatten plants. Lateral leaves ovate-lanceolate, asymmetrical apex, long aristate, margin distantly and irregularly toothed above, costa short, ending below midleaf, median laminal cells oval-hexagonal. Amphigastrium symmetrical, ovate, short acuminate with long arista, costa variable, absent or ending below midleaf (Mohamed & Robinson 1991).
Distribution: China, India (Sikkim), Japan, Peninsular Malaysia, Philippines and Vietnam.

5. ***Distichophyllidium nymanianum*** M. Fleisch., Die Musci der Flora von Buitenzorg 3: 967, f. 167: a-e (1908)
Fraser's Hill: On trunks of tree-fern in forested area in full shade behind the golf course, ca. 1400 m alt., A. *Damanhuri & T.H. Wong 4082.*
This rare monotypic genus was first described by Fleischer (1908) from West-Java, Indonesia. In Peninsular Malaysia, it was first reported to occur only in Cameron Highlands (Mohamed & Robinson 1991). This species often grows in thick large mats on the trunk of trees in montane forest.
This species consists of small plants in light green to brownish-green mats. Leaves ovate, carinate, concave, apex acute to obtuse, ending in a long flexuose arista, limbidium well differentiated, costa lacking, laminal cells hexagonal, thin-walled, seta, smooth, up to 4.5 mm high, capsule erect to suberect, ovoid. Calyptra smooth, fringed at base. The unique features such as the small ecostate leaf with long flexuose arista and strongly carinate leaf-base and papillose peristome will separate this species from others (Mohamed & Robinson 1991).
Distribution: Indonesia (Java), New Guinea and Peninsular Malaysia.

6. ***Pogonatum camusii*** (Thér.) A. Touw, Journal of the Hattori Botanical Laboratory 60: 26 (1986)
Fraser's Hill: On roadside soil banks, in partial shade at the Gap, 850 m alt., *A. Damanhuri s.n.*
This species was discovered in Peninsular Malaysia during an expedition to Pulau Langkawi in 2003. It was collected on soil at the summit of Gunung Raya (Mohamed et al. 2005). In mainland Peninsular Malaysia it was only found on roadside banks at the Gap area in Fraser's Hill where it is often overlooked due to its small size. Its presence in an area is usually betrayed by the neat and conspicuous whitish campanulate calyptra at the end of an elongated seta.
This moss is characterised by the small, delicate, pale green plants. Leaves soft and flaccid. The lower leaves are very small, scale-like, squarrose-recurved with undulate margin, broadly ovate, to almost circular, often with a short, strongly recurved filiform apiculus. Upper leaves ovate to narrowly lanceolate, apex gradually tapering to a filiform acumen. Leaf margin becomes sinuose and more coarsely denticulate

or irregularly bluntly dentate upward, often with long and blunt unicellular teeth, finger like pluricellular teeth, or cilia below the apex. Costa single, faint ending below apex or lacking. Upper laminal cells are isodiametric to shortly elliptic. Seta 1-3 cm long, scabrous (Touw 1986). The peculiar feature of this tiny moss will distinguish it from other species in the genus.
Distribution: Indonesia (Flores, Sumatra), Japan (Ryukyu), Peninsular Malaysia, Philippines (Luzon, Mindanao), Taiwan, Thailand and Vietnam.

7. ***Rhodobryum giganteum*** (Schwägr.) Paris, Index Bryologicus 1116 (1898)
Fraser's Hill: On soil banks, ca. 1400 m alt., *P. Tixier 4606*
This species is the largest *Rhodobryum* in Peninsular Malaysia reaching 7 cm high and confined to Cameron Highlands. Tixier (1971) reported this species from Fraser's Hill. Since the collection by Tixier in 1969, no other collection of this species was made in Fraser's Hill.
Rhodobryum giganteum has small appressed leaves in the lower part of stem and a terminal rosette consisting of very large leaves. Leaves spathulate from a narrow base, apex acuminate, costa percurrent to shortly excurrent or sometimes ending below apex. Cross section of costa with small bundles of hydroids in the middle, without stereids. Upper margin dentate with biseriate teeth. Seta up to 5 cm long, capsule suberect to horizontal.
The presence of biseriate teeth on the leaf margin, hydroids in the centre of costa (seen in cross-section) and the absence of stereid will easily separate it from other species in the genus.
Distribution: Madagascar, South Africa, Southeast Asia (Himalayas, Japan, New Guinea, Peninsular Malaysia) and southern provinces of China.

Conclusions

Although many studies on mosses have been conducted in Fraser's Hill, however, there are still new findings being discovered in almost every collecting trip made to the area. Species that have been reported from only one locality eventually were found in other localities due to more bryoflora explorations that have been carried out in various forest reserves in Peninsular Malaysia. Thus, more studies still need to be carried out in order to discover more interesting findings, perhaps new records for Peninsular Malaysia or new species to science.

Acknowledgements

The authors would like to express their appreciation to World Wildlife Fund for Nature (WWF) Malaysia and Bukit Fraser Research Centre, Faculty of Science and Technology, Universiti Kebangsaan Malaysia for organizing the Fraser's Hill Symposium. This research was partly supported by Universiti Kebangsaan Malaysia (GUP-2018-016) and Ministry of Higher Education (FRGS/1/2017/STG03/UKM/02/2) grants.

References

Damanhuri, A. 2009. The mosses. In Latiff, A., Maimon, A., Norhayati, A. & Jumaat H. A. (eds.). *Bukit Fraser Crown of the Titiwangsa Range*, pp 24-27. Bangi: Bukit Fraser Research Centre, Faculty of Science & Technology, Universiti Kebangsaan Malaysia.

Damanhuri, A. & Nizam, M. S. 2001. Mosses of Fraser's Hill. In Latiff, A., Zakaria, Z., Isa, Z. M., Mat Salleh, K., Hashim, N. M. & Din, L. B. (eds.). *Bukit Fraser: Persekitaran Fizikal, Biologi dan Sosio-ekonomi*, pp 207-223. Bangi: Pusat Pengurusan Penyelidikan, Universiti Kebangsaan Malaysia.

Damanhuri, A., Nur-Aisyah, S., Norhazrina, N. & Maideen, H. 2015. Flora lumut jati (Bryophyta) di Koridor Raub-Bukit Fraser, Pahang. *Prosiding Seminar Saintifik Koridor Raub-Bukit Fraser* 2015, pp 83-87. Bangi: Pusat Penyelidikan Bukit Fraser, Fakulti Sains & Teknologi, Universiti Kebangsaan Malaysia.

Dixon, H. N. 1924. New species of mosses from the Malay Peninsular. *Bulletin of the Torrey Botanical Club* 51(6): 225-259.

Dixon, H. N. 1926. A list of the mosses of the Malay Peninsula. *The Gardens' Bulletin Straits Settlements* 4(1): 1-46.

Fleischer, M. 1908. *Die Musci der Flora von Buitenzorg 3*. Leiden: E.J. Brill.

Manuel, M. G. 1981. A synopsis of the Bartramiaceae Schwaegr. (Bryophytina) in Malaya. *Journal of the Hattori Botanical Laboratory* 50: 249-252.

Mohamed, M. A. H. & Mohamed, A. D. 1986. Four genera of mosses new to Peninsular Malaysia. *Journal of Bryology* 14: 333-338.

Mohamed, M. A. H. & Robinson, H. 1991. A taxonomic revision of the moss families Hookeriaceae and Hypopterygiaceae in Malaya. *Smithsonian Contributions to Botany* 80: 1-44.

Mohamed, H., Yong, K. T., Damanhuri, A. & Latiff, Q.A. 2005. Moss diversity of Langkawi Islands, Peninsular Malaysia. *Malayan Nature Journal* 57(2): 243-254.

Noguchi, A. 1973. Mosses of Malaya collected by Dr. Hiroshi Inoue. *Bulletin of the National Science Museum Tokyo* 16(2): 293-304.

Tixier, P. 1971. A contribution to the bryological knowledge of Fraser's Hill station (Malaysia). *The Garden's Bulletin Singapore* 25:335-353.

Touw, A. 1986. A revision of *Pogonatum* sect. *Racelopus*, sect. nov., including *Racelopus* Dozy & Molk., *Pseudoracelopus* Broth., and *Racelopodopsis* Thér. *Journal of the Hattori Botanical Laboratory* 60: 1-33.

Virtanen, V. 1997. The genus *Breutelia* (Bartramiaceae, Musci) in Southeast Asia and Oceania. *The Bryologist* 100(3): 324-348.

FLORA 05

NOTES ON THE FERN GENUS *DIPLAZIUM* SWARTZ (ATHYRIACEAE) OF FRASER'S HILL

Mohamad Khaduwi, N.A.*, Maideen, H., & Norhazrina, N.
Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi
**Corresponding author email: aliahkhaduwi@gmail.com*

Abstract

The genus *Diplazium* is the most species-rich genus in the family Athyriaceae. One of the edible ferns, locally known as '*pucuk paku*' is included in *Diplazium*. This study highlights morphological variation of *Diplazium* in Fraser's Hill. The slightly wet climate, high altitude and humidity of Fraser's Hill makes it one of the luxuriant forests in Peninsular Malaysia and a very suitable area for *Diplazium* to grow and flourish. More than half (19 taxa) of the number of *Diplazium* recorded in Peninsular Malaysia (27 taxa) are located in Fraser's Hill. Four out of five species of *Diplazium* endemic to Peninsular Malaysia are found in Fraser's Hill, namely *D. angustipinna*, *D. insigne*, *D. kunstleri* and *D. procumbens*. Morphological characteristics such as rhizome type, scale shape and margin as well as position of sori are significant characteristics that can be used to identify *Diplazium*. Only *D. procumbens* have creeping rhizomes while the rest of the species have erect rhizomes. Two types of scale shapes were observed, which were linear and ovate scales. Most *Diplazium* have linear shaped scales except for two species, *D. kunstleri* and *D. latisquamatum* having ovate scales. The margin of scales of *Diplazium* were either smooth or toothed. Most of the species have a smooth margin except *D. bantamense*, *D. crenatoserratum*, *D. esculentum*, *D. procumbens* and *D. proliferum*. Meanwhile, for position of the sori, majority of the species have elongated sori from base towards the end of the veins except in *D. kunstleri* with sori in the middle of the veins and *D. latisquamatum* with sori located at the base of the veins.

Keywords: Athyriaceae, endemic, ferns, rare.

Introduction

The Athyriaceae is nearly cosmopolitan and contains ca. 650 species divided into three genera, following a recent classification (PPG I 2016). The twin-sorus fern genus, *Diplazium* is a monophyletic genus comprising about 350–400 species (PPG 1 2016) placed either in a single broadly defined genus or in two to seven segregate genera (Wei et al. 2013; Wang et al. 2004). Familial placement of the genus has been controversial historically. Previously, *Diplazium* was placed in Woodsiaceae Herter (Wei et al. 2013) together with 15 other genera including *Athyrium*, *Deparia* and *Cystopteris*. Rothfels et al. (2012) placed *Diplazium* in Athyriaceae Alston in the eupolypod II clade of ferns together with other genera such as *Anisocampium*, *Athyrium*, *Deparia* and *Cornopteris*.

The word *Diplazium* is formed from the Greek word '*diplazios*' indicating double sori covered by the indusium on both acroscopic and basiscopic sides of a vein, which is one of the characteristics of the genus (Maideen et al. 2019). *Diplazium* species are mainly terrestrial, rarely epipetric, and can be characterised by the following characters: stem usually erect to 1 m tall, rarely long-creeping; bearing scales at apex, scales colour brown to blackish-brown with margin entire or toothed in which the teeth are commonly formed by two adjacent cells; leaves monomorphic, rarely dimorphic; lamina simple to 3-pinnate-pinnatifid, glabrous or pubescent; veins free or anastomosing; sori elongate, borne on the veins "back-to-back" on one or often on both sides of a vein, covered by indusium, rarely exindusiate; spore usually ellipsoidal, monolete with prominent, winglike folds (Tryon and Tryon 1982).

There are ca. 27 taxa of *Diplazium* recorded in Peninsular Malaysia (Parris & Latiff 1997) in which more than half of the genus (ca. 19 taxa) can be found in Fraser's Hill (Maideen et al. 2001). The slightly wet climate, high altitude and humidity of Fraser's Hill making it one of the luxuriant forests in Peninsular Malaysia and a very suitable area for *Diplazium* to grow and flourish. Four out of five *Diplazium* species endemic to Peninsular Malaysia are located in Fraser's Hill, namely *D. angustipinna*, *D. insigne*, *D. kunstleri* and *D. procumbens*.

Results and Discussion

There are various trails located in Fraser's Hill, namely Bishop Trail, Maxwell Trail, Abu Suradi Trail, Hemmant Trail, Rompin Trail, Pine Tree Trail, Kindersley Trail, trail to Jeriau Waterfall, and in the UKM Research Plot. Most *Diplazium* species can be found in Bishop Trail with seven taxa, followed by Hemmant Trail and UKM Research Plot with three taxa respectively.

Endemic species (Figure 1) were recorded in Bishop Trail (*D. procumbens*), UKM Research Plot (*D. angustipinna* and *D. kunstleri*) and in Tras Valley (*D. insigne*). However, *D. insigne* was not reported since 1929 by Holttum (type locality). *Diplazium tomentosum* is the most common species as it can be found in most trails i.e. Hemmant Trail, Pine Tree Trail, Kindersley Trail and in the UKM Research Plot. In Kindersley Trail, *D. cordifolium* var. *cordifolium* was found growing abundantly near the entrance, whereas in Rompin Trail, *D. cordifolium* var. *pariens* was found growing abundantly near the end of the trail. The most known species in *Diplazium* which is *D. esculentum*, or locally known as '*pucuk paku*' grows abundantly by the river in the trail to Jeriau Waterfall.

The climate of Fraser's Hill is tropical. Its geomorphology is characterised by hilly terrain and most of the natural slopes are steep with 50° gradients. Elevation ranges from 400 to 1300 meters above sea level. The mean annual rainfall is 2624 mm with an average of 208 rain-days per year (Gassim et al. 2001). The temperature varies daily between 16-24 °C with relative humidity averaging at about 90% throughout the year. The high altitude and humidity of Fraser's Hill makes a very suitable area for *Diplazium* to grow although some species prefer to grow in lowland and dry areas.

Morphological characters such as rhizome type, stipe scales, type of lamina and position of sori are significant to identify *Diplazium* species. For rhizome type, only *D. procumbens* have creeping rhizome while the rest of the species have erect rhizomes (Figure 2). Stipe scales can be further examined by its shape and margin. The shape of scales studied varies from lanceolate to ovate where only *D. kunstleri* and *D. latisquamatum* have ovate scales. The margin of scales in *Diplazium* species were either entire or toothed. The presence of teeth in *Diplazium* usually formed by two adjacent cells (Rothfels et al. 2012) which can be observed in *D. crenatoserratum, D. esculentum* and *D. procumbens* meanwhile entire or irregular margin of scales are observed in *D. malaccense, D. tomentosum, D. latisquamatum* and *D. kunstleri*.

Next, lamina in *Diplazium* observed usually pinnate to 3-pinnatifid but some species such as *D. cordifolium* var. *cordifolium* has simple lamina. Other characters such as the position of sori can be used to group *Diplazium* species. Majority of the species have elongated sori from base towards the end of the veins except in *D. kunstleri* which have sori in the middle of the veins and *D. latisquamatum* with sori located at the base of the veins.

Figure 1. Endemic *Diplazium* species. a: *D. procumbens* (Bishop Trail), b: *D. angustipinna*, c: *D. kunstleri* (UKM Research Plot).

Figure 2. Creeping rhizome in *D. procumbens*.

Conclusions

As most of the endemic *Diplazium* species can be found in Fraser's Hill, it is therefore one of the most important components of its biodiversity and plays an important role in maintaining Fraser's Hill Forest Complex ecosystem processes and stability. Hence by protecting Fraser Hill as a whole of Fraser Hill Forest Complex is beneficial to the ecosystem of its forest. Therefore, it is critical to document the significance of protected areas for conserving tropical biodiversity, particularly in mega-diverse Southeast Asia.

Acknowledgements

We are grateful to WWF Malaysia and Universiti Kebangsaan Malaysia (UKM) for organizing this symposium. This research is funded by Universiti Kebangsaan Malaysia grant (UKMGUP-2017-025).

References

Gasim, M.B., Rahim, S.A., Rahman, Z.A. & yaakub, J. 2001. Hydrologic variable of Fraser's Hill. In: Latiff, A., Zuriati, Z., Zaidi, M.I., Kamarudin, M.-S., Noorazuan, M.H. & Laily, B.D. (Eds.) *Fraser's Hill Physical, Biological, and Socio-economic environments*. Bangi: Universiti Kebangsaan Malaysia.

Maideen, H., Jaman, R., Bidin, A.A., Ibrahim, A.Z. & Latiff, A. 2001. Pteridophytes of Fraser's Hill. In: Latiff, A., Zuriati, Z., Zaidi, M.I., Kamarudin, M.-S., Noorazuan, M.H. & Laily, B.D. (Eds.) *Fraser's Hill Physical, Biological, and Socio-economic environments*. Bangi: Universiti Kebangsaan Malaysia.

Maideen, H., Aliah, N., Norhazrina, N. & Go, R. 2019. Rediscovery of *Diplazium* procumbens (Athyriaceae) in Peninsular Malaysia after more than 70 years, with notes on the morphology, spore ornamentation and anatomy. *Phytotaxa* 422(3): 241–247.

Parris, B. & Latiff, A. 1997. Towards a pteridophyte flora of Malaysia: A provisional checklist of taxa. *Malayan Nature Journal* 50: 235–280.

PPG I. 2016. A community-derived classification for extant lycophytes and ferns. *Journal of Systematics and Evolution* 54: 563–603.

Rothfels, C.J., Sundue, M.A., Kuo, L.Y., Larsson, A., Kato, M., Schuettpelz, E. & Pryer, K.M. 2012. A revised family-level classification for eupolypod II ferns (Polypodiidae: Polypodiales). *Taxon* 61: 515–533.

Tryon, R.M. & Tryon, A.F. 1982. *Ferns and allied plants with special reference to tropical America*. New York: Springer.

Wang, M.-L., Hsieh, Y.-T. & Zhao, G.-F. 2004. A revised subdivision of the Athyriaceae. *Acta Phytotaxonomica Sinica* 42: 524–527.

Wei, R., Zhang, X.-C. & Schneider, H. 2013. Toward a new circumscription of the twinsorus-fern genus *Diplazium* (Athyriaceae): A molecular phylogeny with morphological implications and infrageneric taxonomy. *Taxon* 62: 441–457.

FLORA 06

COMPOSITION AND DIVERSITY OF SAPLING IN TRANUM FOREST RESERVE, FRASER'S HILL, PAHANG, MALAYSIA

Zohari, A.F.[1], Nizam, M.S.[1,2], Talip, N.[1]*, & Latiff, A.[1]
[1]Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor.
[2]Institute of Climate Change, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
*corresponding author email: *ntalip@ukm.edu.my*

Abstract

A study on species composition and diversity of saplings was conducted in an upper hill dipterocarp forest at Tranum Forest Reserve, Fraser Hill, Pahang. Two study plots totaling an area of 0.1 ha, each of 25 m x 20 m (0.05 ha), were established at the elevation of about 400 m and 600 m a.s.l. The composition of tree species was represented by 269 individuals belonging to 91 species, 67 genera and 32 families. Rubiaceae was recorded as having the highest total number of seven genera and nine species. At the genus level, Diospyros has the highest number of species (7 species). Euphorbiaceae is the most important family with Importance Value Index (IVi) of 9.87% and the most important species is Xerospermum noronhianum (Myrtaceae) with Importance Value Index (IVi) of 5.34%. Shannon Diversity Index, Evenness Index, and Margalef Richness Index were 3.98, 0.88, and 16.11, respectively.

Keywords: Tranum Forest Reserve, Fraser Hill, sapling, upper hill dipterocarp

Introduction

The hill and upper hill dipterocarp forests in Peninsular Malaysia are among the most species-rich communities. Most studies carried out on vascular plants have focused on the trees in the above storey communities with diameter at breast height (DBH) of ≥ 5 cm (e.g. Nizam et al. 2010; Ahmad Fitri et al. 2017) and ≥ 10 cm (Manokaran & Swaine 1994), despite the fact that the understorey communities especially saplings are responsible for a high percentage of total diversity in the tropical forests (Tchouto et al. 2006). For instance, the species composition of small trees and shrubs is usually higher than that of the large trees (DBH≥ 10 cm) in the primary forest of Pasoh 50 ha plot (Kochummen et al. 1990), in Lambir Hill National Park (Lee et al. 2002) and primary coastal hill forest of Bukit Timah (LaFrankie et al. 2005).

Saplings especially of the dipterocarps are important for their sustainability because they can grow to become big trees. In addition, saplings also provide food resources for many species of insects, birds and mammals. The species composition of saplings is usually different from that of the canopy and thus supports different fauna compared to the canopy. This important group of saplings usually receive limited attention compared to trees with DBH of ≥ 5 cm.

Pahang, the largest state in Peninsular Malaysia has ca. 40% of forested area (Anon. 2013). In fact, many studies involving trees with DBH ≥ 5 cm were already carried out in this state (Kamziah et al. 2011, Nizam et al. 2006, Suratman 2012). However, studies that described the data associated with saplings at DBH less than 5 cm are very limited. The previous study in Fraser's Hill only focused on the trees with DBH (≥ 5 cm) (Shamsul et al. 2020). Thus, the objective of this study was to determine the species composition, community structure and diversity of saplings of < 5 cm DBH in Tranum Forest Reserve, Fraser's Hill, Pahang.

Materials and Methods

In this study, two ecology plots, each of 25 m x 20 m were established in October 2014 at the upper hill dipterocarp of Tranum Forest Reserve, Fraser's Hill. All plants of 1.0-4.9 cm DBH which are classified as saplings have been marked and measured using a measuring tape. Climbers, herbs, and palms were excluded from the census. Specimens of plants were collected for identification purposes. Specimens were collected using pole and cutter before being preserved and processed following methods of Bridson and Forman (1992) and kept in the oven for about one week at 60 °C.

Species identification was done: firstly, by using the flora keys (Corner 1988; Ng 1978, 1989; Symington 2004; Whitmore 1972, 1973); secondly by comparing with herbarium specimens at the herbarium at Universiti Kebangsaan Malaysia (UKMB) and Forest Research Institute Malaysia (KEP). Analysis of the data for this study involves a number of parameters such as density and basal area. Some indices such as Species Importance Value Index (IVi) (Brower et al. 1998) and Shannon Diversity Index (Spellerberg & Fedor 2003) were determined to assess the community structure of species in the study area.

Results and Discussion

Floristic composition

A total of 276 individual saplings were enumerated in Tranum Forest Reserve, Pahang. The flora consists of 91 species from 67 genera and 36 families. Table 1 shows the list of eight families with the highest total number of genera and species present in the study plots. The number of species obtained from this study is considered to be high because the study plot is relatively small (0.1 ha).

Table 1. List of eight families of saplings with the highest total number of genus/genera and species in 0.1 ha plot at Tranum Forest Reserve, Fraser's Hill, Pahang

Family	Total number of genus/ genera	Total number of species	Total individual
Annonaceae	6	9	31
Rubiaceae	7	9	16
Euphorbiaceae	6	8	34
Lauraceae	6	7	10
Ebenaceae	1	5	14
Guttiferae	3	5	14
Meliaceae	4	5	9
Sapindaceae	3	5	26

The family with the highest number of genera is Rubiaceae (seven) followed by Annonaceae, Euphorbiaceae and Lauraceae with six genera each. Meanwhile for the most speciose family, Annonaceae and Rubiaceae lead the rank with nine species followed by Euphorbiaceae with eight species and Lauraceae with seven species (Table 1).

At the genus level, Diospyros is the most speciose with five species followed by Ardisia, Garcinia, Lepisanthes and Syzygium, with three species each (3.33%) (Table 2). The status of Diospyros as the most speciose genus in the plot is rarely recorded for trees ≥ 5 cm DBH.

Table 2. Five most speciose genera of saplings in 0.1 ha plot at Tranum Forest Reserve, Fraser's Hill, Pahang.

Genus	Total species	Family
Diospyros	5	Ebenaceae
Ardisia	3	Myrsinaceae
Garcinia	3	Guttiferae
Lepisanthes	3	Sapindaceae
Syzygium	3	Myrtaceae

Abundance

i) Basal area (BA)

The total basal area per hectare for all trees was 1.12 m2/ha. At family level, Euphorbiaceae contributed the highest basal area of 0.14 m2/ha (12.70%) followed by Annonaceae with 0.13 m2/ha (11.74%), and Sapindaceae with 0.11 m2/ha (9.60 %). Table 3 shows the basal areas of five leading families of saplings in the study plots at Tranum Forest Reserve.

Table 3. Basal areas of five leading families and species of sapling in the 0.1 ha plot at Tranum Forest Reserve, Fraser's Hill, Pahang

Family	BA (m^2/ha)	%	Species	BA (m^2/ha)	%
Euphorbiaceae	0.14	12.70	*Xerospermum noronhianum*	0.078	7.00
Annonaceae	0.13	11.74	*Vitex gamosepala*	0.075	6.73
Sapindaceae	0.11	9.60	*Polyalthia obliqua*	0.070	6.27
Verbenaceae	0.08	6.73	*Antidesma velutinosum*	0.057	5.09
Ebenaceae	0.07	6.57	*Stemonurus malaccensis*	0.055	4.97

At species level, Xerospermum noronhianum (Sapindaceae) contributed the highest basal area of 0.078 m2/ha (7.00%), followed by Vitex gamosepala (Verbenaceae) on the second rank with 0.075 m2/ha (6.73%) while Polyalthia obliqua (Annonaceae) was on the third rank with 0.070 m2/ha (6.27%). Table 3 shows the basal area of five leading species in the study plots at Tranum Forest Reserve, Pahang.

Importance Value Index (IVi)

Euphorbiaceae was the most important family represented by 9.87%, followed by Annonaceae and Sapindaceae with 9.17% and 7.84%, respectively (Table 4). At species level, Xerospermum noronhianum (Sapindaceae) has the highest value with 5.34% while Vitex gamosepala (Verbenaceae) as the second with 4.93% followed by Polyalthia obliqua (Annonaceae) with the IVi of 4.22%. Table 4 shows the five most important species in the study plots. In this study, not one family or species is considered as dominant in relative terms. According to Curtis and Macintosh (1951), only the families with more than 40% of IVi and the species with more than 10% were considered to be relatively dominant.

Table 4. Five families and species of sapling with the highest Importance Value Index (IVi) in 0.1 ha plot at Tranum Forest Reserve, Fraser's Hill, Pahang.

Family	IV_i	Species	IV_i
Euphorbiaceae	9.87	*Xerospermum noronhianum*	5.34
Annonaceae	9.17	*Vitex gamosepala*	4.93
Sapindaceae	7.84	*Polyalthia obliqua*	4.22
Ebenaceae	5.33	*Stemonurus malaccensis*	3.97
Verbenaceae	5.31	*Antidesma velutinosum*	3.7

Species Diversity

The Shannon Diversity Index (H') recorded in this study was 3.98 (Hmax = 4.51). Compared with other studies, the Shannon diversity index was lower. Meanwhile, the value of Shannon Evenness Index (E) was 0.88 and 16.11 for Margalef Richness Index. According to Magurran (1988), species richness and evenness will affect the Shannon Diversity Index. The value of Shannon Evenness Index in this study is considered high and comparable with most of the previous studies of trees ≥ 5 cm DBH conducted in Peninsular Malaysia.

Conclusions

This study found that the upper hill dipterocarp forest at Tranum Forest Reserve has a high number of saplings. Rubiaceae is recorded as the highest total number of genera and species with seven genera and nine, respectively. At the genus level, Diospyros has recorded the highest total number of seven species. Euphorbiaceae also being the most important family with Importance Value Index (IVi) of 9.87% and the most important species was Xerospermum noronhianum (Myrtaceae) with Importance Value Index (IVi) of 5.34%. This preliminary study gave a small contribution of floristic composition for Fraser's Hill.

Acknowledgements

The authors would like to thank Mohamad Murshidi b. Zohari and Ahmad Muttaqin bin Mohd Nor for their assistance during the fieldwork and also Universiti Kebangsaan Malaysia for providing transportation.

References

Ahmad Fitri, Nizam, M.S., Latiff, A., Abd. Rahman, K., Serafina Christine, F. & Shamsudin, I. 2017. Floristic composition and biomass of trees in Temengor Forest Reserve, Perak, Peninsular Malaysia. *The Malaysian Forester* 80 (2): 178-197.

Anon. 2013. *Laporan Tahunan 2013*. Kuantan: Jabatan Perhutanan Negeri Pahang.

Bridson, D. & Forman, L. 1992. *The Herbarium Handbook*. Boston: WCB/McGraw-Hill.

Brower, J. E., Zar, J. H. & Von Ende, C. N. 1998. *Field and Laboratory Methods for General Ecology*. Fourth edition. Wm. C. Lowa: Brown Publishers.

Corner, E. J. H. 1988. *Wayside Trees of Malaya*. Volumes 1 and 2. Third Edition. Kuala Lumpur: The Malayan Nature Society.

Curtis, J.T. & Macintosh, R.P. 1951. An upland continuum in the prairie-forest border region of Wisconsin. *Ecology* 32: 476-496.

Kamziah K.A., Eswani, N., Nazre, M., Awang Noor, A. & Ali M. 2011. Tree species diversity of logged over forest at Tekai Tembeling Forest Reserve, Jerantut, Pahang, Malaysia. *Malaysian Forester* 74 (2): 173-181.

Kochummen, K, M., La Frankie, J. V. & Manokaran, 1990. Floristic composition of Pasoh Forest Reserve, a lowland rain forest in Peninsular Malaysia. *Journal of Tropical Forest Science* 3(1): 1-13.

La Frankie, J.V., Davies, S. J., Wang, L. K., Lee, S. K. & Lum, S. K. Y. 2005. *Forest Trees of Bukit Timah. Population Ecology in a Tropical Forest Fragment*. Singapore: Simply Green.

Lee, H.S., Davies, S.J., La Frankie, J.V., Tan, Yamakura, T., Itoh, A., Ohkubo, T. & Ashton, P.S. 2002. Floristic and structural diversity of mixed dipterocarp forest in Lambir Hills National Park, Sarawak, Malaysia. *Journal of Tropical Forest Science* 14(3): 379-400.

Magurran, A. 1988. *Ecological Diversity and its Measurement*. London: Chapman and Hall.

Manokaran, N. & Swaine, M.D. 1994. *Population Dynamics of Trees in Dipterocarp Forests of Peninsular Malaysia*. Kepong: Forest Research Institute Malaysia.

Ng, F.S.P. 1978 (ed.). *Tree Flora of Malaya. Volume 3*. Kuala Lumpur: Longman Malaysia Sdn. Bhd.

Ng, F.S.P. 1989 (ed.). *Tree Flora of Malaya. Volume 4*. Petaling Jaya: Longman Malaysia Sdn. Bhd.

Nizam, M.S., R. Suhaili, Latiff, A. & Faridah-Hanum, I. 2006. Community structure of trees in Lesong Virgin Jungle Reserve, Pahang, Malaysia. *The Malaysian Forester* 69(2): 163-181.

Nizam, M.S., Amiratul Azzuwana, A.R. & Rohaiza, D. 2013. Komposisi, kepelbagaian dan biojisim spesies pokok di Hutan Lipur Bukit Hijau. In: Abd. Rahman, A.R., Mohd Nasir, A.H., Mohamed Zin, Y., Richard, A.M. & Latiff, A. (eds.). *Banjaran Bintang Gunung Inas, Kedah. Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi*. Siri Kepelbagaian Biologi Hutan 20: 115-129. Kuala Lumpur: Jabatan Perhutanan Semenanjung Malaysia.

Shamsul, K., Nik Norafida, N. A., Mat-Salleh, K. & Latiff, A. 2020. Tree species composition, diversity and biomass estimation in lower montane forest at Fraser's Hill, Pahang, Peninsular Malaysia. The *Malaysian Forester* 83 (1): 114-127.

Spellerberg, I.F. & Fedor, P.J. 2003. A tribute to Claude Shannon (1916–2001) and a plea for more rigorous use of species richness, species diversity and the 'Shannon–Wiener' Index. *Global Ecology & Biogeography* 12: 177-179.

Suratman, M.N. 2012. Tree species diversity and forest stand structure of Pahang National Park, Malaysia. In: Lameed, G.A. (ed.). *Biodiversity Enrichment in a Diverse World*, pp. 473-492. Rijeka: In Tech.

Symington, C. F. 2004. *Foresters' Manual of Dipterocarps. Malayan Forest Record No. 16*. Kepong: Forest Research Institute Malaysia.

Tchouto, M.G.P., De Boer, W.F., De Wilde, J. & Van der Maesen, L.J.G. 2006. Diversity patterns in the flora of the Campo-Ma'an rain forest, Cameroon: do tree species tell it all? *Biodiversity and Conservation* 15: 1353-1374.

Whitmore, T. C. 1972 (ed.). *Tree Flora of Malaya. Volume 1*. Kuala Lumpur: Longman Malaysia Sdn. Bhd.

Whitmore, T. C. 1973 (ed.). *Tree Flora of Malaya. Volume 2*. Kuala Lumpur: Longman Malaysia Sdn. Bhd.

FLORA 07

GUNUNG ULU SEMANGKOK, SELANGOR: RELEVANCE OF EARLY BOTANICAL COLLECTION TODAY

Aliaa Athirah, A.M.*, & Kiew, R.
Forest Research Institute Malaysia (FRIM), 52109 Kepong, Selangor Darul Ehsan, Malaysia
**Corresponding author email: athirahadam129@gmail.com*

Abstract

The flora of Gunung Ulu Semangkuk (GUS) comprises of 273 species of vascular plant in 175 genera and 79 families. The largest family is Orchidaceae (27 species) followed by Fagaceae (13 species) and Zingiberaceae (12 species). 16 % of the species found are endemic to Peninsular Malaysia. Interesting floristic comparisons with Fraser's Hill are possible with early botanical records and showed that oak–laurel forest occur in both areas. Regardless of the similarity of species in both areas, Corybas sp. are not found in GUS. Cloud forest is a small niche with a diverse community which occurs on the summit of GUS. Now, GUS serves as a hiking spot for many nature enthusiasts making the habitat threatened by human activities. Conservation management efforts like visitor access control are urgently required to prevent the loss of flora habitat by physical disturbance.

Keyword: flora, Fraser's Hill, history, Peninsular Malaysia, conservation.

Introduction

Gunung Ulu Semangkuk (GUS) is located in the Main Range of Peninsular Malaysia. This area lies under the Semangkok Forest Reserve in the Hulu Selangor district. The entrance to GUS trail is situated near to the Gap Rest House (3°69' N 101°74' E) at 850 m above sea level, where it rises to the first peak known as Gunung GAP and continues to reach up to 1394 m at the GUS peak (3°68' N 101°76' E). First botanical exploration was done by H.N. Ridley in the year of 1897 as he passed along "The Pahang Track". During those days, Ridley visited the area several times and marked the area as Gunung Semangkuk instead of Gunung Ulu Semangkuk. Based on Ridley accounts, he described 12 species from GUS including the pitcher plant, *Nepenthes ramispina,* gingers, *Camptandra ovata*, *Geostachys primulina* and a variety of ferns, *Selaginella selangorensis var selangorensis.*

As the years passed, Curtis came by the year of 1902. After a decade, Burns-Murdoch came to GUS in 1912. This locality is also known as the Semangkok Pass and The Gap. Most of the botanical collections were then shifted to Fraser's Hill when it opened and became more accessible by the year 1920. A detailed survey was made by Burkill and Holttum where they managed to climb up to the Trigonometrical station in 1922. A team of Japanese botanists, made up of Ando, Kokawa and Koyama did some collections in 1968, around the Gap and Semangkok Forest Reserve during the 5th Osaka University Scientific Expedition. They spend a month around the area, mostly harbouring tree collections which indicate that they only cover lowland up to the hill forest. After a long hiatus of almost a decade later, a team from FRIM came. The comprehensive flora list from Semangkok was included together in Fraser's Hill checklist published in 1998. Now, GUS serves as a hiking spot for day hikers and nature enthusiasts as the location is just less an hour's drive from Kuala Lumpur. This study aims to produce a complete vascular plant list of GUS, and comparison with the flora composition in Fraser's Hill by using early botanical collections.

Materials and Methods

All collections in both KEP and SING herbaria in the BRAHMS (Botanical Research and Herbarium Management) database were carefully examined and analysed. Herbarium specimens were collected for fertile plants and vouchers for sterile material. All specimens were deposited at the KEP herbarium. We also compiled the specimen data from literature e.g. Burkill & Holttum (1923), Kiew (1997) and Turner (1997). This list produced excludes exotic weeds and garden escapes.

Results and Discussion

The list compiled in this study contains 273 species of vascular plant which comprises 175 genera and 79 families (Table 1, Appendix 1). The most species rich families are Orchidaceae (27 species), Fagaceae (13 species), and Zingiberaceae (12 species). 16% of the species are endemic to Peninsular Malaysia. Percentage endemism is lower than the national average of about 25% for tree species (Saw, 2010). The record increases with significant collecting efforts made in GUS.

Table 1: Families, genera and species of vascular plant of Gunung Ulu Semangkuk.

Group	Families	Genera	Species
Lycophytes	2	2	6
Ferns	4	11	12
Gymnosperm	3	6	7
Flowering Plants	70	156	248
Total	79	175	273

The trail to GUS starts near the Gap Rest House. Compacted soil can be seen at the trail, indicating erosion due to heavy visits by visitors. The original vegetation had been shifted to disturbed. Thickets of the bamboo *Gigantochloa scortechinii* (Graminae) formed dense tall clumps along the trail up to 920 m. The disturbance history can be traced as the same bamboo species were found in the herbarium record from SING collected in 1902, during the construction of the road to Fraser's Hill. Open places with fully exposed direct sunlight with poor soil conditions were inhabited by *Sonerila picta* (Melastomataceae) and *Alocasia longiloba* (Araceae) that can be seen from afar. These areas were also grown with shrubs like *Sarcandra glabra* (Chloranthaceae). Forest diversity can be seen when the understorey was filled with *Codonoboea malayana* (Gesneriaceae), *Phyrnium pubinerve* (Marantaceae), and *Amischotolype gracilis* (Commelinaceae). Here, *Paederia foetida* (Rubiaceae) or known as '*akar sekentut*', believed to have medicinal benefits, was found in abundance. Ginger with tangling pale-yellow flowers, *Globba cernua* can be seen in the vicinity along the trail.

Burkill & Holltum (1923) mentioned that as the elevation increases, the forest in the Semangkok Pass changes at about 970 m. Although large emergent dipterocarps are not normally found here, there are at least three dipterocarp species known from such elevations. Big trees like *Payena dasyphylla* (Sapotaceae) of about 20 m tall, and *Agathis borneesis* (Araucariaceae) are found around at this altitude. The closed canopy has prevented the growth of thickets. The ridge trail is densely covered with attractive star-shaped flowers of *Argostemma hookeri* and *Argostemma involucratum* (Rubiaceae). Gesneriads, endemic to Peninsular Malaysia, such as *Codonoboea hispida* and *Codonoboea curtisii* were found at the upper ridge with mossy grounds and peaty habitats. Vitaceae is well represented as *Amplocissus elegans* and *Pterisanthes pulchra* occupy the habitat. Forest herbs, especially Melastomatacea, *Sonerila integrifolia* covers slope areas very well. *Weinmannia fraxinea* (Cunoniaceae) was found, indicating the presence of quartz in the habitat. As the elevation increases to 1200 m, montane species like *Rhododendrum malayanum* (Ericaceae) emerge. The summit of GUS at 1394 m altitude, a flat summit much pressured by visitors where fern species such as *Dipteris conjugata* (Dipteridaceae) were found, indicating disturbance in the area.

Floristic comparison with Fraser's Hill

Despite both GUS and Fraser's Hill being located on the spine of the Main Range, there are a few similarities and differences in its floristic composition. Important tree families in oak- laurel forests of Fagaceae (Castanopsis, Lithocarpus and Quercus) and Lauraceae (Cinnamomum, Litsea) are present in both areas. The trees are often blanketed with epiphytes, ferns, bryophytes and liverworts. Herbaceous plants such as Argostemma, Cyrtandra, Filetia (Acanthaceae) and orchids are very common. Gingers such as Alphinia, Globba, Camptandra are also common in the forest. The ridge is covered by a thin layer of quartzite. Species found in these habitats have a common characteristic of its ability to grow on nutrient poor soil. Similar species discovered like *Camptandra ovata* (Zingiberaceae) and *Piper semangkoanum* (Piperaceae) were also found at Pine Tree Hill in Fraser's Hill. Many Gesneriads were found in both areas like *Codonoboea hirta*, *Codonoboea malayana* and *Codonoboea pumila*. Helmet orchid, Corybas sp. that grows in mossy peat at the highest peak in Fraser's Hill which is Pine Tree Hill (1448 m) were not found in GUS. The floristic composition in these two areas is possible by using early botanical collections made.

Conservation of Gunung Ulu Semangkuk

Type site plays a crucial aspect in population studies where conservation status and extinction of species can be assessed. This points out the importance of type sites to be protected whenever a long term conservation plan is intended to be achieved. Early botanical collections yielded 17 type specimens from GUS as shown in the plant list. In order to know whether a species is extinct or not, it is crucial to ascertain whether the species can be found on the type site, then, at other localities or other similar habitats close to the original known range (Kiew, 1998). Despite the status of type site for many species, no Nepenthes were found during our recent trip. This shows that the flora in GUS is vulnerable to poachers and hikers.

The physiognomy of species in GUS shows that it comprises lowland, hill and montane forests. In general, soil composition changes with elevation from lowland forest, as soil becomes more humic with diminishing nutrients, especially where peat develops (Saw, 2010). The peat layer in lower montane forests is however generally thin. Lower montane forest develops on well drained soil, mainly at elevations between 1000 and 1500 m. There is no presence of big trees at the summit of GUS, where sunlight is abundant but shrubs and small trees are visible. Kumaran et al (2010) stated that the occurrence of cloud forests in Malaysia is at the 1200 m mark of lower montane, taking an altitude of 900 m a.s.l. as the lowermost level of the cloud base. As occurrence of cloud forest is at the summit of GUS which is only a small niche patch with a diversity of species, this area can be easily damaged when hikers clear for campsite or for a better view. The presence of the fern, *Dipteris conjugata* (Dipteridaceae) shows that the area is heavily visited which may disturb the ecosystem to some extent. Litter, fire or physical trampling or damages could prevent seeds or juveniles from growing and the possible introduction of invasive species.

Conclusion

The flora of Gunung Ulu Semangkuk comprises 273 species of plant in 175 genera and 79 families. The largest family is Orchidaceae (27 species) followed by Fagaceae (13 species) and Zingiberaceae (12 species). 16 % of the species found are endemic to Peninsular Malaysia. Floristic comparison with Fraser's Hill using early botanical records show the presence of oak–laurel forest in both areas. Regardless of the similarity of species in both areas, Corybas sp. are not found in GUS. Conservation management like visitor access control is urgently required to conserve the cloud forest at the summit of GUS from being threatened by human activities.

Acknowledgement

We would like to thank Jabatan Perhutanan Negeri Selangor and Universiti Putra Malaysia (UPM) for inviting us to participate in the "Ekspedisi Saintifik Biodiversiti Taman Negeri, Fraser's Hill" in August 2019. This project "Updating the Checklist of Vascular Plants at Fraser's Hill" is funded by the World Wide Fund for Nature, Malaysia (WWF-Malaysia). We are grateful to the Curators of KEP and SING Herbaria for permission to access their databases and examine the specimens under their care.

References

Burkill, I.H. & Holttum, RE. 1923. A Botanical Reconnaissance Upon the Main Range at Fraser Hill. *The Gardens Bulletin Straits Settlements* 3: 19-110.

Kiew R. 1998. Scale of extinction in tropics – A case study of Peninsular Malaysian flowering plants. *Proceeding of The Fourth International Flora Malesiana Symposium 1998*.

Kiew R. 1998. *The Seed Plant Flora of Fraser's Hill: with special reference to its conservation status, Peninsular Malaysia*, Forest Research Institute Malaysia, Kepong.

Saw L.G. 2010. Vegetation of Peninsular Malaysia, Chapter in *Flora of Peninsular Malaysia Series II: Seed Plants*, Volume 1. Forest Research Institute Malaysia, Kepong.

Turner IM. 1997. A catalogue of the vascular plants of Malaya, *Garden's Bulletin Singapore* 47: 1−757.

Kumaran S, Perumal B, Davidson G, Ainuddin A.N., Lee M.S., Bruijnzeel L.A. 2010. Tropical montane cloud forests in Malaysia: Current state of knowledge. *Tropical Montane Cloud Forests: Science for Conservation and Management.* Cambridge University Press.

Appendix 1

[E]- Endemic to Peninsular Malaysia
[T]- Type site from Gunung Ulu Semangkuk

THE VASCULAR PLANTS OF GUNUNG ULU SEMANGKOK

LYCOPHYTES

LYCOPODIACEAE

Lycopodiella cernua (L.) Pic. Serm.
Ridley, H.N. 12039.

SELAGINELLACEAE

Selaginella atroviridis (Hook. & Grev.) Spring.
Ridley, H.N. s.n. August 1904, Ridley, H.N. 12038.

Selaginella ornata (Hook. & Grev.) Spring.
Ridley, H.N. 12039, Ridley, H.N. 12038.?

Selaginella roxburghii (Hook. & Grev.) Spring.
Ridley, H.N. 12041.

[E, T] ***Selaginella selangorensis*** Bedd. ex Ridl.
Ridley, H.N. 12040.

Selaginella minutifolia Spring.
Ridley, H.N. 12037.

FERNS

DAVALLIACEAE

Davallia hymenophylloides (Blume) Kuhn.
Ridley, H.N. 15563.

Davallia trichomanioides Blume.
Ridley, H.N. s.n. August 1904.

POLYPODIACEAE

Microsorum heterocarpum Ching.
Ridley, H.N. s.n. August 1904.

Scleroglossum pusillum (Blume) Alderw.
Ridley, H.N. s.n. August 1909.

Selliguea platyphylla (Sw.) Ching.
Ridley, H.N. s.n. August 1904.

[E]***Xiphopterella spasipilosa*** (Holttum) Parris.
Ridley, H.N. 12035, Burkill, I.H. SFN 8729 A.

PTERIDACEAE

Pteris cadieri* var. *hainanensis (Ching) S.H. Wu.
Burkill, I.H. 8911.

THELYPTERIDACEAE

Amblovenatum immersum (Blume) Mazumdar.
Ridley, H.N. 8658

Cyclosorus aridus (D. Don) Tagawa.
Nor Ezzawanis A.T. FRI 93315.

Coryphopteris gymnopoda (Baker) Holttum **var. *gymnopoda***.
Ridley, H.N. s.n. 1909.

Mesophlebion crassifolium (Blume) Holttum.
Ridley, H.N. s.n. 12 August 1904.

Sphaerostephanos penniger (Hook.) Holttum.
Nor Ezzawanis A.T. FRI 93314.

GYMNOSPERMS

ARAUCARIACEAE

Agathis borneensis Warb.
Ridley, H.N. s.n. September 1922.

GNETACAE

Gnetum gnemon L.
Aliaa Athirah A.M. FRI 88229.

PODOCARPACEAE

Dacrycarpus imbricatus (Blume) de Laub.
Ando, M. AKK 111.

Dacrydium elatum (Roxb.) Wall. ex Hook.
Strugnell, E.J. 20315.

Falcatifolium falciforme (Parl.) de Laub.
Ridley, H.N. s.n. , Ridley, H.N. 12063.

[E]***Podocarpus ridleyi*** (Wasscher) N.E.Gray.
Burkill, I.H. 8877.

Podocarpus rumphii Blume.
Ando, M. AKK 152

FLOWERING PLANTS

ACANTHACAE

***Filetia* sp.**
Aliaa Athirah A.M. FRI 88236.

ACHARIACEAE

Hydnocarpus kunstleri (King) Warb.
Ando, M. AKK 104.

[E]***Ryparosa fasciculata*** King
Ando, M. AKK 53.

ACTINIDIACEAE

Saurauia nudiflora DC.
Holttum, R.E. 11386, Burkill, I.H. 7764.

Saurauia pentapetala (Jack) Hoogland.
Ridley, H.N. 120+2.

[E]***Saurauia rubens*** Ridl.
Curtis, C. s.n. May 1902, Curtis, C. s.n. May 1902.

ANACARDIACEAE

Campnosperma squamatum Ridl.
Ando, M. AKK 162.

Mangifera griffithii Hook.f.
Ando, M. AKK 56.

***Melanochyla* sp.**
Ando, M. AKK 130.

ANNONACEAE

Cyathocalyx maingayi Hook.f. & Thomson.
Ando, M. AKK 393.

Fissistigma fulgens (Hook.f. & Thomson) Merr.
Curtis, C. 3736.

Meiogyne monosperma (Hook.f. & Thomson) Heusden.
Ando, M. AKK 166.

APOCYNACEAE

Alyxia ganophylla Markgr.
Ando, M. AKK 226.

Alyxia oleifolia King & Gamble.
Ridley, H.N. s.n. August 1903, Burkill, I.H. 8871, Murdoch, B. 11975.

Alyxia reinwardtii Blume. **var. *reinwardtii***
Burkill, I.H. 8890, Ridley, H.N. s.n. 1904.

Tabernaemontana pauciflora Blume.
Aliaa Athirah A.M. FRI 88239.

ARACEAE

Alocasia perakensis Hemsl.
Ridley, H.N. s.n. 1905.

Homalomena humilis (Jack) Hook.f.
Ridley, H.N. s.n. 1897, Ridley, H.N. s.n. 1897.

Scindapsus scortechinii Hook.f.
Ridley, H.N. s.n. August 1904.

ARALIACEAE

[E] ***Brassaiopsis rufosetosa*** (Ridl.) Jebb.
Ridley, H.N. s.n. August 1904, Pereira J.T. SAN 159454.

[E] ***Polyscias montana*** (Ridl.) Lowry & G.M.Plunkett.
Ridley, H.N. 15617.

ASCLEPIADACEAE

Dischidia cochleata Blume.
Ridley, H.N. s.n.

BALANOPHORACEAE

Balanophora fungosa J.R. Forst. & G. Forst. **ssp. indica** (Arn.) B. Hansen.

Observation

BEGONIACEAE

[E]***Begonia wrayi*** Hemsl.
Ridley, H.N. 12997.

BURSERACEAE

Canarium patentinervium Miq.
Ando, M. AKK 356, Ando, M. AKK 118, Ando, M. AKK 146, Ando, M. AKK 135.

Dacryodes **sp.**
Ando, M. AKK 102.

Santiria oblongifolia Blume.
Ando, M. AKK 81.

CELASTRACEAE

Euonymus indicus B.Heyne ex Wall.
Ando, M. AKK 148.

Lophopetalum javanicum (Zoll.) Turcz.
Ando, M. AKK 59.

CHLORANTHACEAE

Chloranthus erectus (Buch.-Ham.) Verdc.
Burkill, I.H. 7772.

Sarcandra glabra (Thunb.) Nakai
Burkill, I.H. 8889.

COMPOSITAE

Vernonia arborea Buch.-Ham.
Ridley, H.N. 12067.

CONNARACEAE

Agelaea macrophylla (Zoll.) Leenh.
Ando, M. AKK 404.

DIPTEROCARPACEAE

Anisoptera curtisii Dyer ex King.
Ando, M. AKK 129.

Shorea ovata Dyer ex Brandis.
Ando, M. AKK 131, Ando, M. AKK 86, Ando, M. AKK 73, Ando, M. AKK 106.

Vatica lowii King.
Ando, M. AKK 101.

EBENACEAE

Diospyros maingayi (Hiern.) Bakh.
Ando, M. AKK 46.

[E, T] ***Diospyros selangorensis*** Bakh.
Burkill, I.H. 8883.

Diospyros sumatrana Miq.
Ridley, H.N. 8542.

ELAEOCARPACEAE

Elaeocarpus mastersii King.
Ridley, H.N. s.n. January 1921.

Elaeocarpus palembanicus (Miq.) Corner.
Ando, M. AKK 122, Ando, M. AKK 66.

Elaeocarpus polystachyus Wall. ex Müll.Berol.
Ando, M. AKK 119, Ando, M. AKK 150, Ando, M. AKK 349, Ando, M. AKK 154.

Elaeocarpus stipularis Blume **var. *stipularis***
Ando, M. AKK 414.

ERICACEAE

Rhododendron malayanum Jack.
Ridley, H.N. s.n. 1900

Rhododendron robinsonii Ridl.
Burn-Murdoch, A.M. 4040.

[E]***Rhododendron wrayi*** King & Gamble.
Mead, J.P. 16156, Burn-Murdoch, A.M. 2, Burn-Murdoch, A.M. 1.

ESCALLONIACEAE

Polyosma laetevirens Griff. ex King.
Ando, M. AKK 147.

EUPHORBIACEAE

Homalanthus populneus (Geiseler) Pax.
Ando, M. AKK 221.

Macaranga heynei I.M.Johnst.
Ando, M. AKK 230.

Macaranga hullettii King ex Hook.f.
Ando, M. AKK 365.

Pimelodendron griffithianum (Müll.Arg.) Benth. ex Hook.f.
Ando, M. AKK 37.

FAGACEAE

Castanopsis acuminatissima (Blume) A.DC.
Ando, M. AKK 238.

Castanopsis lucida (Nees) Soepadmo.
Ando, M. AKK 133.

Castanopsis megacarpa Gamble
Ando, M. AKK 366.

[E]***Castanopsis wallichii*** King *ex* Hook.*f*.
Ando, M. AKK 353.

Lithocarpus bennettii (Miq.) Rehder.
Ando, M. AKK 87.

Lithocarpus encleisocarpus (Korth.) A.Camus.
Ando, M. AKK 361.

Lithocarpus suffruticosus (Ridl.) Soepadmo.
Ridley, H.N. 12061.

Lithocarpus sundaicus (Blume) Rehder.
Ando, M. AKK 358, Ando, M. AKK 237.

Lithocarpus wallichianus (Lindl. ex Hance) Rehder.
Ando, M. AKK 80.

Lithocarpus wrayi (King) A.Camus.
Ando, M. AKK 394, Ando, M. AKK 27.

Quercus argentata Korth.
Ando, M. AKK 57.

Quercus gemelliflora Blume.
Ando, M. AKK 1, Ando, M. AKK 9.

Quercus subsericea A.Camus.
Ando, M. AKK 121.

GESNERIACEAE

[E, T] ***Codonoboea curtisii*** (Ridl.) C.L.Lim.
Ridley, H.N. 12083, Curtis, C. s.n. May 1902.

Codonoboea flavescens (Ridl.) Kiew.
Ridley, H.N. s.n. August 1904.

[E, T] ***Codonoboea hirta*** (Ridl.) Kiew.
Ridley, H.N. 12085, Curtis s.n. May 1902.

[T] ***Codonoboea hispida*** (Ridl.) Kiew.
Curtis, C 3752.

[E]***Codonoboea malayana*** (Hook.f.) Kiew
Curtis, C. 3300.

Codonoboea platypus (C.B.Clarke) C.L.Lim
Mhd Nur s.n. 1904.

[E, T] ***Codonoboea pumila*** (Ridl.) C.L.Lim
Burn-Murdoch, A.M. s.n. February 1904,
Curtis, C. 3782.

[E, T] ***Codonoboea venusta*** (Ridl.) Kiew
Curtis, C. 3751, Mhd Nur s.n. August 1904.

GRAMINAE

Crytococcum accrescens (Trin.) Stapf
Ridley, H.N. 12044.

[E]***Holttumochloa magica*** (Ridl.) K.M.Wong.
Ridley, H.N. 12114.

Panicum brevifolium L.
Ridley, H.N. 12046.

[E]***Schizostachyum grande*** Ridl.
Ridley, H.N. 12043.

GUTTIFERAE

Garcinia bancana (Miq.) Miq.
Ando, M. AKK 72.

Garcinia cowa Roxb.
Ando, M. AKK 354, Ando, M. AKK 120.

Garcinia forbesii King.
Ando, M. AKK 411.

Garcinia griffithii T.Anderson.
Ando, M. AKK 357.

Garcinia rostrata (Hassk.) Miq.
Ando, M. AKK 60, Ando, M. AKK 8.

Garcinia urophylla Scort. ex King
Ando, M. AKK 93, Ando, M. AKK 108, Ando, M. AKK 14.

HERNANDIACEAE

Illigera trifoliata (Griff.) Dunn
Ridley, H.N. 8599.

HYPERICACEAE

Cratoxylum sumatranum (Jack) Blume **subsp. *sumatranum***
Ando, M. AKK 224.

ILLICIACEAE

Illicium peninsulare A.C.Sm.
Ando, M. AKK 116.

IXONANTHACEAE

Ixonanthes reticulata Jack.
Ando, M. AKK 143.

LABIATAE

[E]***Callicarpa maingayi*** King & Gamble.
Ridley, H.N. 15651.

Clerodendrum disparifolium Blume
Ridley, H.N. s.n. 1897.

Clerodendrum deflexum Wall.
Aliaa Athirah A.M. FRI 88249.

Gomphostemma javanicum (Blume) Benth.
Ridley, H.N. s.n. August 1904.

Gomphostemma scortechinii Prain.
Ridley, H.N. 8564.

LAURACEAE

Actinodaphne macrophylla (Blume) Nees.
Ando, M. AKK 30, Ando, M. AKK 42.

[E, T] ***Cinnamomum aureofulvum*** Gamble.
Ridley, H.N. 12103, Ridley, H.N. 15598.

Cinnamomum subavenium Miq.
Ando, M. AKK 20.

***Cryptocarya* sp.**
Ando, M. AKK 29.

Dehaasia pauciflora Blume.
Ando, M. AKK 123.

[E]***Endiandra scrobiculata*** Kosterm. ex Kochummen.
Ando AKK 167.

Litsea accedens (Blume) Boerl. **var. *accedens***
Ando, M. AKK 63.

Litsea firma (Blume) Hook.f.
Ando, M. AKK 17.

Litsea machilifolia Gamble.
Ando, M. AKK 145, Ando, M. AKK 142.

Machilus declinata (Blume) de Kok.
Ando, M. AKK 23.

LECYTHIDACEAE

Barringtonia scortechinii King.
Ando, M. AKK 126, Ando, M. AKK 128.

LEGUMINOSAE

[E]***Bauhinia bidentata*** Jack **var. *cornifolia*** (Baker) Bennet.
Ridley, H.N. 12102.

Desmodium laxum DC.
Burkill, H.M. 8851.

Millettia sericea (Vent.) Benth.
Ando, M. AKK 231.

LORANTHACEAE

Barathranthus axanthus (Korth.) Miq.
Ridley, H.N. 12058.

Macrosolen formosus (Blume) Miq.
Aliaa Athirah A.M. FRI 96041.

MAESACEAE

Maesa ramentacea Wall. *ex* Roxb.
Ridley, H.N. s.n. August 1909.

MAGNOLIACEAE

Magnolia elegans (Blume) H.Keng.
Ando, M. AKK 13, Ando, M. AKK 164.

MELASTOMATACEAE

[E]***Anerincleistus grandiflorus*** Ridl.
Ridley, H.N. 15587.

Medinilla clarkei King. **var. *clarkei.***
Aliaa Athirah A.M. FRI 88238.

Melastoma malabathricum L.
Ridley, H.N. s.n. 21 January 1921.

[T] ***Melastoma muticum*** Ridl.
Ridley, H.N. s.n. July 1904.

Melastoma velutinosum Ridl.
Ridley, H.N. s.n. 21 January 1921.

Sonerila picta Korth. **var. *picta***
Aliaa Athirah A.M. FRI 88250.

MELIACEAE

Dysoxylum acutangulum Miq.
Ando, M. AKK 61.

MEMECYLACEAE

Memecylon acuminatissimum Blume.
Ando, M. AKK 62, Ando, M. AKK 50.

Memecylon amplexicaule Roxb.
Ando, M. AKK 168.

Memecylon dichotomum (C.B.Clarke) King.
Ando, M. AKK 25.

Memecylon intermedium Blume.
Ando, M. AKK 69.

Memecylon lilacinum Zoll. & Moritzi.
Burkill, I.H. 8888, Ridley, H.N. 15570.

Memecylon pseudomegacarpum M.Hughes.
Ando, M. AKK 36, Ando, M. AKK 22.

MORACEAE

Artocarpus maingayi King.
Ando, M. AKK 376.

Artocarpus nitidus Trécul.
Ando, M. AKK 228.

Ficus deltoidea Jack **var. *intermedia*** Corner.
Ridley, H.N. 12059.

Ficus dubia Wall. ex King.
Ando, M. AKK 422.

Ficus fulva Reinw. ex Blume.
Ridley, H.N. s.n. January 1921., Ridley, H.N. s.n. January 1921., Ando, M. AKK 412.

Ficus kerkhovenii Valeton.
Ando, M. AKK 55.

Ficus lepicarpa Blume.
Ando, M. AKK 214.

Ficus sumatrana Miq.
Burn-Murdoch, A.M. s.n. July 1904, Ando, M. AKK 407.

Ficus sundaica Blume. **var. *sumatrana*.**
Ando, M. AKK 134.

MYRISTICACEAE

Gymnacranthera farquhariana (Hook.f. & Thomson) Warb. **var. *eugeniifolia.***
Ando, M. AKK 385.

Horsfieldia polyspherula (Hook.f. ex King) J.Sinclair **var. *sumatrana*** (Miq.) W.J.de Wilde.
Ando, M. AKK 421.

Horsfieldia wallichii (Hook.f. & Thomson) Warb.
Ando, M. AKK 64.

Knema furfuracea (Hook.f. & Thomson) Warb.
Ando, M. AKK 38.

Knema hookeriana (Wall. ex Hook.f. & Thomson) Warb.
Ando, M. AKK 35.

Knema malayana Warb.
Ando, M. AKK 161.

Knema pseudolaurina W.J.de Wilde.
Ando, M. AKK 378.

MYRSINACEAE

Labisia pumila (Blume) Fern.-Vill. **var. *pumila.***
Aliaa Athirah A.M. FRI 96043.

MYRTACEAE

Syzygium cinereum (Kurz) Chantar. & J.Parn.
Ando, M. AKK 52.

Syzygium claviflorum (Roxb.) Wall. ex A.M.Cowan & Cowan.
Ando, M. AKK 24, Ando, M. AKK 4.

Syzygium incarnatum (Elmer) Merr. & L.M. Perry **var. *montanum*** (M.R.Hend.) I.M.Turner.
Ando, M. AKK 3.

Syzygium inophyllum DC. **var. *inophyllum***
Ando, M. AKK 160.

Syzygium subdecussatum* var. *subdecussatum
Ando, M. AKK 100.

***Tristaniopsis merguensis* Griff.**
Ando, M. AKK 153, Ando, M. AKK 216, Ando, M. AKK 217, Aliaa Athirah A.M. FRI 96038.

NEPENTHACEAE

[E]***Nepenthes macfarlanei*** Hemsl.
Ridley, H.N. s.n. 20 February 1904, Ridley, H.N. s.n. 1904, Murdoch, B. s.n. 20 February 1904.

Nepenthes macfarlanei x sangiunea
Ridley, H.N. 15562.

[T] ***Nepenthes ramispina* Ridl.**
Ridley, H.N. 12064, Ridley, H.N. 15563, Burn-Murdoch, A.M. s.n. February 1904.

NYSSACEAE

Mastixia pentandra Blume **subsp. *scortechinii***
(King) K.M. Matthew.
Ando, M. AKK 105.

ORCHIDACEAE

Agrostophyllum cyathiforme J.J.Sm.
Ridley, H.N. s.n. August 1904.

Agrostophyllum glumaceum Hook.f.
Ridley, H.N. s.n. July 1897.

Appendicula anceps Blume.
Curtis, C. s.n. May 1902, Curtis, C. s.n. May 1902, Curtis, C. s.n. May 1902, Ridley, H.N. s.n. 1901, Ridley, H.N. s.n. 1904.

Ascidieria longifolia (Hook.*f.*) Seidenf.
Ridley, H.N. s.n. 1904.

Bryobium hyacinthoides (Blume) Y.P.Ng & P.J.Cribb.
Ridley, H.N. 181.

Bulbophyllum uniflorum (Blume) Hassk.
Curtis, C. s.n. May 1902.

Coelogyne radicosa Ridl.
Burkill, I.H. SFN 8892.

Coelogyne tomentosa Lindl.
Ridley, H.N. s.n. 1904.

Coelogyne xyrekes Ridl.
Ridley, H.N. s.n. 1904.

Cryptostylis arachnites (Blume) Hassk.
Ridley, H.N. s.n. 1904.

Cystorchis aphylla Ridl.
Ridley, H.N. s.n. 1904, Ridley, H.N. 8780.

Dendrobium longipes Hook.*f.*
Curtis, C. s.n. May 1902, Curtis, C. s.n. May 1902, Ridley, H.N. s.n. August 1904, Curtis, C. s.n. May 1902.

Dendrobium padangense Schltr.
Curtis, C. s.n. May 1902.

Dendrobium sanguinolentum Lindl.
Machado, A.D. s.n. 1893, Ridley, H.N. 8478.

Dendrochilum pallidiflavens Blume.
Ridley, H.N. 15615.

Dilochiopsis scortechinii (Hook.*f.*) Brieger.
Ridley, H.N. 12023.

Liparis atrosanguinea Ridl.
Curtis, C. s.n. May 1902.

Mycaranthes oblitterata Blume**.**
Ridley, H.N. s.n. January 1904, Ridley, H.N. 12024.

***Pholidota* sp.**
Curtis, C. s.n. September 1902.

Pholidota ventricosa (Blume) Rchb.f.
Ridley, H.N. s.n. August 1905.

Phreatia pusilla (Blume) Lindl.
Curtis, C. s.n. May 1902 , Holttum, R.E. SFN 11396.

Podochilus muricatus (Teijsm. & Binn.) Schltr.
Ridley, H.N. s.n. August 1904.

Spathoglottis aurea Lindl.
Ridley, H.N. 12022, Aliaa Athirah A.M. FRI 96031.

Tainia speciosa Blume.
Ridley, H.N. s.n. 1904.

Trichotosia ferox Blume.
Ridley, H.N. s.n. August 1904.

Trichotosia pauciflora Blume.
Burkill, I.H. 8881.

Trichotosia poculata (Ridl.) Kraenzl.
Ridley, H.N. 15564.

PALMAE

Areca montana Ridl.
Murdoch, B. s.n. 1 March 1905.

***Calamus exilis* Griff.**
Ridley, H.N. s.n. 11 August 1904, Ridley, H.N. s.n. 11 August 1904.

[E]***Calamus viridispinus* Becc.**
Ridley, H.N. 12115, Ridley, H.N. 12121.

Calamus laevigatus
Ridley, H.N. 12120.

Daemonorops geniculata (Griff.) Mart.
Ridley, H.N. s.n. August 1904, Ridley, H.N. s.n. August 1909.

Daemonorops kunstleri Becc.
Ridley, H.N. s.n. August 1904.

Iguanura geonomiformis Mart.
Ridley, H.N. s.n. May 1904, Ridley, H.N. s.n. May 1904.

[E, T] ***Licuala glabra*** Griff. **var. *selangorensis*** Becc.
Ridley, H.N. s.n. 9 January 1911, Ridley, H.N. 12117, Ridley, H.N. s.n. August 1904, Ridley, H.N. s.n. April 1894, Ridley, H.N. 15881.

Licuala glabra Griff. var. ***glabra.***
Ridley, H.N. s.n. May 1904.

[E]***Licuala malajana*** Becc. **var. *malajana.***
Ridley, H.N. s.n. July 1897.

Pinanga limosa Ridl.
Aliaa Athirah A.M. FRI 88230.

PANDANACEAE

***Benstonea* sp.**
Aliaa Athirah A.M. FRI 96044.

PENTAPHYLACACEAE

Adinandra acuminata Korth.
Ando, M. AKK 389, Ando, M. AKK 401.

[E]***Adinandra integerrima*** T.Anderson ex Dyer.
Ando, M. AKK 18.

Adinandra villosa Choisy.
Ando, M. AKK 359.

Pentaphylax euryoides Gardner & Champ.
Ando, M. AKK 36.

PHRYMACEAE

Cyrtandromoea subsessilis (Miq.) B.L. Burtt.
Aliaa Athirah A.M. FRI 88228

PHYLLANTHACEAE

Antidesma cuspidatum Müll.Arg.
Ando, M. AKK 49.

Aporosa lunata (Miq.) Kurz
Ando, M. AKK 415.

Aporosa symplocoides (Hook.f.) Gage
Ando, M. AKK 67.

Baccaurea kunstleri King ex Gage
Ando, M. AKK 48.

[E]***Glochidion tetrapteron*** Gage
Ridley, H.N. 8522.

PIPERACEAE

[E]***Piper conibaccum*** DC.
Ridley, H.N. 12056.

[E, T] ***Piper semangkoanum*** C.DC**.**
Burkill & Holltum 8883.

PITTOSPORACEAE

Pittosporum reticosum Ridl.
Ridley, H.N. 12073.

PRIMULACEAE

[E]***Ardisia monticola*** Ridl.
Ridley, H.N. 12065.

[E]***Ardisia subverticillata*** Julius A & Utteridge TMA
Burkill, I.H. 8874.

RHIZOPHORACEAE

Carallia brachiata (Lour.) Merr.
Ando, M. AKK 373.

[E]***Pellacalyx saccardianus*** Scort.
Ando, M. AKK 26, Ando, M. AKK 371.

ROSACEAE

Prunus maingayi (Hook.) J.Wen.
Ridley, H.N. 12107.

Rubus glomeratus Blume.
Curtis, C. s.n. May 1902.

Rubus moluccanus L. **var.** ***moluccanus***
Curtis, C. s.n. May 1902.

RUBIACEAE

Aidia **sp.**
Aliaa Athirah A.M. FRI 96036.

Argostemma parvifolium Benn.
Ridley, H.N. 12078.

[E]***Argostemma subcrassum*** King.
Curtis, C. 3747.

Canthium **sp.**
Curtis, C. s.n.

Chassalia angustifolia (Ridl.) A.P.Davis.
Ridley, H.N. 15667.

[E, T] ***Chassalia bracteata*** Ridl.
Ridley, H.N. s.n. 22 January 1921.

Gaertnera diversifolia Ridl.
Ridley, H.N. 12080.

Ixora javanica (Blume) DC. var. ***javanica.***
Aliaa Athirah A.M. FRI 88240.

[E]***Lasianthus politus*** Ridl.
Aliaa Athirah A.M. FRI 88247.

Paederia foetida L.
Aliaa Athirah A.M. FRI 88248.

Rennellia morindiformis (Korth.) Ridl.
Curtis, C. s.n. May 1902.

RUTACEAE

Acronychia pedunculata (L.) Miq.
Ando, M. AKK 115.

Tetractomia tetrandra (Roxb.) Merr.
Ando, M. AKK 68.

SABIACEAE

Meliosma pinnata (Roxb.) Maxim.
Curtis, C. 3754.

SALICACEAE

[E]***Casearia flexula*** Ridl.
Burkill, I.H. SFN 8880.

Homalium longiflorum Benth. ex Koord.
Ando, M. AKK 10.

SAPINDACEAE

Xerospermum noronhianum (Blume) Blume.
Ando, M. AKK 33.

SAPOTACEAE

Payena lucida A.DC.
Ando, M. AKK 374, Ando, M. AKK 377.

Payena dasyphylla (Miq.) Pierre.
Pereira J.T. SAN 159455.

SMILACACEAE

Smilax calophylla A.DC.
Ridley, H.N. s.n. August 1904, Burkill, I.H. 8867, Aliaa Athirah A.M. FRI 96046.

STEMONURACEAE

Stemonurus malaccensis (Mast.) Sleumer
Ando, M. AKK 391.

SYMPLOCACEAE

Symplocos adenophylla Wall. ex G.Don **var. *adenophylla***
Ridley, H.N. 8549, Ando, M. AKK 137, Ando, M. AKK 347.

Symplocos cochinchinense (Lour.) S.Moore **var. *cochinchinense***
Ando, M. AKK 350.

Symplocos crassipes C.B.Clarke **var. *curtisii*** (Oliv.) Noot.
Ando, M. AKK 43.

Symplocos rubiginosa Wall. ex DC.
Ando, M. AKK 16.

THEACEAE

Schima wallichii (DC.) Korth.
Ando, M. AKK 16.

URTICACEAE

Poikilospermum microstachys (Barg.-Petr.) Merr.
Ridley, H.N. s.n. 1904.

VIOLACEAE

Rinorea anguifera (Lour.) Kuntze
Ando, M. AKK 2.

ZINGIBERACEAE

[E, T]***Alpinia murdochii*** (Baker) Ridl.
Burkill, I.H. 8868, Curtis, C. s.n. May 1902, Ridley, H.N. 12030.

[E]***Amomum lappaceum*** Ridl.
Ridley, H.N. s.n. 1904.

[E]***Amomum xanthophlebium*** Ridl.
Ridley, H.N. 12106.

[E, T] ***Camptandra ovata*** Ridl.
Ridley, H.N. s.n. August 1904, Ridley, H.N. 6250, Ridley, H.N. 15573, Burn-Murdoch, A.M. s.n. February 1904.

[T] ***Etlingera metriocheilos*** (Griff.) R.M. Sm**.** var. ***rubrostriata*** (Holttum) I.M. Turner.
Corner SFN 30776

[E, T] ***Geostachys primulina*** Ridl.
Ridley, H.N. 12029.

[E]***Globba cernua*** Baker**.**
Aliaa Athirah A.M. FRI 88243.

Globba patens Miq.
Curtis, C. s.n. May 1902, Aliaa Athirah A.M. FRI 88244.

Globba pendula Roxb.
Ridley, H.N. 13126.

[E]***Globba variabilis*** Ridl. **ssp. *variabilis.***
Curtis, C. 2755, Curtis, C. 20, Curtis, C. 2755, Ridley, H.N. s.n. 19 August 1904.

[E, T] ***Hornstedtia striolata*** Ridl.
Ridley, H.N. 12105.

[E]***Zingiber elatior*** (Ridl.) Theilade
Ridley, H.N. s.n. August 1904.

FAUNA

Summary of papers presented during the fauna session:

FAUNA01 – Altitudinal diversity and abundance of harvestman (Arachnida: Opiliones) in Fraser Hill, Malaysia
Kamarulzaman, F.E., Abdullah, N.A., Rahim, F., & Hazmi, I.R.*

This study managed to record the composition of harvestmen throughout the altitudinal gradient in Fraser's Hill. The harvestmen community structure was proven to be shaped by altitudinal factors where different species composition was found at each different elevations. The diversity of harvestmen at Fraser's Hill was generally high, proving the need to maintain the area as a protected site.

FAUNA02 – Temporal changes in forest structure and resource abundance affect occupancy and diversity of tropical montane birds
Soh, M.C.K.*, Ridley, A.R., Peh, K. S.-H., Puan, C.L., & Mitchell, N.J.

Malcom's study had demonstrated that the climate had changed at high altitudes via a trend analysis, but there were no associated changes in bird communities beyond a slight shift in species composition. In general, colonisation and persistence probabilities were affected by changes in arthropod abundance. The occupancies of birds restricted to higher elevations and certain foraging guilds such as insectivores and frugivores declined with changes in less canopy cover, ground cover and arthropod abundance. However, bird sensitivities to the same environmental changes were not dependent on body size.

FAUNA03 – Calling Songs of cicada in Fraser's Hill
Nurashikin, W., Azman, S., & Jalinas, J.*

This study on the bioacoustics communication between cicadas that can be heard from long distances is species-specific and is useful for species identification. All the recorded songs in Fraser's Hill were analysed based on five criteria that can differentiate each song. Each song can be heard at different times at various locations and it proves the richness of cicada diversity in Fraser's Hill.

FAUNA04 – Biodiversity assessment at Fraser's Hill Forest Complex via camera trapping study
Sagtia Siwan, E.*, Cheong, C., Hong, C.W., & Abidin, S.Z.

This camera trapping study amounts to 6,405 trap nights resulting in 31 species of non-volant mammals. More than half of the non-volant mammals found in this study are totally protected under the Wildlife Conservation Act 2010 and over one third of the species are listed as threatened under the IUCN Red List of Threatened Species. This indicates the high conservation value of the Fraser's Hill Forest Complex. Besides that, this study also recorded the presence of Indo-Chinese encroachers and poaching activities by locals in the area.

FAUNA05 – Diversity of Tephritid fruit flies in Raub, Pahang
Wee, S.L.*, & Har, S.K.

Based on the trapping results of using two different fruit fly male attractants, the diversity of tephritid fruit flies at the site is moderate, with a record of ten species belonging to three genera. This study had also shown that many true fruit fly species from the genera of Bactrocera, Zeugodacus and Dacus (Diptera: Tephritidae) are of economic importance. They infest a wide range of fruits and vegetables, but some species are also reported as important pollinators of certain endemic wild orchid species in rainforests.

FAUNA06 – Fireflies (Coleoptera: Lampyridae) of Fraser's Hill, Pahang, Malaysia
Badruddin, N.*, & Ballantyne, L.A.

Dr. Nada explained that while congregative fireflies live in the estuary, inland forest fireflies occur in relatively lower abundance but higher in species diversity. This insect occupies a range of habitats from lowlands to mountain tops and the risk of species loss is greater in the highlands as it supports rare and endemic species. Two firefly species, new to science, were recorded in her study, namely *Medeoptryx fraseri* and *Luciola jengai* where they were taxonomically described by Ballantyne et al. 2019. *Medeoptryx fraseri* has only been recorded in Fraser's Hill, while *Luciola jengai* also occurs in Jengai Forest Reserve, Terengganu. As tropical highlands are known to support many endemic species (Merckx et al. 2015), there could be a possibility that *M. fraseri* is endemic to Fraser's Hill, and further study is required to conclusively determine this.

FAUNA07 – Preliminary findings of interesting cassidinae (Coleoptera: Chrysomelidae) species of Fraser's Hill, Pahang
Muhaimin, A.M.D., & Yaakop, S.*

This study introduces the diversity of Cassidinae species in Fraser's Hill. The 12-month study collected a total of 316 individuals from 14 Cassidinae species. From that, *Chiridopsis punctata* is the most abundant species with 244 individuals which can be found in both mid and low altitudes. *Aspidimorpha miliaris* is one of the species that is unique to higher altitude and is not found in other altitudes.

FAUNA08 – Diversity of small mammals and their ectoparasites load at Fraser's Hill, Pahang, Malaysia
Mohd-Taib, F. S.*, Mohd-Salleh, W., Rosli, M. Z., Asyikha, R., Md-Lasim, A., & Mohd-Ngesom, A.M.

This study unveiled the small mammal community in Fraser's Hill, and their role as an important host for ectoparasites. Since Fraser's Hill forest encompassed a fairly diverse species of small mammal, and they are hosts to a high prevalence of ectoparasite, it indicates the high possibility of tick bites among visitors trekking along the trails, subsequently transmitting disease agents to trekkers. Therefore, visitors need to take precautionary measures to avoid tick bites when tracking at the trails.

FAUNA09 – Updated list of species of moth fauna (Lepidoptera: Heterocera) of Fraser Hill, Pahang
Asri, L.N., Salleh, N.K., Juhari, M.A.A., & Sulaiman, N.*

This study presented an update of the list of moths' species as one of the efforts to advocate for the conservation of Fraser's Hill for the uniqueness of its aesthetic fauna species. The moths of Fraser's Hill recorded a total of 107 species in 14 families. Several moth families are newly recorded in Fraser's Hill besides the Erebidae, namely the Crambidae (11 species), Drepanidae (2 species), Pyralidae (3 species) and Thyrididae (2 species). Continuous surveys should be done to update the checklist of moths in Fraser's Hill as their role is crucial in the ecosystem such as pollination, decomposition, nutrient cycling and as food sources for other animals.

FAUNA10 – Butterflies species (Lepidoptera: Rhopalocera) in the vicinity of Fraser's Hill Research Centre of Universiti Kebangsaan Malaysia and Jeriau waterfall area of Fraser's Hill, Pahang, Malaysia
Salleh, N.K., Asri, L.N., Sulaiman, N.*, & Juhari, M.A.A.

Overall, from the period 2001 until this current study, a total of 85 butterfly species were recorded at Fraser's Hill (Norela et. al 2010, Norfazliana et al. 2018, Nurul Atika 2017, Zaidi et al. 2001). Butterfly species of

Fraser's Hill make up approximately 4.24% of the butterfly species identified in Malaysia (2004 species) and 0.53% of the butterfly species identified worldwide (16,167 species) (BOLD SYSTEM 2020). One of the subspecies, *Eurema* is recorded as a new additional butterflies' taxon of Fraser's Hill, namely *Eurema brigitta* (Stoll) *senna* (Felder). This subspecies, also known as No Brand Grass Yellow, is a small butterfly of Coliadinae with a wingspan of 36-40 mm.

FAUNA11 – Metabolite profiles of highland stingless bee honey
Muhamad, A.*, Sulaiman, N., Juhari, M.A.A., Alias, H., Johari. N.A., Mat Isa, M.N., & Mamat, M.R.

This study was designed to develop the PPBF UKM Kelulut repository, by comparing the stingless bee honey metabolite profile from lowland habitat and after adaptation to highland habitat. It was shown that the metabolite profiles of the stingless bee honey for both before and after adaptation to high altitudes did not show any significant difference. Only organic acids concentration was found to be slightly different after adaptation. Hence, this suggests that the stingless bees are able to survive and adapt to high altitudes with slight modification of the hives.

FAUNA12 – Anuran species composition and diversity at Sungai Jeriau, Fraser's Hill, Pahang, Peninsular Malaysia
Mohammad Syafiq Haiqal, S., Nur Hidayah, S., Daicus, B., Juliana, S., Ehwan, N., & Norhayati, A.*

This study was conducted to identify anurans species diversity and the relationship between microhabitat and temporal variation. The most recent report on amphibians of Fraser's Hill by Norhayati et al. (2011) recorded 23 species, bringing the current number to 25 species. Out of all 12 species recorded in this study, three are listed as near threatened, namely *Limnonectes blythii*, *Megophrys longipes* and *Pulchrana banjarana.* For *P. banjarana* and *M. longipes*, the threat they currently face is that their extent of occurrence is less than 20,000 km^2 with most of their habitats declining in quality and extent, as well as habitat loss (Ming 2017). *Limnonectes blythii*, on the other hand, is declining in its extent and number due to overharvesting of the individuals for human consumption, not to mention the habitat loss due to forest clearance (van Dijk & Iskandar 2004).

Extended abstracts for all the papers listed above:

FAUNA 01

ALTITUDINAL DIVERSITY AND ABUNDANCE OF HARVESTMEN (ARACHNIDA: OPILIONES) IN FRASER HILL, MALAYSIA

Kamarulzaman, F.E.[1,2], Abdullah, N.A.[1,2], Rahim, F.[1,3], & Hazmi, I.R.[1,2]*
[1]Department of Biological Science and Biotechnology, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor
[2]Center for Insect Systematics, Faculty of Science and Technology,
Universiti Kebangsaaan Malaysia, 43600 Bangi, Selangor
[3]Islamic Science Institute, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Negeri Sembilan
Corresponding author email: izfahazmi@ukm.edu.my

Abstract

Study of harvestmen in Malaysia have started in the 1970s focusing on the taxonomic aspect of the group. However, till today, there is still a limited record on the distribution of harvestmen in the country. Thus, the objective of this study is to determine the diversity and abundance of harvestmen at different altitudes of Fraser's Hill, Pahang, Malaysia. Active sampling was conducted monthly in four consecutive months in 2012 at Hutan Lipur Lata Jarum (250m), Raub-Fraser Hill corridor (500 m and 750 m) and Fraser's Hill (1000 m). Harvestmen were collected by hand and sweep net during both night and day. A total of 893 harvestmen from two suborders, three families and 10 genera (*Marthana, Zaleptus, Gagrella, Koyamaia, Dentobunus, Tithaeus, Tegestria, Hologagrella, Pasohnus* and *Tarnus*) were successfully recorded. Shannon diversity index is highest at 1000 m (H' = 2.078) and lowest at 500 m (H' = 1.021). There is no significant difference ($F = 0.74$, df=2, $p>0.05$) in abundance of harvestmen at different altitudes. Nevertheless, cluster analysis showed that the composition of harvestmen were separated into two groups according to altitudinal differences where harvestmen found at 500 m and 750 m were grouped together at 100% similarity while harvestmen found at 250 m and 1000 m were separated into different groups. This study may serve as a baseline data for future reference on ecological studies of harvestmen in Malaysia.

Keywords: harvestmen, Fraser's Hill, Opiliones, altitude

Introduction

Harvestmen are the third largest Arachnid group after Acari and spiders (Proud et al. 2012). A total of 6411 species of harvestmen had been described from all over the world (Huang et al. 2009). Harvestmen have a fused head and body part where it is oval in shape with the size ranging from 4 to 10 mm. The study of harvestmen in Malaysia was first conducted by Suzuki in 1972. Later in 2011, Fatin-Elina and Faszly (2011) conducted a preliminary record of harvestmen in Sabah; and a preliminary checklist of harvestmen in Malaysia had been published by Fatin-Elina et al. (2019). A morphometric study had also been done on the harvestment found in Lata Jarum, Pahang (Nur-Syahirah et al. 2019).

Altitudinal studies had been done on various organisms to study the effect of climate change. The study on diversity of harvestmen at different altitudes had also been done by Komposch & Gruber (1999), Stasiov & Bitusik (2001), Stasiov (2004, 2008) and Almeidae-Neto et al. (2006). These previous studies however, only cover a small group of the species which limit the knowledge on a whole bigger community of harvestmen (Proud et al. 2012). In addition, records of harvestmen remain incomplete in Malaysia, with limited number of studies done on this group of organisms. Thus, this study attempts to provide a latest record on the diversity of harvestmen at different altitudes of Fraser's Hill, Pahang, Malaysia.

Materials and Methods

Harvestmen were collected at Fraser's Hill, Pahang over three elevational ranges; at 250 m (Hutan Lipur Lata Jarum 3°59'53.1"N 103°37'26.8"E); 500 m (Raub-Fraser's Hill Corridor: 3°42'45.19"N 101°46'18.96"E); 750 m (Raub-Fraser's Hill Corridor: 3°42'01.84"N 101°45'10.72"E); and 1000 m (Fraser's Hill 3°71'22.20"N 101°72'79.30"E). Sampling was conducted monthly for four consecutive months from December 2011 to March 2012. Active sampling method was used to collect harvestmen, either directly using hand or sweep net. The collection of specimens were done at both day (0900-1200) and night (2000-2400). Specimens collected

at different elevations were kept separated and preserved in 90% alcohol. Identification was done up to morphospecies using several published taxonomic keys (Pinto-Da-Rocha et al. 2007; Suzuki 1972; 1982). All specimens were deposited at the Center for Insect Systematics (CIS), Universiti Kebangsaan Malaysia.

Shannon diversity index (H') were calculated using Paleontological Statistics Software Package for Education and Data Analysis (PAST) version 3.26b. Chi-squared analysis was conducted to determine any significant difference in the composition of harvestmen between different altitudes. The chi-squared analysis, cluster analysis and two-way dendrogram were generated using PCORD version 6.0. One-way ANOVA was conducted to test for any significant difference on the abundance of harvestmen at different altitudes using PAST version 3.26b.

Results and Discussion

A total of 893 individuals of harvestmen from two suborders, three families and 10 genera were successfully recorded. The morphospecies list are shown in Table 1. Apparently, the number of genus collected in this study only consist of 18% (10 out of 55 genera) of the total number of genus which have been recorded in Malaysia. A total of 20 morphospecies and only 10 species were successfully identified up to species level due to limitation in source of taxonomic key as reference for identification of harvestmen in Malaysia. This study recorded a declining trend in abundance of harvestmen across altitudinal gradient from lowest elevation to the highest elevation (Figure 1). However, one-way ANOVA showed no significant difference (F = 0.74, df=2, p>0.05) in abundance of harvestmen at different altitudes. Results of this study showed a unimodal pattern where species are found in abundance at middle elevation and decrease as the altitude increases. This is consistent with the study done by Stasiov (2008) and Komposch & Gruber (1999). The variations shown between different altitudes was caused by temperature, humidity, habitat structure and level of disturbance (Almeida-Neto et al. 2006; Proud et al. 2011; Sanders et al. 2003).

Nevertheless, the Shannon diversity index showed to be highest (H' = 2.10) at 1000 m followed by 250 m (H'= 2.01), 750 m (H'= 1.15) and 500 m (H'= 1.02). The sampling of harvestmen at 1000 m had been done at various trials with multiple habitat niches such as shrubs, rocks, mosses as well as higher plants. The various different niches could contribute to different resources that cater to different harvestmen species resulting in high diversity of harvestmen at the highest elevation. Chi-squred test showed significant difference (χ^2 = 321.988 df = 27, p<0.05) in composition of harvestmen at different altitudes. At 75% similarity in cluster analysis, the composition of harvestmen can be divided into three groups according to altitudes (Figure 2). Group 1 consisted of harvestmen found at 250 m. Group 2 consisted of harvestmen found at altitude 1000 m while Group 3 consisted of harvestmen found at altitude 500 m and 750 m. The result of this study proved that the composition of harvestmen are different following different elevations.

Table 1 Morphospecies list of harvestmen individuals collected from three different altitudes at Fraser's Hill, Pahang.

Taxa	**Code**	**Altitudes (m)**				**No. of individuals**	**Individual percentage (100%)**
		250	**500**	**750**	**1000**		
Suborder: Eupnoi							
Sclerosomatidae							
Dentobunus luteus	Dent	2	8	19	8	37	4.1
Dentobunus sp1	Dentsp1	0	0	0	1	1	0.1
Dentobunus sp2	Dentsp2	0	0	0	2	2	0.2
Gagrella longipalpis	Gagr	1	1	2	0	4	0.4
Gagrella sp1	Gagrsp1	16	1	0	9	26	2.9
Gagrella sp2	Gagrsp2	0	0	0	2	2	0.2
Gagrella sp3	Gagrsp3	0	1	0	0	1	0.1
Gagrella sp4	Gagrsp4	0	1	2	0	3	0.3
Gagrella sp5	Gagrsp5	0	3	1	1	5	0.6
Gagrella sp6	Gagrsp6	3	4	3	0	10	1.1

Hologagrella reticulata	Holo	0	2	0	0	2	0.2
Koyamaia curvipes	Koya	1	28	3	14	46	5.2
Marthana ferruginea	Mart	11	369	121	0	501	56.1
Marthana sp1	Martsp1	8	0	0	5	13	1.5
Marthana sp2	Martsp2	4	0	0	0	4	0.4
Marthana sp3	Martsp3	1	0	0	0	1	0.1
Zaleptus quadrimaculata	Zale	17	144	57	3	221	24.7
Suborder: Laniatores							
Assamiidae							
Tarnus pulcher	Tarn	0	1	0	0	1	0.1
Epedanidae							
Pasohnus bispinosus	Paso	0	0	0	1	1	0.1
Tegestria seriata	Tege	0	4	1	0	5	0.6
Tithaeus fraseri	Tith	0	0	0	2	2	0.2
Tithaeus sp1	Tithsp1	2	1	0	1	4	0.4
TOTAL		**67**	**568**	**209**	**49**	**893**	**100**

*Code use for morphospecies in two-way dendrogram generated from cluster analysis.

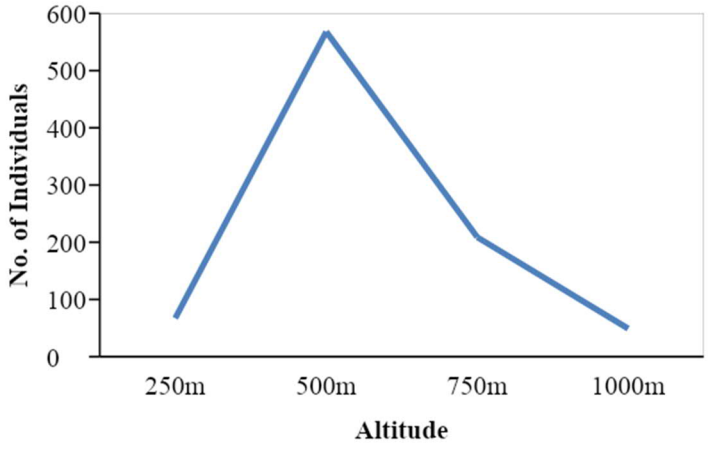


Figure 1. Number of harvestmen individuals across altitudinal gradient from 500 m to 1000 m in Fraser's Hill, Pahang

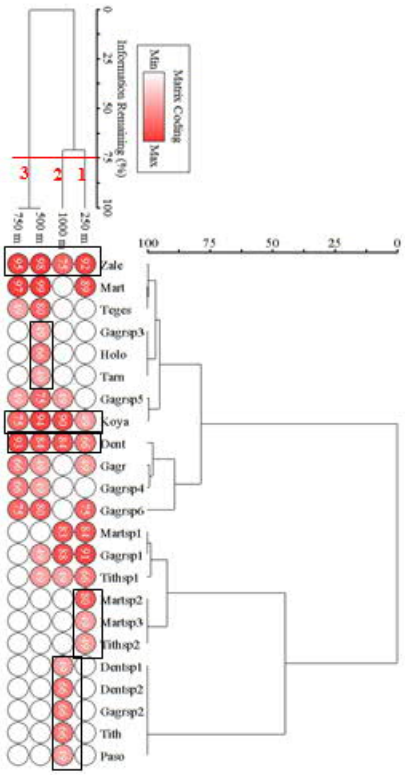


Figure 2 Two-way dendrogram showing similarity between morphospecies of harvestment in different altitudinal gradients.

Group 1 consisted of harvestmen species that can be found in the lowest altitude (250 m) at low dipterocarp forest of Hutan Lipur Lata Jarum. This forest has a high density of vegetation. Three harvestmen species (*Marthana* sp2, *Marthana* sp3 dan *Tithaeus* sp2) were uniquely showing specific adaptation towards this lower forest area. Group 2 on the other hand consisted of harvestmen found at 1000 m which is in upper hill dipterocarp forest (Fraser's Hill). This area has a patchy canopy cover causing sunlight to reach the forest floor during the day (Brown et al. 1994). The *Dentobunus* sp1, *Dentobunus* sp2, *Gagrella* sp2, *Pasohnus bispinosus* and *Tithaeus fraseri* are unique to this altitude showing their sensitivity towards UV light where they can only be found at night. Group 3 showed 100% similarity between composition of harvestmen at altitude 500 m and 750 m (Raub-Fraser's Hill Corridor). This is due to the similarity in the habitat structure at both altitudes where both are hill dipterocarp forests with minimal human disturbance. There were nine morphospecies of harvestmen commonly found in both altitudes (*Zaleptus quandrimaculata, Marthana ferruginea, Tegestria seriata, Koyamaia curvipes, Dentobunus luteus, Gagrella longipalpis, Gagrella* sp4, *Gagrella* sp5 and *Gagrella* sp6). The other three morphospecies (*Gagrella* sp3, *Hologagrella reticulate* and *Tarnus pulcher)* however were unique to altitude 500 m. The *Zalaptus quadrimaculata, Koyamaia curvipes* and *Dentobunus luteus* however are more flexible in utilisation of resources as they can be found at all altitudes.

Conclusion

This study managed to record the composition of harvestmen throughout the altitudinal gradient in Fraser's Hill. The diversity of harvestmen at Fraser's Hill was generally high proving the need to maintain the area as a protected site. The harvestmen community structure was proven to be shaped by altitudinal factors where different species composition was found at each different elevation. The checklist of morphospecies provided in this study may serve as baseline data for future reference. There is an urgent need in taxonomic studies of harvestmen to assist in the identification of species found in Malaysia.

References

Almeida-Neto, M., Machado, G., Pinto-da-Rocha, R., & Glaretta, A.A. 2006. Harvestmen (Arachnida: Opiliones) species distribution along three Neotropical elevational gradients: an alternative rescue effect to explain Rapoport's rule. *Journal of Biogeography* 33: 361-375.

Brown, M.J., Parker, G.G. & Posner, N.E. 1994. A survey of ultraviolet-B radiation in forests. *Journal of Ecology* 82: 843-854.

Fatin-Elina, K. & Faszly, R. 2011. A Preliminary Record of Harvestmen (Arachnida: Opiliones) from Imbak Canyon Conservation Area. In A. Latiff and W. Sinun (eds) *Imbak Canyon Conservation Area, Sabah: Geology, Biodiversity and Socio-economic Environment.* Proceedings of the Seminar on Imbak Canyon Scientific Expedition, 14-15 March 2011.

Fatin-Elina, K., Dzulhelmi, M.N., Nur Syahirah, M., Faszly, R. & Izfa Riza, H. 2019. A preliminary checklist of harvestmen (Arachnida: Opiliones) in Malaysia. *Serangga 22*(1): 65-84.

Huang, D., Seiden, P.A. & Dunlop, J.A. 2009. Harvestmen (Arachnida : Opiliones) from the Middle Jurassic of China. *Naturwissenschaften* 96: 955-962.

Nur-Syahirah, M., Dzhulhelmi, M. N., Fatin-Athirah, P., Fatin-Elina, K., Faszly, R. & Yosni, B. 2019. Kajian morfometrik ke atas harvestmen (Arachnida: Opiliones) dari Lata Jarum, Pahang, Semenanjung Malaysia. *Serangga* 24(1): 173-198

Pinto-Da-Rocha, R., Machado, G. & Giribet, G. 2007. *Harvestmen The Biology of Opiliones*. President and Fellows of Harvard College. Harvard University Press.

Proud D.N., Felgenhauer, B.E., Townsend Jr, V. R., Osula, D. O., Gilmore III, W. O., Napier, Z. L. & Van Zandt, P. A. 2012. Diversity and Habitat Use of Neotropical Harvestmen (Arachnida: Opiliones) in a Costa Rican Rainforest. *International Scholarly Research Network Zoology* 1-17.

Suzuki, S. 1972. Opiliones of Semangkok Forest Reserve, Malaysia. *Journal of Science of The Hiroshima University*. 24(1): 1-37

Suzuki, S. 1982. A small collection of Harvestmen from Malaysia (Opiliones, Arachnida). *Acta Arachnol*. 31(1): 27-34.

FAUNA 02

TEMPORAL CHANGES IN FOREST STRUCTURE AND RESOURCE ABUNDANCE AFFECT OCCUPANCY AND DIVERSITY OF TROPICAL MONTANE BIRDS

Soh, M.C.K.[1]*, Ridley, A.R.[1], Peh, K. S.-H.[2,4], Puan, C.L.[3], & Mitchell, N.J.[1]
[1]School of Biological Sciences, The University of Western Australia, Perth, WA, Australia
[2]School of Biological Sciences, University of Southampton, Southampton, UK
[3]Faculty of Forestry, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia
[4]Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, UK
**Corresponding author email: malcolmsoh@gmail.com*

Abstract

Tropical montane forests (TMFs) have high endemism and provide fundamental ecosystem services but are experiencing rapid deforestation and climate change. Here we examine the resilience of tropical montane birds in Peninsular Malaysia to environmental change by comparing field data collected at the same nine locations in Fraser's Hill and Cameron Highlands 14 years apart. While we were able to demonstrate that the climate had changed at high altitudes via a trend analysis, there were no associated changes in bird communities beyond a slight shift in species composition at only one of nine sites. Species composition in our sampled sites, unlike species richness, showed some differences between sampling years, most notably with a tea plantation site showing a greater similarity to less disturbed sites than it did in our earlier survey. In general, colonisation and persistence probabilities were affected by changes in arthropod abundance. Functional traits also played a role in moderating the sensitivity of birds to changes in vegetation structure and food abundance. The occupancies of birds restricted to higher elevations and certain foraging guilds such as insectivores and frugivores declined with changes in less canopy cover, ground cover and arthropod abundance. However, bird sensitivities to the same environmental changes were not dependent on body size. We recommend maintaining habitat structural heterogeneity and food abundance to mitigate the effects of habitat degradation to montane bird communities and investing in long-term biodiversity surveys to monitor the effects of climate change.

Keywords: cloud forest, species richness, species composition, dynamic occupancy, global warming

NOTE: The full text of the extended abstract is not published here at the request of the author.

FAUNA 03

CALLING SONGS OF CICADA IN FRASER'S HILL

Nurashikin, W., Azman, S., & Jalinas, J.*
Department of Biological Sciences and Biotechnology,
Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor
**Corresponding author email: johari_j@ukm.my*

Abstract

Male cicadas produce loud calling songs through its tymbal organ to attract females for mating purposes. This bioacoustic communication amongst cicadas that can be heard from long distances is species-specific and is useful for species identification. This study is to characterise the calling songs of *Platylomia spinosa*, *Pomponia* near *picta*, *Orientopsaltria* sp. 1, Sp. 1, Sp. 2 and Sp. 3 in Fraser's Hill, Pahang. Calling songs were recorded in selected trails in Fraser's Hill during the day in July by using microphone and linear PCM recorder. Echeme duration, echeme period, inter-echeme duration, no. of echeme/s and dominant frequency are the five features used in this study. The calling song of *P. spinosa* is a birdlike song consisting of regular repetition of phrase, calling song of *Pomponia* near *picta* consists of three parts continuous high pitched train of pulses and *Orientopsaltria* sp. 1 calling song consists of repeated constant echeme. Sp. 1's calling song is composed of repeating quick buzz and click sound, calling song of Sp. 2 is a continuous loud song and Sp. 3 consist of high pace buzz sound. In our analysis, all calling songs showed their unique characteristic features and act as an identification key for each group. Calling songs of Sp. 1, Sp. 2 and Sp. 3 are still in the process of identification. More calling songs of different groups of cicada will be recorded and characterised to establish a sound library of local cicada in the future.

Keywords: bioacoustics, cicada, *Platylomia spinosa*, *Pomponia* near *picta*, *Orientopsaltria* sp.

Introduction

Insects communicate by producing chemicals or sound. Signals produced by insects via vibration or sound is an amplitude-time waveform which is detectable by microphone or vibration sensor and is simply designated as acoustic signals or sound (Mankin et al. 2011; Webb, Litzkow & Slaughter 1988). Bioacoustic activity produced by insects are consistent in acoustic rhythm and species-specific (Drosopoulos & Claridge 2006; Hertach et al. 2016). It has been used as a tool to validate the identity of similar organisms from different places (Trilar & Gogala 2002) or to differentiate cicada that are of morphologically similar taxa (Gogala & Trilar 1999). Cicada species can be identified based on sound recognition of calling songs produced by male cicadas. Cicada calling songs of Fraser's Hill has never been characterised and this can add new data to the diversity of cicada songs in Malaysia. This study is to characterise and identify the calling songs of male cicadas and to generate a sound library of cicada calling songs.

Materials and Methods

Sampling of calling songs

Complete calling songs were recorded by using SONY linear PCM recorder (model IP-470) with frequency range 50-20 000 Hz with parabolic stereo microphone. The songs were recorded in WAV format with a sampling rate of 44.1 kHz and sample size of 16-bit resolution. The calling songs were recorded at selected trails in July 2018 from 07:00hr to 19:00 hr.

Acoustic analysis

The recorded calling songs of cicada in the field were referred to a cicada expert to identify its taxonomy up to genus level. The acoustic analysis for recorded songs were conducted by using the Raven Pro 1.3 (The Cornell Lab of Ornithology, New York, United State of America). The recorded songs were digitised into oscillogram, spectrogram and mean amplitude spectrum. The digitised songs were analysed into five features; echeme period, echeme duration, inter-echeme duration, number of echemes per second and dominant frequency.

Results and Discussion

Song analysis

The calling song of *Platylomia spinosa* was recorded at 19:42 hr, is a bird-like song and has repeated similar consistent phrase for 19 s. Each phrase consists of two parts: part 1 and part 2. Part 1 consists of 4-6 echemes and part 2 is a buzzing song. Loud and high pitch continuous calling songs of *Pomponia* near *picta* was recorded from 19:00 hr to 19:40 hr. One complete song lasts for 22 s and consists of three parts; part 1, part 2 and part 3. Calling song of *Orientopsatria* sp. 1 was recorded at 09:50 hr, continuous song with total duration of 132.4 s and consist of constant echeme (Table 1).

Calling song of Sp. 1 was recorded at 10:19 hr and consists of two parts; part 1 and part 2. Part 1 consists of 484 echemes, buzz sounds, and part 2 consists of click sounds at the end of the song. Calling song of Sp. 2 was recorded at 17:10 hr and composed of a continuous train of short echemes. Calling song of Sp. 3 was recorded at 11:38 hr and composed of trains of echemes. Each echeme consists of two parts: part 1 and part 2 (Table 1).

Table 1. Calling songs of cicadas at Fraser's Hill

Species	Echeme period (s)	Echeme duration (s)	Inter-echeme duration (s)	No. of echeme/s	Dominant frequency (kHz)
Platylomia spinosa	0.164 ± 0.01	0.100 ± 0.03	0.064 ± 0.08	8.571	3.202
Pomponia near *picta*	0.118	0.086	0.032	6.526	3.180
Orientopsaltria sp. 1	0.381 ± 0.07	0.233 ± 0.00	0.149 ± 0.07	2.545	3.5 -3.7
Sp. 1	0.321 ± 0.05	0.163 ± 0.06	0.158 ± 0.08	3.587	4.7-5.2
Sp. 2	0.250 ± 0.07	0.163 ± 0.05	0.087 ± 0.05	4.061	4.4 – 5.1
Sp. 3	0.140 ± 0.05	0.127 ± 0.05	0.013 ± 0.00	7.379	4.018

Song comparison analysis

Calling songs of *Platylomia spinosa*, *Pomponia* near *picta* and *Orientopsaltria* sp. 1 were identified based on the key sound and parameter measured in this study. However, another three calling songs of Sp. 1, Sp. 2 and Sp. 3 are still in the process of identification. These songs can be segregated and identified based on temporal factors and can act as nature's alarm clock. According to Zaidi et al. (2001), four species from genus *Platylomia* were recorded in Fraser's Hill; *P. abdulla, P. flavida, P. saturate and P. spinosa.* Only two species of *Orientopsaltria* recorded; *O. padda* and *O. ruslani,* and no record on cicada calling song of genus *Pomponia* in Fraser's Hill.

Conclusion

All recorded songs in Fraser's Hill were analysed based on the five criteria that can easily differentiate each song. Each song can be heard at different times in various locations and it proves the richness of cicada diversity in Fraser's Hill. Extensive study must be done to explore more on fauna acoustic diversity especially cicada.

Acknowledgements

We express our gratitude to the science officer and lab assistance in Central Insect Systematic (CIS) UKM, fellow laboratory mates from Toxicology and Applied Entomology Laboratory. and officers from Pusat Penyelidikan Bukit Fraser, UKM for the assistance rendered throughout this study.

References

Drosopoulos, S. & Claridge, M.F. 2006. *Insects Sounds and Communication: Physiology, Behaviour, Ecology and Evolution.* Florida: Taylor and Francis.

Gogala, M. & Trilar, T. 1999. The song structure of *Cicadetta Montana Macedonia* Schedl with remarks on songs of related singing cicadas (Hemiptera: Auchenorrhyncha: Cicadomorpha: Tibicinidae). *Reichenbachia, Schriftenreiha Taxonomic Entomology* 33(1) 91-97.

Hertach, T., Puissant, P., Gogala, M., Trilar, T., Hagmann, R., Baur, H., Kunz, G., Wade, E.J., Loader, S., Simon, C. & Nagel, P. 2016. Complex within a complex: integrative taxonomic reveals hidden diversity in *Cicadetta brevipennis* (Hemiptera: Cicadidae) and unexpected relationships with a song divergent relative. *PLoS ONE* 11(11):e0165562.

Mankin, R.W., Hagstrum, D.W., Smith, M.T., Roda, A.L. & Kario, M.T.K. 2011. Prospective and promise: a century of insect acoustic detection and monitoring. *American Entomology* 7: 30-44.

Trilar, T. & Gogala, M. 2002. Description of the song of *Purana sagittata* Schouten & Duffels (Homoptera, Cicadidae) from Peninsular Malaysia. *Tijdschrift voor Entomologie* 145: 47-55.

Webb, J.C., Litzkow, C.A. & Slaughter, D.C. 198. A computerized acoustical larval detection system. *Applied Engineering in Agriculture* 4:367-375.

Zaidi, M.I., Azman, S., Salmah, Y., Idris, A.G., Nor-Zarneeeda, N. & Gozanga, A.D. 2001. Cicada (Homoptera: Cicadoidea) fauna of Fraser's Hill: a survey and overview. In Latiff, A., Zakaria, Z., Isa, Z.M., Mat-Salleh, K., Hashim, N.M. & Din, L. M. (ed.) *Bukit Fraser: Persekitaran Fizikal, Biologi, dan Sosio-ekonomi.* Bangi: Pusat Pengurusan Penyelidikan, Universiti Kebangsaan Malaysia.

FAUNA 04

BIODIVERSITY ASSESSMENT AT FRASER'S HILL FOREST COMPLEX VIA CAMERA TRAPPING STUDY

Sagtia Siwan, E.*, Cheong, C., Hong, C.W., & Abidin, S.Z.
World Wide Fund for Nature (WWF) Malaysia, 1 Jalan PJS 5/28A, Petaling Jaya Commercial Centre (PJCC), 46150 Petaling Jaya, Selangor, Malaysia.
**Corresponding author email: esiwan@wwf.org.my*

Abstract

Fraser's Hill Forest Complex spans about 830 km^2 and has no known camera trapping study on its wildlife diversity prior to 2014. WWF-Malaysia has conducted a small-scale camera trapping study to assess the diversity of non-volant mammals in this landscape. The study was carried out in three phases from November 2014 to July 2019 with a total of 46 camera trap locations deployed across the Fraser's Hill Forest Complex in a non-systematic manner based on accessibility. The minimum convex polygon created by connecting the outermost camera traps covers a total area of 373 km^2. Camera trapping efforts amount to 6,405 trap nights resulted in 31 species of non-volant mammals, of which 10 species are considered as threatened under the IUCN Red List of Threatened Species. The study managed to provide first photographic evidence of threatened species in Fraser's Hill Forest Complex such as dhole, leopard, clouded leopard, Malayan tapir, Malayan sun bear, Sumatran serow, Sunda pangolin and binturong. The study also recorded the presence of Indo-Chinese encroachers and poaching activities by locals in the area. Presence of non-volant mammals of high conservation value as well as poaching threats strengthen the need for gazettement of Fraser's Hill Forest Complex as a state or a national park in order to improve its protection through park authorities. Furthermore, such gazettement would also boost the landscape's visibility from an eco-tourism perspective.

Keywords: Fraser's Hill Forest Complex, state park, non-volant mammals, camera trap

Introduction

WWF-Malaysia's priority conservation area comprises the Fraser's Hill Town Board, state land forests and six Permanent Reserved Forests. This priority conservation area is collectively called the Fraser's Hill Forest Complex as the landscape encompasses various forest reserves and different land status. The Fraser's Hill Forest Complex has high biodiversity, serves as a water catchment forest and arguably an important refuge for pollinators that help to pollinate durians - an important economic thrust of the Raub district.

WWF-Malaysia has been advocating to the Pahang State government for the gazettement of the Fraser's Hill Forest Complex as a state park. However, the absence of wildlife diversity studies within the Fraser's Hill Forest Complex has left a knowledge gap in terms of ecological needs and refuge for wildlife in this large landscape. Anecdotal sources of the presence of rare, threatened, and endangered species in Fraser's Hill Forest Complex are mostly without photographic evidence which lacks proper justification to show the importance of this habitat for wildlife. To overcome this lack of information on wildlife diversity, WWF-Malaysia began its camera trapping study in 2014.

Though other field-based wildlife studies involve methods such as direct observations and physical trappings, camera trapping presents a non-invasive study with reliable records of wildlife presence, reduced error in identification and increased chance of detecting elusive species (O'Connell et al., 2010). The aim of the study is to address the information gap on the diversity of ground-dwelling wildlife particularly on non-volant mammals in Fraser's Hill Forest Complex. It also aims to gather other ground information such as threats to wildlife and changes in land use in order to better position advocacy work for the gazettement of Fraser's Hill Forest Complex as a state park.

Materials and Methods

Study area

The Fraser's Hill Forest Complex spans an area up to 82,895 hectares, covering the Fraser's Hill Town Board, some state land forests, Batu Talam Forest Reserve (FR), Sg. Sia FR, Rotan Tunggal FR, Rotan Tunggal Tambahan FR, Sempam FR and Teranum FR - all within the district of Raub, Pahang. Fraser's Hill Forest Complex is made up of upper and lower montane forests as well as hill and upper hill dipterocarp forests. It lies within the Central Forest Spine (DTCP, 2009) which acts as a contiguous forest network linking the northern and southern forests along the Titiwangsa Range and the Selangor State Park in the south-west.

Materials

Three different brands of camera trap were deployed based on the availability of resources at each phase of the study. They are Reconyx (model: HC550, HF2X, and WR6); Bushnell (model: Trophy Cam HD Max and Aggresor); and custom-made units made of Sony P41 camera coupled with "Trails End" Snapshotsniper controller board enclosed in a 1040 Pelican case. The camera traps will be triggered to take pictures as wildlife passes across its detection zone. The camera trap does this by using sensors that can detect heat and motion, which is ideal for warm-blooded wildlife like mammals. Two models of Global Positioning System (GPS) unit used for this study were Garmin 60 CSx and Garmin GPSMap 64s.

Data collection

The study was carried out in three different phases due to resource limitations. Phase 1 of the camera trapping study was carried out from 20th November 2014 to 31st December 2015 whereby a total of six locations were deployed with camera traps, mostly within the Fraser's Hill Town Board. Phase 2 of the study was conducted from 9th July 2016 till 13th May 2017 with 13 camera trap locations. Phase 3 of the camera trapping study had 27 locations and the sampling started from 12th September 2018 to 29th July 2019. The field team trekked a total of 295 km in search of suitable camera trap locations, deployment, and retrieval of all 46 camera traps since November 2014 to July 2019. This study adopted convenient sampling, essentially due to lack of resources, whereby locations of camera traps were selected based on accessibility and placed in a non-systematic manner. However, we had ensured that the distribution of camera trap locations covers most of the Fraser's Hill Forest Complex so that the information generated from the study is representative of the forest complex in its entirety.

Data analysis

Data obtained from the camera traps were entered into a camera-trap database developed by WWF-Malaysia. Wildlife photos were identified up until species level whenever possible. Detection of the same species is treated as independent if the detections are more than 30 minutes apart (O' Brien et al., 2003). Dataset from all three phases were combined to provide a larger dataset, which enables better estimation of the activity class as recommended by relevant studies (Beier & McCullough, 1990; Wagner *et al.*, 2001). We will present the activity class for species that has more than 10 detections, as anything lower than that may not reflect the real pattern due to skewness (Ruffino et al., 2010).

Results and Discussion

Effort

Camera trapping efforts amount to 6,405 trap nights. The elevation range of the camera trap locations are from 170 m a.s.l to 1,488 m a.s.l. The average distance between the traps was about 1.12 km. The closest distance between camera traps was 0.01 km whereas the furthest was 9.54 km apart. The minimum convex polygon created by connecting the outermost camera traps totals up to an area of 373 km^2, which is about 45% of the Fraser's Hill Forest Complex.

Species composition

A total of 31 species of non-volant mammals, nine avian species and one reptilian species were recorded. Although the study aims to assess non-volant mammals (Class Mammalia), species from other Classes such as Aves and Reptilia were also recorded at some of the camera trap stations, as they too are mostly ground-dwelling species. The pie chart below (Figure 1) provides a breakdown of species recorded according to Class and Order (Mammalia only).

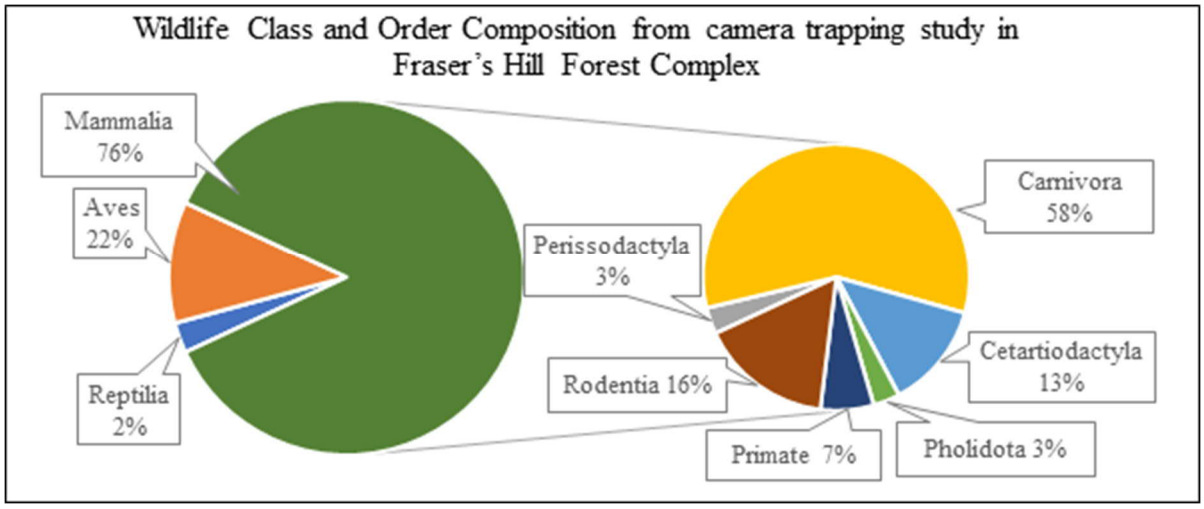


Figure 1: Composition of species according to Class and Order (Mammalia only).

Species list, activity class and RAI.

Table 1 shows all 41 species found through this study listed according to Class and Order coupled with its activity class and Relative Abundance Index (RAI). Corresponding protection status in the Wildlife Conservation Act (WCA) 2010 as well as its category of IUCN Red List of Threatened Species are also presented in Table 1. Out of 31 species of non-volant mammals, 19 species (61%) are classified as "Totally Protected" under the Wildlife Conservation Act 2010 whereas 10 species (32%) are threatened under the IUCN Red List of Threatened Species.

The RAI value of barking deer is the highest (5.44±1.22) followed by wild boar (5.42±1.55) and Malayan sun bear (1.71±0.61). The 10 threatened species of non-volant mammals found from this study are binturong (Vulnerable), clouded leopard (Vulnerable), dhole (Endangered), leopard (Vulnerable), Malayan sun bear (Vulnerable), Malayan tapir (Endangered), Malayan tiger (Critically Endangered), pig-tailed macaque (Vulnerable), Sumatran Serow (Vulnerable) and Sunda pangolin (Critically Endangered) - refer Appendix. Among the threatened species of non-volant mammals, Malayan sun bear recorded highest RAI value of 1.71±0.61, followed by pig-tailed macaque (1.22±0.30) and Malayan tapir (1.10±0.28) whereas among the threatened cat species, clouded leopard has the highest RAI value (0.57±0.26).

Table 1. List of species from camera trapping study at Fraser's Hill Forest Complex.

CLASS, Order & Scientific Name	Activity Class	RAI	WCA 2010[1]	IUCN[2]
MAMMALIA				
Carnivora				
Banded civet (*Hemigalus derbyanus*)	N	0.24±0.08	TP	NT
Banded linsang (*Prionodon linsang*)	N	0.26±0.12	TP	LC
Binturong (*Arctictis binturong*)	N/A	0.08±0.04	TP	VU
Clouded leopard (*Neofelis nebulosa*)	C	0.57±0.26	TP	VU
Common palm civet (*Paradoxurus ermaphroditus*)	N	0.13±0.05	P	LC
Common treeshrew (*Tupaia glis*)	D	0.64±0.29	P	LC
Crab-eating mongoose (*Herpestes urva*)	PD	0.20±0.08	TP	LC
Dhole (*Cuon alpinus*)	N/A	0.07±0.05	TP	EN
Golden cat (*Catopuma temminckii*)	C	0.66±0.24	TP	NT
Large Indian civet (*Viverra zibetha*)	N/A	0.13±0.09	TP	LC
Leopard (*Panthera pardus*)	PD	0.42±0.15	TP	VU
Leopard cat (*Prionailurus bengalensis*)	N	1.27±0.35	TP	LC
Malayan sun bear (*Helarctos malayanus*)	C	1.71±0.61	TP	VU
Malay weasel (*Mustela nudipes*)	N/A	0.02±0.01	TP	LC
Marbled cat (*Pardofelis marmorata*)	C	0.24±0.11	TP	NT

Masked palm civet (*Paguma larvata*)	N	1.34±0.27	TP	LC
Malayan tiger (*Panthera tigris jacksonii*)	N/A	0.03±0.03	TP	CR
Yellow-throated marten (*Martes flavigula*)	D	1.67±0.37	TP	LC
Cetartiodactyla				
Barking deer (*Muntiacus muntjac*)	C	5.44±1.22	P	LC
Mousedeer (*Tragulus sp.*)	C	0.29±0.23	P	LC
Sumatran serow (*Capricornis sumatraensis*)	N/A	0.22±0.12	TP	VU
Wild boar (*Sus scrofa*)	C	5.42±1.55	P	LC
Perissodactyla				
Malayan tapir (*Tapirus indicus*)	PN	1.10±0.28	TP	EN
Pholidota				
Sunda pangolin (*Manis javanica*)	N/A	0.18±0.12	TP	CR
Primate				
Pig-tailed macaque (*Macaca nemestrina*)	D	1.22±0.30	P	VU
White-thighed langur (*Presbytis siamensis*)	N/A	0.06±0.03	P	NT
Rodentia				
Brush-tailed porcupine (*Atherurus macrourus*)	N	1.69±0.80	P	LC
Grey-bellied squirrel (*Callosciurus caniceps*)	N/A	0.02±0.02	NIL	LC
Horse-tailed squirrel (*Sundasciurus hippurus*)	N/A	0.05±0.03	NIL	NT
Malayan porcupine (*Hystrix brachyura*)	N	0.72±0.36	P	LC
Three-striped ground squirrel (*Lariscus insignis*)	D	0.51±0.21	NIL	LC
AVES				
Accipitriformes				
Crested serpent eagle (*Spilornis cheela*)	N/A	0.09±0.05	TP	LC
Columbiformes				
Emerald dove (*Chalcophaps indica*)	N/A	0.10±0.06	P	LC
Galliformes				
Great Argus-pheasant (*Argusianus argus*)	N/A	0.03±0.03	TP	NT
Malayan partridge (*Arborophila campbelli*)	N/A	N/A	TP	LC
Mountain peacock-pheasant (*Polyplectron inopinatum*)	D	0.89±0.37	TP	VU
Red jungle fowl (*Gallus gallus*)	D	0.60±0.31	P	LC
Passeriformes				
Malayan whistling thrush (*Myophonus robinsoni*)	N/A	0.01±0.01	TP	NT
Orange-headed thrush (*Geokichla citrina*)	N/A	0.02±0.02	TP	LC
White-rumped shama (*Copsychus malabaricus*)	N/A	0.04±0.04	P	LC
REPTILIA				
Squamata				
Water monitor lizard (*Varanus salvator*)	N/A	0.06±0.05	P	LC

Activity Class: C – Cathemeral; D – Diurnal; N – Nocturnal; PD – Predominantly Diurnal; PN – Predominantly Nocturnal; N/A – Not available. [1]Wildlife Conservation Act (WCA) 2010 status: P – Protected; TP – Totally protected. [2]IUCN Red List Status 2019: CR – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; LC – Least Concern.

Conclusion

More than half of the non-volant mammals found in this study are totally protected under the Malaysian law and over one third of the species are listed as threatened under the IUCN Red List of Threatened Species. This indicates the high conservation value of the Fraser's Hill Forest Complex. Given the evidence of poaching encountered during this study, it is highly pertinent to gazette Fraser's Hill Forest Complex as a state park to enhance protection of its wildlife diversity through park enforcement and management as well as to sustain its ecosystem services.

Acknowledgements

This study was made possible through funding from CIMB Islamic Bank Berhad, PPG Coatings (Malaysia) Sdn. Bhd. and WWF-Malaysia donors. We would like to thank Pahang Forestry Department as well as Department of Wildlife & National Parks for the approval of this study. We also would like to thank Fraser's Hill Development Corporation for their support and finally all volunteers as well as indigenous people who had helped in the fieldwork of the study.

References

Beier, P. & McCullough, D. R. 1990. Factors Influencing White-tailed Deer Activity Pattern and Habitat Use. *Wildlife Monographs* 109: 1-51.

DTCP. 2009. *Final Report CFS 1: Master Plan for Ecological Linkages*. Regional Planning Division of Department of Town and Country Planning (DTCP) Peninsular Malaysia, Kuala Lumpur, Malaysia.

O'Brien, T.G., M.F. Kinnaird, & H.T. Wibisono. 2003. Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. *Animal Conservation* 6: 131–139.

O'Connell, A. F., Nichols, J. D. & Karanth, K. U. (Eds.). 2010. *Camera traps in animal ecology: methods and analyses*. Springer Science & Business Media.

Ruffino, M.B.M., Abdul Kadir, A.H., Choon, D.T., Magintan, D., Ngau, C., Abu Zahraim, I., Hamidi, J., Zainal, A.M., Idlan, R. & Fauzul Azim, Z. A. (2010). A study on activity pattern of clouded leopard and marbled cat in Temenggor Forest Reserve, Hulu Perak. *Journal of Wildlife and Parks* 26: 59-66

Wagner, O. R., Hightower, D. A., & Pace, R.M. 2001. Measuring Levels and Patterns of Activity in Black Bears. *Ursus* 12:181-188.

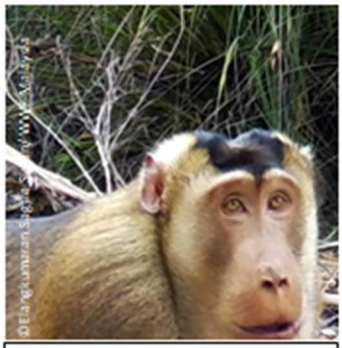
Appendix: Camera trap photos of threatened species in Fraser's Hill Forest Complex

Binturong

Malayan sun bear

Clouded leopard

Leopard



Pig-tailed macaque

Malayan tapir

Sumatran serow

Sunda pangolin

Dhole

Malayan tiger

FAUNA 05

DIVERSITY OF TEPHRITID FRUIT FLIES IN RAUB, PAHANG

Wee, S.L.*, & Har, S.K.
Department of Biological Science and Biotechnology,
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
**Corresponding author email: slwee@ukm.edu.my*

Abstract

Many true fruit fly species from the genera of *Bactrocera*, *Zeugodacus* and *Dacus* (Diptera: Tephritidae) are of economic importance. They infest a wide range of fruits and vegetables, but some species are also reported as important pollinators of certain endemic wild orchid species in rainforests. The fauna of tephritid fruit flies was surveyed in the forest fringe of Ulu Dong, Raub, Pahang using traps baited with two fruit fly male attractants, methyl eugenol and cue lure. There were ten traps for each lure type and the sampling was conducted fortnightly for a period of six months. A total of 1,296 individual fruit flies were trapped; with six *Bactrocera*, three *Zeugodacus* and one *Dacus* species reported.

Keywords: *Bactrocera*, *Zeugodacus*, *Dacus*, methyl eugenol, cue lure

Introduction

True fruit flies from the family Tephritidae is one of the serious fruit and vegetable pests of economic importance worldwide (White & Elson-Harris 1992). Gravid female fruit flies often lay eggs under the soft skin of ripening fruits and vegetables. The newly hatched larvae will then feed on the tissues voraciously, either making the fruits unmarketable or causing total destruction to the infested fruits.

There are about 63 species of fruit flies reported in Malaysia but only six are considered as fruit pests of economic importance (Vijaysegaran 1988). These include *Bactrocera dorsalis* Hendel, *B. carambolae* Drew & Hancock, *B. umbrosa* (Fabricius), *B. latifrons* (Hendel), *Zeugodacus cucurbitae* (Coquillett), and *Z. tau* (Walker) (Vijaysegaran & Osman 1991). Certain male fruit flies are strongly attracted to male lures, methyl eugenol (ME) and cue-lure (CL) (Tan & Lee 1982, Tan & Nishida 2012). This unique behaviour of strong attraction to male lures has been manipulated for fruit fly control and management such as detection, surveillance, suppression and eradication of isolated fruit fly populations (see review by Tan & Nishida 2012).

This study aims to survey the diversity of fruit flies in the forest fringe of Ulu Dong, Raub, Pahang and to document the diversity, distribution and abundance of fruit flies in the natural ecosystem in view of their importance as fruit pest as well as specific pollinators for endemic orchids from the genus of *Bulbophyllum* (Ong et al. 2011, Tan & Nishida 2012).

Materials and Methods

Sampling site

This study was conducted at the fringe of a hill dipterocarp forest between Kampung Peruas, Ulu Dong and Gunung Benom, Raub, Pahang. There were various types of fruit trees planted in the adjacent villages, such as banana, jackfruit, chempedak, wax apples, papaya, star fruits and mangoes that host the tephritid fruit flies.

Fruit fly sampling

The transparent trap design described by Tan (1984) was used. Male attractants, ME and CL were used. Each attractant was mixed with insecticide malathion at a ratio of 4:1 v/v. The mixture of lure-insecticide was impregnated onto cotton wicks that was placed at the centre of the trap. The attracted male fruit flies will enter through the holes at both ends of the baited trap. After consuming the chemical mixture, the attracted males would be killed before they could escape (Ibrahim et al. 1979). The mixture of attractant and insecticide used did not alter the effectiveness of lure (White & Elson-Harris 1992).

A total of 20 traps, each baited either with ME (n = 10) or CL (n = 10), were placed at a transect line, with ca. 30 m apart while traps of different lures were placed at least 5 m apart. Each trap was hanged from tree

branches at a height of ~1.5 m above the ground. The trap placement was in a randomised block design. After 24 hr, the trapped male fruit flies were collected into separate containers according to sites, traps and male attractants. Fourteen samplings were conducted fortnightly from July 2010 to January 2011.

In the laboratory, the specimens were pinned and dried in an oven at 40ºC for a week before further sorted for species identification. Specimens were identified by examining morphological characteristics under a stereomicroscope (Meiji-Labax Co. Ltd., Tokyo, Japan) based on published references (White & Elson-Harris 1992, Drew & Hancock 1994, Drew et al. 1998).

Statistical analysis

The Shannon-Wiener Diversity index (H'), species richness (R) and species evenness (E) were obtained based on the fly captured data at the site.

Results and Discussion

A total of 1,296 individual male fruit flies were captured by ME- and CL-baited traps. Ten fruit fly species from the genera of *Bactrocera*, *Dacus* and *Zeugodacus* were identified. ME-baited traps caught the most individuals (1,032) which consisted four species, namely *Bactrocera carambolae* Drew and Hancock, *B. dorsalis* (Hendel), *B. occipitalis* (Bezzi) and *B. umbrosa* (Fabricius). *B. dorsalis* was the most abundant species (25.8%), followed by *B. carambolae* (18.4%). *B. dorsalis* is the dominant fruit fly species in Malaysia with 117 host fruits recorded (Allwood et al. 1999). The species is more fecund than *B. carambolae* (Wee 2002), the second most important fruit fly species which has about 75 host fruits (Allwood et al. 1999). There were also individuals of *Bactrocera* that bear intermediate morphological traits between *B. carambolae* and *B. dorsalis* (15.2%). The occurrence of this intermediate morphotype *Bactrocera* spp. was first reported by Wee & Tan (2005). They were speculated to be the hybrids of *B. carambolae* and *B. dorsalis*, as both species are the cryptic species from the *Bactrocera dorsalis* complex and were able to interbreed in semi-field cage trials and produce viable offspring in the laboratory (Wee 2002). A significantly low numbers of *B. umbrosa* and *B. occipitalis* (9-12%) were also trapped in ME-baited traps. *B. umbrosa*, also known as artocarpus fruit fly, is an oligophagous species attacking only Artocarpus fruits from the family of Moraceae (Allwood et al. 1999). *B. occipitalis* was reported with limited distribution in Malaysia, i.e. only present in Sabah, East Malaysia (Drew & Hancock 1994). However, the species were recorded in Bangi, Selangor by Wee & Shelly (2013). This indicates that the species now has a wider distribution than previously reported.

CL-baited trap caught only 264 individuals, but the lure managed to trap as many as six species from three genera, namely *Bactrocera melostomatos* Drew and Hancock, *B. nigrotibialis* (Perkins), *Dacus vijaysegarani* Drew and Hancock, *Zeugodacus caudatus* (Fabricius. and *Z. cucurbitae* (Coquillett) and *Z. tau* (Walker) (Table 1). The most abundant CL-responding species was *Z. tau*, a pest of vegetables with 34 hosts (Allwood et al. 1999). Its abundance was significantly higher than *Z. cucurbitae*, both of which are main pests of Cucurbitaceae plants such as cucumber, bitter gourd, and pumpkin. *Z. cucurbitae* is regarded as the most serious and abundant cucurbit pests in Malaysia (Vijaysegaran 1988) but was found to present only in low numbers at the site. *Z. caudatus* is another cucurbit pest which only infests the flower head rather than the fruits (White & Elson-Harris 1992). Four specimens of male *Dacus vijaysegarani* were also captured by CL-baited traps. The members of *Dacus* are more peculiar than the genera of *Bactrocera* and *Zeugodacus* by having a petiole and elongate abdomen mimicking the wasps. Not many *Dacus* species are recorded in Malaysia. Most of the species of *Dacus* are found in the African continent. The presence and identification of *D. vijaysegarani* was first documented by Drew et al. (1998).

Table 1. Summary of fruit fly species sampled using male attractants, methyl eugenol (ME) and cue lure (CL), as baits in traps from July 2010 to January 2011.

Species	ME-trap	CL-trap	Percentage (%)
Bactrocera carambolae	238	0	18.4
Bactrocera dorsalis	335	0	25.8
Bactrocera morphohybrid*	197	0	15.2
Bactrocera melastomatos	0	30	2.3
Bactrocera nigrotibialis	0	4	0.3

Bactrocera occipitalis	150	0	11.6
Bactrocera umbrosa	112	0	8.6
Dacus vijaysegarani	0	4	0.3
Zeugodacus caudatus	0	47	3.6
Zeugodacus cucurbitae	0	5	0.4
Zeugodacus tau	0	174	13.4
Total	1032	264	100.0

**Bactrocera* sp. with intermediate morphological characteristics between *B. carambolae* and *B. dorsalis* (Wee & Tan 2005).

The Shannon-Wiener Diversity index (H') was at 1.94, with species richness, R of 10 and species evenness, E at 0.84. This shows that the site has a moderate diversity of fruit fly fauna with a fairly even distribution.

Conclusion

Based on the trapping results using two different fruit fly male attractants, the diversity of tephritid fruit flies at the site is moderate, with a record of ten species belonging to three genera. Due to the short sampling duration of 6 months, with some host fruits being seasonal in nature, as well as the fact that not all species of tephritid male fruit fly respond to ME and CL, the fruit fly diversity at the site may have been underestimated. Therefore, future fruit fly sampling using more recently discovered fruit fly male attractants for a longer sampling period, i.e. at least a year to cover the fruiting seasons for all available host fruits would yield a better estimate of fruit fly diversity at the site.

Acknowledgements

Research permission granted by the Department of Forestry of Peninsular Malaysia, Ministry of Natural Resources and Environment and Pahang State Forestry Department, Malaysia are greatly appreciated. The study is partially supported by ST-2019-005(@MAL-23170) and ST-2016-004(@R20443) by International Atomic Energy Agency, Austria.

References

Allwood, A.J., Chinajariyawong, A., Drew, R.A.I., Hameck, E.L., Hancock, D.L., Hengsawad, J.C., Jipanin, M., Kon Krong, C., Kritsaneepaiboon, S., Leong, C.T.S. & Vijaysegaran, S. 1999. Host plant records for fruit flies (Diptera: Tephritidae) in South East Asia. *The Raffles Bulletin of Zoology*. In supplement No. 7–92.

Drew, R.A.I. & Hancock, D.L. 1994. The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia. *Bulletin of Entomological Research*, Supplement 2.

Drew, R.A.I. & Romig, M. C. 2013. *Tropical Fruit Flies of South-East Asia: Indomalaya to North-West Australia*. CAB International, UK.

Drew, R. A. I., Hancock, D. L. & White, I. M.1998. Revision of the tropical fruit flies (Diptera: Tephritidae: Dacinae) of Southeast Asia II. *Dacus* Fabricius. Invertebrate Taxon. 12: 567-654

Ibrahim, A. G., Singh, G. & King, H. S. 1979. Trapping of the fruit-flies, Dacus spp. (Diptera: Tephritidae) with methyl euginol in orchards. *Pertanika* 2: 58-61.

Ong, P.T., Hee, A.K.H., Wee, S.L., & Tan, K.H. 2011. *Bulbophyllum* (Orchidaceae) flowers attractive to *Bactrocera* fruit flies (Diptera: Tephritidae). *Malesian Orchid Journal* 8: 93-102

Tan, K.H. 1984. Description of a new attractant trap and the effect of placement height on catches of two *Dacus* species (Diptera: Tephritidae). *Journal of Plant Protection in the Tropics* 1: 117-120.

Tan, K.H. & Lee, S.L. 1982. Species diversity and abundance of *Dacus* (Diptera: Tephritidae) in five ecosystems of Penang, West Malaysia. *Bulletin of Entomological Research* 72: 709-716.

Tan, K.H., Nishida, R. 2012. Methyl eugenol – its occurrence, distribution, and role in nature, especially in relation to insect behavior and pollination. *Journal of Insect Science* 20:56.

Vijayasegaran, S. 1988. The current situation of fruit flies in Peninsular Malaysia. Pp. 430 *in* Vijaysegaran, S. & Ibrahim, A. G. (Ed.). *First International Symposium on Fruit Fly in the Tropics*. MARDI, Kuala Lumpur.

Vijaysegaran, S. & Osman, M. S. 1991. *Fruit Flies in Peninsular Malaysia: Their Economic Importance and Control Strategies*. Proceedings of The International Symposium on The Biology and Control of Fruit Flies, Okinawa, Japan.

White, I.M. & Elson-Harris, M.M. 1992. *Fruit flies of economic significance: Their identification and bionomics*. Oxford, CAB International.

Wee, S.L. 2002. *Behaviour and Reproductive Ecology of Bactrocera carambolae and B. papayae.* Ph.D. thesis. University Science Malaysia, Penang, Malaysia.

Wee, S.L. & Shelly, T.E. 2013. Capture of *Bactrocera* fruit flies in traps baited with liquid versus solid formulations of male lures in Malaysia. *Journal of Asia-Pacific Entomology* 16: 37-42.

Wee, S.L. & Tan, K.H. 2005. Evidence of natural hybridization between two sympatric sibling species of *Bactrocera dorsalis* complex based on pheromone analysis. *Journal of Chemical Ecology* 31: 845–858.

FAUNA 06

FIREFLIES (COLEOPTERA: LAMPYRIDAE) OF FRASER'S HILL, PAHANG, MALAYSIA

Badruddin, N.[1]*, & Ballantyne, L.A.[2]
[1]Forest Biodiversity Division, Forest Research Institute Malaysia (FRIM), Selangor, Malaysia.
[2]School of Agricultural and Wine Sciences, Charles Sturt University, Wagga Wagga, Australia.
**Corresponding author email: nada@frim.gov.my*

Abstract

Fireflies are known for their ability to produce light. Unlike the congregative fireflies living in the estuary, inland forest fireflies occur in relatively lower abundance but higher in species diversity. This insect occupies a range of habitats from lowlands to mountain tops. Around the world, fireflies are at threat from habitat lost and pollution. The risk of species loss is greater in the highlands known to support rare and endemic species. Surveys of fireflies in Fraser's Hill were conducted in 2013, 2015 and 2016 to identify the species of fireflies present in the area. Five nature trails were surveyed in 2013 while two nature trails were surveyed in 2015 and 2016. The trail ranged between 500 and 1,500 meter in length with different levels of disturbance and terrain condition. A total of 13 possible firefly species from nine genera were identified from the study. Two firefly species, new to science were also recorded. Currently, one of the new species is only known to occur in Fraser's Hill, Malaysia, therefore it could possibly be an endemic species. Further study on fireflies in other areas is needed for verification.

Keywords: fireflies, new species, species diversity

Introduction

Fireflies are insects with special ability to produce light. The light display is a form of communication of the adults in their mating ritual. Fireflies recorded worldwide are more than 2,000 species, and records of fireflies in Malaysia are gradually increasing in recent years with interests coming from local and international ecologists, conservationists and taxonomists. Malaysian fireflies can be defined into two groups based on their habitat and light displaying behaviour.

Unlike the congregative fireflies that occupy certain river estuaries, inland forest fireflies, also known as solitary fireflies, occupy numerous habitat types from lowlands to mountain tops. The solitary fireflies are also relatively higher in species diversity although their abundance within certain habitats is lower compared to the congregative fireflies. Their specific relationship with different niches of their habitat and limited dispersal abilities may explain the risk of extinction they could face. Around the world, fireflies are reported to be at threat from habitat loss including fragmentation, urbanisation and other human disturbances. Recent studies also showed their more confined distribution within certain habitats, suggesting highland-occupying fireflies could be susceptible to habitat alterations caused by climate change and landscape modifications (Macedo et al. 2016, Wattanachaiyingcharoen et al. 2016).

Realising the limited information we have thus far on this elusive insect, in particular those inhabiting the highland areas, surveys of fireflies were conducted in 2013, 2015 and 2016 to collate baseline information of the presence and diversity of fireflies within the Fraser's Hill Forest Complex. The information gained from the survey will add-value to the current biodiversity information available of this area and of Malaysia, in general.

Materials and Methods

Study area

Five nature trails situated within the Fraser's Hill Forest Complex were surveyed for the presence of fireflies in July 2013. The five trails selected (Abu Suradi, Bishop, Hemmant, Kindersley, and Mager trails) ranged between 500 and 1,500 m in length with differing terrain conditions and disturbances. Based on the 2013 survey, two trails with the highest collection of adult fireflies i.e. Bishop and Mager trails, and these trails were surveyed in April 2015 and 2016. Repeated survey of the two trails was conducted in September 2016.

Firefly sampling and identification

Survey of fireflies was conducted at night by active searching using sweeping nets to collect adult fireflies and soft forceps to collect the larvae. The sampling was done along the length of the trails, in 3m-belt transect located to the left and right of the trails. Commencement of survey was standardised to be between 8.00-8.45 pm, and the duration of survey in each trail ranged between 30 minutes and 2 hours 20 minutes, depending on time spent to collect the fireflies and the trail length.

Specimens were put in 70% ethanol solution and brought back to the laboratory for identification and curation. Some adult specimens were preserved as dry collection while the rest of the adult fireflies and all of the larva specimens were preserved in a 70% ethanol solution. The specimens were identified to species level where possible using available taxonomic keys by Ballantyne et al. (2013), Ballantyne and Lambkin (2013), Fu et al. (2012), Jeng et al. (1999, 2001) and Itsura et al. (2005). All specimens were deposited in FRIM's Insect Reference Collection.

Results and Discussion

Firefly diversity in Fraser's Hill

Overall, the surveys recorded a total of 13 firefly species comprising 45 adults and 66 larvae (Table 1, Figure 1). All the five trails surveyed in July 2013 showed the presence of fireflies, with Bishop and Mager trails recorded the highest number of adult species.

Sampling along Bishop Trail in different years showed only *Diaphanes* sp. larvae, and this was persistent in all the survey sessions. While the *Curtos costipennis* and *Medeoptryx fraseri* were found seasonal in occurrences as both the species were only found during April 2015 and April 2016 surveys. Other fireflies were only collected once for each trail.

Table 1. Species of fireflies present in Fraser's Hill forest according to trail and survey sessions.

Firefly species	Bishop Trail				Mager Trail				AS	H	K
	Jul '13	Apr '15	Apr '16	Sep '16	Jul '13	Apr '15	Apr '16	Sep '16	Jul '13	Jul '13	Jul '13
1. *Abscondita pallescens*	-	-	6	1	-	-	1	-	-	-	1
2. *Abscondita terminalis*	4	-	1	-	-	-	-	-	-	-	-
3. *Curtos costipennis*	-	2	6	-	-	-	-	-	-	-	-
4. *Curtos obscuricolor*	-	-	-	-	-	-	-	-	-	-	-
5. *Diaphanes* sp.	14 (L)	5 (L)	26 (L)	11 (L)	2	-	-	-	-	-	-
6. *Lamprigera* sp.	-	-	-	1	-	-	-	-	-	1 (L)	-
7. *Luciola jengai**	-	-	-	1	-	-	-	-	-	-	-
8. *Luciola pallidipes*	2	1	-	-	-	-	-	-	-	-	-
9. *Luciola* sp.	-	1 (L)	4 (L)	-	-	-	-	-	-	-	-

10. *Medeoptryx fraseri**	-	8	7	-	-	-	-	-	-	-	-
11. *Pyrocoelia* sp.	-	-	1	-	-	-	-	-	-	1 (L)	-
12. *Pygoluciola* sp.	-	-	-	-	1	-	-	-	-	-	-
13. *Stenocladius* sp.	-	1 (L)	-	-	-	-	-	-	1 (L)	-	-

*****New firefly species; (L) Larva; A.S- Abu Suradi Trail; H- Hemmant Trail; and K- Kindersley Trail

Figure 1. Some of the adult (a-d) and larval (e-h) fireflies collected in Fraser's Hill Forest Complex. (a) *Pygoluciola* sp., (b) *Diaphanes* sp., (c) *Luciola pallidipes*, (d) *Abscondita terminalis*, (e) *Lamprigera* sp., (f) *Stenocladius* sp., (g) *Diaphanes* sp. and (h) *Pyrocoelia* sp. Note: Images are not in scale. Photos by FRIM.

Fireflies were found flying in the forest at height of approximate 1.5–5.0 m above ground either flashing their lights or producing continuous glow. Some adults were collected resting or in copulating positions on herbaceous plants. Most firefly larvae were collected from the ground. Firefly larvae are forest floor dwellers, and it is also common for different species of firefly larvae to live nearby or in water sources such as shallow streams and ponds (Nagelkerken et al. 2008, Viviani 2001, Fu & Meyer-Rochow 2013). The *Diaphanes* larvae

(Figure 1g) was found crawling on leaves and stems of plants during the surveys. Only one record known from a described firefly larva is active on plants (Jeng et al. 2001), therefore such finding is uncommon.

Discovery of new firefly species in Fraser's Hill

Two new firefly species were recorded from the surveys. They were collected along Bishop Trail. The new species are named *Medeoptryx fraseri* and *Luciola jengai* representing the type locality of the specimens collected. The taxonomic descriptions of the two species were recently published in October 2019 (Ballantyne et al. 2019)**.** *Medeoptryx fraseri* has only been recorded in Fraser's Hill, while *Luciola jengai* also occurs in Jengai Forest Reserve, Terengganu. As tropical highlands are known to support many endemic species (Merckx et al. 2015), there could be a possibility that *M. fraseri* is endemic to Fraser's Hill, and further study is required to conclusively determine this.

Conclusion

Fraser's Hill Forest Complex supports an array of firefly species. The study is among a few to specifically study the inland forest fireflies or the solitary fireflies of Malaysia. More research is needed for this group of insects to understand their requirements to survive in our forested areas which are increasingly being threatened by human disturbances and climate change.

Acknowledgements

We thank Abdul Zairi, A. of Perbadanan Kemajuan Bukit Fraser and staff of FRIM Biodiversity Division for assistance in the field. This study was funded by 10th and 11th Malaysia Plans.

References

Ballantyne, L., Fu, X., Lambkin, C., Jeng, M.-L., Faust, L., Wijekoon, W. M. C. D., Li, D. & Zhu, T. 2013. Studies on South-East Asian fireflies: *Abscondita*, a new genus with details of life history, flashing patterns and behaviour of *Abs. chinensis* (L.) and *Abs. terminalis* (Olivier) (Coleoptera: Lampyridae: Luciolinae). *Zootaxa* 3721 (1): 1–48.

Ballantyne, L. A. & Lambkin, C. L. 2013. Systematics and phylogenetics of Indo-Pacific Luciolinae fireflies (Coleoptera: Lampyridae) and the description of new genera. *Zootaxa* 3653 (1): 1–162.

Ballantyne, L. A., Lambkin, C. L., Ho, J. -Z., Jusoh, W. F. A., Nada B., Nak-Eiam, S., Thancharoen, A., Wattanachaiyingcharoen, W. & Yiu, V. 2019. The Luciolinae of S. E. Asia and the Australopacific region: a revisionary checklist (Coleoptera: Lampyridae) including description of three new genera and 13 new species. *Zootaxa* 4687(1): 1–174.

Fu, X., Ballantyne, L. A. & Lambkin, C. L. 2012. The external larval morphology of aquatic and terrestrial Luciolinae fireflies (Coleoptera : Lampyridae). *Zootaxa* 3405: 1–34.

Fu, X. & Meyer-Rochow, V. B. 2013. Larvae of the firefly *Pyrocoelia Pectoralis* (Coleoptera: Lampyridae) as possible biological agents to control the land snail *Bradybaena Ravida*. *Biological Control* 65(2): 176–83.

Itsuro, K., Fumiyasu, S. & Masataka, S. 2005. The Lampyrid genus *Drilaster* (Coleoptera, Lampyridae, Ototretinae) of the Ryukyu Archipelago, southwest Japan. *Japanese Journal of Systematic Entomology* 11 (2): 225–62.

Jeng, M. -L., Lai, J., Yang, P. S. & Sato. M. 1999. On the validity of the generic name *Pyrocoelia* Gorham (Coleoptera, Lampyridae, Lampyrinae), with review of Taiwanese species. *Japanese Journal of Systematic Entomology* 5(2): 347–62.

Jeng, M. -L., Lai, J., Yang, P. S. & Sato. M. 2001. Revision of the genus *Diaphanes* Motschulsky (Coleoptera, Lampyridae, Lampyrinae) of Taiwan. *Japanese Journal of Systematic Entomology* 7(2): 203–35.

Macedo, M. V., Flinte, V., de Oliveira Araujo, C., da Silveira, L. F. L., Bouzan, A. M., Dufrayer, R., Viana, J. H., de Oliveira Araujo, R., Hentz, E. & Monteiro, R. F. 2016. Elevational ranges and local extinction risk of beetles occurring in the 'Campos de Altitude' in southeastern Brazil. *Oecologia Australis* 20(2): 121–32.

Merckx, V. S. F. T., Hendriks, K. P., Beentjes, K. K. et al. 2015. Evolution of endemism on a young tropical mountain. *Nature* 524(7565): 347–50.

Nagelkerken, I., Blaber, S. J. M., Bouillon, S., Green, P., Haywood, M., Kirton, L. G., Meynecke, J. -O., Pawkuj, J., Penrose, H. M., Sasekumar, A. & Somerfield, P. J. 2008. The habitat function of mangroves for terrestrial and marine fauna: a review. *Aquatic Botany* 89(2): 155–85.

Viviani, V. R. 2001. Fireflies (Coleoptera: Lampyridae) from southeastern Brazil: habitats, life history, and bioluminescence. *Annals of the Entomological Society of America* 94(1): 129–45.

Wattanachaiyingcharoen, W., Nak-eiam, S., Phanmuangma, W., Boonkiaew, S. & Nimlob, N. 2016. Species diversity of firefly (Coleoptera: Lampyridae) in the highlands of northern Thailand. *NU International Journal of Science* 13(2): 24–32.

FAUNA 07

PRELIMINARY FINDINGS OF INTERESTING CASSIDINAE (COLEOPTERA: CHRYSOMELIDAE) SPECIES OF FRASER'S HILL, PAHANG

Muhaimin, A.M.D.[1,2], & Yaakop, S.[1,2]*
[1]Centre for Insects Systematics, Faculty Science and Technology, Universiti Kebangsaan Malaysia
[2]Pusat Penyelidikan Bukit Fraser UKM, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
Corresponding author email: salmah78@ukm.edu.my

Abstract

Cassidinae is one of the subfamilies in the Chrysomelidae group that are commonly known as leaf beetles. Consisting of two tribes; Cassidini and Hispini, they are known for their unique coin (Cassinidi) and spiky (Hispini) body shape. Cassidinae samples were collected by sweeping nets as an active sampling method. Sites were chosen based on three different areas according to elevations; low (< 500 m), mid (500 – 900 m), and high (> 900 m) elevations a.s.l. The 12-month sampling has collected 316 individuals with 14 species. However, 244 individuals are from one species alone, *Chiridopsis punctata*. Despite being morphologically attractive, finding specimens from the subfamily is rather hard, compared to the more abundant subfamily of Galerucinae. The understanding of this group has a big gap on information which includes their diet, life cycle, habitat preferences, and others. More sampling efforts may also increase the sample size hence provide more information towards this group. Nevertheless, this study gives an introduction to Cassidinae species, especially to Fraser's Hill diversity, that is hidden and to be explored, with more species expected to be discovered in the future.

Keywords: Chrysomelidae, Fraser's Hill, elevation, altitude

Introduction

Chrysomelidae is one of the well-known groups from Coleopteran groups. They have been studied widely as some of the species are pests for certain crops and stored products (Jolivet et al. 2009). Unfortunately, most of the studies were done overseas with the local species getting less attention. Studies on local leaf beetle only received more interest around the early 90's and continued to draw attention until around 2010 (Mohamedsaid 1990, 1999, 2010) and most recently Muhaimin et al. (2019) on Crysomelidae. There are so many aspects that need to be discovered to understand the ecology and biology of leaf beetles especially the local species. One of the most unique subfamily from Chrysomelidae is Cassidinae which is also known as tortoise beetle. There are two described tribes under Cassidinae which are the Cassidini and Hispini.

Fraser's Hill is one of the famous tourist sites in Malaysia. Located in the district of Raub, Pahang, it is known for its natural forest ecosystem with tranquil, cool, and breezy environment. Besides that, Fraser's Hill hosts the annual bird race activity to attract more tourists. Because of this, this place is well known not only for local tourists, but also those from overseas. As Fraser's Hill is a highland environment, different species composition can be observed as altitude changes. This includes plant composition, and also insects like Cassidinae. In view of the above information, this study was carried out to record the Cassidinae composition along different altitudinal gradients of Fraser's Hill.

Materials and Methods

This study was carried out at three different altitudes at Fraser's Hill, which are low (< 500 m), mid (500–900 m), and high (> 900 m) elevations a.s.l. from December 2016 to November 2017. Fraser's Hill has different vegetation composition at different altitudes. The lower elevation comprises lowland dipterocarp forests, while the mid elevations is hill dipterocarp forests. The high elevations are made up of montane forests such as *Pinus* species. Collection of beetles were done by an active sampling method which is by sweep nets along the forest edges. All the samplings were done from 08:00 hr. to 13:00 hr during the active time of beetles. The sampling was conducted for 12 months, from December 2016 to November 2017. The samples collected during the sampling were preserved in alcohol before being brought to the lab for identification process.

Results and Discussion

The sampling had successfully collected 316 individuals of Cassidinae beetles with 14 species from all three altitudes (Table 1 & Figure 1). From the number, mid altitude has the most individuals collected with 154, followed by the low (138), while the high altitude collected the lowest number (24). Species *Chiridopsis punctata* has the highest abundance of species population with 244 individuals and is present in both mid and low altitudes. However, information regarding this particular species is extremely hard to find, except for Kishimoto-Yamada et al. (2016) where they found this species at Sabah, and Mohamedsaid (2000) recorded this species as one of the Malaysian Chrysomelid diversity, but with no information on its locality.

Table 1. Cassidinae species collected from three altitudes at Fraser's Hill

Species	High	Mid	Low	subtotal
Aspidimorpha furcata	0	6	2	8
Aspidimorpha sanctaecrucis	0	2	3	5
Aspidimorpha miliaris	2	0	0	2
Chiridopsis punctata	0	129	115	244
Dactylispa sp.1	0	4	0	4
Dactylispa sp.2	4	2	0	6
Dicladispa sp.	0	0	1	1
Gonophora haemorrhoidalis	0	4	9	13
Hispini sp.1	0	0	3	3
Hispini sp.2	2	0	1	3
Hispini sp.3	0	5	2	7
Hispini sp.4	0	1	1	2
Laccoptera nepalensis	16	1	0	17
Platypria sp.	0	0	1	1
Total	24	154	138	316

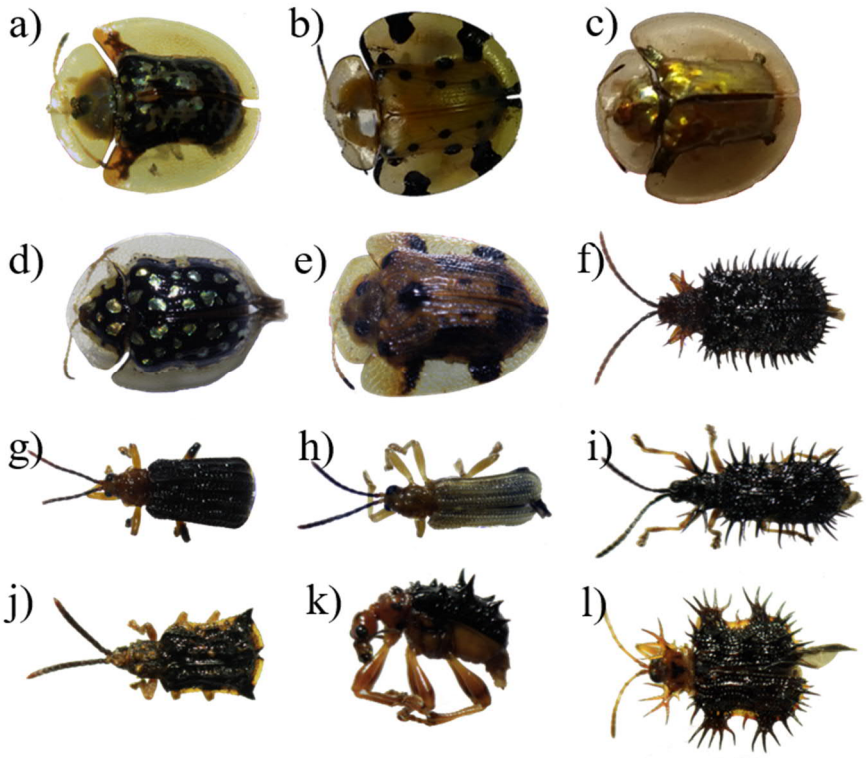


Figure 1. Some of the Cassidinae species collected from Fraser's Hill; a) *Aspidimorpha furcate*, b) *Aspidimorpha miliaris*, c) *Aspidimorpha sanctaecrucis*, d) *Chiridopsis punctata*, e) *Laccoptera nepalensis*, f) *Dactylispa* sp., g) *Gonophora haemorrhoidalis*, h) Hispini sp.1, i) Hispini sp. 2, j) Hispini sp. 3, k) Hispini sp. 4, l) *Platypria* sp.

Only one species that is exclusively found at high altitude, is *Aspidimorpha miliaris* with only two individuals. Although *A. miliaris* was found only at high altitude, but the number of individuals is very low to make a solid conclusion that the species is exclusive to high altitude. This is because previous reports indicate that *A. miliaris* can also be found in much lower altitudes (Jazmin & Flores 2019, Kishimoto-Yamada et al. 2016).

Another species that is abundant at high altitude is *Laccoptera nepalensis* where only one individual is found at the mid altitude. This species is believed to prefer plants from the Convolvulaceae family, and have been recorded to consume the morning glory (*Ipomoea carnea*) (Sultan et al. 2008). This species also has a synonym name as *Cassida quadrimaculata*, however the current valid name is *L. nepalensis* (Sekerka 2008).

This study also indicates that mid and low altitudes hold a much higher number of individuals and species compared to higher altitude. It might be picturised that Cassidinae do prefer warmer environments such as the middle and lower altitude serve, compared to cooler surroundings in which higher altitude offers. However, more research must be done before any conclusion is made. Besides that, this model (lower beetle assemblages on higher altitude) is also similar to previous studies on leaf beetles (Flinte et al. 2009; Flinte et al. 2011). Nevertheless, the vegetation complexes are more diverse and compact at mid altitude, where the lower ground plant species and higher ground plant species mix. This will create more variety and selection of food choices not only for the beetles, but also to the micro-habitats (Macedo et al. 2016).

From the 14 species collected in this study, only six species can be identified up to species level. Four species were only identified up to genus level, and the remaining four species were identified as tribe level. This indicates that leaf beetle research in Malaysia is still lacking and needs prompt action to increase knowledge towards this diverse and interesting insect group.

This study had successfully collected 316 individuals; however, this number is rather low despite a long duration of 12-month sampling. This might be because this study only used one sampling technique, which was sweeping nets. By applying a more variety of sampling methods like light trap and fogging, more samples could be gathered. Nevertheless, this study only serves as an introduction to the leaf beetle species in Fraser's Hill, and a preliminary reference for future studies.

Conclusions

The 12-month study had collected a total of 316 individuals from 14 Cassidinae species. From that, *Chiridopsis punctata* is the most abundant species with 244 individuals which can be found in both mid and low altitudes. *Aspidimorpha miliaris* is one of the species that is unique to higher altitude and not found in other altitudes, however due to the low number collected, this finding is not conclusive. This study also highlights that more leaf beetle species might be found if multiple sampling techniques were to be applied in leaf beetle study.

Acknowledgements

The authors would like to express our gratitude to Fraser's Hill Research Center, UKM (PPBF, UKM) for providing facilities during our research there. Also, this study would not have progressed smoothly without research grants GP-2019 K013317 and GUP-2018-037 and LIV-2015-01.

References

Flinte, V., de Freitas, S., de Macedo, M. V. & Monteiro, R. F. 2011. Altitudinal and temporal distribution of *Plagiometriona* Spaeth, 1899 (Coleoptera, Chrysomelidae, Cassidinae) in a tropical forest in southeast Brazil. *ZooKeys* 157: 15-31.

Flinte, V., de Macedo, M. V. & Monteiro, R. F. 2009. Chrysomelids and their host plants along an altitudinal gradient in an Atlantic Rain Forest in the State of Rio de Janeiro, Brazil. In Jolivet et al. (eds.) *Research on Chrysomelidae* Volume 2, pp. 31-56. Brill, Leiden, The Netherlands. Jazmin, J. C., & Flores Jr, A. A. U. 2019. Beetles in Selected Barangays of Catarman, Northern Samar, Philippines.

Jolivet, P., Santiago-Blay, J. A. & Schmitt, M. 2009. *Research on Chrysomelidae* Volume 2. Brill, Leiden, The Netherlands, 300 pp

Kishimoto-Yamada, K., Takizawa, H. & Mahadimenakbar, M. D. 2016. Temporal occurrence patterns of Chrysomelidae (Coleoptera) on the Universiti Malaysia Sabah Campus, Borneo. *The Coleopterists Bulletin* 70(3): 541-548.

Macedo, M. V., Flinte, V., de Oliveira Araujo, C., da Silveira, L. F. L., Bouzan, A. M., Dufrayer, R., Viana, J. H., Araujo, R, O., Hentz, E. & Monteiro, R. F. 2016. Elevational ranges and local extinction risk of beetles occurring in the "Campos de Altitude" in southeastern Brazil. *Oecologia Australis* 20(2): 121-132.

Mohamedsaid, M. S. 1990. A new species of *Lilioceris* from Sabah, Malaysia (Chrysomelidae: Criocerinae). *Entomological Review of Japan 45*(2): 93-95.

Mohamedsaid, M. S. 1999. Leaf beetles of the subfamily Galerucinae from Pulau Tioman, Peninsular Malaysia (Coleoptera: Chrysomelidae). *Raffles Bulletin of Zoology* 47: 245-252.

Mohamedsaid, M. S. 2000. List of Malaysian Chrysomelidae (Coleoptera) in the collection of UKM. *Serangga* 5(2): 343-360.

Mohamedsaid, M. S. 2010. The Galerucinae with sound production devices (Coleoptera: Chrysomelidae). *Entomologische Zeitschrif—Stuttgart* 160(6): 259-262.

Muhaimin, A. M.D., Halim, M., Zulaikha, S. A. S. & Yaakop, S. Habitat preferences of leaf beetles (Coleoptera: Chrysomelidae) based on abiotic factors: a study from Fraser's Hill, Pahang, Malaysia. *IOP Conference Series: Earth and Environmental Science* 269 (1): 012035.

Sekerka, L. U. K. Á. Š. 2008. Species of *Cassida* Linné, 1758 described by Thunberg and their present status (Coleoptera: Chrysomelidae: Cassidinae). *Genus 19*(2): 301-306.

Sultan, A., Borowiec, L., Rafi, A., Ilyas, M., Naz, F. & Shehzad, A. 2008. Tortoise beetles of Rawalpindi-Islamabad, Pakistan and their host preferences (Coleoptera: Chrysomelidae: Cassidinae). *Genus 19*(1): 93-102.

FAUNA 08

DIVERSITY OF SMALL MAMMALS AND THEIR ECTOPARASITES LOAD AT FRASER'S HILL, PAHANG, MALAYSIA

Mohd-Taib, F. S.[1]*, Mohd-Salleh, W.[1], Rosli, M. Z.[1], Asyikha, R.[1], Md-Lasim, A.[1], & Mohd-Ngesom, A.M.[2]
[1]Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia
[2]Centre for Toxicology and Health Risk Study (CORE), Faculty of Health Sciences, Universiti Kebangsaan Malaysia
**Corresponding author email: farah_sh@ukm.edu.my*

Abstract

The natural and conserved habitat of Fraser's Hill, Pahang, Malaysia is home to the diverse and rich fauna communities. It is particularly famous for endemic montane species especially birds, bats and insects. However, small mammals playing a pivotal role in the ecosystem balance, are poorly studied in this area. Therefore, the aim of this study is to assess the species richness and diversity of small mammals, as well as their ectoparasite load. The study was conducted within five trapping nights in January 2020 covering four different trails around the Fraser's Hill area (Bishop, Hemmant, Jeriau and PPBF trails). Capture-release method was performed by deploying 100 cage traps distributed equally in each trail. Captured individuals were examined for ectoparasites. A total of 16 small mammal individuals from eight species were captured, with Bishop recorded the highest abundance with six individuals, followed by Jeriau. The most dominant species were *Rattus tiomanicus* and *Tupaia glis*. From the total individuals captured, eight individuals had been infested with ectoparasites, with a cumulative number of 115 mites, eight fleas and 16 ticks. Parasite load was the highest in *Maxomys surifer* which was infested with 114 mites and one flea. Hemmant trails recorded the highest abundance of ectoparasites. This study revealed that Fraser's Hill forest has a fairly diverse small mammal species, and they are hosts to a high prevalence of ectoparasite, indicating the potential of tick bites among visitors. Therefore, visitors need to take precautionary measures to avoid tick bites when tracking at the trails.

Keywords: mites, precaution, rodents, squirrels, ticks

Introduction

Tropical mountain forests are very rich in species and are generally considered as hotspots of biodiversity. They also provide great ecosystem services to humans as a source of freshwater and tourism hotspots (Grêt-Regamey et al. 2012). However, this ecosystem is vulnerable and under threat due to habitat disturbance, unsustainable tourism and climate change as a result of human interventions (Bubb et al. 2004). According to Peh et al. (2011), the diversity of flora and fauna of tropical mountain forests is underestimated due to lower scientific studies conducted, compared to lowland ecosystems. Therefore, continuous research and biodiversity inventories are necessary in order to identify potential threats to this ecosystem.

Fraser's Hill, standing at 1,400 m a.s.l., is one of the montane forests in Peninsular Malaysia exhibiting minimal habitat degradation from land development. Due to this, it encompasses a relatively high species richness and endemicity of biological flora and fauna. For instance, Strange (2004) recorded a cumulative number of 257 bird species in Fraser's Hill, whereby Cheong (2013) listed 52 mammals, 27 amphibian and 26 reptile species here. However, there are no specific reports on small mammals inhabiting this area. Therefore, in this study, we report on the small mammal species in several localities in Fraser's Hill. Apart from that, these trails receive a high number of tourists and visitors throughout the year, who may be exposed to tick bites and infestation. Therefore, this is the first insight on the ectoparasite load among small mammals in this area.

Materials and Methods

Study area

The study was conducted at four different trails at Fraser's Hill, Pahang, namely Bishop, Hemmant, Jeriau and UKM Research Centre trails (PPBF) (Figure 1). Two of these trails were located at high elevation (>1200 m a.s.l.) – Bishop and Hemmant, and two other trails were located at slightly lower elevation (<1200 m a.s.l.) – Jeriau and PPBF. Table 1 lists the details of the study areas.

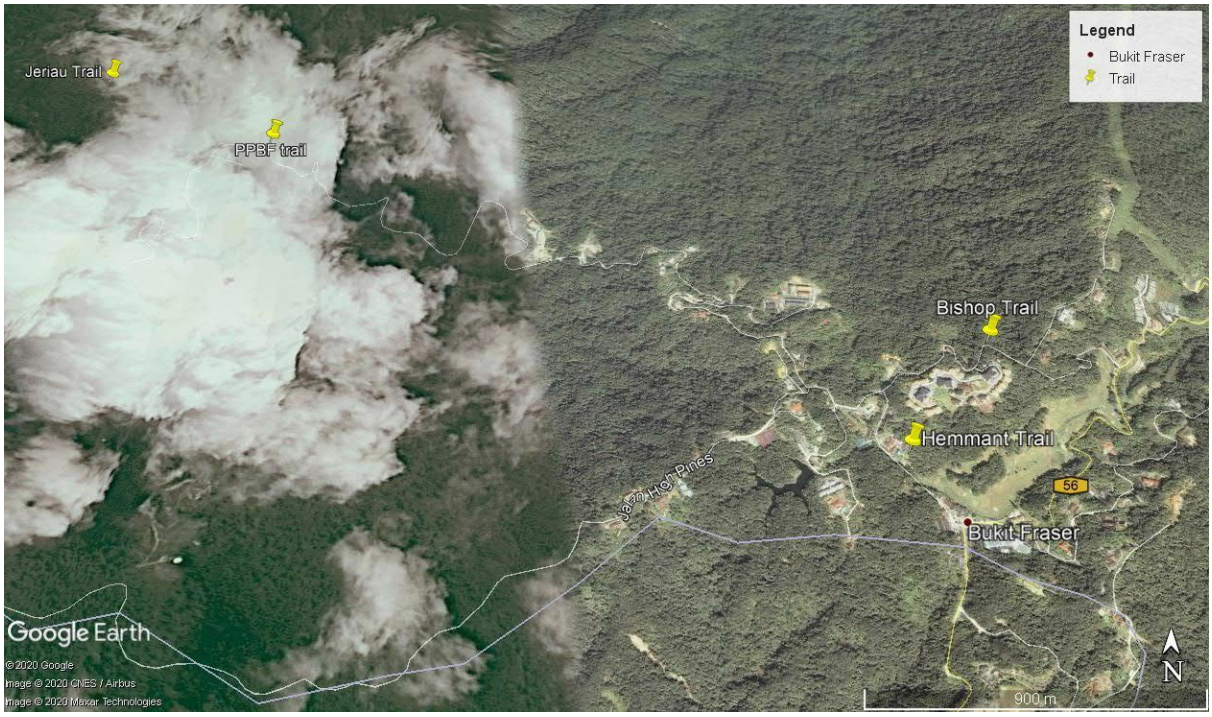


Figure 1. Map showing the location of the four trails.

Table 1. Details of the location of each sampling trail

Trails	Coordinates		Elevation (m a.s.l.)
	Latitude	Longitude	
Bishop	3°43'0.74"N	101°44'15.68"E	1235
Hemmant	3°42'49.35"N	101°44'6.78"E	1278
Jeriau	3°43'39.95"N	101°42'38.10"E	970
PPBF	3°43'30.05"N	101°42'59.37"E	1037

Small mammal sampling

Small mammal sampling was conducted in five trapping nights in January 2020. A total of 25 cage traps (16×16×50 cm) were deployed at each trail, and the traps were baited with different bait types (banana, oil palm fruit, sweet potato with peanut butter and salted fish). The trapped individuals were anesthetised with an intramuscular injection of Zoletil®100 (Massolo et al. 2003) from 0.02 up to 0.05 mL depending on the weight of the animals (King et al. 2011). Prior to release back to their captured sites, the captured individuals were weighted, morphologically measured and inspected for presence of ectoparasites. Species identification was done according to Francis (2008). For each small mammal individual, the ectoparasites were collected with a pair of forceps and stored in a cryo vial for further verification in the lab. For the purpose of this study, each small mammal individual was counted for the ectoparasite load according to the ectoparasite groups (ticks, mites and fleas).

Results and Discussion

A total of 16 small mammal individuals from eight species and three families were recorded during the sampling. Family Muridae was the most dominant with five species, whereby Sciuridae was represented by two species, and Tupaidae was only represented by one species. Table 2 lists the abundance of small mammals captured at each site. Bishop and Jeriau trails recorded the most abundant captures with five individuals each, followed by Hemmant and PPBF with three individuals each. However, family Muridae was mostly captured at Jeriau, whereby Tupaidae was the only record from Bishop trail, and Sciuridae from PPBF trail. Overall, higher elevation trails had lower Muridae but higher Sciuridae and Tupaide. The lower elevation trails were highly dominated by family Muridae.

Table 2. Abundance of small mammals captured at each trail

Family	Species	Bishop	Hemmant	Jeriau	PPBF
Muridae	*Maxomys surifer*	0	1	0	0
	Niviventer cremoventer	0	1	0	0
	Rattus exulans	0	1	0	0
	Rattus rattus	0	0	1	0
	R.tiomanicus	0	0	4	1
Sciuridae	*Tamiops mcclellandii*	0	0	0	2
	Callosciurus caniceps	1	0	0	0
Tuapaidae	*Tupaia glis*	4	0	0	0

There were three groups of ectoparasites collected from small mammals at the Fraser's Hill trails (ticks, mites and fleas). Ticks were most abundant at Jeriau and Bishop trails, whereby mites were only found at Hemmant trail and flea at both Bishop and Hemmant trails (Table 3). Overall, Bishop encompassed the highest diversity of ectoparasites, with representatives from all the three ectoparasite groups, whereby Jeriau was only represented by ticks. An exception for Hemmant trail, although very low in small mammal abundance, one individual *M. surifer* was found to be heavily infested with mites (114 individuals recovered), and one flea. None of the small mammals at PPBF trail were infested by ectoparasites.

Table 3. Parasite load based on the small mammal host and locality.

Trail	Species	Tick	Mite	Flea
Bishop	*T. glis*	4	0	3
	T. glis	1	0	0
	T. glis	2	0	4
	T. glis	0	1	0
	C. caniceps	0	0	0
Hemmant	*N. cremoventer*	0	0	0
	M. surifer	0	114	1
Jeriau	*R. exulans*	0	0	0
	R. tiomanicus	6	0	0
	R. tiomanicus	0	0	0
	R. tiomanicus	1	0	0
	R. tiomanicus	2	0	0
PPBF	*R. tiomanicus*	0	0	0
	R. rattus	0	0	0

This study indicates that Fraser's Hill encompasses fairly diverse small mammal species, compared to a study by Shahfiz et al. (2011) which only recorded five species in Cameron Highland, Malaysia. A small mammal study conducted at lowland forest in Malaysia recorded higher species richness (Yusof et al. 2019), or almost similar to Fraser's Hill (Razali et al. 2018). Md. Nor (2001) indicated that at an elevation of 1200-1400 m, the species richness of small mammals is higher compared to altitude >1400 m. This can be attributed to the broader tolerance range of both highland and lowland species assemblages, thus resulting in a mixture of species composition from both ranges, such as in the case of Fraser's Hill. In this study, there is a mixture of Muridae species which are common at the lower altitude, and Sciuridae such as *Tamiops mcclellandiii*, which is more common at higher elevation. Several members from Muridae family such as *Rattus tiomanicus* were found in a wide variety of habitats in the lowland areas, including secondary forests, agricultural areas, plantations as well as mossy forests (Payne et al. 1985). This species was recorded abundantly at Jeriau trail, due to the variable landscape attributes such as scrubs and mossy forests.

On another note, small mammals are important hosts for ectoparasites, which spend part of their life cycle taking blood meals (Mihalca et al. 2012). In this study, *Tupaia glis* and *Rattus tiomanicus* were heavily infested with ticks. These species were also reported as important hosts for ticks, as shown in the blood meal of ticks collected from small mammals from various habitats (Che Lah et al. 2015). The high ectoparasite load among the small mammals suggests a high possibility of tick bites among visitors trekking along the trails,

subsequently transmitting disease agents to trekkers. Ectoparasite load has been associated with the body mass of the host (Razali et al. 2018, Mysterud et al. 2015), as higher body mass will provide a greater surface for ectoparasites to attach (Mysterud et al. 2015). This could possibly explain the high mite load in one particular species, *Maxomys surifer* that weighed 222 g compared to other species which generally weigh below 200 g.

Conclusion

This study unveiled the small mammal community in Fraser's Hill, and their role as an important host for ectoparasites. Due to variable altitude and landscape attributes, there is a mixture of highland and lowland small flora and fauna assemblages, thus contributing to a high species richness and diversity of small mammals in this area. This place also receives a high number of visitors throughout the year, particularly to enjoy nature and trekking down the nature trails, which may expose them to ectoparasite infestation. Therefore, precautionary measures need to be taken by all trekkers due to the risk of disease agent transmission from ectoparasites.

Acknowledgements

We thank Pusat Penyelidikan Bukit Fraser of UKM (PPBF) for providing logistics and assistance throughout the sampling period. This study was funded by Universiti Kebangsaan Malaysia through research grant GUP-2018-152.

References

Bubb, P., May, I., Miles, L. & Sayer J. 2004. *Cloud Forest Agenda*. United Nations Environment Programme World Conservation Monitoring Centre. (accessed on 12 February 2010) http://sea.unep-wcmc.org/forest/cloudforest/presspack/PDF/ScreenCompleteCloudsq4.pdf)

Che Lah, E. F., Yaakop, S., Ahamad, M. & Md Nor, S. 2015. Molecular identification of blood meal sources of ticks (Acari, Ixodidae) using cytochrome b gene as a genetic marker. *ZooKeys* 478: 27–43.

Cheong, C. 2013. Fraser's Hill- *A Lush Highland Hideaway*. WWF-Malaysia, Petaling Jaya

Francis, C.M. 2008. *A Guide to The Mammals of Southeast Asia*. New Jersey, Princeton University Press, pp. 328–346.

Grêt-Regamey, A., Brunner, S. H. & Kienast, F. 2012. Mountain ecosystem services: who cares? *Mountain Research and Development* 32(1): doi.org/10.1659/MRD-JOURNAL-D-10-00115.S1

King, W. J., Wilson, M. E., Allen, T., Festa-Bianchet, M. & Coulson, G. 2011. A capture technique for free-ranging eastern grey kangaroos (*Macropus giganteus*) habituated to humans. *Australian Mammalogy* 33: 47–51.

Massolo, A., Sforzi, A. & Lovari, S. 2003. Chemical immobilization of crested porcupines with tiletamine HCl and zolazepam HCl (Zoletil) under field conditions. *Journal of Wildlife Diseases* 39: 727–731

Md. Nor, S. 2001. Elevational diversity patterns of small mammals on Mount Kinabalu, Sabah, Malaysia. *Global Ecology & Biogeography* 10: 41–62.

Mihalca, A. D., Dumitrache, M. O., Sandor, A. D., Magdas, C., Oltean, M. Gyorke, A., Matei, I. A., Ionica, A., D'Amico, G., Gozma, V. & Gherman, C. M. 2012. Tick parasites of rodents in Romania: host preferences, community structure and geographical distribution. *Parasites & Vector* 5(266): 1–7.

Mysterud, A., Byrkjeland, R., Qviller, L. & Viljugrein, H. 2015. The generalist tick *Ixodes ricinus* and the specialist tick *Ixodes trianguliceps* on shrews and rodents in a northern forest ecosystem- a role of body size even among small hosts. *Parasite & Vectors* 18(1): 1–10.

Payne, J., Francis, C. M. & Phillipps, K. 1985. *A Field Guide to the Mammals of Borneo*. Kota Kinabalu and Kuala Lumpur: The Sabah Society and WWF Malaysia.

Peh, K. S. H., Soh, M. C. K., Sodhi, N. S., Laurance, W. F., Ong, D. J. & Clements, R. 2011. Up in the clouds: is sustainable use of tropical montane cloud forests possible in Malaysia? *BioScience* 61(1): 27–38.

Razali, N. B., Abdul-Rahim, A. R., Md-Nor, S. & Mohd-Taib, F. S. 2018. Impacts of forest farm practice on small to medium-sized mammals at Kemasul Forest Reserve, Pahang, Malaysia. *AIP Conference Proceedings* 1940: 020045.

Razali, N. B., Shamsudin, N., Rahaniza, A. M. J., Yaakop, S., Khoo, J. J. & Mohd-Taib, F. S. 2018. Ectoparasites (ticks and mites) prevalence on small to medium-sized mammals associated with habitat condition in Kemasul, Pahang. *Serangga* 23(1): 72–88.

Shahfız, M. A., Shahrul Anuar, M. S., Shukor, M.N. et al. 2011. Survey of small mammals at two forest reserves in Cameron Highlands. *Proceedings of Forestry Department of Peninsular Malaysia*, pp. 293–298.

Strange, M. 2004. *Birds of Fraser's Hill: An Illustrated Guide and Checklist*. Singapore: Nature's Niche.

Yusof, M. A., Mohd-Taib, F. S., Ishak, S. N., Md-Nor, S., Md-Sah, S. A., Mohamed, N. Z., Azhari, N. N., Neela, V. & Sekawi, Z. 2019. Microhabitat factors influenced the prevalence of pathogenic *Leptospira* spp. in small mammal host. *EcoHealth* 16: 260–274.

FAUNA 09

UPDATED LIST OF SPECIES OF MOTH FAUNA (LEPIDOPTERA: HETEROCERA) OF FRASER HILL, PAHANG

Asri, L.N.[1,2], Salleh, N.K.[1,2], Juhari, M.A.A.[1,2], & Sulaiman, N.[1,2]*
[1]Department of Biological Sciences & Biotechnology, Faculty of Science and Technology
Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia
[2]Pusat Penyelidikan Bukit Fraser, Fakulti Sains dan Tekonologi,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor.
**Corresponding author: vozela@ukm.edu.my; norelaganun@gmail.com*

Abstract

A survey of the moth fauna (Lepidoptera: Heterocera) was conducted from 13th to 15th December 2019 in the vicinity of the Fraser's Hill Research Centre (PPBF) of Universiti Kebangsaan Malaysia. Moths were sampled using a light trap illuminated by a 160W mercury vapor light bulb and set between 1900hrs to 2300hrs. A total of 107 species in 14 families and 31 subfamilies of moths was collected. Erebidae was found to be the most dominant family with 39 species recorded, followed by Geometridae (34 species), Crambidae (11 species), Notodontidae (9 species), Lasiocampidae, Sphingidae, Pyralidae (each with 3 species), Uraniidae, Thyrididae (each with 2 species), Bombycidae, Drepanidae, Noctuidae, Nolidae and Saturniidae (each with 1 species). *Lyssa zampa* which belongs to Uraniidae is recorded as the most abundant species found with eight individuals.

Keywords: Lepidoptera, Geometridae, Erebidae, moth

Introduction

Altitude and latitude of the insect habitat influence the diversity, abundance and the distribution of the insect population through resource diversity, increasing harsh and unpredictable environment and reduced primary productivity (Lawton 1987). As one of the highland reserve areas with an elevation of 1,456m above sea level (a.s.l), Fraser's Hill is characterised by a modest climate with high relative humidity which makes the areas cool and comfortable all year round. This feature makes Fraser's Hill ideal for the growth of various plants, especially flowering plants, making it a great habitat for Lepidopterans which comprise butterflies and moths (Norela et al. 2010). Lepidoptera is the second largest insect order that have been described worldwide and approximately 95% out of 160,000 species are moths (Joanason et al. 2014). Barcode of Life Data System (2014) (BOLD SYSTEM) stated that approximately 174,250 species in 126 families and 46 super families have been described. However, Malaysia has only 14,876 species. Lepidopteran larvae depend on plants as food and the range of moth food plants largely reflect their distributions and plant diversity in the forest (CSIRO 2020; Fiedler et al. 2008). Current survey reported an updated list of moth species within a small area from Fraser's Hill conducted in the vicinity of the research centre. The previous study recorded 100 species from 16 families (24 subfamilies) from Fraser's Hill (Norela et al. 2010) and no updated list of moth species has been made. Thus, this paper aims to update the list of species of moths as one of the efforts to advocate for the conservation of this area for the uniqueness of its aesthetic fauna species.

Materials and Methods

The samplings were conducted in three consecutive nights from 13th December until 15th December 2019 at the Fraser's Hill Research Centre, UKM. The specimens were collected by using two light traps illuminated by a 160-watt mercury vapor bulb from 1900hrs until 2300hrs. Specimens were photographed and species identification was made based on Schulze and Fiedler (2003), Holloway (1986; 1993; 1996a; 1996b; 1997; 1998; 1999) and Barlow (1982).

Results and Discussion

A total of 192 individuals representing 107 species (Table 1) in 14 families and 31 subfamilies of moths were collected. Erebidae was found to be the most dominant family with 39 species recorded, followed by Geometridae (34 species), Crambidae (11 species), Notodontidae (9 species), Lasiocampidae, Sphingidae,

Pyralidae (each with 3 species), Uraniidae, Thyrididae (each with 2 species), Bombycidae, Drepanidae, Noctuidae, Nolidae and Saturniidae (each with 1 species). *Lyssa zampa* is recorded as the most abundant species found with eight individuals. This species can be found throughout each day of the sampling period. It is followed by *Lymantria dispar* and *Pogonopygia nigralbata* (each with 7 individuals). A total of 66 species of moths represented by only one individual throughout the sampling period was recorded. Most of the species belonged to Erebidae (47 species).

The family Erebidae is most dominant in Fraser's Hill. This family is the biggest family of Lepidoptera that consist of 1760 genera and 24,569 described species worldwide (Nieukerken et al. 2011; Olive et al. 2015). The members of the family exhibit high diversity of coloration, size, behaviour and ecology. The family contains large species including the Lepidopteran with the largest wingspan, the white witch moth, *Thysania agrippina* (280 mm) as well as some of the smallest of all micronoctuines with wingspans of as little as 5.7 mm (Kitching & Rawlins 1998). The species in the family can be identified based on the adult wing characteristics. This moth group inhabits various habitats. Many of Erebidae are phytophagous while some are polyphagous. Some species have negative economic impact as pests to agricultural crops such as the *Limantria dispar,* a gypsy moth attacking deciduous trees in Europe (Kitching, 1984; Zúbrik et al. 2016). Geometridae is the second most abundant family in this study and is one of the largest families in Lepidoptera with 20,000 species identified, with 112,000 to 165,000 lepidopteran species that have been described (Pitkin 2002; Scoble 1999). More than half of geometrid species recorded in this study have been identified to belong to subfamily Ennominae. This subfamily is the largest in Geometridae which has a total of 10,000 species worldwide belonging to 1,100 genera (Holloway 1993; Pitkin 2002). Ennomines have a wide ecological range except the very high latitude and in the tropic altitudes. Some of the Ennomines are native to lowland forest types and several species appear to fly mostly in the forest understorey (Holloway 1993).

Comparison with previous studies

Overall, the total number of species identified is higher than species recorded from previous studies (Norela et al. 2010) with 97 species as new records in Fraser's Hill. However, the number of individuals is lower (196 individuals) compared to the previous studies. Recently, iNaturalist (2020) listed that 18,613 moth species have been recorded in Malaysia and 2,513 species have been identified. In addition, BOLD System (2014) recorded 8,617 moth species from Malaysia and 73,408 species worldwide, in which Fraser's Hill recorded in 2010 and 2020 comprises 4.25% of the identified species (Table 1). The most abundant moth species are represented by Erebidae which comprises 39 species from nine subfamilies found in Fraser's Hill. However, this was not recorded by Norela et al. (2010). Several moth families are newly recorded in Fraser's Hill beside the Erebidae such as Crambidae (11 species), Drepanidae (2 species), Pyralidae (3 species) and Thyrididae (2 species). Geometridae ranks the second most abundant moth family after Erebidae in Fraser's Hill and they are the most-described moth family worldwide (Pitkin 2002; Scoble 1999).

Table 1 Comparison of the moth species recorded with previous studies

No.	Family	Current study	Bukit Fraser (Norela et al. 2010)	Gunung Jerai (Norela et al. 2006)	Malaysia (BOLD system)	BOLD System (Worldwide)
1.	Agaristidae	-	1	1	-	-
2.	Arctiidae	-	15	9	-	-
3.	Bombycidae	1	1	1	39	210
4.	Cossidae	-	1	1	25	365
5.	Crambidae	11	-	-	423	6109
6.	Drepanidae	2	-	-	116	284
7.	Erebidae	39	-	-	2383	12992
8.	Eupterotidae	-	2	2	49	432
9.	Geometridae	30	26	7	1001	24297
10.	Lasiocampidae	3	4	3	119	1793
11.	Limacodidae	-	6	1	95	849
12.	Lymantridae	-	5	1	-	-
13.	Noctuidae	1	13	20	516	8041
14.	Nolidae	1	3	-	329	1237

15.	Notodontidae	8	12	2	195	3800
16.	Pyralidae	3	-	2	64	6000
17.	Saturniidae	1	2	-	382	4049
18.	Sphingidae	3	5	6	2821	1956
19.	Thyrididae	2	-	-	18	294
20.	Uraniidae	2	1	1	42	700
Total species		107	100	57	8617	73408

In comparison to Gunung Jerai, the species recorded are much lower than Fraser's Hill with 57 species which indicates that Gunung Jerai recorded only half of the species recorded in Fraser's Hill under 14 families (Norela et al. 2006). Even though both mountain ranges have approximately the same altitude (1000m to 1300m a.s.l.), Gunung Jerai and Fraser's Hill are covered by different types of vegetation. Gunung Jerai comprise of upper dipterocarp and hill dipterocarp vegetation (Juliana et al. 2006) while the vegetation profile of Fraser's Hill is mainly covered by lower montane forests. Its vegetation is dominated by Fagaceae (oak family) and Lauraceae (cinnamon family) (Lee 2014). Different types of vegetation can be one of the factors in the differences of moth diversity and distribution. This is because moth larvae feed on specific plants as their main food source. In addition, the declining number of moth species are attributed to habitat fragmentation especially the functional moth group and indirectly changes the community structure in the ecosystem (Schmidt & Roland 2006). Thus, the stability of moth distribution reflects the stability of nature (Norela et al. 2006).

Conclusion

This study recorded a total of 107 species of moths in 14 families at Fraser's Hill. This is considered high from a small sample size area, hence a comprehensive study at Fraser's Hill needs to be carried out to add to the existing species list. There will be more moth species that can be discovered by extending the duration of the sampling period and the size of the sampling area. Continuous surveys should be done to update the checklist of moths in Fraser's Hill as their role is crucial in the ecosystem such as pollination, decomposition, nutrient cycling and as food sources for other animals.

Acknowledgments

The authors would like to thank the Fraser's Hill Research Centre of Universiti Kebangsaan Malaysia for giving permission to conduct the study. This research was funded by grant ST-2017-013.

References

Barlow, H. S. 1982. *An Introduction to the Moths of South East Asia*. Kuala Lumpur: Malaysia Nature Society.

Butterflies and Moths of North America. 2019. (https://www.butterfliesandmoths.org/-taxonomy/Crambidae). [18 July 2019].

Barcodes of Life Data System (BOLD System). 2014. *Lepidoptera* {Order} (http://v3.boldsystems.org/index.php/TaxBrowser_Taxonpage?taxid=113). [30 January 2020].

CSIRO. 2020. *Insects and Their Allies: Lepidoptera: Moths and Butterflies*. http://www.ento.csiro.au/education/insects/lepidoptera.html. [17 January 2020].

Fiedler, K., Brehm, G., Hilt, N., Sussenbach, D., & Hauser, C. L. 2008. Variation of diversity patterns across moth families along a tropical altitudinal gradient. *Ecological Studies*. 198: 167-179.

Holloway, J. D. 1999. The Moths of Borneo: Family Lymantriidae. *Malayan Nature Journal*. 53: 1–188.

Holloway, J. D. 1998. The Moths of Borneo: Families Castniidae, Callidulidae, Drepanidae and Uraniidae. *The Malayan Nature Journal*. 52: 1–155.

Holloway, J. D. 1997. The Moths of Borneo: Family Geometridae, subfamilies Sterrhinae and Larentiinae. *The Malayan Nature Journal*. 51: 1–242.

Holloway, J. D. 1996a. The Moths of Borneo: Family Geometridae, Subfamilies Oenochrominae, Desmobathrinae and Geometrinae. *The Malayan Nature Journal*. 49: 147–326.

Holloway, J. D. 1996b. The Moths of Borneo: Family Geometridae, Subfamilies Oenochrominae, Desmobathrinae and Geometrinae. *Malayan Nature Journal*. 49: 207-208.
Holloway, J. D. 1993. The Moths of Borneo: Family Geometridae, Subfamily Ennominae. *The Malayan Nature Journal*. 47: 19.
Holloway, J. D. 1998. The Moths of Borneo: Families Castniidae, Callidulidae, Drepanidae and Uraniidae. *The Malayan Nature Journal*. 52: 1–155.
Idris, A. B., Nor, S. M. & Rohaida, R. 2002. Study on diversity of insect communities at different altitudes of Gunung Nuang in Selangor, Malaysia. *Journal of Biological Sciences*. 2(7): 505-507.
iNaturalist Network. 2019. *Butterflies and Moths (Order Lepidoptera).* https://www.inaturalist.org/taxa/47157-Lepidoptera. [30 January 2020].
Jonason, D., Franzen, M., & Ranius, T. 2014. Surveying moths using light traps: effects of weather and time of year. *PloS one*, *9*(3), 1-7.
Juliana, W.A., Nizam, M.S., Nor Faizah, Z., Nik Norafida, N.A., Zainudin Ibrahim, A., Rohani, S & Sani, M. 2006. Komposisi dan Kepelbagaian spesies pokok di Hutan Simpan Gunung Jerai. Dlm. Shaharuddin, M. I., Wan Yusoff, W. A., Jalil, M. S., Yusoff, M & Latiff, A. (pnyt.). *Hutan Simpan Gunung Jerai, Kedah: Pengurusan, Persekitaran Fizikal, dan Kepelbagaian Biologi.* Siri kepelbagaian Biologi Hutan 6, Jabatan Perhutanan Semenanjung Malaysia. Hlm. 305-315
Kitching, I. J. & Rawlins, J. 1998. *The Noctuoidea: Handbook of Zoology, Lepidoptera, Moths and Butterflies*, Vol. 1. Systematics and Evolution (ed. by N.P. Kristensen). Pg: 355–401. W. de Gruyter, Berlin.
Kitching, I. J. 1984. An historical review of the higher classification of the Noctuidae (Lepidoptera). *Bulletin of the British Museum (Natural History): Entomology*. 49: 153–234.
Lawton, J. H., MacGarvin, M., & Heads, P. A. 1987. Effects of altitude on the abundance and species richness of insect herbivores on bracken. *The Journal of Animal Ecology*. 147-160.
Nieukerken, E.J., Kaila, L., Kitching, I.J., Kristensen, N.P., Lees, D.C., Minet, J., Mitter, C., Mutanen, M., Regier, J.C., Simonsen, T.J. and Wahlberg, N., 2011. Order Lepidoptera Linnaeus, 1758. In: Zhang, Z.-Q. (Ed.) Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, 3148(1): 212-221.
Norela, S., Aizat, M. A., Maimon, A., Zabidi, M. Y. & Tahir, A. M. 2010. Diversity of Moths (Lepidoptera: Heterocera) in Lojing Highlands, Kelantan. In: *Conserving Lojing Highlands for Sustainable Development.* Kota Bharu: Penerbit Universiti Malaysia Kelantan. ms 135-143.
Norela, S., Azman, S. & Zaidi, M. I. 2006. Fauna Rama–Rama (Lepidoptera: Heterocera) di Hutan Simpan Gunung Jerai. Dlm. Shaharuddin, M. I., Wan Yusoff, W. A., Jalil, M. S., Yusoff, M & Latiff, A. (pnyt.). *Hutan Simpan Gunung Jerai, Kedah: Pengurusan, Persekitaran Fizikal, dan Kepelbagaian Biologi.* Siri kepelbagaian Biologi Hutan 6, Jabatan Perhutanan Semenanjung Malaysia. Hlm. 366–372.
Olive, B., Suresh, K. S., Purnendu, M., Kaushik, M. & Bulganin, M. 2015. Taxonomic Account of Erebidae (Lepidoptera: Noctuiodea) Pests of Tea gardens of West Bengal, India. *Journal of Entomology and Zoology Studies*. 3(5): 185–192.
Pitkin, L. M. 2002. Neotropical ennomine moths: a review of the genera (Lepidoptera: Geometridae). *Zoological Journal of the Linnean Society*. 135(2-3): 121-401.
Schmidt, B. C. & Roland, J. 2006. Moth Diversity in a Fragmented Habitat: Importance of Functional Group and Landscape Scale in the Boreal Forest. *Annals of the Entomological Society of America*. 99(6): 1110–1120.
Scoble, M. J. 1999. *Geometrid Moths of the World: A Catalogue (Lepidoptera: Geometridae)*. Kitching, I. J (ed.). 2:1200. Collingwood. CSIRO Publishing.
Tan, M. K. & Kamaruddin, K. N. 2014. *Orthoptera of Fraser's Hill, Peninsular Malaysia*. Lee Kong Chian Natural History Museum: National University of Singapore, Singapore.
Zúbrik, M., Hajek, A., Pilarska, D., Špilda, I., Georgiev, G., Hrašovec, B., Hirka, A., Goertz, D., Hoch, G., Barta, M. and Saniga, M.,. 2016. The potential for Entomophaga maimaiga to regulate gypsy moth *Lymantria dispar* (L.) (Lepidoptera: Erebidae) in Europe. *Journal of Applied Entomology*, *140*(8), 565-579.

FAUNA 10

BUTTERFLIES SPECIES (LEPIDOPTERA: RHOPALOCERA) IN THE VICINITY OF FRASER'S HILL RESEARCH CENTRE OF UNIVERSITI KEBANGSAAN MALAYSIA AND JERIAU WATERFALL AREA OF FRASER'S HILL, PAHANG, MALAYSIA

Salleh, N.K.[1,2], Asri, L.N.[1,2], Sulaiman, N.[1,2]*, & Juhari, M.A.A.[1,2]
[1]Department of Biological Sciences & Biotechnology, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia
[2]Fraser's Hill Research Centre, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor.
**Corresponding author email: vozela@ukm.edu.my*

Abstract

A survey of the butterfly fauna (Lepidoptera: Rhopalocera) was conducted from 13th to 15th December 2019 in the vicinity of Fraser's Hill Research Centre (PPBF) of Universiti Kebangsaan Malaysia and Jeriau waterfall area. Butterflies were sampled using a sweeping net from 10:00 hr to 17:00 hr. A total of eight species in three families and five subfamilies of butterflies were collected. This study has added one new record for Fraser's Hill, namely *Eurema brigitta* (Stoll) *senna* (Felder).

Keywords: butterflies, Fraser's Hill, Lepidoptera, Rhopalocera, highland

Introduction

Lepidoptera which comprises butterflies, skippers, and moth is the second largest insect order. There are over 1,182 species of butterflies recorded in Peninsular Malaysia and 944 species in Borneo (Hollaway 1982, Otsuka 2001, Wilson et al. 2015). According to Bonebrake et al. (2010), the abundance and species diversity of butterflies are higher in the tropical region due to their role as pollinating agents that contribute to the growth, development, and the dispersal of host plants.

Fraser's Hill, Pahang is a highland located between latitude 30 46' 25'' to 30 47' 50'' and longitude 1100 43' 50'' to 1010 45' 15'' East of the Titiwangsa Main Range. This highland, located between 1000 to 1525 a.s.l, is home to diverse flora and fauna (Cheong 2013, Jumaat & Maimon 2009, Ng et al. 2009). This study was carried out to extend the documentation of butterfly species of Fraser's Hill and as one of the efforts to conserve this area for its uniqueness in aesthetic highland fauna species.

Materials and Methods

Samplings were conducted in three consecutive days from 13 to15 December 2019 in the vicinity of Fraser's Hill Research Center and Jeriau Waterfall. The specimens were collected by using sweeping nets between 10:00 hr to 17:00 hr. Specimens collected were placed within a triangular folded paper envelope and stored in a plastic container. The specimens were brought back to the UKM laboratory where they were pinned and oven dried. The specimens were identified to species level according to Corbet and Pendlebury (1992).

Results and Discussion

A total of 27 individuals representing eight species from three families (Nymphalidae, Papilionidae and Pieridae) and five subfamilies (Coliadinae, Danainae, Pierinae, Polyommatinae, and Satyrinae) of butterflies were recorded during the sampling period (Table 1 & Appendix 1). The genus *Eurema* appeared dominant in the study area and there are four species recorded. The species are characterised by the morphology of bright to pale yellow or lemon-colored wings with black margin on the apical side of forewings. They are usually found fluttering around bushes or roadsides (Noor Azrizal et al. 2015). One of the subspecies, *Eurema* is recorded as a new additional butterfly taxon of Fraser's Hill, namely *Eurema brigitta* (Stoll) *senna* (Felder). This subspecies, also known as No Brand Grass Yellow, is a small butterfly of Coliadinae with a wingspan of 36-40 mm. According to Tan (2009), the species can be found flying in open grassy areas and usually in the vicinity of its host plants, *Cassia mimosoides.* Young leaves of this plant are food sources for its larvae.

Table 1. The species of butterfly recorded in this study at Fraser's Hill.

No	Taxa
	NYMPHALIDAE
	Subfamily: Satyrinae
1.	*Yptima pandocus* (Moore) *corticaria* (Butler)
	LYCAENIDAE
	Subfamily: Polyommatinae
2.	*Jamides elpis* (Godart) *pseudelpis* (Butler)
	PIERIDAE
	Subfamily: Coliadinae
3.	*Eurema andersonii andersonii* (Moore)
4.	*Eurema brigitta* (Stoll) *senna* (Felder)*
5.	*Eurema sari* (Horsfield) *sodalis* (Moore)
6.	*Eurema simulatrix tecmessa* (de Niceville)
	Subfamily: Pierinae
7.	*Appias cardena perakana* (Fruhstorfer)
	Subfamily: Danainae
8.	*Parantica aspasia aspasia* (Fabricius)

* New record of butterfly to Fraser's Hill, Pahang

The number of collected taxa in the present study is very low compared to the previous studies carried out at Fraser's Hill. Studies by Norfazliana et al. (2018) listed 32 species; Suhairiza et al. (2017) listed 138 species; Norela et al. (2010) listed 47 species and Zaidi et al. (2001) listed 26 species. Overall in the period of 2001 until this current study, a total of 85 species were recorded at Fraser's Hill (Norela et. al 2010, Norfazliana et al. 2018, Nurul Atika 2017, Zaidi et al. 2001). Butterfly species of Fraser's Hill make up approximately 4.24% of the butterfly species identified in Malaysia (2004 species) and 0.53% of the butterfly species identified worldwide (16,167 species) (BOLD SYSTEM 2020). In addition, Table 2 showed the differences in the total number of butterfly species between the few highlands in Malaysia.

Table 2. Total species of butterflies

Locations	Total Species	References
Fraser's Hill	85	Current study 2020, Norfazliana, Mohd Afiq Aizat & Norela 2018, Nurul Atika 2017, Norela et al. 2010, Zaidi et al. 2001
Cameron Highlands	70	Nur Amira et al. 2017, Norela et al. 2011
Genting Highlands	214	Chia 2014
Malaysia	2004	BOLDSYSTEM 2020
Worldwide	16,167	BOLDSYSTEM 2020

There are few factors that contribute to these differences. First, is the weather condition. Braby (1995) mentioned that butterfly species abundance might be affected by climatic factors such as drought and heavy

rain. During the 3-day sampling period in this study, it rained throughout. According to Welzbacker (2017), when it rains, butterflies hide under leaves or among the grasses and flowers to avoid raindrops wetting their wings and body. Most butterflies need a body temperature of at least 55°F to be able to fly. If they try to fly when it is colder, they would be very weak and most likely fall to the ground. If a butterfly does get wet, it will stay still until their body and wing dries (Welzbacker 2017). Besides the raining season, the number of species recorded was influenced by the limited sampling effort. The sampling was done within a short period of time and was only able to cover a small area of Fraser's Hill, hence the low number of specimens collected. The sampling time might have also affected the results as butterflies are generally more abundant from April to September than during the other months of the year (Corbet and Pendlebury 1992).

Conclusion

Eurema brigitta (Stoll) *senna* (Felder) is a new record of butterfly subspecies at Fraser's Hill. This study was recorded within a short period of survey and covered only a small area. Hence, a prolonged survey should be considered when drawing up a checklist of butterflies in Fraser's Hill.

Acknowledgements

The authors would like to thank the Universiti Kebangsaan Malaysia Fraser's Hill Research Centre for the permission to sample the butterflies in the area. This research was funded by grant ST-2017-013.

References

Barcodes of Life Data System (BOLD System). 2020. *Lepidoptera* {Order} (http://v3.boldsystems.org/index.php/TaxBrowser_Taxonpage?taxid=113). [25 January 2020].

Braby, M. 1995. Seasonal-Changes in relative abundance and spatial-Distribution of Australian lowland tropical Satyrine Butterflies. *Australian Journal of Zoology* 43(3): 209-229.

Bonebrake, T.C., Ponisio L.C., Boggs C.L. & Ehrlich P.R. 2010. More than just indicators: a review of tropical butterfly ecology and conservation. *Biological conservation* 143(8): 1831–1841.

Cheong, C. 2013. *Fraser's Hill- A Lush Highland Hideaway*. WWF-Malaysia, Petaling Jaya.

Chia, K. H. 2014. *Exploring the diversity of butterflies (Lepidoptera) at different elevations in Genting Highlands and the validity of graphium species in Peninsular Malaysia*. M.Sc. Thesis, Faculty of Science, Universiti Malaya.

Corbet, A. & Pendlebury, H. 1992. *The Butterflies of The Malay Peninsula*. Kuala Lumpur: Malayan Nature Society.

Holloway, J., Bradley, J. & Carter, D. 1987. *Cie Guides to Insects of Importance to Man. I. Lepidoptera*. CAB International.

Jumaat, H. Adam & Maimon A. 2009. Chapter 1 Introduction. In. Latiff, A., Maimon Abdullah, Norhayati Ahmad & Jumaat, H.A. (Eds). *Bukit Fraser: Crown of the Titiwangsa Range*, pp 1-8. Fraser's Hill Research Centre and Fraser's Hill Development Corporation, Selangor.

Ng, Y. F., Norela S. & Maimon A. 2009. Fauna of Bukit Fraser. In. Latiff, A., Maimon Abdullah, Norhayati Ahmad & Jumaat, H.A. (Eds). *Bukit Fraser: Crown of the Titiwangsa Range*, pp 37-67. Fraser's Hill Research Centre and Fraser's Hill Development Corporation, Selangor.

Noor Azriza W., Mohd Sofian A. & Mohammed Rizman I. 2015. A review on morphological characterization, variation and distribution pattern of *Eurema* butterflies of Peninsular Malaysia. *Journal of Biodiversity and Environmental Sciences* 6 (3): 359-372.

Norela S., Maimon A., Mohd Faizal R. R., Khazril Fahmy H., & Juhari, M.A.A. 2010. Fauna kupu-kupu (Lepidoptera: Rophalocera) di Bukit Fraser, Pahang. Dlm. Adam, J.H., Gasim, M.B., Sarkawi, Z., Choy, E.A., Rahman, Z.A., Tambi, N. & Juhari, M.A.A. (Pnyt.). *Biokejuruteraan Penilaian Ekosistem & Spesies 2010 Bukit Fraser, Pahang*, pp 51-60. Fraser's Hill Research Centre and Fraser's Hill Development Corporation.

Norela S., Risda F., Mohd Zabidi Y., Suraya S. & Maimon A. 2011. Fauna kupu-kupu (Lepidoptera: Rhopalocera) di Gunung Jasar dan Air Terjun Parit, Tanah Rata, Cameron Highlands. Dlm. Abd. Rahman Abd. Rahim, Koh, H.L., Mohd. Paiz Kamaruzaman, Muhammad Abdullah & Latiff, A.

(Eds.). *Hutan Pergunungan Cameron Highlands: Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi.* Malaysia: Jabatan Perhutanan Semenanjung Malaysia.

Norfazliana G., Mohd Afiq Aizat J., & Norela S. 2018. An updated checklist of butterflies (Lepidoptera: Rhopalocera) from the Fraser's Hill, Pahang, Malaysia. *Serangga* 23(2): 143-154

Nur Amira Z. A., Nursyahirah Z. & Nivaarani, A. 2017. Diversity of Lepidoptera at R.E.A.C.H Biod Centre, Cameron Highlands, Malaysia. *Journal of Wildlife and Parks* 32:41-55

Nurul Atika S. 2017. *Diversity of Lepidoptera in Royal Belum State Park, Perak and Fraser's Hill, Pahang*. M.Sc. Thesis. Universiti Kebangsaan Malaysia.

Otsuka, K. 2001. *A Field Guide to the Butterflies of Borneo and South East Asia*. Kota Kinabalu: Hornbill Books.

Suhairiza S., Aisyah Z., Azman S., Mohd Zabidi M. Y., Mohamad Afiq Aizat J. & Norela Su. 2017. Species diversity and abundance of butterfly (Lepidoptera: Rhopalocera) at different altitudes along the Raub Corridor to Fraser's Hill, Pahang, Malaysia. *Serangga* 22(1): 123-145

Tan, H. 2009. *Life History of the No Brand Grass Yellow (Eurema brigitta senna*). https://butterflycircle.blogspot.com/2009/10/life-history-of-no-brand-grass-yellow.html [27 January 2010]

Welzbacker, H. 2017. *Where do butterflies go when it rains?* https://askdruniverse.wsu.edu/2017/12/18/butterflies-go-rains/ [27 January 2020]

Wilson, J., Jisming-See, S., Brandon-Mong, G., Lim, A., Lim, V., Lee, P. & Sing K. 2015. The first Peninsular Malaysia butterfly count. *Biodiverse Data Journal* 3: 1-16

Zaidi, M. I., Azman, S., Salmah, Y., Idris, A. G., Zarheeda, N. & Gonzaga, A. D. 2001. Butterflies within the Resort and Recreational Areas of Fraser's Hill. In Latiff, A., Zakaria, Z., Isa, Z. M., Mat-Salleh, K., Hashim, N. M. & Din, L. (Eds.). *Bukit Fraser Persekitaran Fizikal, Biologi dan Sosioekonomi,* pp 169-173. Selangor: Universiti Kebangsaan Malaysia.

APPENDIX 1

Fraser's Hill Butterflies taxa.

Eurema sari (Horsfield) *sodalis* (Moore)
Family: Pieridae
Subfamily: Coliadinae

Appias cardena perakana (Fruhstorfer)
Family: Pieridae
Subfamily: Pierinae

Parantica aspasia aspasia (Fabricius)
Family: Pieridae
Subfamily: Danainae

Yptima pandocus (Moore) *corticaria* (Butler)
Family: Pieridae
Subfamily: Danainae

FAUNA 11

METABOLITE PROFILES OF HIGHLAND STINGLESS BEE HONEY

Muhamad, A.[1]*, Sulaiman, N.[2], Juhari, M.A.A.[2], Alias, H.[1], Johari. N.A.[1], Mat Isa, M.N.[1], & Mamat, M.R.[1]
[1]Malaysia Genome Institute, National Institutes of Biotechnology Malaysia, Ministry of Science, Technology and Innovation (MOSTI), Jalan Bangi, 43000 Kajang, Selangor
[2]Department of Biological Sciences and Biotechnology; Fraser's Hill Research Centre, Faculty Science and Technology, 43600 Universiti Kebangsaan Malaysia, Bangi, Selangor
** Corresponding author email: aziramuhamad@nibm.my; azira.muhamad@gmail.com*

Abstract

Honey has been traditionally harvested from bees living in low altitude environments. In this study, we assessed the ability of the stingless bee to survive at high altitudes based on the honey produced by the stingless bees. A collection of raw stingless bee honey from Fraser's Hill Research Centre UKM was chemically analysed using Nuclear Magnetic Resonance (NMR) spectroscopy platform. NMR is unique among other analysis techniques since it is able to produce quantitative ingredient profiles for both targeted and non-targeted components of food in general. Simultaneous identification and quantification of compounds in one single measurement is detected by acquiring the spectroscopic fingerprint specific for each individual sample. Hence, the main objective is to assess and compare the metabolites in honey samples taken before and after stingless bee's adaptation from low to high altitude by using NMR analysis.

Keywords: stingless bee honey, Nuclear Magnetic Resonance (NMR), fingerprint

Introduction

The location of Fraser's Hill Research Centre UKM (PPBF) which is surrounded by preserved tropical rainforests, is believed to be home to various species of pollinators such as birds, bats and bees. In this study, bees from the Meliponini tribe, or better known as Kelulut or stingless bees are the subject of the study of sustainability and adaptation from lowland to highland areas. Stingless bee has been reported as a major pollinator for lowland timber species in Malaysia (Momose et al. 1998). Among the characteristics that influence the function of Kelulut as a pollinator are, easily adaptable; uniformity of flower sources (Ramalho et al. 1994); can be conserved for breeding and harvesting of honey; contain large food reserves in the nest; sharing of pollen resources in nests that reduce the need for the stingless bees to come out during the rainy season; as well as the speed in the formation of the forager team through the transfer of source information to the conservation team within the nest, allowing the activity of collecting nectar and pollen from the same source to be carried out by stingless bees from within the same nest (Heard 1999).

Many studies have shown the function of Kelulut as a pollinator in lowland areas. In Malaysia, however, there is limited information on the ability of Kelulut to colonise in the highlands. Salim et al. (2012) have reported the discovery of *Sundatrigona moorei Schwarz* at an altitude of 457 to 1128 m a.s.l. in Ulu Gombak Forest Reserve. Preliminary observations have also found that an unidentified species of Kelulut in Fraser's Hill at an altitude of 1220 m a.s.l. is capable of surviving at a lower temperature range than normal, between 17 °C to 25 °C. Following these findings, this study was designed to develop the PPBF UKM Kelulut repository, by comparing the stingless bee honey metabolite profile from lowland habitat and after adaptation to highland habitat.

Materials and Methods

Sample preparation

Modifications were made to the original method by Ohmenhaeuser et al. (2013) in order to minimise sample usage. 250 mg of honey is dissolved using ultra-pure water and homogenised at 600 rpm, 20 ºC for 1 hour on a shaker. The insoluble material was then removed from the homogenised sample by centrifugation at 10,000 rpm, 4 ºC, for 10 mins. Four parts of the sample were mixed with one part phosphate buffer at pH 6.0 (1 M KH_2PO_4, 0.1% TMSP, 2 mM NaN_3 in D_2O). 550 µl of the sample in buffer was then transferred to a 5 mm NMR tube.

NMR spectra acquisition and pre-processing

The honey sample in buffer was subjected to NMR spectroscopy analysis. NMR spectrum was recorded at 300 K on Bruker Ascend 700 MHz NMR Spectrometer (Bruker Biospin, Germany) equipped with a 5 mm TCI triple-resonance Cryoprobe (frequency 700.4 MHz ^{1}H). 32 scans and four dummy scans of 65 k points were obtained with a spectrum width of 15.985 ppm and acquisition time of 1.46 s. The NMR ^{1}H spectrum was phased, baseline corrected and calibrated by TSP signal at 0.0 ppm using Topspin 3.2.

Spectral analysis

NMR pre-processed data was transferred to Chenomx NMR Suite 8.1 by comparing the integration of a known reference signal (TSP) with a signal derived from a compound reference containing chemical shifts and peak multiplication. The metabolites were identified based on the Chenomx database of compounds at pH 6. Metabolites assigned included amino acids, organic acids and common sugars.

Results and Discussion

Metabolite profiling

Stingless bee honey metabolite profiling was performed using ^{1}H NMR technology. This platform allows the identification of metabolites through NMR metabolic fingerprints of different kelulut honey samples. Unique and specific characteristics were identified through relative comparison and metabolic characterisation using Chenomx NMR Suite 8.1 database software. The metabolic profiles of kelulut honey obtained showed the major sugar content of glucose, fructose, sucrose and maltose; amino acids such as phenylalanine, alanine, valine, isoleucine and tyrosine; organic acids such as acetic acid, lactic acid and formic acid; as well as ethanol were at different relative concentrations. The concentration of sugars and amino acids were almost similar, with no significant difference between before and after habitat adaptation.

However, for organic acids, the NMR analysis showed that there was a difference in the content of lactic acid and formic acid in *T. apicalis* honey (log 06030304), *T. binghami* (log 06030404 and log 06030406) and *L. terminata* (log 06030501), where the formic acid content was found to be higher after adaptation compared to before adaptation (Figure 1). This finding was in contrast to lactic acid, in which the content of this metabolite was lower after adaptation than before adaptation (Figure 1).

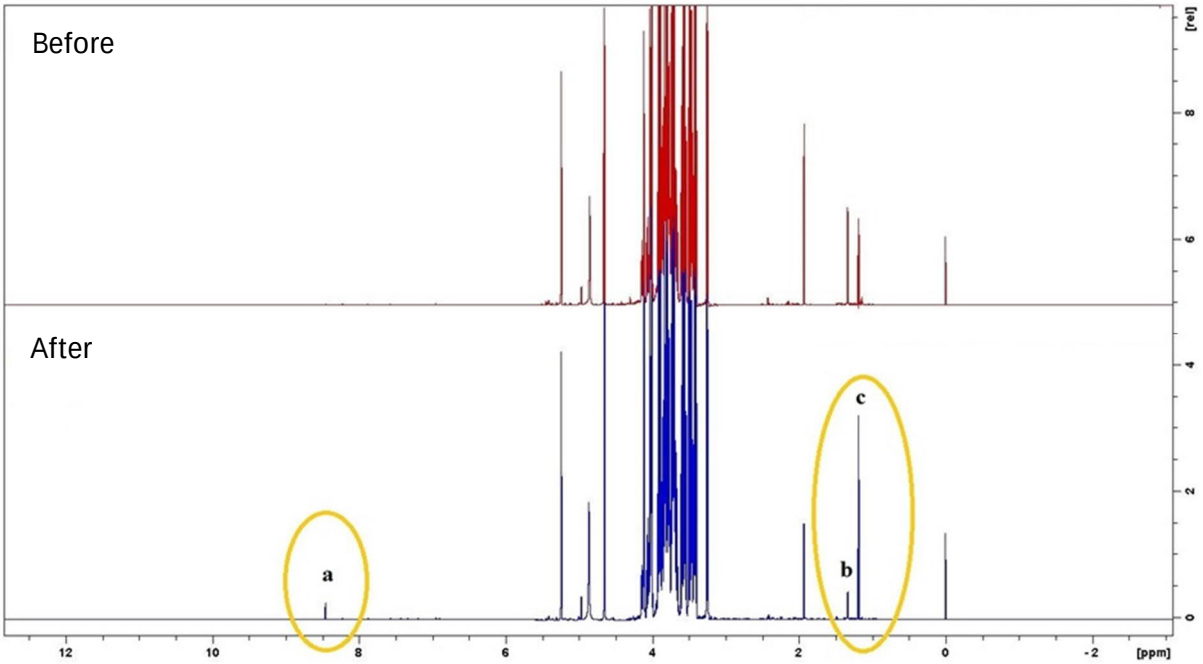


Figure 1. ^{1}H NMR spectra of *T. apicalis* before and after habitat adaptation. Major differences can be seen in the yellow circle, representing the concentration of formic acid (a), lactic acid (b) and ethanol (c).

Changes in the content levels of the two organic acids may occur as a result of the microbial flora response to changes in ambient temperature changes. Formic acid plays a role in the biosynthesis of various compounds for energy metabolism and pathways associated with the response to stress (Pietzke et al., 2020). The

fermentation process of sugar also produces formic acid which is involved in the process of phosphate oxidation. Lactic acid is a product of glycolysis metabolic activity. Increased concentrations of lactic acid in honey may be due to the digestive system (Arrese & Soulages, 2010). This indicates that the metabolic process of acidosis occurred as a result of muscle tissues being used at high frequency for movement of the wings. Excessive lactic acid production is also associated with stress (Strachecka et al. 2019).

The resulting metabolite products are believed to be related to the physical activity of the stingless bees during the adaptation period. The period included the following processes of transit from lowlands in thin hive boxes with higher temperatures, limited food sources and long distance transfers. The adaptation of the Kelulut colony to the highlands at an altitude of 1200 m a.s.l. was facilitated by designing insulated hive boxes as well as providing an environment with adequate food resources. The insulated hive allows the gap between day and night temperatures to be reduced and maintained at the optimum temperature level (25-28 °C) for the stingless bees to strive. Sources of resin, nectar and pollen were also found abundantly in the vicinity of the PPBF UKM which assisted in the adaptation process for the stingless bees.

Conclusions

Metabolite profiles of the stingless bee honey for both before and after adaptation to high altitudes did not show any significant difference. Only the organic acids concentration was found to be slightly different after adaptation. Hence, this suggests that the stingless bees were able to survive and adapt to high altitudes with slight modification of the hives. However, further studies need to be performed to assess the relationship between stress and environmental factors to the metabolites in the stingless bee honey.

Acknowledgements

The authors would like to thank UKM for funding under the Research University Grant (GUP-UKM 2017-038).

References

Arrese, E.L. & Soulages, J.L. 2010. Insect fat body: energy, metabolism, and regulation. *Annual Review of Entomology* 55: 207–225.

Heard, T. A. 1999. The role of stingless bees in crop pollination. *Annual Review of Entomology* 44:183–206.

Momose, K., Yumoto, T., Natamitsu, T., Kato, M., Nagamasu, H., Sakai, S., Harrison, R.D., Itioka, T., Hamid, A. A. & Inoue, T. 1998. Pollination biology in a lowland dipterocarp forest in Sarawak, Malaysia. I. Characteristics of the plant-pollinator community in a lowland dipterocarp forest. *American Journal of Botany* 85(10): 1477-1501.

Nagamitsu, T., Momose, K., Inoue, T. & Roubik, D.W. 1999. Preference in flower visits and partitioning in pollen diets of stingless bees in an Asian tropical rainforest. *Research on Population Ecology* 41: 195-202.

Ohmenhaeuser, M., Monakhova, Y.B, Kuballa, T. & Lachenmeier, D.W. 2013. Qualitative and Quantitative Control of Honeys Using NMR Spectroscopy and Chemometrics. *ISRN Analytical Chemistry* 825318.

Pietzke, M., Meiser, J. & Vazquez, A. 2020. Formate metabolism in health and disease, *Molecular Metabolism* 33: 23-37.

Ramalho, M., Giannini, T. C., Malagodibraga, K. S. & Imperatriz-Fonseca, V.L. 1994. Pollen harvest by stingless bee foragers (Hymenoptera, Apidae, Meliponinae). *Grana* 33: 239–44.

Salim, H. M. W., Dzulkiply, A. D., Harrison, R.D., Fletcher, C., Kassim, A.R. & Potts, M.D. 2012. Stingless bee (Hymenoptera: Apidae: Meliponini) diversity in dipterocarp forest reserves in Peninsular Malaysia. *The Raffles Bulletin of Zoology* 60(1): 213-219.

Strachecka, A., Grzybek, M., Ptaszynska, A. A., Los, A., Chobotow, J. & Rowinski, R. 2019. Comparison of Lactate Dehydrogenase Activity in Hive and Forager Honey bees May Indicate Delayed Onset Muscle Soreness – Preliminary Studies. *Biochemistry Moscow* 84: 435–440.

FAUNA 12

ANURAN SPECIES COMPOSITION AND DIVERSITY AT SUNGAI JERIAU, FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA

Mohammad Syafiq Haiqal, S.[1], Nur Hidayah, S.[1], Daicus, B.[3], Juliana, S.[2], Ehwan, N.[1], & Norhayati, A.[1,2]*
[1]Department of Biological Sciences & Biotechnology, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia
[2]Bukit Fraser Research Centre, Faculty of Science and Technology, Universiti Kebangsaan Malaysia,
43600 UKM Bangi, Selangor, Malaysia
[3]Institute of Biological Sciences, Faculty of Science, University of Malaya,
50603 Kuala Lumpur, Malaysia
**Corresponding author email: norhayatiahmad@ukm.edu.my*

Abstract

The most up-dated number of amphibian species at Fraser's Hill is 22 species. Previous studies on amphibians at Fraser's Hill are on taxonomic and species list leaving many gaps on the ecology. This study was, thus, conducted to identify species diversity and the relationship between microhabitat and temporal variation. Amphibians were surveyed using the active sampling of visual encounter survey method by four people from 23rd to 27th of October 2016. The surveys were completed using artificial lights to search for animals between 19:00 h to 23:00 h. The surveys produced a total of 85 individuals from 12 species. The most abundant species was *Limnonectes blythii* with 32 individuals or 37.6% of the total number of individuals. Species accumulation curve indicates that the asymptote is not distinct enough. Nevertheless, the species richness of the study site is estimated at 18 species compared to the observed 12. The statistical fit of the species abundance distribution is the geometric series. This shows that the amphibian assemblage in the study area has several dominant species. This study could facilitate the management of rare and endemic species in the development plan of the area.

Keywords: amphibians, frogs, montane forests, diversity, tropical rainforest

Introduction

Faunal records of amphibians and reptiles of Fraser's Hill were first reported by Smith (1922). Since then, other major reports include Berry (1975), who recorded 15 species, and Leong and Lim (2003), who reported 43 species of reptiles (two turtles, 20 lizards, 21 snakes) and 22 species of amphibians (one caecilian, 21 frogs). Inventory and continuous review, however, are still required to monitor any change to the composition or species diversity. For example, Wood et al. (2008) discovered the endemic *Ansonia jeetsukumarani* from Fraser's Hill. An update of herpetofauna records of Fraser's Hill was published by Norhayati et al. (2011), with a total of 14 species of amphibians, adding five new locality records, which brings the total to 22 species. Although many studies have been done over those years, knowledge about amphibians is still incomplete, because of the lack of detailed research on the distribution of many species, especially the rare ones. Thus, the objectives of this study were to identify species abundance distribution and species diversity of the anurans at Sungai Jeriau, Fraser's Hill, Pahang.

Methods and Materials

Study area

Fraser's Hill (3°43'N, 101°45'E) is located along the Selangor-Pahang border, approximately 80 km from Kuala Lumpur. It occupies a total land area of about 2804 ha within the Titiwangsa Range and rises to an altitude of 1448 m a.s.l. Vegetation in the area is composed primarily of upper dipterocarp and lower montane forests dominated by trees from the families Fagaceae and Lauraceae, with patches of cloud forests on mountain tops (Leong & Lim 2003). The annual rainfall was 3230 mm and the temperature was moderate, averaging around 22°C. The mild weather makes Fraser's Hill a popular tourist destination renowned for its diverse flora and fauna. Most impressive is its rich bird diversity with a record of 247 species and an additional 61 hypothetical species (Strange 2004). The sampling sites were along the streams within the Pusat Penyelidikan Bukit Fraser (PPBF) area and Sg. Jeriau from the entrance of the Sg. Jeriau Recreation Forest to the Sg. Jeriau waterfall. Sampling was conducted in 5 days, from 23-27 October 2016.

Sampling method

Frogs were sought with the naked eye with the aid of headlights in suitable microhabitats, such as along the banks of streams and trails, along the riverbanks of Sungai Jeriau near the Pusat Penyelidikan Bukit Fraser (PPBF) of Universiti Kebangsaan Malaysia. Specimens were caught by active sampling using hands and dip nets based on visual and audio cues. Measurements of the specimens were taken with a Mitutoyo digital calliper to the nearest 0.1 mm. Parameters measured were the snout-vent length (SVL), measured from the tip of the snout to the tip of the vent and tibia length (TL). At most, two voucher specimens were euthanised with Tricaine (Ethyl 3-aminobenzoate methanesulfonate salt), fixed in 10% formalin and transferred to 70% alcohol for storage. Colour photographs were taken and liver tissue was extracted and stored in 95% ethanol prior to preservation. Taxonomic nomenclature follows Frost et al. (2011). All specimens were deposited at the Zoology Museum, Universiti Kebangsaan Malaysia, Bangi, Selangor (UKMHC).

Data Analysis

PAST software (version 3.06) was used to calculate diversity measures, including Dominance index (D), Shannon diversity index (H'), and the Evenness index (E). Species accumulation curves were generated by the software EstimateS (version 9.1.0).

Results and Discussion

A total of 85 individuals from 12 species were found in this study, comprising five families: Dicroglossidae (48 individuals, 56%), which was the most abundant family, followed by Ranidae (19 individuals, 22%), Rhacophoridae (12 individuals, 14%), Bufonidae (3 individuals, 4%) and Megophryidae (3 individuals, 4%) (Table 1). Based on the last published accounts of the amphibians here, there is an addition of two anuran species, *Fejervarya limnocharis* and *Polypedates discantus*. The updated number of amphibian species is now 25 (Table 2).

Dicroglossidae, Ranidae and Rhacophoridae are represented by three species each, followed by Megophryidae with two species and Bufonidae with only one species. *Limnonectes blythii* was the most abundant species with 32 individuals, which accounted for 37.6% of the total number of captured individuals, followed by *Limnonectes deionodon* and *Amolops larutensis*, each with 15 individuals (17.6% respectively) and *Polypedates discantus* with 8 individuals (9.4%). Other species showed abundance ranging between 1.2% and 3.5%. Shannon's diversity index is 1.86, while Simpson's index is 0.78, reflected by the high evenness value of 0.5.

Table 1. Number (relative abundance is in percentage) of species and individuals of amphibians at Jeriau River in Fraser's Hill

No.	Family/Species	n	Rel. Abundance (%)	IUCN Status*
	Bufonidae	3	3.5	
1	*Phrynoidis asper*	3	3.5	LC
	Dicroglossidae	48	56.5	
2	*Fejervarya limnocharis*	1	1.2	LC
3	*Limnonectes blythii*	32	37.6	NT
4	*Limnonectes deinodon*	15	17.6	DD
	Megophryidae	3	3.5	
5	*Leptobrachella sola*	1	1.2	LC
6	*Megophrys longipes*	2	2.4	NT
	Ranidae	19	22.4	
7	*Amolops larutensis*	15	17.6	LC
8	*Odorrana hosii*	1	1.2	LC
9	*Pulchrana banjarana*	3	3.5	NT
	Rhacophoridae	12	14.1	
10	*Philautus petersi*	2	2.4	LC

11	*Polypedates discantus*	8	9.4	NA
12	*Polypedates leucomystax*	2	2.4	LC
	TOTAL	85	100	

* IUCN Red List Conservation Status 2020

Table 2. Checklist of the amphibians and reptiles of Fraser's Hill, Pahang.
Data source: 1= Leong & Lim (2003); 2= Norhayati et al. (2011), 3=Current study

	Taxa	Location	Data source
	AMPHIBIA		
	Ichthyophiidae		
1	*Ichthyophis* sp	Jeriau; The Gap: Bukit Telaga	1
	Bufonidae		
2	*Ansonia jeetsukumarani*		1, 2
3	*Phrynoidis aspera*	Semangko Pass; High Pines, Jeriau	1, 2, 3
	Dicroglossidae		
4	*Limnonectes blythii*	The Gap; Jeriau	1, 3
5	*Limnonectes deinodon*	Bishop's Trail; Sungai Hijau, Jeriau	1, 2, 3
6	*Limnonectes nitidus*	Jeriau	1
7	*Limnonectes plicatellus*		1
8	*Fejervarya limnocharis*	Jeriau	3
	Megophryidae		
9	*Leptobrachella sola*	The Gap, Jeriau	1, 3
10	*Megophrys nasuta*	Jeriau; Bishops Trail	1, 2
11	*Megophrys longipes*	Bishop's Trail; The Gap, Jeriau	1, 2, 3
	Microhylidae		
12	*Metaphrynella pollicaris*	Bishop's Trail; Ledgeham Road	1, 2
13	*Microhyla butleri*		1
	Ranidae		
14	*Amolops larutensis*	Jeriau	1, 2, 3
15	*Odorrana hosii*	Bishop's Trail; Sungai Hijau, Jeriau	1, 2, 3
16	*Pulchrana banjarana*	Jeriau	1, 2, 3
17	*Chalcorana labialis*	Sungai Hijau	2
18	*Abavorana luctuosa*	Jeriau	1
	Rhacophoridae		
19	*Philautus petersi*	Bishop's Trail, Jeriau	2, 3
20	*Philautus vermiculatus*		1
21	*Polypedates leucomystax*	Telecom's Loop; UKM Research Centre	1, 2, 3
22	*Polypedates discantus*	UKM Research Centre	3
23	*Rhacophorus bipunctatus*	Lady Maxwell Road; Valley Road	1, 2
24	*Zhangixalus prominanus*	Lady Maxwell Road; Jeriau; UKM Research Centre; Singapore House	1, 2
25	*Theloderma aspera*	Telecom's Loop; UKM Research Centre	1
	REPTILIA		
	Testudinidae		
1	*Manouria emys emys*	The Gap	1
2	*Manouria impressa*	Bishop's Trail	1
	Agamidae		
3	*Acanthosaura titiwangsaensis*	Pine Tree Trail	2
4	*Draco blandordii*	Semangko Pass	1

5	*Gonocephalus belli*	Semangko Pass	1
	Eublepharidae		
6	*Aeluroscalabotes felinus*	Jeriau	2
	Gekkonidae		
7	*Cnemaspis flavolineata*	The Gap	1
8	*Cyrtodactylus quadrivirgatus*	Bishop's Trail; Jeriau	1, 2
9	*Gehyra mutilata*	Telecom's Loop	1, 2
10	*Gekko monarchus*	Telecom's Loop	1
11	*Hemidactylus frenatus*		2
12	*Hemiphyllodactylus harterti*		1
13	*Ptychozoon kuhli*	The Gap	1
	Scincidae		
14	*Eutropis multifasciata*		1
15	*Larutia miodactyla*	Semangko Pass	1
16	*Larutia trifasciata*		1
17	*Lipinia vittigera*	The Gap resthouse	1
18	*Sphenomorphus bukitensis*		1
19	*Sphenomorphus indicus*		1
20	*Sphenomorphus praesignis*	Semangko Pass	1
21	*Sphenomorphus stellatus*		1
	Varanidae		
22	*Varanus dumerilii*		1
23	*Varanus rudicollis*		1
24	*Varanus salvator*		1
	Colubridae		
25	*Amphiesma inas*		1
26	*Asthenodipsas vertebralis*	Telecom's Loop	1
27	*Calamaria lowi*		1
28	*Calamaria lumbricoidea*		1
29	*Calamaria schlegeli*	The Gap; Road along Richmond House	1
30	*Collorhabdium williamsoni*		1
31	*Gongylosoma baliodeira*	The Gap	1
32	*Gonyosoma prasinum*	The Gap	1
33	*Lycodon butleri*	Telecom's Loop	1
34	*Macrocalamus lateralis*	Road along Richmond House	1
35	*Oligodon purpurascens*		1
36	*Orthriophis taeniurus*		1
37	*Psammodynastes pulverulentus*	High Pines Road; Road along UEP bungalow	1
38	*Pseudorabdion longiceps*		1
39	*Rhabdophis chrysargos*	Semangko Pass; Telecom's Loop; The Gap	1
40	*Sibynophis collaris*		1
	Elapidae		
41	*Calliophis gracilis*	The Gap	1
42	*Calliophis intestinalis*		1
	Viperidae		
43	*Ovophis monticola*		1

A few commensal species were found at the built area of the research centre, such as *Fejervarya limnocharis*, *P. discantus* and *P. leucomystax*. The most recent report on amphibians of Fraser's Hill by Norhayati et al. (2011) recorded 23 species, bringing the current number to 25 species. Out of all 12 species recorded in this study, three are listed as near threatened, namely *Limnonectes blythii*, *Megophrys longipes* and *Pulchrana banjarana*. For *P. banjarana* and *M. longipes*, the threat they currently face is their extent of occurrence is less than 20,000 km^2 with much of the habitats that they are in are declining in quality and extent, as well as habitat loss (Ming 2017). *Limnonectes blythii*, on the other hand, is declining in its extent and number due to overharvesting of the individuals for human consumption, not to mention the habitat loss due to forest clearance (van Dijk & Iskandar 2004).

Acknowledgements

We would like to acknowledge the logistics assistance provided by the management of Bukit Fraser Research Centre, especially Assoc. Prof. Dr. Tukimat Lihan, Assoc. Prof. Dr. Norela Sulaiman, and Mr. Mohd Afiq Aizat Juhari. This study is funded by LIV-2015-01.

References

Frost D. R. 2009. *Amphibian Species of the World: An Online Reference*. Version 5.3 (12 February 2009). American Museum of Natural History, New York, USA. Available from http://research.amnh.org/herpetology/amphibia/index.php.

Leong, T. M. & Lim, K. K. P. 2003. Herpetofaunal records from Fraser's Hill, peninsular Malaysia, with larval descriptions of *Limnonectes nitidus* and *Theloderma asperum* (Amphibia: Ranidae and Rhacophoridae). *The Raffles Bulletin of Zoology* 51: 123-136.

Ming, L. 2017. *Pulchrana banjarana*. (amended version published in 2004) The IUCN Red List of Threatened Species 2017: e.T58556A113804552.

Norhayati, A., Farah, A. D., Chan, K. O., Daicus, B. & Muin, M. A. 2011. An update of herpetofaunal records from Bukit Fraser, Pahang, Peninsular Malaysia. *Malaysian Applied Biology* 40(2): 9-17.

Smith, M. A. 1922. On a collection of reptiles and batrachians from the mountains of Pahang, Malay Peninsula. *Journal of the Federated Malay States Museums* 10: 263-282.

Strange, M. 2004. *Birds of Fraser's Hill. An Illustrated Guide and Checklist*. Nature's Niche Pte Ltd, Singapore.

van Dijk, P. P. & Iskandar, D. 2004. *Limnonectes blythii*. The IUCN Red List of Threatened Species 2004: e.T58329A11767558. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58329A11767558.en.

Wood, P. L., Grismer, L. L., Ahmad, N. & Senawi, J. 2008. Two new species of torrent-dwelling toads *Ansonia* Stoliczka, 1870 (Anura: Bufonidae) from Peninsular Malaysia. *Herpetologica* 64(3): 321-340.

ECOSYSTEM SERVICES

Summary of papers presented during the ecosystem services session:

ES01 – Root tensile characteristic and contribution of selected Pennisetum species on the shear strength of sandy soil
Ali Rahman, Z.*, Emhemed Ettbeb, A., Idris, W.M.R., Adam, J.H., Abd. Rahim, S., Ahmad Tarmidzi, S.N., & Lihan, T.

The tensile strength of *Penissetum polystachion* and its contribution on the soil shear strength of root-permeated soil have been established from this study. The faster and full vegetation coverage are found in the plot with fibre net facility rather than without fibre net. The selected species can be potentially adopted as biological material in hydroseeding options which can offer cheaper supply and maintenance.

ES02 – A document analysis of economic valuation studies on ecosystem services in Fraser's Hill Forest Complex
Abd Rahman, A.S., & Abdul Samad, A.R.*

It was found that there is still a lack of information on economic valuation studies in FHFC. FHFC's area provides many ecological services to the community but has yet to be valued. Thus, further economic valuation studies for FHFC are needed in the effort to highlight the magnitude of its net social benefit that can be enjoyed by the community.

ES03 – The richness and uniqueness of dragonflies and damselflies of Fraser's Hill as a treasure for ecotourism
Choong, C.Y.

This study has shown that Fraser's Hill has been a refuge for at least 45 species, and some of them are endemic to Peninsular Malaysia such as *Drepanosticta pan*, *Drepanosticta silenus*, *Calicnemia rectangulata*, *Coeliccia sameerae* and *Idionyx laidlawi*. Fraser's Hill is also a place to look for highland species such as *Orthetrum triangulare*, *Calicnemia chaseni* and *Ceriagrion fallax*. The diversity and uniqueness of Odonata fauna of Fraser's Hill has a good potential to be developed as a dragonfly watching ecotourism hotspot.

ES04 – Economic values of bird watching in Fraser's Hill
Shaari, N.F., & Abdul Samad, A.R.*

This study indicates that visitor's willingness to pay is RM8.99 per visitor per visit for improvements in Fraser's Hill especially for bird conservation and rehabilitation. The finding of this study may provide a guideline to Fraser's Hill management and to the policy makers to develop management policies that enhance the ecotourism contribution for conservation of bird habitats in Malaysia.

ES05 – Abiotic factors that influence the daily activities of stingless bee *Tetrigona apicalis* at Fraser's Hill Research Centre, Universiti Kebangsaan Malaysia
Sulaiman, N.*, Jauhari, M.A.A., Alias, H., Mamat, M.R., Mat Isa, M.N., & Hurairah, S.N.

This study has determined two abiotic factors that highly affect the movements of the stingless bees, *Tetrigona apicalis* in the highland which are temperature and light intensity. The factors influencing the flight intensity of bees are important for the meliponiculture farmers in identifying the suitable time for workers to manage the stingless bees besides their important role in the pollination process in the ecosystem.

ES06 – Nature therapy for learning disorder kid@UKM Fraser's Hill Research Centre
Mamat, M.R.*, Muhammad, A., Sulaiman, N., Jauhari, M.A.A., Alias, H., Johari, N.A., Mat Isa, M.N., Rodzli, N.A., Mohd Sohi, B.S., Wan Seman, W.K.I., Koon, M., & Tan, J.

This study has shown that the programme has made learning comfortable for children with learning disorders. This study concluded that learning among nature was helpful to this group of children with learning disorders as it had a therapeutic effect on them. This shows that nature therapy can improve young people's learning ability.

ES07 – Increasing visitor arrivals to Fraser's Hill via highland birdwatching and primate watching: A win-win approach with Genting Highlands
Chan, E.*, & Ang, P.

This study suggests promoting both locations as primary attractions for highland bird watching and primate watching and combining the advantages of an untouched bio-diverse site of Fraser's Hill and high visitor arrivals of Genting Highlands in a win-win situation. The bird and primate diversity in Fraser's Hill and Genting Highlands are undoubtedly abundant with easy accessibility to areas to sight birds and primates, making both sites an outstanding attraction to local and international birdwatchers and primate watchers as nature lovers. Visitors to one highland will add on and compliment the other highland to complete a good outing.

Extended abstracts for all the papers listed above:

ES 01

ROOT TENSILE CHARACTERISTIC AND CONTRIBUTION OF SELECTED PENNISETUM SPECIES ON THE SHEAR STRENGTH OF SANDY SOIL

Ali Rahman, Z.[1]*, Emhemed Ettbeb, A.[1], Idris, W.M.R.[1], Adam, J.H.[1], Abd. Rahim, S.[2], Ahmad Tarmidzi, S.N.[1], & Lihan, T.[1]
[1]Department of Earth Science and Environment, Faculty of Science and Technology
Universiti Kebangsaan Malaysia, 43600 Bangi MALAYSIA.
[2]Environmental Science Program, Faculty of Science and Natural Resources
Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu Sabah MALAYSIA
**Corresponding author email: zarah1970@ukm.edu.my*

Abstract

Soil is among earth's material that is associated with the natural process of erosion. Highly weathered soils generally are weak and can be eroded when barrenly open. Presence of vegetation cover can intercept rainfall runoff and bind soil particles which subsequently improve soil stability. The aim of this study is to study the use of *Penissetum polystachion* as a biological material in soil bioengineering for improving the soil shear strength of root-permeated sandy soil. Hydroseeding technique was applied on studied plots which were facilitated with and without fiber netting (product known as paddy straw blanket) as well as a control plot for reference. Routine observations of the species were made for six months before an experimental program was proceeded for tensile and soil shear strength tests. Root tensile tests exhibited a positive relationship between root tensile force and root diameter. Shear strength of soil was apparently affected by the plant roots as compared to that of soil without roots (control). Biomass content also agrees with soil water content, w_s , and contributes to the increase in shear strength parameters of cohesive and angle of friction for root-permeated soil. The results have suggested the potential application of this species for slope vegetation in improving the slope stability in soil-bioengineering schemes.

Keywords: erosion, Pennisetum, tensile, shear strength

Introduction

Soil erosion can happen even at flat and gentle slopes but at a slow rate, however, it can be extremely worse when the slope is openly barren, steep and exposed to heavy rainfall. The removal of slope vegetation is among the controlling factors that also contributes to slope instability (Gray & Sotir 1996). Soil strength due to weathering can be slowly weakened and minor surface erosion starts to happen. Gray & Ohashi (1983) stated that the climatic elements almost become a triggering factor to the problems associated with soil erosion. Several measures have been adopted to minimise surface erosion and slope stability. Soil-bioengineering techniques have successfully been adopted but it is also common to find this approach being combined with hard engineering (retaining wall, shotcrete, nailing and netting etc.). Vegetation can naturally manage slope erosions and bring benefits back to the soil environment through modification of soil bio-physical, chemical and mechanical properties and subsequently enriching the diversity and abundance of micro organisms (Stokes et al. 2014).

Plants such as Vetiver (*Vetiveria zizanioides*), Signal (*Brachiara decumbens*) and Bermuda (*Cynodon dactylon*) grasses have been successfully used for slope erosion and stability. Many native species available locally can be selected and examined for their potential application in soil-bioengineering schemes. Grass species of *Pennisetum polystachion* is well established in many countries in tropical regions (Bhattacharjee et al. 2007; Danano 2007). It can offer an affordable cost of supply and maintenance rather than depending on commercial products. Beside that, local species can be an added-value, economically cost-effective and can diversify with the current products available in the market. Objectives of this paper are to present the results of tensile resistance of roots and the soil shear strength root-permeated sandy soil of the selected species.

Materials and Methods

Plant, plot and hydroseeding

Grass species of *P.polystachion* (Linnaeus) Schultes was used in this study. Its common name is mission or foxtail grass and can grow up to 2 m height, initially introduced as a fodder grass. It is regarded as a dominant weed and enemy to agricultural plants. It reproduces from seed and can quickly invade a cultivated field.

Hydroseeding is a mixture of soil tackifier, seed, water, fertiliser and paper mulch. Hydroseeding slurry was manually sprayed on each plot. The plots were monitored for six months and were routinely watered twice a day. Plot study was prepared at Fraser Hill's Research Center (PPBF UKM) with an average slope angle of 40^o. It is underlain by the soil developed from weathering of granitic rocks. In this study, three types of plots were applied, namely control plot (CP), plot with fiber netting (paddy straw blanket; WFP) and plot without fiber netting (NFP). Each plot was built with sand bricks of 500 cm x 200 cm x 30 cm dimension.

Vegetation coverage

Each plot was divided into 10 grids each measuring 1 m^2. Each month, the vegetation coverage area was monitored by measuring the boundary of successful growth of the studied species over the total area of the plot. Measurement was carried out by a universal tape meter.

Root tensile and soil strength tests

The plants from each plot were carefully dug out and washed to remove the dirt. A vernier caliper was used to measure the root diameter. Ten cm length of root was cut and weighed. End root was clamped into the entire wedge grip length and was pulled vertically at a rate of 5mm/min. Tensile force at rupture is taken as peak load (F_{max}). Root diameter was measured after the test at several points close to the point of ruptures. For shear strength test, a box sample was dug out carefully from the ground using a metal knife with dimensions of 200 mm x 200 mm x 100 mm and wrapped to maintain its moisture content. A sample of 60 mm x 60 mm x 25 mm was trimmed from the box sample and fitted into the brass box of direct shear box equipment. Sample was horizontally sheared at a strain rate of 1.2 mm/min. Three samples were tested, and each was sheared under applied normal loads, σ_n of 10, 20 and 30 kPa (British Standard Institution 1990).

Results and Discussion

Vegetation cover

Vegetation cover measurement was performed every month for up to six months. The results of this observation is shown in Figure 1. As expected, control plot (CP) was empty as this plot was left barren without hydro-seeding. The WFP plot showed higher vegetation coverage compared to NFP plot. At an early stage, a similar trend was found and vegetation coverage for NFP managed to reach 95%. The use of fiber net to the plot can produce successful growth of the studied species at a faster rate if compared to plot with no fiber net.

Root tensile resistance

Forty-eight root samples had been uprooted carefully and cleaned before the samples were prepared for the test. The diameters of the root ranged between 0.19 and 0.49 mm with an average of 0.36 ± 0.08 mm. The tensile force values ranged between 2.10 N and 9.98 N with an average of 5.35 ± 1.94 (Table 1).

Table 1. Root diameter and tensile force values for of the studied species

Root Diameter, d (mm)			Tensile force, T_f (N)		
Minimum	Maximum	Mean	Minimum	Maximum	Average
0.19	0.49	0.36 ± 0.08	2.10	9.98	5.35±1.94

The relationship between root tensile force and root diameter is shown in Figure 2. This relationship can be best represented by a power law equation to encompass the scattered values of the tensile force and diameter (Eq.4).

$$T_f = 22.79 d^{1.448} \quad R^2=0.8018 \qquad \text{Eq.4}$$

This study indicated that the higher the root tensile force which reflects its tensile strength towards better resistance to tensional force when slope experiencing soil movement (Stokes et al. 2009).

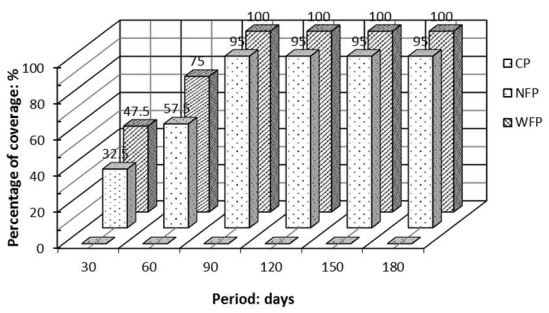


Figure 1. Vegetation coverage of the studied species over six months period

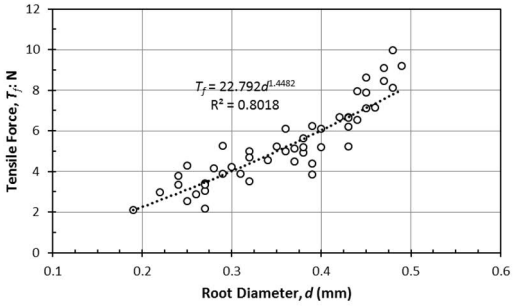


Figure 2. A positive relationship of tensile force against root diameter.

Soil shear strength

The shear strength parameter, biomass and water content for different plots are shown in Table 2. The peak stresses for each type of plot increase as the applied normal stresses were increased. For comparison, at equivalent applied normal stress of 20 kPa, the peak values are 13.4 kPa, 16.8 kPa and 17.6 kPa for CP, NFP and WFP plots, respectively. A similar trend was observed for internal friction angle, (and cohesive, *c* values. Biomass content in NFP was found to be less than WFP plot. It is clearly seen that root-permeated soils have improved the shear strength parameters and soil moisture contents. Roots were responsible for minor re-arrangement of soil particles and cross-bridging to create additional binding (Ali & Osman 2008; Veylon et al. 2015). Sandy soil has very little cohesion and resistance effectively comes from friction due to interaction between particles. Installation of fiber netting has significantly increased the soil moisture content (Table 2). Coupling effect of fiber net and root biomass has attributed to the improvement of moisture content of soil.

Table 2. Shear strength parameters, biomass, and water content

Treatments	Normal pressure (kPa)	Peak shear stress (kPa)	Internal friction angle ((º)	Cohesion value *c* (kPa)	Average Biomass (g)	Mean water content. w_s (%)
CP	10	8.1	30.4	2.04	n.a*	20.5
	20	13.4				
	30	19.8				
NFP	10	11.5	35.6	3.72	0.59	23.7
	20	16.8				
	30	25.8				
WFP	10	12.6	36.3	4.44	1.14	43.4
	20	17.6				
	30	27.3				

*n.a = not available (no plant)

Conclusions

The tensile strength of *Penissetum polystachion* and its contribution on the soil shear strength of root-permeated soil have been established from this study. A positive relationship between tensile force and root diameter can be best presented in a power law equation with minor scatteredness of the data variation (R^2=0.8018). The installation of fiber net has improved the shear strength parameters, biomass and moisture content of soil. The faster and full vegetation coverage found in plot with fiber net facility rather than without fiber net. The selected species can be potentially adopted as biological material in hydroseeding options which can offer cheaper supply and maintenance.

Acknowledgements

The authors would like to thank UKM for the financial support through research grant GUP-2016-068. Thank also given to the laboratory assistant staffs of Civil Engineering, Faculty of Engineering and Architecture and

FORCE, Department of Applied Physic, FST, UKM for assisting the mechanical testing of root tensile and direct shear box tests.

References

Ali, F. H. & Osman, N. 2008. Shear strength of a soil containing vegetation roots. *Soils and Foundations* 48(4): 587-596

Bhattacharjee, R., Khairwal, I.S., Bramel, P.J. & Reddy, K.N. 2007. Establishment of a pearl millet [*Pennisetum glaucum* (L.) R. Br.] core collection based on geographical distribution and quantitative traits. *Euphytica* 155: 35-45

British Standard Institution 1990. *Methods of test for soil for civil engineering purposes - Part 7: Shear Strength Tests (Total Stress)*. BS1377, London, pp. 62

Danano, D. 2007. Improved Grazing Land Management: Ethipia. In Liniger, H. & Critchley, W. (eds.), *Where the Land is Greener* (pp 313-316). Bern, Switzerland: WOCAT

Gray, D.H., & Ohashi, H. 1983. Mechanics of fiber reinforcing in sand. *Journal of Geotechnical Engineering Division, ASCE* 109(3): 335-353.

Gray, D. H. & Sotir, R. 1996. *Biotechnical and Soil Bioengineering Slope Stabilization*. John Wiley & Sons, New York.

Stokes, A., Atger, C., Bengough, A.G., Fourcaud, T. & Sidle, R.C. 2009. Desirable plant root traits for protecting natural and engineered slopes against landslides. *Plant and Soil* 324(1-2): 1–30.

Stokes, A., Douglas, G.B., Fourcaud, T., Giadrossich, F., Gillies,C., Hubble, T., Kim, J.H., Loades, K.W., Mao, Z., McIvor, I.R.,Mickovski, S.B., Mitchell, S., Osman, N., Phillips, C., Poesen,J., Polster, D., Preti, F., Raymond, P., Rey, F., Schwarz, M. & Walker, L.R. 2014. Ecological mitigation of hillslope instability: Ten key issues facing researchers and practitioners. *Plant and Soil* 377(1–2): 1–23.

Veylon, G., Ghestem, M., Stokes, A. & Bernard, A. 2015. Quantification of mechanical and hydric components of soil reinforcement by plant roots. *Canadian Geotechnical Journal* 52(11):1-11.

ES 02

A DOCUMENT ANALYSIS OF ECONOMIC VALUATION STUDIES ON ECOSYSTEM SERVICES IN FRASER'S HILL FOREST COMPLEX

Abd Rahman, A.S., & Abdul Samad, A.R.*
Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia.
**Corresponding author email: abdrahim_as@upm.edu.my*

Abstract

The present paper has applied the document analysis method to interpret and review past studies on the economic and environmental valuation of Fraser's Hill Forest Complex (FHFC), and to review the potential establishment of FHFC into a State Park. Fraser's Hill is renowned as a recreational and educational destination as it is situated in the Raub District of Pahang, where three states border across the Titiwangsa Range. The cool climate of certain areas in FHFC is similar to Cameron Highlands which is a conducive climate for tropical highland tourism. However, the threat of commercial development activities that disrupt the ecosystem of the forests within FHFC has alerted many bodies, including international organisations such as, the World Wildlife Fund for Nature (WWF). These bodies represent the public's voice concerning the conservation of nature and preservation of the biodiversity of forests' ecosystems. The main objectives of this study are to review and to bridge the gap of past studies on ecosystem services valuation in FHFC and to venture into establishing FHFC into a State Park. This study is based on past researches related to Fraser's Hill whereby a comprehensive analysis was carried out to ensure all potential ecosystem services provided by FHFC can be valued. A total of 29 journal articles and eight non-journal articles comprising issues related to FHFC were scrutinised. The inputs extracted were analysed thoroughly and tabled into sampling documents and data analysis. It was found that many types of ecosystem services have not yet been valued in terms of monetary worth. This is required in the calculation of the total economic value of FHFC in the analysis of the feasibility to convert FHFC into a State Park. The findings of this study will demonstrate potential significant types of ecological services and will highlight the needs for a thorough economic evaluation study to assess the prospective for FHFC to become a unique State Park.

Keywords: document analysis, Fraser's Hill, state park, conservation, ecotourism

Introduction

Waterfalls, wildlife, bird population and the beauty of flora are among the natural beauties that are available in Malaysia. These have always been the main attractions for tourists to enjoy and appreciate the natural beauty which FHFC possesses. FHFC is an area located in Raub District of Pahang which consists of six forest reserves. The area has been subjected to environmental concerns which is mainly related to land development and other human causes. Therefore, the status of the forest reserves in FHFC were suggested to be reviewed and gazetted as a State Park. A State Park is part of the Forest Eco Park initiatives in Malaysia which is in line with the National Forestry Policy 1978. There are a number of differences in the management system, as well as the regulations to adhere to under State Park. The main differences are closely related to the aim of the establishment of the park itself. A State Park focuses not only on the preservation of the forests' biodiversity, but also on the extraction of the benefits of its existence whilst managing the State Park's sustainability factor. However, the idea of realising a self-sustaining model for the conservation of forest areas is dependent on the ecotourism industry, a growing industry that is bound to the forces of market supply and demand. Hence, to establish a State Park, a thorough evaluation is needed as the market for ecotourism is also subjugated by the threats of competitions, consumers' preferences and all the risks involved in the process. The study area, which is 75km away from the capital city of Kuala Lumpur and 400km away from Singapore in the south, has good connectivity to the cities. This study area, FHFC, is already well known as a popular holiday retreat with multiple highland tourist resorts located along the southern Titiwangsa Range, covered with lush rainforest and green valleys. Thus, one way to realise and evaluate its potential as a public goods and to quantify the potential of FHFC to become a State Park, is to run a comprehensive economic valuation process that includes the utmost important components, namely the Socioeconomic Impact Analysis, the Total Economic Valuation and the Cost-benefit Analysis. Consequently, the objectives of this study are to review and bridge the gap of past studies on ecosystem services valuation in FHFC, and to evaluate the feasibility of establishing FHFC as a State Park, using Document Analysis Method.

Materials and Methods

The Application of Document Analysis

Document collection process has managed to gather 29 journal articles and 8 non-journal articles to be further studied and their contents scrutinised. Then, the information from the documents were interpreted through the initial processes of document analysis. This involved skimming, reading, and interpreting the themes suggested by the contents of the journals studied. The method of thematic analysis was used to obtain better quality results.

Document Analysis

The Document Analysis method is an effective complement to other research studies and has relevance on its own as a stand-alone method (Glenn., A. B., 2017). This is because it relies on a robust data collection and documentation of research procedures. It is a practice in document analysis to include detailed descriptions on how the study was designed and executed in the report section of the research paper.

Thematic Analysis

With reference to The Economics of Ecosystem and Biodiversity (TEEB) classification framework of the components of ecosystem services, the codes to be generated in the Thematic Analysis were replaced with respect to the framework given in TEEB. Thematic Analysis is a method used to analyse qualitative data. Frequently, this method is applied to a set of texts, such as, interview transcripts. Information will be carefully examined and interpreted into common themes – topics, ideas and patterns of meanings that come up repeatedly (Caulfield, J., 2019). There are various approaches to conducting Thematic Analysis, but the most common form follows a six-step process to generate relevant themes and codes to be used as an instrument to analyse the collected literature. Considering that the established TEEB model has all the relevant variables to reflect the value of ecosystem services involved, the framework of analysing documents was structured based on this model.

The Economics of Ecosystem and Biodiversity Context

TEEB model is an international initiative to draw attention to the benefits of biodiversity. It focuses on the values of biodiversity, the growing costs of biodiversity loss and ecosystem degradation, and the benefits of actions addressing these pressures. This model draws together expertise from across the fields of science, economics, and policy to enable practical actions to be developed and implemented. TEEB initiatives have brought together over five hundred authors, reviewers and case studies from across the continents on the values of biodiversity by looking at the flow of ecosystems. Ecosystem services benefit people, society and the economy from the resources received from nature. Examples of these benefits include water provision and purification, flood and storm control, carbon storage and climate regulation, food and materials provision, scientific knowledge, recreation and tourism (MA, 2005a; TEEB, 2010; TEEB, 2011; see also Chapter 2). TEEB initiatives have demonstrated the usefulness of presenting evidence on the values of nature and targeting the messages to different audiences. Understanding and communicating the economic, social and cultural value of ecosystem services (many of which nature provides for “free”) are crucial in fostering better management, conservation and restoration practices.

Analysing Thematic Analysis

At this stage, relevant documents from the e-library of University Putra Malaysia were assessed from an online platform. The foundation of this study is based on the 29 journal articles and eight non-journal articles that are relevant to the topic of economic valuation on ecosystem services in FHFC. As Bowen (2017) argued, researchers should prioritise content quality of the documents according to the framework of the project rather than depend on the quantity of documents gathered.

The process of analysing the documents involved skimming through the contents and reading the documents to obtain all significant data or information. The analysed documents were categorised according to the relevance of contents in the context of FHFC State Park establishment. The documents were sorted out according to its contents, namely, the location of the study site, land-status of the study site and the types of research. The ideal location searched for was Fraser’s Hill or the area along Raub District. Valuable information on FHFC was identified and extracted to be further analysed. Relevant journal articles and non-journal articles on locations outside the study site were also important to the research study as the data and

information on the ecosystem services available provided can be utilised as well, especially in the case of Cameron Highlands and other State Parks in Malaysia.

Results and Discussion

Assessment of FHFC as a State Park

The feasibility of FHFC to be gazetted as a State Park was assessed and its sustainability was compared to other State Parks of its size. The distance of FHFC to Kuala Lumpur is deemed to be the most advantageous as travellers, regardless of origin, have easy access to the place. The surrounding local residents of Raub District and the Fraser's Hill township, which are situated outside the boundaries of FHFC and within FHFC boundaries respectively, are folks who have been catering to tourists for decades. Fraser's Hill town is already a highland destination to begin with, thus, gives key opportunities for FHFC to establish itself as an eco-tourism destination with its own unique identity in Malaysia. The dense forest of FHFC is where many species of flora and fauna are found, which include endemic species; some of the world's endangered animal species; formation of hilly mountain terrains; and different dipterocarp forests at different altitudes.

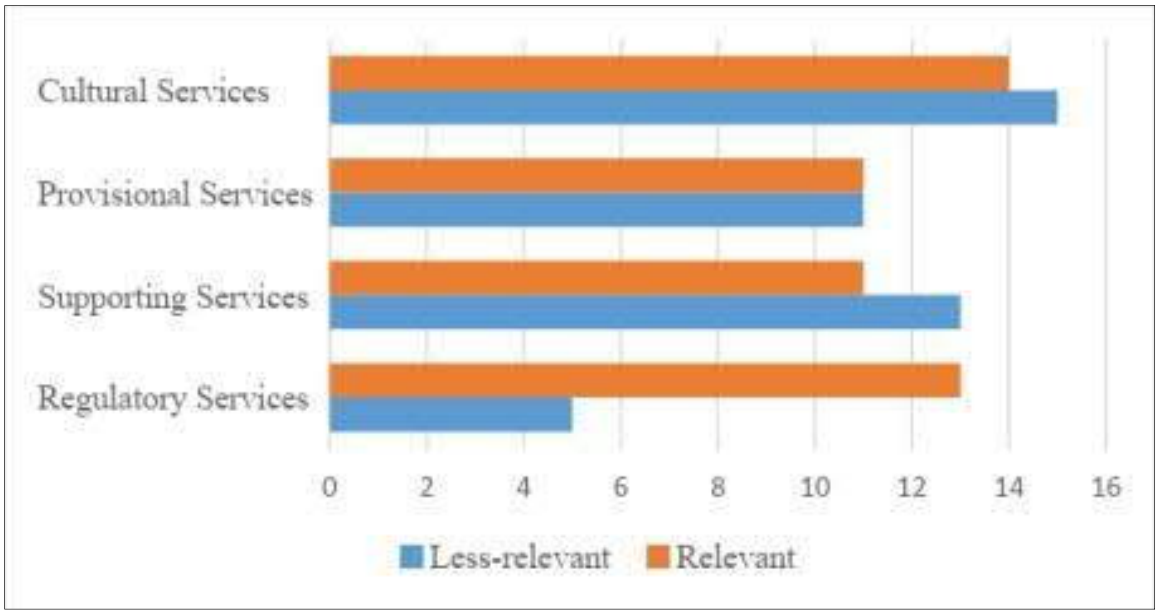


Figure 1. Thematic Analysis of Selected Documents

Thematic Analysis Results

From the thematic analysis, the different types of ecological services were identified from the gathered journals and non-journal articles (Figure 1). Relevance of the documents were segregated based on the correlation of its contents to the coded themes in the context of TEEB. There are at least 11 relevant documents for each sub-service to serve as reference for future economic valuation studies in FHFC. Most of the literatures gathered were relevant and included the ecosystem services that the area has. The information gathered from the literatures were selectively collated to respond to the diverse types of field of journal and non-journal articles which frequently contain irrelevant information for our current economic valuation studies. There were also vivid expressions of concerns towards the future of FHFC as a conserved area from multiple authors of the documents gathered. The discontentments were mostly related to the threat of rapid development of areas outside the boundaries of FHFC, including the cultivation of durian orchards and previous plans to develop Fraser's Hill virgin forest.

Figure 2. Identified Economic Valuation Methods

It was found that there is still a lack of information on economic valuation studies in FHFC. A detailed estimation of the monetary values of the ecosystem services provided by FHFC is still lacking as compared to other State Parks (Figure 2). The two economic valuation journal articles that were done in Fraser's Hill had a selective sample group and did not include comprehensive information to compute the overall value of the ecological services for FHFC.

Conclusion

Due to its strategic location, FHFC has the potential to become a state park. It has its own uniqueness as compared to other State Parks of its size. FHFC's area provides many ecological services to the community but has yet to be valued. Thus, further economic valuation studies for FHFC are needed in the effort to highlight the magnitude of its net social benefit that can be enjoyed by the community.

Acknowledgements

We would like to express our utmost gratitude to WWF Malaysia for their full support in our research project. Our project will not be as meaningful as it is today without the passion and commitment that WWF-Malaysia has shown. The team also appreciates the researchers of the FHFC area who have been involved in the hope for more secure and sustainable ecological services in FHFC to be conserved.

References

Abdullah, M.P., Khalik, W.M.A.W.M., & Idris, M.I. 2015. Water Quality of the Raub-Fraser's Hill Corridor. *Proceeding SESKORFRA*, 104-108.

Adam, J.H., Ming, L.K., Juhari, M.A.A., Jalaludin, M.A., Idris, W.M.R., Othman, A.R., & Tarmidzi, S.N.A. 2011. Cluster analysis of submontane forest along western slope of Frasers' Hill Research Centre in Raub District, Malaysia. *Bangladesh Journal of Botany*, 40(2), 121-132.

Akhter, S. 2014. *Economic Valuation of Eco-Tourism Resources in Pulau Perhentian Marine Park, Malaysia*.

Bann, C. 1999. *A contingent valuation of the mangroves of Benut, Johor State, Malaysia*. Johor State Forestry Department, 87pp.

Cheong, C. 2013. *Fraser's Hill-A Lush Highland Hideaway*. WWF-Malaysia, Petaling Jaya.

Chooi, Y.S., Cheong, Y.L., Tan, P.E., and Lau, W.H. 2014. Checklist of Spiders in Fraser's Hill Wildlife Reserve, Selangor. Malaysia. *Journal of Wildlife and Parks*, 27, pp.65-70.

Hassin, N.H., Muhamad Noor, A.N., Mungkar, A.N., Hasnil, H.U., Abdul Rahman, N.H., Abas, M.A., & Abdul Karim, M.F. 2019. A pilot study for sustainable ecotourism at Gunong Stong State Park, Kelantan using Visitor Experience and Resource Protection (VERP) management framework. *Journal of Tropical Resources and Sustainable Sciences*, 7(1), 40-46.

Herman, S.M.A., Nur, A.C.M., Ahmad, S., & Ramachandran, S. 2014. Willingness to pay for highland's agro-tourism recreational facility: A Case of Boh Tea Plantation, Cameron Highlands, Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 19, No. 012009, pp. 1755-1315).

Herman, S., Shuib, A., Ramachandran, S., Mohd Rusli, Y., & Richards, A.L.D.R.I.C.H. 2012. The need for recreational economic valuation at Perlis State Park. *The Malaysian Forester*, 75(1), 73-80.

Jamilah, O., Emira, A.N., & Fatin, R.N. *Can scenic indicators help in sustaining healthy ecosystems of Fraser's Hill?*

Jayaraj, V.K., Daud, S.H.M., Azhar, M.I., Sah, S.A.M., Mokhtar, S.I., & Abdullah, M.T. 2013. Diversity and conservation status of mammals in Wang Kelian state Park, Perlis, Malaysia. *Checklist*, 9(6), 1439-1448.

Kanniah, K.D., Tan, K.P., Cracknell, A.P., Huete, A.R., Idris, N.H., Lau, A.M.S., & Ahmad, A. 2018. Assessment of biophysical properties of Royal Belum tropical forest, Malaysia. *Singapore Journal of Tropical Geography*, 39(1), 90-106.

Kiew, R. 1992. *The Conservation Status of Plants at Fraser's Hill with Recommendations for Their Conservation*. Department of Biology, Universiti Pertanian Malaysia.

Misni, A., Rasam, A.R.A., & Buyadi, S.N.A. 2017. Spatial analysis of habitat conservation for hornbills: A case study of Royal Belum-Temengor forest complex in Perak State Park, Malaysia. *Pertanika Journal of Social Science and Humanities*, 25, 11-20.

Nordin, F.A. 2012. *Orchid Flora of Fraser's Hill, Malaysia* (Doctoral Dissertation, Universiti Putra Malaysia).

Osman, M.H. 2009. Experience in stabilisation of rock slopes in Pahang. *Esteem Academic Journal*, 5(1), 161-174.

Othman, J. 2015. Assessing scenic beauty of nature-based landscapes of Fraser's Hill. *Procedia Environmental Sciences*, 30, 115-120.

Pek, C.K., Tee, C.H., & Ng, P.Y. 2010. Hill recreational and services valuation: a case study of Taman Melawati Hill. *Sunway Academic Journal*, 7, 33-47.

Puan, C.L. 2005. *Environmental attitudes and willingness to pay for highland conservation: the case of Fraser's Hill, Malaysia*. Unpublished Master's Thesis, Universiti Putra Malaysia, Selangor.

Puan, C.L., Zakaria, M., Ghani, A.N.A., & Mohd, A. 2005. Contingent Valuation of a Malaysian Highland Forest: Non—market Benefits Accrued to Local Residents. *Journal of Applied Sciences*, 5(5), 916-919.

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., & Davidson, N. 2013. The economics of ecosystems and biodiversity for water and wetlands. *IEEP, London and Brussels*, 78.

Sarguna, DS., Tharshini, A., Zaza Amirah, Z.A., Nik Mohd Maseri, N.M., & Zulhazman, H. 2017. Assessment on Local Community Perception of Gunung Stong State Park and its Role in Income from Sustainable Tourism. *J. Trop. Resour. Sustain. Sci*, 5, 89-92.

Schwabe, K.A., Carson, R.T., DeShazo, J.R., Potts, M.D., Reese, A.N., & Vincent, J.R. 2015. Creation of Malaysia's Royal Belum State Park: a case study of conservation in a developing country. *The Journal of Environment & Development*, 24(1), 54-81.

Sharif, A. 2019. *Govt forms RCI to probe Wang Kelian mass graves*. New Straits Times. Retrieved from https://www.nst.com.my/

Solikin, A., Rahman, R.A., Saefrudin, E., Suboh, N., Zahari, N.H., & Wahyudi, E. 2019. Forest Valuation Using Travel Cost Method (TCM): Cases of Pahang National Park and Srengseng Jakarta Urban Forest. *Planning Malaysia*, 17(9).

Suhaimi, S., Zakaria, A., Sulaiman, A., Yaakob, M.Z.M., Juhary, M.A.A., & Sulaiman, N. 2018. Species diversity and abundance of butterfly (Lepidoptera: Rhopalocera) at different altitudes along the Raub Corridor to Fraser's Hill, Pahang, Malaysia. *Serangga*, 22(1).

Suhaimi, S., Zakaria, A., Sulaiman, A., Yaakob, M.Z.M., Juhary, M.A.A. and Sulaiman, N. 2018. Species diversity and abundance of butterflies (Lepidoptera: Rhopalocera) at different altitudes along the Raub Corridor to Fraser's Hill, Pahang, Malaysia. *Serangga*, 22(1).

Tan, M.K., & Kamaruddin, K.N. 2014. *Orthoptera of Fraser's Hill, Peninsular Malaysia*. Lee Kong Chian Natural History Museum, National University of Singapore, Singapore.

Yacob, M.R., Radam, A., Shuib, A., Samarahan, K., & Sarawak, M. 2009. A contingent valuation study of marine parks ecotourism: The case of Pulau Payar and Pulau Redang in Malaysia. *Journal of Sustainable Development*, 2(2), 95-105.

ES 03

THE RICHNESS AND UNIQUENESS OF DRAGONFLIES AND DAMSELFLIES OF FRASER'S HILL AS A TREASURE FOR ECOTOURISM

Choong, C.Y.
Centre for Insect Systematics, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor
Corresponding author email: cychoong@ukm.edu.my

Abstract

Dragonflies and damselflies collectively known as Odonata are a group of aesthetic insects, normally found at freshwater habitats. Their vibrant colour and fascinating behaviour have drawn the attention of naturalists. Dragonfly watching is a rapidly growing hobby among many naturalists. With the presence of various aquatic habitats and ease of accessibility, Taman Eko Rimba Jeriau can be a good location for dragonfly watching at Fraser's Hill. Peninsular Malaysia is one of the geographic regions rich in Odonata fauna. More than 250 species have been known to occur in Peninsular Malaysia. Fraser's Hill is a refuge for at least 45 species, and some of them are endemic to Peninsular Malaysia such as *Drepanosticta pan*, *Drepanosticta silenus*, *Calicnemia rectangulata*, *Coeliccia sameerae* and *Idionyx laidlawi*. These species are particularly of interest for dragonfly watchers. Fraser's Hill is also a place to look for highland species such as *Orthetrum triangulare*, *Calicnemia chaseni* and *Ceriagrion fallax*. The diversity and uniqueness of Odonata fauna of Fraser's Hill has a good potential to be developed as a dragonfly watching ecotourism hotspot.

Keywords: biodiversity, dragonfly watching, endemic, highland, insects

Introduction

Dragonflies and damselflies, collectively known as dragonflies by laymen, are a group of aesthetic insects in the insect order Odonata. The word Odonata is of Greek origin meaning tooth. They are a group of easily recognised insects with a pair of large compound eyes, extremely short antennae, two pairs of membranous net-veined wings (sometimes in colour) and a slender body. Odonata is an important biotic component for aquatic ecosystems. It is categorised as an aquatic insect because its larval stage is aquatic. Small rivers, forest streams, lakes, ponds, swamps, marshes and waterfalls are some of the aquatic habitats where dragonflies are easily found. Both the adult and larval insects are excellent predators, mainly predating on other insects.

Close to 6,000 Odonata species are widely distributed throughout the world (Dijkstra et al. 2013). More than 400 species can be found within Malaysia, with Peninsular Malaysia containing more than 250 species (Choong et al. 2017a). This shows that Malaysia is rich in Odonata fauna, which may render a good potential for dragonfly watching. Dragonfly watching is popular in North America, Europe and Australia (Lemlin 2009), and it is a rapidly growing hobby in Asia. Dragonfly watching in Malaysia is still considered new for the large populace, however, it is gaining more and more attention from naturalists. Fraser's Hill is a highland resort attracting both local and foreign tourists with its unique dragonfly fauna. The potential of dragonfly watching as an ecotourism product for Fraser's Hill is discussed in this paper.

Odonata of Fraser's Hill

Among all the states in Peninsular Malaysia, Pahang state is quite well studied for its Odonata fauna. Published Odonata records of Pahang in recent years include Tasik Bera (Norma-Rashid et al. 2001; Choong et al. 2016); Tasik Chini (Fadilawati et al. 2008); Cameron Highlands (Ng et al. 2011); Sungai Bebar (Dow et al. 2012); Kuala Tahan (Ng et al. 2012); Krau Wildlife Reserve (Choong 2014); and Tioman Island (Choong et al. 2017b).

The highlands of Fraser's Hill is part of the Titiwangsa mountain range, located at the western part of Pahang state. Fraser's Hill has been one of the hotspots for Odonata study since the colonial times. The Odonata records of Fraser's Hill are scattered in various publications (Laidlaw 1934; Kemp & Kemp, 1989; Kalkman 2004; Ng & Choong 2010; Norma-Rashid 2010; Choong 2015). Choong (2020) has compiled all the published records of Odonata in Fraser's Hill totaling 45 species – 23 are damselfly species and 22 are dragonfly species. This represents 18% of the species in Peninsular Malaysia. Some of the interesting species in Fraser's Hill are

shown in Table 1. *Drepanosticta pan*, *Drepanosticta silenus*, *Calicnemia rectangulata*, *Coeliccia sameerae* and *Idionyx laidlawi* are endemic to Peninsular Malaysia, and most of them happened to be highland species. These species are particularly of interest for enthusiasts from overseas. Other highland species such as *Orthetrum triangulare*, *Calicnemia chaseni* and *Ceriagrion fallax* are normally not common species. These highland and endemic species are of interest for dragonfly watching.

Table 1. Interesting Odonata species from Fraser's Hill

Species	IUCN status	Remarks
Damselflies		
Calicnemia chaseni	LC	Highland species
Calicnemia rectangulata	NA	Highland species; Endemic to Peninsular Malaysia
Ceriagrion fallax	LC	Highland species
Coeliccia sameerae	NA	Endemic to Peninsular Malaysia
Drepanosticta pan	DD	Highland species; endemic to Peninsular Malaysia
Drepanosticta silenus	DD	Highland species; endemic to Peninsular Malaysia
Dragonflies		
Idionyx laidlawi	NA	Only known from Fraser's Hill
Orthetrum triangulare	LC	Highland species

IUCN status: LC=Least Concern, DD=Data Deficiency and NA=No Assessment.

Dragonfly Watching in Fraser's Hill

Bird watching is an established ecotourism activity in Fraser's Hill. The activity of dragonfly watching is not much different from bird watching, and it is a rapidly growing hobby among many naturalists in Malaysia. Fraser's Hill is rich in Odonata fauna with at least 45 species being known to occur there, and a good number of them are endemic and strictly highland species (Table 1). Various aquatic habitats such as waterfalls, forest streams, drainages and ponds are found in Fraser's Hill (Figure 1), and many of them are easily accessed by road. Taman Eko Rimba Jeriau is located within Fraser's Hill where the main freshwater bodies are found. The beautiful Jeriau Waterfall and forest streams located within Taman Eko Rimba Jeriau is accessible by a well-managed walkway. With these advantages, Fraser's Hill has a good potential to be developed for dragonfly watching and potentially to be on par with the well-known bird watching activity there.


Figure 1. Some of the aquatic habitats in Fraser's Hill.

Conclusion

The rich and unique Odonata fauna and the accessibility of various aquatic habitats such as waterfalls and forest streams, have made Fraser's Hill a potential site for dragonfly watching, particularly at Taman Eko Rimba Jeriau.

Acknowledgements

The author thanks Pusat Penyelidikan Bukit Fraser for providing logistics during the study of Odonata diversity in Fraser's Hill at various occasions.

References

Fadilawati, A., Choong, C.Y., Ng, Y.F. & Zainal Abidin, A.H. 2008. Kepelbagaian pepatung (Odonata) di kawasan Tasik Chini Pahang, Malaysia. *Proceedings of the 10th MSAB Symposium*, pp. 809–813.

Choong, C.Y. 2014. Odonata (Insecta) fauna of Krau Wildlife Reserve, Pahang, Malaysia. *Journal of Wildlife and Parks* 28: 73–80.

Choong, C.Y. 2015. Odonata (Insecta) fauna of Fraser's Hill, Peninsular Malaysia. *Prosiding SESKORFRA 2015*, pp. 70–74.

Choong, C.Y. 2020. Kepelbagaian Odonata (Insecta) di Bukit Fraser, Pahang. In: Sulaiman, N., Aizat Juhari, M.A. & Mohd Akhairi, M.A. (eds.). *Bukit Fraser – Kepelbagaian Biologi dan Persekitaran Fizikal*, pp. 149–155.

Choong, C.Y., Alwen, B.M., Izzat Husna, M. & Amirrudin, B.A. 2017b. Odonata fauna of Tioman Island, Pahang, Peninsular Malaysia. *Journal of Wildlife and Parks* 32: 31–40.

Choong, C.Y., Izzat-Husna, M. & Amirrudin, B.A. 2016. Odonata (Insecta) fauna of Tasek Bera Ramsar Site, Pahang, Peninsular Malaysia. *Journal of Wildlife and Parks* 31: 39–48.

Choong, C.Y., Yasser, M.A. & Nurfarhana, H.H. 2017a. *Ancient Creatures: Dragonflies and Damselflies of Malaysia*. Ministry of Natural Resources and Environment, Putrajaya, Malaysia. 115 p.

Dijkstra, K-D.B., Bechly, G., Bybee, S.M., Dow, R.A., Dumont, H.J., Fleck, G., Garrison, R.W., Hamalainen, M., Kalkman, V.J., Karube, H., May, M.L., Orr, A.G., Paulson, D.R., Rehn, A.C., Theischinger, G.,

Trueman, J.W.H., van Tol, J., von Ellenrieder, N. & Ware, J. 2013. The classification and diversity of dragonflies and damselflies (Odonata). *Zootaxa* 3703(1): 36–45.

Dow, R.A., Ng, Y.F. & Choong, C.Y. 2012. Odonata of Sungai Bebar, Pahang, Malaysia, with four species recorded for the first time from mainland Asia. *Journal of Threatened Taxa* 4(3): 2417–2426.

Kalkman, V. 2004. From cool hill resorts to humid rainforest: an odonatological trip to Peninsular Malaysia (July 2002). Echo. *Agrion* 8(2): 26–28.

Kemp, R.G. & Kemp, G.S. 1989. Some dragonfly records from the states of Pahang and Perak, West Malaysia. *Notulae odonatologicae* 3(3): 37–48.

Laidlaw, F.F. 1934. A note on the dragonfly fauna (Odonata) of Mount Kinabalu and of some other mountain areas of Malaysia, with a description of some new or little known species. *Journal of the Federated Malay States Museums* 17: 549–561.

Lemelin, H. 2009. Goodwill hunting: dragon hunters, dragonflies and leisure. *Current Issues in Tourism* 12(5-6): 553–571.

Ng, Y.F & Choong, C.Y. 2010. Dragonflies (Odonata) of Fraser Hill, Pahang. In: Adam, J., Gasim, M.B., Sakawi, Z. Choy, E.A., Rahman, Z.A., Tambi, N. & Juhari, M.A.A. (eds.) *Bio-Kejuruteraan Penilaian Ekosistem & Spesies 2010 Bukit Fraser*, pp. 45–50.

Ng, Y.F., Choong, C.Y. & Dow, R.A. 2012. Odonata records from Kuala Tahan, Pahang, Peninsular Malaysia in December 2010. *Notulae odonatologicae* 7(9): 77–88.

Ng, Y.F., Dow, R.A. & Choong, C.Y. 2011. New records of Odonata (Insecta) from the Cameron Highlands, with the first records of two species for Malaysia. *Journal of Science and Technology in the Tropics* 7: 9–16.

Norma-Rashid, Y. 2010. Odonata of Fraser's Hill, montane ecozones with conservation implications. *Proceedings of National Biodiversity Seminar 2008*, pp. 49–59.

Norma-Rashid, Y., Mohd-Sofian, A. & Zakaria-Ismail, M. 2001. Diversity and distribution of Odonata (dragonflies and damselflies) in the freshwater swamp lake Tasek Bera, Malaysia. *Hydrobiologia* 459: 135–146.

ES 04

ECONOMIC VALUES OF BIRD WATCHING IN FRASER'S HILL

Shaari, N.F., & Abdul Samad, A.R.*
Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia.
**Corresponding author email: abdrahim_as@upm.edu.my*

Abstract

The present paper has applied a dichotomous contingent valuation method to investigate the willingness to pay (WTP) of the visitors for bird watching service in one selected area in Peninsular Malaysia. Fraser's Hill is a notable center for bird watching. This area has become an area for migrating birds that fly all the way from Siberia, Russia, Europe, and China. The Ministry of Tourism Malaysia has recognised Fraser's Hill as the best bird watching destinations in Malaysia since 1988. Fraser's Hill is a great destination for relaxing and birding pursuits. The bird watching activity somehow will create a negative impact on the natural resources. Thus, the aim of this study is to estimate the WTP for bird watching service. Logit and Probit models were used to estimate the visitor's WTP for bird conservation in Fraser's Hill. The study is based on a sample of 190 respondents in Fraser's Hill that were randomly picked for data collection during the International Bird Race Competition in May 2015. The results of the study indicate that visitor's willingness to pay is RM8.99 per visitor per visit for improvement in Fraser's Hill especially for bird conservation and rehabilitation and the WTP is strongly influenced by income and education. The finding of this study may provide a guideline to Fraser's Hill management and to the policy makers to develop policy management that enhance the ecotourism contribution for conservation of bird habitat in Malaysia.

Keywords: contingent valuation method, bird watching, conservation, willingness to pay, Fraser's Hill

Introduction

Nature park is a park with natural attractions, which can have a positive effect for people who visit. At the same time, it helps in the development of tourism and ecotourism, contributing to the increased rise in the number of tourist arrivals and the availability of job opportunities in that sector (Yacob et al. 2009). There are a lot of suitable activities that can be done at Nature Parks such as recreational and any other nature-related activities. Waterfalls, wildlife, birds and the flora and fauna are among the natural beauties that are found in national or state parks in Malaysia. These have become the main attractions to tourists to enjoy and appreciate the beauty of nature.

However, this park must be protected and conserved to maintain the aesthetic values of the area. Entrance fee, or also known as conservation fee is a system where visitors are being charged every time they visit the park, and the authorities will use the money for maintenance, management and for any infrastructures in the park (Yacob et al. 2009). The charging fees for the utilisation of parks should be given special attention because there is always a short supply of government funds coupled with the lax or non-existent enforcement of environmental regulations (Radam & Mansor 2005). Currently, there is no entrance fee being charged at the access point of Fraser's Hill and only some activities such as horse riding, archery, and boating at Fraser's Hill impose a fee.

In this respect, the purpose of this research is to investigate the willingness to pay of the visitors for bird watching service by using environmental economic tools ie. dichotomous contingent valuation method (CVM).

Location of the Study Site

Fraser Hill is a highland resort and located in Pahang, locally known as Bukit Fraser. It is situated about 100km north of Kuala Lumpur and 400km away from Singapore in the south. This cooling holiday retreat is one of several highland tourist resorts located along the vast Titiwangsa Range, which is covered with lush rainforests and green valleys. It is also one of the last few hill stations in Malaysia, an imprint left behind by the former British colonial era. Fraser's Hill has become one of the leading international destinations for bird watching as its forests are still virgin, the mountains are still green with cool climate making it an ideal destination for migratory birds (Chong, Ahmad, & Ramli 2013).

Fraser Hill is an amazing place for recreational activities and is mind relaxing for many people. Bird watching activity is relaxing and gives many tourists enjoyment in watching many different species of birds in Fraser Hill. Bird watching activities actually have a value to it, yet the admission for this activity is free. In addition, when too many people come for bird watching, it will somehow create a negative impact on the natural resources. In order to maintain the natural environment for birds, the management of Fraser Hill should impose a charge to visitors who come for bird watching. Thus, this study is to find out the willingness-to-pay of visitors who partake the bird watching activity in Fraser's Hill. Besides, if there exists an appropriate charge for bird watching activity, it will help the management to maintain and upgrade the facilities at Fraser Hill to increase visitor's satisfaction.

Materials and Methods

The Application of Contingent Valuation Method

The contingent valuation method (CVM) is used to derive the willingness-to-pay of users in Fraser Hill for conservation of bird habitats and natural resources. From this value, the monetary benefits of conserving Fraser Hill is estimated. In estimating these values, the CVM is used. CVM is the most common stated preference approach found in literatures (Adamowicz, Louviere, & Williams 1994). Contingent valuation generally generates information on willingness to pay (WTP) or willingness to accept (WTA) distribution and how the distribution differs with respondent characteristics such as income, education level, geographic location, and the nature of the use of the environmental goods (Carson & Hanemann 2005). The difference between WTP and WTA is the amount provided; where WTP requires a maximum willingness to pay to acquire a necessary good that is not currently owned; and WTA is a minimum compensation to voluntarily give up a goods that is currently owned (Carson & Hanemann 2005).

There are four possible responses from respondents to the double-bounded choice question: (yes, yes); (yes, no); (no, yes); and (no, no) (Carson & Hanemann, 2005). Those questions were used to extract the value of WTP from respondents.

$$\Pr(\text{yes, yes}) = \Pr(C2 \leq WTP^*) \quad (1)$$
$$\Pr(\text{yes, no}) = \Pr(C1 \leq WTP^* < C2) \quad (2)$$
$$\Pr(\text{no, yes}) = \Pr(C3 \leq WTP^* < C1) \quad (3)$$
$$\Pr(\text{no, no}) = \Pr(WTP^* < C3) \quad (4)$$

C1, C2 and C3 represent the bid value, and all values are in Ringgit Malaysia (RM). C1 is the starting bid value. If the respondent's response to C1 is 'yes', then it is followed by a higher amount in the second valuation question, and if the answer is 'no', then the following question will be followed up by offering a lower amount of valuation, which is C3, and last but not least, the WTP* indicates the true value of WTP per entrance for bird watching activity.

There are five sets of bidding prices from a range RM2 to RM6. Each bid amount was randomly assigned based on previous studies on bird watching activities in Malaysia. This section is the main part of the CVM questionaire. The questionnaire was developed in two languages, English and Bahasa Malaysia as the target respondents are the visitors to Fraser's Hill consisting of Malaysians and also foreigners. For the purpose of this study, data was collected from 190 respondents: consisting of participants of the Fraser's Hill International Bird Race and also visitors to Fraser's Hill.

Results and Discussion

Results showed that, majority of respondents are males, and are in mid-twenties to mid-thirties. Besides, the majority of respondents are college and university graduates; employed by the private sectors; and self-employed. Their income level ranged between RM1001 to RM2000. Respondents from this study site are likely to love nature as they are engaging in bird watching activities and it is assumed that they are more aware about environmental and conservation issues.

Based on Table 1, the total numbers of respondents are 190 and were divided into five groups, with roughly

the same number of respondents in each group. Questionnaires were divided with five different starting values for bidding, which is RM2, RM3, RM4, RM5 and RM6.

Table 1: Distribution of questionnaire

Bid1	**Frequency**	**Percent**
2	47	24.74
3	23	12.11
4	34	17.89
5	43	22.63
6	43	22.63
Total	190	100.00

Table 2: Parameter estimates for dichotomous choice model for Fraser's Hill.

	Logit Model	Probit Model
Constant	1.9936	1.2152
	(1.1876)*	(0.6933)
Bid1	-0.2846	-0.1704
	(0.1256)**	(0.0726)
AGE	-0.0879	-0.0479
	(0.0945)	(0.0545)
SEX	-0.2781	-0.1514
	(0.4106)	(0.2357)
JOB	-0.0905	-0.0581
	(0.1101)	(0.0642)
EDU	0.0929	0.0592
	(0.1628)	(0.0956)
INCOME	0.2633	0.1388
	(0.1361)*	(0.0706)
Log-likelihood	-97.5046	-97.5526
McFadden R-Square	0.0625	0.0621

Note: Figure in the parentheses is standard error. ***Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table 2 shows only INCOME has a significant impact on WTP among the other demographic variables. Other socio-demographic variables such as age, gender, educational levels, and employment are not significant with WTP in both models. Variable incomes are significant and have a positive relationship in the analysis, in which it is consistent with another study done on marine parks. This showed that high income respondents will put an extra amount on bird watching service and also on environmental conservation compared to respondents with lower income. As the bid value (Bid1) was negative and significant at 5% level, it indicates that as the offered amount increases, respondents will not be willing to pay extra.

Table 3: Estimating of mean WTP for Fraser's Hill

Model	WTP (RM)
Logit	8.56
Probit	9.15

Based on Table 3, the values of WTP were calculated using Logit and Probit models. The calculated mean WTP is RM8.56 using the logit model, and RM9.15 in the probit model. From Table 2, the logit model shows the better result as compared to the probit model in terms of McFadden-R2 and Log-likelihood value.

Conclusion and Policy Implications

The aim of this study is to investigate the willingness to pay of visitors for bird watching activities in Fraser's Hill. This study was done to recommend an entrance fee mechanism for birding activities in Fraser's Hill so as to ensure that the management of Fraser's Hill is sustainable in its financial resources to continue its conservation efforts and preserving the natural habitat of its flora and fauna.

The monetary amount recommended in this study can become a basis value or as a benchmark value if the entrance fee mechanism is implemented at Fraser Hill. However, this value might be low as there is a possibility that respondents are willing to pay at a lower bid value for conservation in Fraser Hill. The results indicate that the respondents are willing to pay about RM8.56 and RM9.15 per entry.

Based on the findings, the entrance fee mechanism is highly recommended to be implemented in Fraser's Hill because it will help the management of Fraser Hill to not only utilise the funds for maintenance, but also to improve other facilities related to birdwatching.

References

Adamowicz, W., Louviere, J., & Williams, M. 1994. Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities. *Journal of Environmental Economics and Management*. http://doi.org/10.1006/jeem.1994.1017.

Carson, R.T. and Hanemann, W.M. 2005. Contingent valuation. *Handbook of environmental economics*, *2*, 821-936.

Er, A.C., Chong, S.T., Ahmad, H., Sum, S.M. and Ramli, Z. 2013. The sustainability of Fraser's Hill as an eco-destination. *International Journal of Business Tourism and Applied Sciences*, *1*, pp.109-115.

Radam, A. and Mansor, S.A. 2005. Use of dichotomous choice contingent valuation method to value the Manukan Island, Sabah. *Pertanika Journal of Social Science and Humanities*, *13*(1), pp.1-8.

Yacob, M.R., Radam, A., Shuib, A., Samarahan, K. and Sarawak, M. 2009. A contingent valuation study of marine parks ecotourism: The case of Pulau Payar and Pulau Redang in Malaysia. *Journal of Sustainable Development*, *2*(2).

ES 05

ABIOTIC FACTORS THAT INFLUENCE THE DAILY ACTIVITIES OF STINGLESS BEE, *Tetrigona apicalis* AT FRASER`S HILL RESEARCH CENTRE, UNIVERSITI KEBANGSAAN MALAYSIA

Sulaiman, N.[1]*, Jauhari, M.A.A.[1], Alias, H.[2], Mamat, M.R.[2], Mat Isa, M.N.[2], & Hurairah, S.N.[1]
[1]Department of Biological Science and Biotechnology; [2]Fraser`s Hill Research Centre, Faculty Science and Technology, 43600 Universiti Kebangsaan Malaysia, Bangi, Selangor
[2]Malaysia Genome Institute, National Institutes of Biotechnology Malaysia, Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), Jalan Bangi, 43000 Kajang, Selangor
**Corresponding author email: vozela@ukm.edu.my; norelaganun@gmail.com*

Abstract

This study aims to identify the influences of abiotic factors (temperature, relative humidity, light intensity and wind speed) towards daily activities of stingless bees (*Tetrigona apicalis*) in and out of the nest. The study was conducted at Fraser's Hill Research Center, Universiti Kebangsaan Malaysia, Pahang, Malaysia over three consecutive days for 12 hours with 3 replications for each study area. The time of study was from 7 am until 7 pm. There was a significant positive correlation ($p<0.05$) between temperature, relative humidity, and light intensity on the activities of stingless bees, *Tetrigona apicalis* in and out of the nest. The effect of abiotic factors on lowland stingless bee species *Tetrigona apicalis* was also presented as a comparison. In conclusion, this study enables the identification of abiotic influences on the activities of stingless bee in and out of the nest of the species studied.

Keywords: *Tetrigona apicalis*, daily activities, abiotic factors

Introduction

Stingless bee is classified in kingdom Animalia, phylum Arthropoda, class Insecta, order Hymenoptera, family Apidae, genus *Tetrigona* and species *apicalis* (Smith, 1857) (Syafrizal, et al., (2012). The eusocial bees (Hymenoptera, Meliponini, Apidae) are distributed widely in tropical and subtropical regions Michener (1975). In Peninsular Malaysia, *Tetrigona apicalis* are distributed widely in the states of Negeri Sembilan, Selangor and Terengganu (https://www.mybis.gov.my/sp/61883). Stingless bees serve as an effective pollinating agent (Heard, 1999). There is still no study of *T. apicalis* on the effects of environmental factors affecting their daily activities of exiting and entering the nest. Therefore, this study is focused on the relationship between movements of *apicalis* with the abiotic factors at high altitude. The objective of the study is to determine the abiotic factors (wind speed, relative humidity, temperature, and light intensity) toward the inward and outward movements of *T. apicalis* at high altitude and compare with the same species at the lowlands.

Materials and Methods

Field observational study

Field observational study was conducted at the highlands at the Fraser's Hill Research Centre of Universiti Kebangsaan Malaysia, Pahang. In comparison, a similar study was conducted at lowlands at the Stingless Bee Repository Center, Malaysia Genome Institute, Bangi, Selangor. The inward and outward movements from the nests of the species studied were recorded using video cameras (HTC RE Camera) at both study areas. Video recordings were taken for 5 min. at every hour starting from 7 a.m. until 7 p.m. The total time for reading to be taken was 12 hrs for three consecutive days in one sampling replicate. Abiotic factors were also measured by using Tes meter lux, Hanna temperature and relative humidity meter and Prova anemometer. Regression analysis was conducted by using *Microsoft Excel* where the variables identified were temperature, relative humidity, wind speed and light intensity with the movement of *T. apicalis* from its nest.

Results and Discussion

The effect of abiotic factors towards the daily activities of T. apicalis

In the morning, the number of *T. apicalis* activities in the highland was the lowest and began to increase in the total number coming in and out of their nest when temperature increased until 12:00 hr. The highest number of *T. apicalis* could be seen during midday (11:00 hr until 12:00 hr), at temperatures between 24.4 ºC to 26.1 ºC. This showed that low temperatures in the highland had caused the reduced number of *T. apicalis* movement from the nests. Then it was observed that the number of *T. apicalis* activities are more dominant in the afternoon as the temperature was higher (between 27.6 ºC to 29.6 ºC). The number of *T. apicalis* activities began to decrease from late afternoon (18:00 hr) until 19:00 hr as the temperature dropped slightly to 21 ºC.

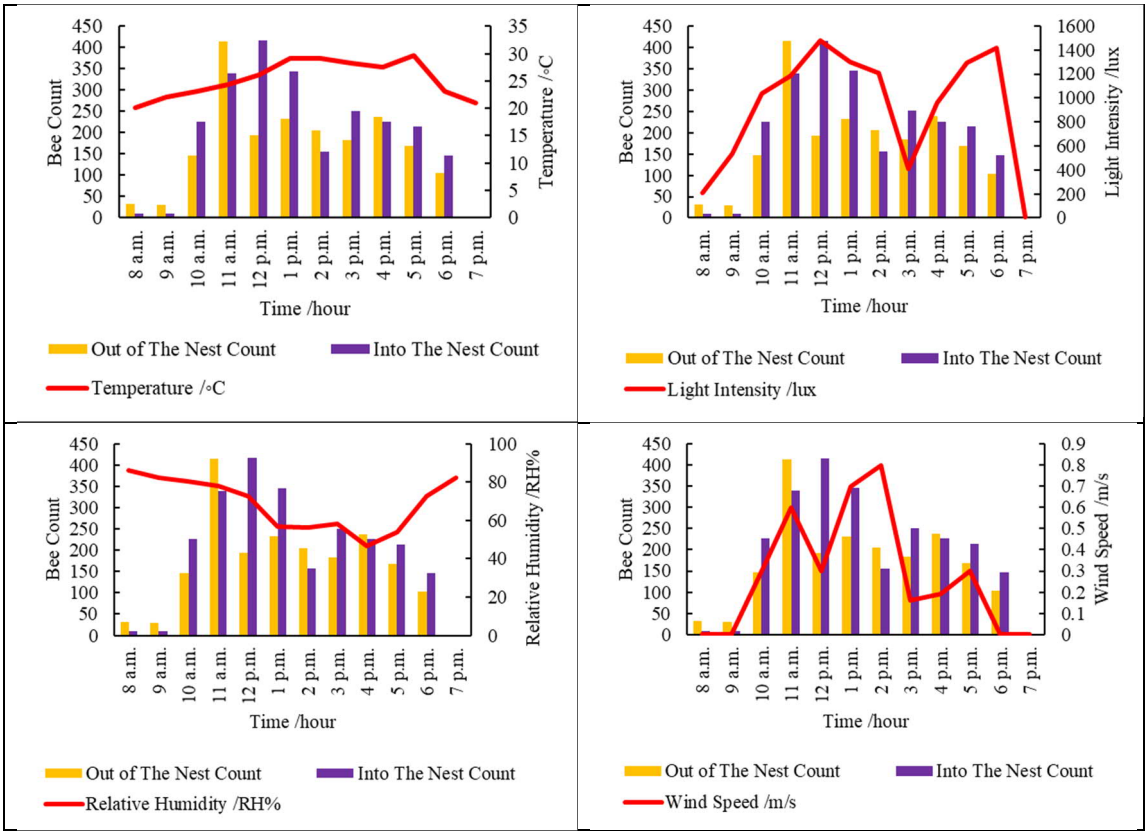


Figure 1. The relationship between *T. apicalis* counts against time influenced by abiotic factors in the highlands.

The light intensity was low (206 lux) in the early morning (08:00 hr until 09:00 hr) (Figure 1) and the foraging activities of bees were also low but began to increase from 10:00 hr until 12:00 hr as the light intensity increases to 1479 lux. The movement of bees decreases again until 15:00 hr as the light intensity value dropped to 411 lux. The light intensity drastically increases again until 18:00 hr and the number of foraging bees were correspondingly higher although it dropped later until 18:00 hr and night at 8.56 lux. Wind speed in the highland was lowest early in the morning; 0 m/s, whereby the movement of bees was minimal and continued to increase until midday. Wind speed was highest at 14:00 hr (0.8 m/s) and the foraging activities of bees observed were also low. The number of bees increased slightly until night when the wind speed decreased.

Relative humidity observed in the highland was initially high in the beginning of the morning (86.2 % R.H.) and the number of bees foraging was low. The trend of relative humidity continued to drop gradually until 13:00 hr where the number of bees' movements was higher. This implied that lower relative humidity might result in a higher number of foraging bees. The activities of bees fluctuate in the lowest range of relative humidity (46.6 % R.H. until 56.7 % R.H.) from 13:00 hr until 16:00 hr. Next, the relative humidity had risen until 19:00 hr at night whereby the number of bees foraging was seen to have been decreasing with time.

Figure 2. The relationship between bees count against time influenced by abiotic factors in lowland.

Overall, temperatures observed in lowland were not highly variated (refer Figure 2). The lowest temperature identified in the morning was 26.9 ºC at 08:00 hr and began to increase minimally until 12:00 hr. The bees were foraging in and out, effectively in the early morning for pollination. Bee count decreased slightly until 12:00 hr as the temperature increased to 33 ºC. The number of bees increased slightly until night where the temperature observed were uniformly high (28.9 ºC to 32.3 ºC). Light intensity in the lowland increased from early morning until 12:00hr at its peak (6250 lux). The number of bees foraging was higher than in the afternoon. The light intensity fluctuated in the afternoon and decreased until 19:00 hr. Wind speed in the lowland was averagely constant the whole day (0 m/s). At 15:00 hr in the afternoon, the wind speed was slightly higher at 0.6 m/s where the number of bees foraging was low. The relative humidity was the highest in the early morning (75.6 % RH) but started decreasing until noon (58.5 % RH). The number of bees foraging was high at 09:00 hr but decreases slightly until 12:00 hr. In the afternoon, the relative humidity was higher than the morning where bees' activities fluctuated slightly and decreased typically until late afternoon.

Regression analysis determined the effects of abiotic factors to the number of bees foraging (Table 1). P-value obtained for the inward movement of stingless bees was significant for temperature and light intensity in highland areas. The p-value for temperature and light intensity was statistically significant respectively; 0.025, 0.030 ($p<0.05$). Two abiotic factors had affected the movement of species studied in the highlands due to the lower temperatures during sampling activities, resulting in a higher number of bees foraging. Longer length of daylight during the dry season influenced external activities where it became more intensive. Whereas, during the cold months where a shorter daylight period was seen, the foraging activities had also decreased. The collection of pollen was influenced by temperature, humidity, and daily luminosity Figueiredo-Mecca et al. (2013).

Abiotic factors regulating the foraging activities of bees were temperature and luminosity. The foraging frequency of bees and both these variables had obtained a positive correlation. Foraging activities of bees were neither influenced by relative humidity nor wind speed. The movement activities of the bee species depended on the availability of floral resources during daytime as well as body size and behavior of each visitor. At certain periods of the day, the scarcity of floral resources produced by most plants will stimulate the bees' movements to the flowers early in subsequent days, which happened before the period in which the

abiotic conditions were highly favorable (Polatto et al. 2014). Wind speed factor did not bring much changes in the long run as the wind speed in both study locations were not high. Occurrence of strong winds affecting the flight movements of bees were minimum in this study. Climate conditions, especially air temperature and rain, restrain foraging activities for the colony, although these factors affect different species. Several species collect their sources of food although the weather was not favourable to avoid competition and interruption of food sources (Hrncir et al. 2016). Past study had found that the effects of abiotic factors such a temperature and sun rise towards pollination activities were closely related to the physiological characteristics of bees (Hrncir & Maia-Silva 2013), where vision is needed when minimum light was present. The earlier time for sunrise or suitable maximum temperature for bee flight will consequently cause earlier bee flights. The parameter related to relative humidity impacted pollination indirectly by influencing the abundance of resources (Hrncir & Maia-Silva 2013). Therefore, in the wet season, when there were plenty of flowering plants, the bee colonies increased their efforts in food searching. However, in the dry season, the bees reduced their effort in finding their food sources.

Table 1. Regression analysis for the inward movement of species studied in highland into its nest.

	Coefficients	Standard Error	*t*	*P*	Lower 95.0%	Upper 95.0%
Intercept	-649.02	550.09	-1.18	0.25	-1770.93	472.89
Temperature (ºC)	31.44	13.36	2.35	0.03	4.20	58.69
Relative Humidity (%)	0.41	3.537	0.12	0.91	-6.80	7.62
Wind Speed (m/s)	-118.20	93.32	-1.27	0.21	-308.53	72.13
Light Intensity (lux)	0.091	0.040	2.27	0.03	0.01	0.17

Conclusion

As a conclusion, two abiotic factors were determined to be highly affecting the movements of the species studied; *Tetrigona apicalis* in the highland which are temperature and light intensity. The p-value obtained for the inward movement of stingless bees was significant for temperature ($p<0.05$) and light intensity ($p<0.05$) in the highland areas. Other environmental abiotic factors minimally affected the activities of stingless bees. The factors influencing the flight intensity of bees were important for the meliponiculture farmers in identifying the suitable time for workers to manage the stingless bees besides their important role in the pollination process in the ecosystem.

Acknowledgements

The authors gratefully acknowledge Universiti Kebangsaan Malaysia (GUP-2017-038) and Malaysia Genome Institute for supporting this research.

References

Figueiredo-Mecca, G., Bego, L.R., Nascimento, F.S. 2013. Foraging Behavior of Scaptotrigona depilis (Hymenoptera, Apidae, Meliponini) and its Relationship with Temporal and Abiotic Factors. *Sociobiology* 60. 277-282.

Heard, T.A. 1999. The Role of Stingless Bees In Crop Pollination. *Annual Review of Entomology* 44(1): 183–206.

Hrncir M., Maia-Silva C. 2013. On the Diversity of Foraging-Related Traits in Stingless Bees. *Pot-Honey*, pp 201-215. Springer: New York, NY.

Hrncir, M., Jarau, S. & Barth, F.G. 2016. Stingless bees (Meliponini): senses and behavior. *Journal of Comparative Physiology* 202(9–10): 597–601.

Jaffé, R., Pope, N., Carvalho, A.T., Maia, U.M., Blochtein, B., de Carvalho, C.A.L. 2015. Bees for Development: Brazilian Survey Reveals How to Optimize Stingless Beekeeping. *PLoS ONE* 10(3).

Michener, D.C. 1975. The Bees of the World. 2ND Ed. pp 992. Maryland: Johns Hopkins University Press
Polatto et al. 2014. Influence of Abiotic Factors and Floral Resource Availability on Daily Foraging Activity of Bees: Influence of Abiotic and Biotic Factors on Bees. *Journal of Insect Behavior* 27: 593–612.
Sakagami, S.F., Inoue, T. & Salmah, S. 1990. Stingless bees of central Sumatra. *Natural history of social wasps and bees in equatorial Sumatra*, pp 125–137. Sapporo: Hokkaido University Press.
Wille, A. 1983. Biology of the Stingless Bees. *Annual Review of Entomology* 28(1): 41–64.
Wilms, W., Wendel, L., Zillikens, A., Blochtein, B. & Engels, W. 1997. Bees and Other Insects Recorded on Flowering Trees in a Subtropical *Araucaria* Forest in Southern Brazil. *Studies on Neotropical Fauna and Environment* 32(4): 220–226.

ES 06

NATURE THERAPY FOR LEARNING DISORDERS KID @ UKM FRASER'S HILL RESEARCH CENTRE

Mamat, M.R.[1]*, Muhammad, A.[1], Sulaiman, N.[2], Jauhari, M.A.A.[2], Alias, H.[1], Johari, N.A.[1], Mat Isa, M.N.[1], Rodzli, N.A.[1], Mohd Sohi, B.S.[1], Wan Seman, W.K.I.[1], Koon, M.[3], & Tan, J.[3]

[1]Malaysia Genome Institute, National Institutes of Biotechnology Malaysia, Ministry Science, Technology and Inovation (MOSTI), Jalan Bangi, 43000 Kajang, Selangor

[2]Department of Biological Sciences and Biotechnology; Fraser`s Hill Research Centre, Faculty Science and Technology, 43600 Universiti Kebangsaan Malaysia, Bangi, Selangor

[3]Andante Education Department, Andante International Foundation, 63 Jalan Ecohill 3/2C Setia ecohill, 43500 Semenyih Selangor

**Correspondence: razif@nibm.my; mrazifmamat@gmail.com*

Abstract

Learning in a natural environment has proven time and again to boost the speed of knowledge transferred. In this study, we assessed nature therapy for children with learning disorders at UKM Fraser's Hill Research Centre. Six boys of ages between 12 to 17 years old with history of Autism, Dyslexia, Attention Deficit Hyperactive Disorder (ADHD), Oppositional Defiant Disorder (ODD), challenging behaviours and non-conventional learners, were involved in a 3-day program. Series of activities and workshops were organised such as Stingless Bee Presentation Session, Pitcher Plant Tour, Papermaking Session, Terrarium-making Session, Soap-making Session, Light Trap-making Session, Nature and Insect Observation and Jungle Trekking. Safety was highly prioritised, and the program was well adjusted to weather and time. The boys enjoyed the whole program and had much to look forward to for another similar program. They were hungry for more knowledge and experience with the natural environment.

Keywords: nature therapy, learning disorder, stingless bee

Introduction

Autism Spectrum Disorder (ASD) is a complex developmental disorder associated with symptoms that include "persistent deficits in social communication and social interaction across multiple contexts" and "restricted, repetitive patterns of behavior, interests, or activities". Oppositional defiant disorder (ODD) is a type of behaviorial disorder. Children with ODD are uncooperative, defiant, and hostile toward peers, parents, teachers, and other authority figures. Attention deficit/hyperactivity disorder (ADHD) is the most common neurobehaviorial disorder of childhood. According to the Centers for Disease Control and Prevention: "if untreated, a person with ASD, ODD & ADHD will struggle with impairments in crucial areas of life, including relationships with peers and family members, and performance at school or work" 2(p1). Unfortunately, current ASD, ODD & ADHD treatments fall far short of ideal, offering only limited relief from symptoms and often involving serious side effects.

Learning in a natural environment has proven time and again to boost the speed of learning. Not only so, but that is how learning should be. In this article, we report the results of a preliminary experiment exploring a possible treatment for ASD, ODD & ADHD through nature. If controlled experiments and clinical trials bear out this potential, such natural treatments promise to supplement current approaches to managing ASD, ODD & ADHD, with the advantages of being widely accessible, inexpensive, no stigmatizing, and free of side effects.

A team of six boys of the ages between 12 to 17 years old with history of Autism, Dyslexia, Attention Deficit Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder (ODD), challenging behaviors and non-conventional learners, was involved in a 3-day program at UKM Fraser's Hill Research Centre. These teenagers were treated and closely monitored by Dr Mervynn Koon. The programme was designed to give exposure to nature and teach certain knowledge and skills. We hope that after the end of the session, the children will learn something from nature and improve their lack of learning abilities.

Materials and Methods

The program itinerary.

DAY 1 (25, July 2019)	DAY 2 (26, July 2019)	DAY 3 (27, July 2019)
Arrival Tent Setup Tea Time Pitcher Plant Tour Wash Up Prep for Night Presentation BBQ Dinner Presentation Session (Topic: Meliponary) Feedback Lights Out	Morning Call Breakfast Papermaking Session Jungle Walk (for material hunt) Lunch Terrarium-making Session (with hunted materials) Soap-making Session Mandi Sungai at Air Terjun Dinner Light Trap Setup Jungle Trekking, Nature and Insect Observation Light Trap Review Lights Out	Morning Call Final Light Trap Review Breakfast Dismantling and packing up Closing Ceremony Group Photo Session Team Heads Back

Event highlights in the program.

#	SESSION	FOCAL AREA
1	Pitcher Plant Tour	Nature, Plant
2	Meliponary Presentation Session	Entomology and Meliponary
3	Papermaking Session	Green Living
4	Terrarium-making Session	Plant, Nature, Green Living
5	Soap-making Session	Green Living
6	Light Trap-making Session and Review	Nature, Entomology, Science (observation skills)
7	Jungle Trekking	Nature, Plant, Entomology, Science (observation skills), Outdoor Skills
8	Nature and Insect Observation	Nature, Entomology, Science (observation skills)

Facilitators

#	Main Personnel	Information	Role In The Program
1	Mohd Razif Mamat	Scientist Translational Research & Prototype Development Centre	Overall Facilitator, Green Living Facilitator
2	Mohd. Afiq Aizat Juhari	Researcher Pusat Penyelidikan Bukit Fraser	Plant, Nature, Entomology Facilitator
3	Mohd Noor Mat Isa	Scientist Genome Computing Centre	Program Facilitator
4	Wan Mohd Khairulikhsan Wan Seman	Scientist Protein expression and Purification	Program Facilitator

5	Dr. Nazahiyah Ahmad Rodzli	Scientist Structural and Applied Genomics	Program Facilitator
6	Halimah Alias	Scientist Genome Sequencing	Program Facilitator
7	Bibi Syahila Md Sohi	Technologist Lab Services	Program Facilitator
8	David Sya	Outdoor Instructor Khootz Outdoor Ventures	Outdoor Facilitator
9	Joshua Chin	Plant Conservationist Preservation and Conservation Dept Andante Foundation	Outdoor Facilitator

Participants

A team of six boys of the ages between 12 to 17 years old from Khootz Outdoor Ventures were sent for this program. Among the many conditions once faced by the boys include: Autism, Dyslexia, Attention Deficit Hyperactive Disorder (ADHD), Oppositional Defiant Disorder (ODD), challenging behaviors and non-conventional learners. These boys had been learning and living in an outdoor natural environment for the past months to which the degree of their conditions had remarkably lessened. They are now in a stable phase where they are able to interact normally with their peers, adults around them and external people. This is their first time venturing to Bukit Fraser and utilising their basic knowledge and skills, to live there.

Results and Discussion

Feedback from the facilitators

The facilitators from Andante and Khootz do see a potential positive impact by scientists and teachers working together in such a venue (environment) for such a micro workshop for the boys. There were astounding remarks of working with the MGI and UKM facilitators as a team. Safety was well considered and with quick thinking, the program was well adjusted to weather and time. In fact, the program was not far off from what Khootz had been delivering. On the other hand, our facilitators believed that there could be better event coordination from all sides for future sessions. They also noted that it would be good to have a brief introduction session amongst the facilitators (i.e. name, designation, etc.). Other suggestions include a brief session on genetics and apiary, botany, ecology, water, and soil. The goodie pack received was very useful. No major incidents took place or major issues highlighted.

Feedback from the participants

The boys enjoyed the whole program and had much to look forward to another one. They were hungry for more knowledge and experience with the ecology found there. They loved the trekking and sessions. BBQ dinner was great. This was their first time running a presentation in front of a team of adults; all of whom are new and unfamiliar to them. Upon reflection, this was their overcoming hurdle to public speaking and subsequently realizing the need to learn more about the subject matter. The feedbacks given did serve as a guiding point. They were excited over all the hands-on activities conducted on day two. Participants were glad to receive a goodie pack each. They requested and suggested a good introduction to the personnels and sessions. When asked if they wish to return? The ‘yes’ answer came with a big smile. No major incidents took place or major issues highlighted.

Questionnaire (Post Event) for Feedback and Evaluation

Ten questions were asked and the participant’s answers are appended below.

1. What did you remember most about the program?
    - Night jungle walk/hike, paper-making, bar soap-making, BBQ, making insect trap & observations
    - Spider (insect) observation
    - Walking nature trails
    - Honey harvesting (Stingless bee), jungle trekking and night walk

- Waterfall
- Soap-making, afternoon and evening hikes (nature and insect observations)

2. How much did you enjoy learning in the program? (on the scale of 1-10)
   Only 2 persons out of the whole group rated their enjoyment at 9/10. The others gave a perfect 10/10.

3. Describe your observations and feedback about the environment and facilities of the program.
   Generally, everyone described their observations and appreciation of being surrounded by fresh air, cool air and natural environment. They noted that facilities are clean and tidy.

4. What did you learn most out of the program?
   - Soap-making (same answer from 3 persons)
   - Tarantula, insects and bugs
   - Stingless bee identification
   - Stingless bees and the ecosystem

5. If given another chance to attend the program, what would you like to have experience?
   - Night hike, swimming, searching for wildlife
   - More on tarantulas and insects
   - Birding, photography, jungle craft, wildlife and ecology, plants and seeds
   - Watch for rare animals and precious plants at Fraser's Hill, study of animals, DIY activities
   - Learn more about animals and strawberry farm nearby
   - Bird watching, more trails and collect more specimens

6. Did you understand the content of the program? (e.g. The sessions, instructions, information, etc.)
   - Not all (especially Bahasa and it was spoken too fast)
   - Yes, understood the main points but couldn't pick up deeper words
   - Yes, except those technical terms in Bahasa
   - The others replied 'yes'.

7. How were the facilitators in the program?
   - Good, kind, polite and helpful
   - Kind and very humble
   - Friendly and helpful
   - Kind, thoughtful, helpful and patient in explaining words
   - Friendly and willing to teach
   - Kind and polite

8. How was the accommodation of the program?
   - Accommodation is portable (tent), neat, clean and tidy.
   - Memorable
   - Clean, tidy and comfortable
   - Cooling, peaceful and quiet
   - Clean, tidy, orderly, partly sheltered and comfortable

9. What are your thoughts about the length of the program?
   - Not enough, hope can stay longer
   - Length too short
   - Prefer months
   - Too rushed and activities done in a rush. Look forward to a week program
   - I think 4 days 3 nights
   - Too short

10. Why would you encourage someone your age to attend the program?
    - Because it is far from the city area, the air is fresh and good place to visit to learn more things there

- Because of the potential transformation the program can do to people my age and to encourage young people my age to devote their lives to nature
- To promote passion for nature, raise awareness of environment and share the enjoyment with others
- So that they can learn more about rare and precious plants and animals that we have in Malaysia
- Because many people have not been given a chance to be in this kind of environment (to learn)
- Because many people my age did not have a chance to go outdoors to experience what I feel in outdoors

Compilation of pictures

Conclusion

Based on overall feedbacks from the participants, all of them acknowledged that they learned a lot from this programme. The programme made learning comfortable for them. Learning no longer posed a challenge for those having conditions. Therefore, the programme had a therapeutic effect on them. On top of that, learning in a natural environment was key to improving their ability to learn. Real life flora and fauna captured their attention. Those with short attention spans could concentrate better due to the excitement in learning. This too is the result of incorporating nature in learning programmes.

In conclusion, learning with and in nature was helpful to this group of students. The learning program exhibited a therapeutic effect on these students. This shows that nature therapy can improve young people's learning ability.

Acknowledgements

Prof. Madya. Dr Norela Sulaiman of Head of UKM Research Centre Bukit Fraser for hosting this event. Team of Malaysia Genome Institute and UKM Research Centre Bukit Fraser scientist cum facilitators in the event for the practical hands-on activities and coordination. Andante Foundation and Khootz Outdoor Ventures as part of participants and facilitators.

References

Jalil, A. 2014. *Beescape for Meliponines*. Singapore: Partidge Publishing.

Jalil. A., & Roubik, D. 2016. *Handbook of Meliponiculture*. Akademi Kelulut Malaysia.

Kuo, F.E., & Taylor, A.F. 2003. A Potential Natural Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a National Study. *American Journal of Public Health.* Vol 94: 1580 -1586.

Schreibman, L., Dawson, G., Stahmer, A.C., Landa, R., Roges, S.J., Mcgee, G.G., Kasari, C., Ingersoll, B., Kaiser, A.P., Bruinsma, Y., McNerney, E., Wetherby, A., Halladay, A. 2015. Naturalistic Developmental Behavioral Interventions: Empirically Validated Treatments for Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders* volume 45,2411–2428

Rasmussen, C. 2008. Catalog of Indo-Malayan/Australasian stingless bees (Hymenoptera: Apidae: Meliponini). *Zootaxa 1935*.

Smith, D.R. 2012. Key to works of Indo-Malayan Stingless Bee – v.1.1.*11th International Conference of the Asian Apicultural Association.* Kuala Terengganu

Xiong, C.S. 2015. A Conservation Assessment of Stingless Bees (Apidae: Meliponini) in Singapore. *Cohort AY2015/2015 S1*.

ES 07

INCREASING VISITOR ARRIVALS TO FRASER'S HILL VIA HIGHLAND BIRDWATCHING AND PRIMATEWATCHING: A WIN-WIN APPROACH WITH GENTING HIGHLANDS

Chan, E.*, & Ang, P.
Treks Events Sdn Bhd, Lot AW/G5.00, GF, Awana Hotel Genting Highlands Resort
Genting Highlands, Pahang 69000 Malaysia.
**Corresponding author email: info@treks.events*

Abstract

There are at least 250 native and migratory bird species recorded each in Fraser's Hill and Genting Highlands with both sites having their own 'lifer' bird species as well as sharing similar bird species. Combining both sites will offer visitors the opportunity to experience lowland, mid-montane (3000ft asl) and montane birds (6000ft asl). Similarly, there are about five primate species recorded each in both highlands with the Siamangs, Dusky leaf monkey and Surili leaf monkey being the key attraction species. Both highlands are well known tourist attractions with Genting Highlands recording more than 20 million in visitor arrivals per annum in recent years (Poh 2019). While Genting Highlands need 'more' nature-interested visitors, Fraser's Hill needs to increase its visitor arrivals. This study aims to promote both locations as primary attractions for highland bird watching and primate watching combining the advantages of an untouched bio-diverse site of Fraser's Hill and high visitor arrivals of Genting Highlands in a win-win situation. Visitors to one highland will add on the other highland to complete a good outing. Therefore, making Genting Highlands more known for its forest attractions can help bring a substantial increase in tourist arrivals to Fraser's Hill via bird watching and primate watching.

Keywords: Fraser's Hill, Genting Highlands, bird watching, primate watching, visitor arrivals

Introduction

Genting Highlands is a destination more known for its entertainment attractions rather than its rainforest. This has in many ways kept its rainforest and its biodiversity assets (BIO Assets) intact and very much 'alive' in areas that are not intended for development. Two key areas of preserved land are the Awana IBA (Important Bird Area) and IPA (Important Primate Areas) all untouched forest on the south face of Genting Highlands.

The World Bird Conference was held at the Awana Genting Highlands in 1999 and its influence has produced the allocation of a parcel of land for the purpose of promoting bird watching in Genting Highlands. The area is called the Awana IBA (Important Bird Area) which was launched in 2010. At that time the official count of resident, native and migratory birds was 257 species recorded from the Old Gombak Road to mid hills Goh Tong Jaya to the peak of Gunung Ulu Kali. The Awana IBA and the bird port at Ulu Kali are the most popular sites for bird watching. Meanwhile, there is an initiative to develop an IPA (Important Primate Area), similar in status to the Awana IBA on a private basis. IPA (Important Primate Areas) has promoted a new nature activity that began in 2015 with documentation of sightings and a record of their population. Primate watching was introduced in Genting Highlands in 2016. It has steadily received more attention via dedicated FB publications to the general public and nature interest groups. Comparatively, Fraser's Hill is far less developed, and its biodiversity assets are equally intact and in abundance. Fraser's Hill IBA has been a well-known bird watching destination world-wide. However, the IPA is not an established activity and is usually done on the side when the primates are sighted at birding ports or on the route to birding ports. Thus, we have taken initiative to explore Fraser's Hill IBA and the potential to document primate diversity in Fraser's Hill.

Materials and Methods

The Genting Highlands is located at the peak of Gunung Ulu Kali at 1,800m above sea level between the states of Pahang and Selangor, Malaysia. The Genting Highlands forest is characterised by four different types of rainforests based on elevation beginning with the Hill Dipterocarp Forest @ 1500ft asl at Genting Sempah, The Upper Dipterocarp Forest @ 3000ft asl at Awana Hotel, the Montane Oak Forest @ 4500ft asl at Chin Swee Temple and the Montane Ericaceous Forest @ 6000ft asl at Gunung Ulu Kali. We began our bird

sighting from December 2018 to December 2019. Birds were sighted through direct observation through walking and using vehicles. The areas covered in Genting Highlands are Goh Tong Jaya, Awana IBA, Chin Swee Temple Complex and Ulu Kali ridge. For primates, we conducted primate surveys from January 2015 to January 2020. The areas covered in Genting Highlands are from Genting Sempah to Genting View Resorts, Genting Permai, Institute Aminuddin Baki, Goh Tong Jaya, RW Awana Resorts, Chin Swee Temple Complex to Genting Highlands Resorts by walking and using of vehicles. In addition, numerous trips were made to Fraser's Hill to survey birds and primates from January 2019 – February 2020. Birds were sighted at various locations at Fraser's Hill via walking and using vehicle. The areas covered in Fraser's Hill are old Jelai Resort, Telekom Loop, Jalan Lady Maxwell, Waterfall Road, Jeriau Waterfalls, the New Gap Road, Richmond Road, Hemmant Trail and Bishop Trail. At this point in time, primates are sighted at the Jeriau Waterfalls and the New Gap Road and the various bird areas covered above. Sightings of primates are by walking and using vehicles. Our observation and photographic equipment includes an Omicron 8x42 1000yards binoculars, a Nikon D5300 slr digital camera with Tamron G1 SP 150-600mm f/5-6.3 VR and Nikon 300mm f/4D AF-S with Nikon AF1 TC 14E.

Results and Discussions

Attractions of Bird watching in Genting Highlands and Fraser's Hill

Regularly sighted forest birds at Awana IBA (at 3000ft asl) are Barbet, Bee-eater, Broadbill, Bulbul, Dove, Drongo, Eagle, Flowerpecker, Flycatcher, Hornbill, Iora, Kingfisher, Magpie, Malkoha, Minivet, Nuthatch, Pigeon, Shrike, Sibia, Laughingthrush, Spiderhunter, Starling, Sunbird, Swallow, Tailorbird, Tit, Trogon, White-eye, Woodpecker, Woodshrike. Regularly sighted birds at the bird port at Ulu Kali (6000ft asl) are Babbler, Niltava, Laughingthrush, Fulvetta, Mesia, Minla, Sibia. During the migratory bird season, the regular bird species are Siberian Blue Robin, Mugimaki Flycatcher, Siberian Thrush and recently, rarer ones includes Rufous headed Robin and Grey-sided Thrush. These are usually sighted at the Ulu Kali bird port. Comparatively, Fraser's Hill has similar spread of regularly sighted birds as Genting Highlands with the exception of some lowland species, Patridges and Trogons.

Attractions of primate watching in Genting Highlands and Fraser's Hill

The south-face of Genting Highlands aka Awana Valley from an elevation of 3000ft asl – 5000ft asl is home to 12 families of siamang that make the roadside forests their territorial home. For records and identification, our research has placed names on these families, they are Romeo & Juliet, Ramses, Socrates, Chewbacca, Noah, Megatron, Optimus, David, Tenaga, Salad, Leonidas Shakespeare and Michelangelo. In addition, there are more than 20 other siamang families that are found beyond these roadside boundaries which we have not given names to. In addition, there are six sites where White-thighed Surili and Dusky Leaf Monkeys are regularly sighted in the Awana Valley. Comparatively, Fraser's Hill has similar species of primates however, no territorial areas have been established for regular sighting at this juncture.

Visitor numbers for Fraser's Hill and Genting Highlands - Comparison

In addition, we have compiled statistical data to indicate visitors to Fraser's Hill and Genting Highlands from 2015 to 2019 (Table 1, Table 2) (Tourism Pahang, 2019). The purpose of this data is to help highlight the following understanding :-

1. That by improving and increasing nature-based activities in Genting Highlands, there can be spin off and spillover effects to increasing visitor arrivals to Fraser's Hill
2. That by improving and increasing nature-based activities in Genting Highlands, new hobbyists, nature-enthusiasts, nature-photography buffs especially the domestic market segment, the Indonesian, Thai, Vietnam, Philippines in ASEAN and the China and India market segments in the international sector can be developed and harnessed to effect Fraser's Hill visitor arrivals.
3. That it makes good sense to develop unique and strategic relations between Fraser's Hill and Genting Highlands

Table 1 Visitor Arrivals to Fraser's Hill and Genting Highlands (2015- Jan-Sep2019)

No	Destination	2015	2016	2017	2018	2019
1	Fraser's Hill	115,785	123,483	127,612	103,649	101,899
2	Genting Highlands	6,399,688	8,320,798	9,130,023	7,951,907	8,468,609

Table 2 Comparison of Visitor Arrivals based on International, ASEAN and Domestic (Jan-Sep of 2018 and 2019)

No	Destination	International		ASEAN		Domestic	
		2018	2019	2018	2019	2018	2019
1	Fraser's Hill	3,277	3,022	2,193	1,992	98,179	96,885
2	Genting Highlands	917,974	935,097	1,512,945	1,719,623	5,520,988	5,813,889

The number of annual visitors to Genting Highlands had increased every year since its inception. Just last year in 2019, the visitor arrival is more than 20 million according to its annual report (Poh 2019). However, this has not translated to a substantial increase in nature enthusiast visitors especially from Western countries who shun Genting Highlands for obvious reasons ie. It is not a destination for nature activities. Comparatively, Fraser's Hill attracts more nature-interested Western tourists compared to Genting Highlands (Poh 2019). Many of these Western tourists are generally keener to explore Fraser's Hill pristine forests including Birdwatchers. While Genting Highlands need 'more' nature-interested visitors, Fraser's Hill would need to increase its visitor arrivals. This study aims to promote both locations as primary attractions for highland Bird watching and Primate watching combining the advantages of an untouched Bio-diverse site of Fraser's Hill and high visitor arrivals of Genting Highlands in a win-win situation. Visitors to one highland will add on and compliment the other highland to complete a good outing. Therefore making Genting Highlands more known for its forest attractions can help bring a substantial increase in tourist arrivals in Fraser's Hill via Bird watching and Primate watching.

Method of win-win: Connecting Fraser's Hill and Genting Highlands Professional Service Providers
To improve the impact of Genting Highlands for bird watching and primate watching, TREKS had established TREKS Nature Academia at Resorts World Awana that offers professional bird watching and primate watching activities and services for local and international visitors. In addition, TREKS Conservation and Eco System Preservation Initiatives help maintain the Awana IBA as well conduct daily recording of primate sightings at all IPA sites. These efforts are directed to increase awareness and participation of local visitors with the hope of attracting a substantial increase of awareness and participation of western tourists as well Asian tourists from China, South Korea, India and Indonesia.

Simultaneously, a bonding of Fraser's Hill and Genting Highlands, players in bird watching and primate watching is to be established between Ornithological Tours by Mr. KS Durai and TREKS Nature Academia. In addition, further working relationship is to be established with Professional Bird Guides who are already bringing birdwatchers and who might want to extend their services to primate watchers or add primate watching to their bird watching tours.

Method of Win-Win: Promoting a Combined Bird watching and Primate watching Package.
Visitors can begin their bird watching and primate watching escape at either Genting Highlands and end up in Fraser's Hill or vice versa, begin at Fraser's Hill and end their outing at Genting Highlands. The package will include transport, accommodation, journey meals, PA insurance, entry fees (where applicable) and professional guide fees.

Conclusion

The bird and primate diversity in Fraser's Hill and Genting Highlands are undoubtedly abundant and easy accessibility to areas to sight the birds and primates make both sites an outstanding attraction to local and international birdwatchers and primate-watchers as nature lovers. Therefore, making Genting Highlands more known for its forest attractions can help bring a substantial increase in tourist arrivals in Fraser's Hill via bird

watching and primate watching. In return, Fraser's Hill can help increase western visitors to Genting Highlands.

Acknowledgement

The authors acknowledge Prof Dr Badrul Munir Md Zain from Universiti Kebangsaan Malaysia for scientific discussion and suggestion to improve the extended abstract. We also acknowledge Mr. K.S. Durai, from Ornithological Tours for his contribution during bird and primate sightings in Frasers's Hill and En. Long Roslee bin Ngah, caretaker of the Ulu Kali Bird port for his contribution to bird sightings in Genting Highlands.

References

Poh, C. 2019. *New Development Vibrancy at Genting Highlands*. [Online]. Available at https://www.edgeprop.my/content/1619896/new-development-vibrancy-genting- highlands

Tourism Pahang. 2019. *Statistik Kedatangan Pelancong, Januari – December 2019*. [Online]. Available at http://www.pahangtourism.org.my/index.php/about-us/downloads/file/107-tourist-arrival-2019

SUSTAINABILITY

Summary of papers presented during the sustainability session:

SUS01- Perception of selected local and indigeneous communities on the establishment of a state park at the Fraser's Hill Forest Complex
Cheong, C.

Four local and indigenous communities located within and around the Fraser's Hill Forest Complex were selected to measure their awareness on the legal status of the surrounding forests and their perception on the establishment of a state park. Only 27% of respondents feel that it means that the forests are more protected and conserved. The proposed Frasers Hill state park would need to factor in the impacts on communities, taking into account their social and economic well-being. Besides that, any interventions on these communities have to be targeted to the needs of the specific community in order for it to be effective and to gain their support and buy-in.

SUS02- The willingness to pay value of conserving Fraser's Hill Forest Complex via contingent valuation method
Hong, C.W.*, Sagtia Siwan, E., Phang, Z.Y.M., Abdul Samad, A.R., & Cheong, C.

This study on the Willingness to Pay (WTP) value to conserve FHFC was conducted with the aim to provide economic justification to the Pahang State Government for the full protection of the Fraser's Hill Forest Complex as a state park due to its ecological functions such as ecotourism and water provisioning. The results of this WTP study showed that 72% (398 respondents) stated they are willing to pay to conserve FHFC regardless of the amount of the value if FHFC is gazetted as a state park. The WTP value to conserve FHFC if gazetted as a state park is between RM101 to RM193 per person per year based on perception.

SUS03- Particulate matter concentration at rural and high-altitude area: Case study in Fraser Hill
Abd Hamid, H.H.*, Uning, R., Othman, M., & Latif, M.T.

This study aims to determine the potential origin and concentrations of Particulates Matter (PM) by different sizes at Fraser's Hill Research Center, Universiti Kebangsaan Malaysia as this area is undisturbed and has fewer sources of pollution. PM levels are affected by relative humidity, temperature, and meteorological conditions. The result of this study showed that the concentration of PM had increased towards the end of sampling period with highest PM concentration during mid-night.

SUS04- The impact of land-use change on amphibians of the Titiwangsa range (Project plan)
Butler, C.W.*, Soh, M.C.K., Puan, C.L., Ahmad, N., Belabut, D., Razgour, O., Doncaster, C.P., & Peh, K.S.-H.

Amphibians are a very good indicator of environmental change. This project will investigate how changes in habitat quality affect montane amphibians in Peninsular Malaysia. Butler will use innovative methods and technology in his research to survey amphibians across a habitat-disturbance gradient and collect genetic samples. He will also model occurrence data with habitat covariates and determine the factors affecting the distribution of amphibians within the Titiwangsa Range. Additionally, this study will examine the genetic connectivity and resilience of sub-populations residing in montane forests across different geographic scales. Filling these knowledge gaps will provide the foundations for evidence-based management practices to best conserve these unique forests.

SUS05- A cost-benefit analysis of state park status for Fraser's Hill Forest Complex
Mohamad, I.S.I., & Abdul Samad, A.R.*

This study aims to establish the economic and environmental valuation of Fraser's Hill Forest Complex (FHFC) towards achieving a State Park status. The main objective of Intan's project concept is to establish how Cost Benefit Analysis (CBA) can be used to quantify the social costs and social benefits and whether the establishment of FHFC as a State Park is feasible or not. It is expected that the evaluation will contribute with empirical evidence on the underlying economic costs and benefits related to the establishment of a State Park.

SUS06- A total economic valuation of forest ecosystem services in Fraser's Hill Forest Complex
Azhar, M.Z., & Abdul Samad, A.R.*

In his project concept, the author showed that the Total Economic Valuation (TEV) approach will be used to assess the total economic value of Fraser's Hill Forest Complex (FHFC). The main objective of the project is to develop a general profile of the various ecosystem services and establish the approach of TEV. The study will use market and non-market-based valuation techniques to estimate the total economic value of FHFC. This method can avoid under-valuation of Fraser's Hill forest resources since it includes non-market values, ecological functions, and non-use benefits. Zuber's project is expected to reveal the importance to the future use value and willingness to invest for conservation and restoration of FHFC forest resources given its conservation significance.

SUS07- Fraser's Hill Research Centre, Universiti Kebangsaan Malaysia: Potential for research collaboration
Sulaiman, N.*, Che Rose, R.A., & Juhari, M.A.A.

A wide range of research were carried out at the Fraser's Hill Research Center (PPBF) such as, Land use: fragmentation of forests, urban green patches and protected areas; Chemistry and Physical: hydrology & hydrogeology, engineering biology, sedimentation, erosion and air and water quality; Bio-ecology: biological diversity of flora and fauna, bioindicator, ethnobotany, ecological functions & ecosystem health; Social Environment: ecotourism, socio-economic, recreation, public health, sustainable development, history, culture, and ethnicity. In addition, this area consists of a variety of research plots for bioengineering, insect, and herb studies. More research needs to be conducted to build the case for FHFC's protection and the author welcomes collaborations as it has the potential as a learning destination of highland tropical research.

SUS08- Performance of selected plant species on man-made slope in bio-engineering application at Fraser's Hill Research Centre, Pahang
Ahmad Tarmidzi, S.N.*, Ali Rahman, Z., Idris, W.M.R., Adam, J., Abd. Rahim, S., Lihan, T., & Juhari, M.A.A.

This study identified the performance of four plant species after the application of bioengineering at the Fraser's Hill Research Centre. Bioengineering utilizing *A. graminifolia* (aka bamboo orchid) has been proven as a viable technique (compared to three other plants) in increasing plant cover, greening barren slopes and improving the physico-chemical properties of soil as well as reducing soil erosion on slopes.

SUS09- Regeneration of Fraser's Hill: Conservation, development and management plan
Johari, M.N.*, Shariff, I.M., Kamarudin, N.A., Sahidan, N.N., Taufik, N.F.N., Che Ramli, N.F., Ilyas, A., Aziz, S., Said, S.Y., & Ramli, R.R.

The regeneration of Fraser's Hill is a concept that comprises all aspects of development benefits and potential fair distribution of economic growth. The benefits of this upgrading and development will benefit the local community, tourists, developers, and investors, including the State and Federal Government. This study explored the heritage significance of Fraser's Hill, in order to establish Fraser's Hill tourism product and branding by positive manipulation of history, culture, nature and other values, and to produce a conservationand management plan for economic development.

SUS10- Recent landslides and indicators for occurances of large scaled-old-dormant landslides in Fraser's Hill
Nazer, N.S.M., Arifin, M.H.*, Simon, N., Sulaiman, N., Hussin, H., & Azmi, A.

Dormant landslides are inactive landslides that can turn into critical geohazard incidents if reactivated. Large-scaled and old dormant landslides can transform into geo disaster, especially when lives and socio-economic interests are involved. Bukit Fraser lies along a geopotential zone for landslide movements. The geomorphological features correspond to the existence of large-scaled-old-dormant landslides with a positive sign of reactivation. This study employed geomorphological characteristics as indicative measures during the assessment of large-scaled-old dormant landslides in Bukit Fraser. Shallow landslide events that kept occurring within this area indicate the possible sign of imminent failure.

Extended abstracts for all the papers listed above:

SUS 01

PERCEPTION OF SELECTED LOCAL AND INDIGENOUS COMMUNITIES ON THE ESTABLISHMENT OF A STATE PARK AT THE FRASER'S HILL FOREST COMPLEX

Cheong, C.
World Wide Fund for Nature (WWF) Malaysia, 1 Jalan PJS 5/28A, Petaling Jaya Commercial Centre (PJCC), 46150 Petaling Jaya, Selangor, Malaysia
**Corresponding author email: ccheong@wwf.org.my*

Abstract

With a size of 82,895 ha., 95.6% of the Fraser's Hill Forest Complex (FHFC) is made up of Permanent Reserved Forests (PRF) and 4.4% state land forests. Four local and indigenous communities located within and around the Fraser's Hill Forest Complex were selected to measure their awareness on the legal status of the surrounding forests and their perception on the establishment of a state park. Through a survey involving a total of 181 respondents from three local communities from the Fraser's Hill Town Board, Kampung Muhibbah Teranum and Kampung Baharu Teras, their perception of what it means when a forest is declared as a State Park, only 27% of respondents feel that it means that the forests are more protected and conserved. The indigenous community of Pos Buntu, however, do not seem interested in the legal status of the surrounding protected forest because, to them, the forest is the source of their food and medicine. As such it is crucial that, with the lack of knowledge and understanding amongst these communities on the environmental and legal aspects of the forest they are living in, positive and constant engagements with them has to be activated as a forerunning activity towards the establishment of a state park at the Fraser's Hill Forest Complex.

Keywords: communities, legal status, perception, state park, Fraser's Hill Forest Complex

Introduction

According to the Pahang State Structural Plan 2050 (JPBD, 2017), forests make up 57% (2.05 million ha.) of the total land area of the state; out of which, 43% are Permanent Reserved Forest. Since the year 2012, WWF-Malaysia has advocate to the Pahang State Government that an area of 82,895 hectares be gazetted as the Fraser's Hill State Park (FHSP), which would encompass the existing Fraser's Hill Town Board (FHTB), state land forests and six permanent reserved forest of Sg Sia, Batu Talam, Teranum, Sempam, Rotan Tunggal and Rotan Tunggal Tambahan. This area is collectively referred to as the Fraser's Hill Forest Complex (FHFC). It lies within the Central Forest Spine and acts as a contiguous forest network, allowing movement of wildlife, linking the northern and southern forests along the Titiwangsa Range and the Selangor State Park in the south-west. 93% of the FHFC are protected either as water catchment forests and/or soil protection forests or both (NRE, 2017). With the exception of the small township within the FHTB, most of the proposed area consists of forested mountainous areas with peaks reaching almost 2,000m above sea level. It contains headwaters of major rivers that flow into the Sungai Pahang river basin which encompasses an area of 28,692 km² (JPS, 2011).

A study by the Department of Environment (DOE) in 2008 on Fraser's Hill had recommended the establishment of a State Park in Fraser's Hill by gazetting a certain portion of forests to ensure the conservation of Fraser's Hill's rich biodiversity and natural resources. The state park will not only maintain and boost Fraser's Hill as a trademark of biodiversity conservation and scientific research, but also capitalise on the full potential of Fraser's Hill as a nature-based tourism destination. This will improve the tourism industry in Fraser's Hill and, subsequently, improve the economic well-being of its population.

Besides the community in the FHTB, the study also recommends to look into passing on the economic benefits of nature-based tourism to the other communities in and around the proposed area, provided they are willing to participate. The communities that live within and around the area comprise of local and indigenous villages engaged mainly in the agriculture industry. It is therefore pertinent that demographic and socioeconomic data as well as the sentiments and awareness level of the communities living within and around the proposed park is obtained as a preamble in planning strategies involving the communities. The specific objective of this study

is to examine the level of awareness of the communities living in the surrounding FHFC on its legal status and their perception on what it means when a forest is declared as a state park.

Materials and Methods

Study Area

Four communities living within and adjacent to the Fraser's Hill Forest Complex were identified to undergo this study – the Fraser's Hill Town Board, Kampung Muhibbah Teranum, Kampung Baharu Teras and Pos Buntu. They were selected as we wanted to examine communities with dependency on different natural resources and ecosystem services; the FHTB being a tourist destination; Kampung Muhibbah Teranum, a local community; Kampung Baharu Teras, an agriculture-based community; and Pos Buntu, an indigenous community. The FHTB and Pos Buntu are located within the Fraser's Hill Forest Complex whereas Kampung Muhibbah Teranum and Kampung Baharu Teras are located adjacent to it.

Data Collection

A three-pronged approach was used to collect data and information from these locations. Preliminarily, key informant interviews were carried out at all four locations to gauge their response towards the impending household survey and to gather rough estimates on the number of households in the community. Following up on this, focus group discussions (FGD) were carried out, basically to understand the general sentiments of the community and develop in-depth understanding of key issues as seen by the community, which may not be captured by the survey. Data collection was carried out through personal interviews using the survey questionnaire which has been pilot-tested for all selected communities, except one. In Pos Buntu, Participatory Rural Appraisal (PRA) tools were utilised on the community to gather information as a group. PRA is an approach of data collection which has sets of participatory and largely visual techniques used in assessing group and community resources by incorporating opinions and knowledge of rural communities. This decision was made at the preliminary meeting with key informants in Pos Buntu, during which it was agreed that information from the indigenous people community will be gathered through a more conversational, visual and collective medium. Only data on basic information of respondents and household demography were obtained after the meeting using the survey questionnaires.

Results and Discussion

A total of 201 households (or respondents) were surveyed using the questionnaires with, FHTB 55; Kampung Muhibbah Teranum 22; Kampung Baharu Teras 104; and Pos Buntu 20. In our efforts to mitigate possible bias, inaccuracy and influence on the data collected, the enumerators have ensured that the respondents surveyed are not from the same household or immediate family members within that community.

Level of awareness on the legal status of the forest surrounding their homes.

The survey was aimed to examine the knowledge of the people living in areas surrounding the forest reserves to see if they are aware of its legal status. The accepted answers are Forest Reserve, Permanent Forest Reserve and Protected Forest; while answers that are viewed as incorrect or vague include Virgin Forest, Fully Controlled Forest, State Forest, Highland Forest, State Park, Normal Forest, Not Being Fully Protected, and Status under Wildlife Department.

From the results, as illustrated in Figure 1, an average of 56% of all the respondents interviewed are knowledgeable on the legal status of the forests surrounding their home; whether it is a protected forest, forest reserve or permanent forest reserve. On the other hand, an average of 44% of the respondents either do not know; did not specify what they said they know; or thought they know (when they answered incorrectly) on the legal status of the forests surrounding their homes. 56% of the respondents from the FHTB are knowledgeable on the legal status, possibly due to numerous engagements in environmental activities on recycling, environmental legislations, ecosystem services, climate change, ecotourism and nature guiding by WWF-Malaysia in the past years. Kampung Muhibbah Teranum recorded the highest percentage (64%) of respondents who are knowledgeable on the legal status of the forest around them. Much of the forested land adjacent to and near Kampung Muhibbah Teranum had been cleared for agricultural activities and the issue of deforestation has somehow captured their attention to be aware of the legality of these clearings. Unlike

the Fraser's Hill Town Board and Kampung Muhibbah Teranum community, the Kampung Baharu Teras community is a predominantly farming community, possibly responsible for the clearing of the forested areas around the area, including adjacent to nearby Kampung Muhibbah Teranum. They were very uncooperative during interviews and a large portion of them declined to answer certain questions, especially those related to the land status and environmental issues. This has led us to believe that it is possible that they may be very well aware of the legal status of the land they are encroaching in.

During the multiple focus group discussions and key informant interviews, as well as the application of Participatory Rural Appraisal (PRA) tools at the community meeting in Pos Buntu, some of the villagers admitted that they have cleared areas of land for farming purposes to provide food for the growing family when asked about the forest surrounding the village. Although some admitted that clearing up forested land is wrong, the legal status of the protected forest surrounding them seems to be of no interest to the residents of Pos Buntu.

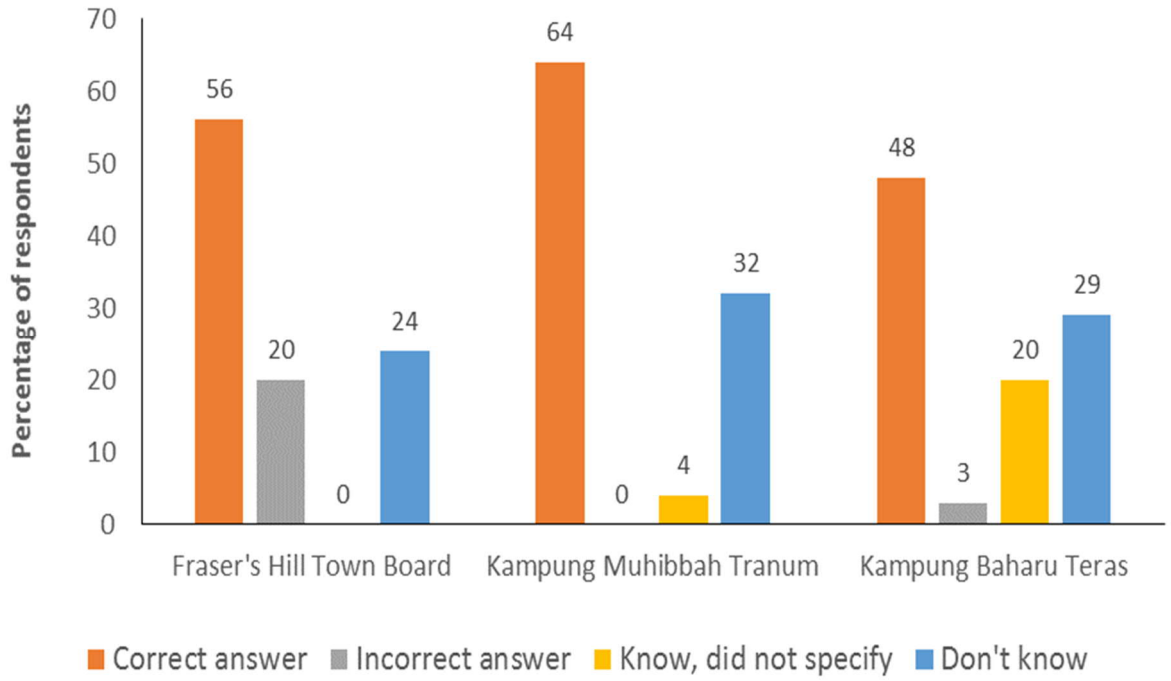


Figure 1. Knowledge on the legal status of forest surrounding respondents home.

Perception on what it means when an area is declared a State Park.

The respondents were asked if they know what it means when a forest is declared as a State Park to assess if they are able to understand the role that a state park plays. A summary of common responses from respondents of the three communities is captured in Figure 2. An average of 13% of the respondents have no idea or are not sure what a state park means. However, one very striking and common response garnered by an average of 27% of the respondents feel that a state park means that the forests are more protected and conserved. The other responses such as no trespassing; restricted access; stricter law enforcement; no illegal activities such as forest and land clearing; better forest management; no logging; no poaching; and wildlife is protected – all characteristics of a state park, recorded a total average of 32%. Overall, more than half (59%) of the respondents have a general idea of what a state park means and entails.

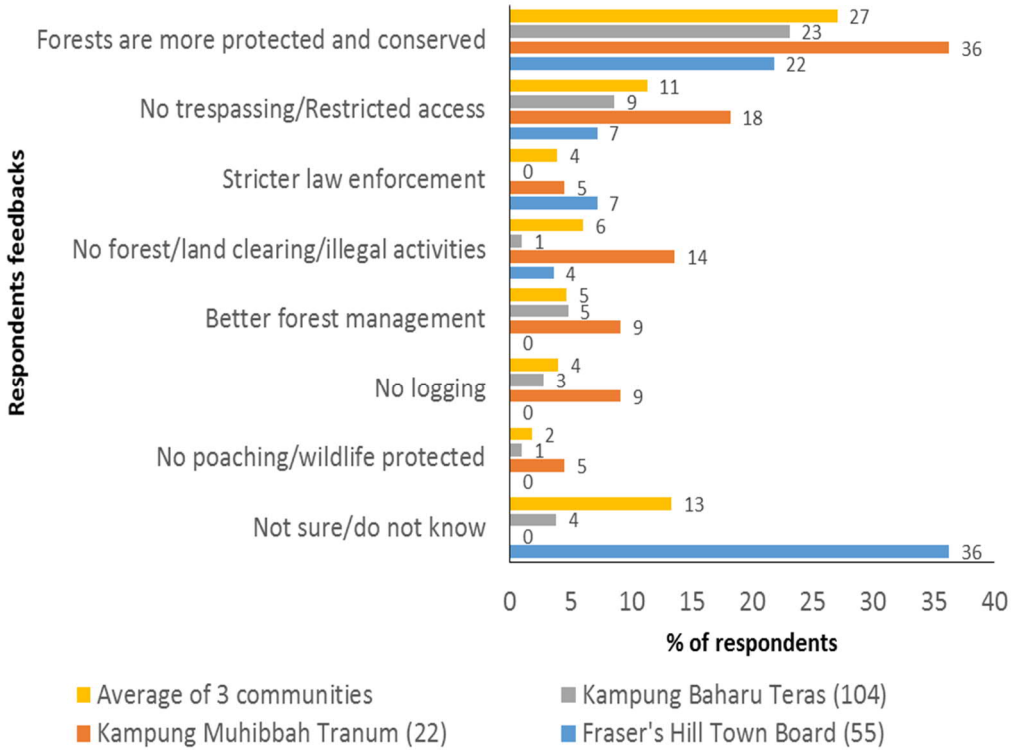


Figure 2. Summary of responses on what it means when an area is declared as a State Park.

The Semais of Pos Buntu still practices communal food production and sharing economy. The Pos Buntu community rely strongly on the natural resources for food, water, medicine, fiber, fuel and income generation. However, they also live under a traditional system that gives respect to nature. Although the relationship between society and forest is different in a traditional Orang Asli belief system from the modern society, with major differences in the areas of access to food and medicinal resources in the forested areas, the Pos Buntu community is aware of the threats facing the forested areas, as well as the linkages between pollution and weather pattern changes. Most of nature education is delivered by the elders to the younger generations informally, through narratives, superstitions and traditional rules.

Recommendations

Considering that the Fraser's Hill Town Board residents and the community at Pos Buntu are going to be living in a state park, they will be the most impacted with the establishment of the state park in their day to day activities such as permits at entrances, job opportunities, communications and legal issues. Their awareness, engagement and buy-in will have a meaningful impact in the development and decision making processes in the establishment of a state park. It will possibly trigger the community to be more engaged to ensure that their interests are taken care of and make the FHSP a participatory community-driven project instead of wholly handled by government agencies or authorities.

The residents of Kampung Muhibbah Teranum and Kampung Baharu Teras, though living adjacent to the FHFC, are the direct beneficiaries of the natural resources and ecosystem services of the FHFC. The Kampung Baharu Teras community is a predominantly farming community. It was clear that farming activities especially in the production of the highly-prized 'Musang King' durians are given priorities above any other activities such as ecotourism or agrotourism. The community has a low rate of interest on environmental knowledge and awareness specifically on their dependency on a thriving and healthy forest for a profitable production of durians. Positive and constant engagements to deliver environmental awareness on local issues amongst the school children and subsequently, the larger community need to be prioritised.

The poverty in Pos Buntu is undeniable, with average household income estimated at RM200 per month. Towards the end of the year, between September and December, is the hunger period, where income generation is limited. Complimentary economic activities such as ecotourism can be introduced as an alternative income to tide over the lean period. There is a need to expose the community to the potential they have in developing a successful ecotourism product. Visits, training and sharing sessions with other Orang Asli communities who are already generating good income from ecotourism, such as the Orang Asli groups in Royal Belum State Park and Taman Negara, would be a good exposure to them.

Conclusion

Communities are the grassroots and guardians of nature as they thrive and depend on the natural resources and ecosystem services that nature provides. The impacts that they will face when their surrounding area is gazetted as a state park will be different in terms of their social and economic well-being and hence, their support and buy-in is crucial. As such, any early interventions on these communities, be it education and awareness; capacity building; or participatory engagements have to be targeted to the needs of the specific community for it to be effective.

Acknowledgements.

The author wishes to acknowledge the report on "A Sociological Survey of the Local and Indigenous Communities Within and Around the Proposed Fraser's Hill State Park and Its Surrounding Forests" commissioned by WWF-Malaysia for this paper. Deep appreciation goes to the respondents from the four communities for their cooperation and patience during the survey as well as the key informants for providing valuable information and anecdotes especially Tok Batin Amran and Pak Lok of Pos Buntu. Thanks also goes to the four enumerators from Universiti Malaya who had tirelessly collected data from the four communities and a special note of thanks goes to Maizura binti Ismail and Ahmad Afandi bin Nor Azmi who had spearheaded and facilitated the PRA session at Pos Buntu. Last but not least, a heartfelt appreciation goes to PPG Industries, Jebsen and Jessen and WWF-Malaysia who had made this survey possible through their generous funding.

References

DOE. 2008. *Development Coordination Study in Bukit Fraser, Pahang*. Department of Environment (DOE), Putrajaya.

JPBD. 2017. *Rancangan Struktur Negeri Pahang 2050*. PLANMalaysia@Pahang, Jabatan Perancang Bandar dan Desa Negeri Pahang.

JPS. 2011. *Review of the National Water Resources Study (2000-2050) and Formulation of National Water Resources Policy. Volume 12 – Pahang.* Jabatan Pengairan dan Saliran, Kementerian Air, Tanah dan Sumber Asli.

NRE. 2017. *A Master List of Protected Areas in Malaysia – A Tool for National Biodiversity Conservation Management and Planning.* Ministry of Natural Resources and Environment, Putrajaya, Malaysia.

WWF-Malaysia. 2015 (u.p). *A Sociological Survey of the Local and Indigenous Communities Within and Around the Proposed Fraser's Hill State Park and Its Surrounding Forests.* WWF-Malaysia, Petaling Jaya.

SUS 02

THE WILLINGNESS TO PAY VALUE OF CONSERVING FRASER'S HILL FOREST COMPLEX VIA CONTINGENT VALUATION METHOD

Hong, C.W.[1]*, Sagtia Siwan, E.[1], Phang, Z.Y.M.[1], Abdul Samad, A.R.[2], & Cheong, C.[1]
[1]World Wide Fund for Nature (WWF) Malaysia, 1 Jalan PJS 5/28A, Petaling Jaya Commercial Centre (PJCC), 46150 Petaling Jaya, Selangor, Malaysia
[2] Faculty of Economics and Management, Universiti Putra Malaysia,
Jalan Universiti 1 Serdang, 43400 Seri Kembangan, Selangor
**Corresponding author email: cwhong@wwf.org.my*

Abstract

The Fraser's Hill Forest Complex (FHFC) is located in the district of Raub in the state of Pahang which covers a total area of 82,895 ha. and comprises the Fraser's Hill Town Board (FHTB), state land forest and six Permanent Reserved Forests. This study on the Willingness to Pay (WTP) value to conserve FHFC was conducted with the aim to provide economic justification to the Pahang State Government for the full protection of the Fraser's Hill Forest Complex as a state park due to its ecological functions such as ecotourism and water provisioning. Two Contingent Valuation Method (CVM): open-ended and iterative bidding, was used to estimate the WTP value. A total of 554 respondents comprising the local community and tourists of Fraser's Hill and its surrounding forest complex were recorded in this study. The study showed that, out of the total 554 respondents, a total of 398 respondents (72%) were 'willing to pay', if Fraser's Hill Forest Complex is gazetted as a State Park, giving values of RM101 and RM193 per person per year respectively. The WTP value can be used as a future guideline for management recommendations or planning of tourism-based fees in Fraser's Hill Forest Complex.

Keywords: Fraser's Hill Forest Complex, willingness to pay, contingent valuation method, state park

Introduction

1.1 Background: Fraser's Hill Forest Complex

The Fraser's Hill Forest Complex (FHFC) is located in the district of Raub in the state of Pahang. In view of the rich biological assets and ecological functions that this forest complex contributes to the people of Malaysia, WWF-Malaysia has placed this forest as one of its priority conservation areas. At 82,895 ha., the FHFC comprises the Fraser's Hill Town Board (FHTB), state land forest and six Permanent Reserved Forests of Batu Talam, Sungai Sia, Rotan Tunggal, Rotan Tunggal (Tambahan), Sempam and Tranum.

The FHFC houses the tributaries of some of the major rivers that flow into Sungai Pahang, the longest river in Peninsular Malaysia with a total catchment area of 29,300 km², is the main source of potable water supply and irrigation for the state (JPS, 2011).

With regards to the richness of biodiversity in FHFC, Kiew (1998) has found that Fraser's Hill is home to 952 species of seed plants including 36 species which are endemic - only found in Fraser's Hill and more than 260 bird species have been recorded here. An assessment of mammals using camera traps conducted in the forested areas around the Fraser's Hill Town Board by WWF-Malaysia revealed almost 30 species of mammals including the melanistic leopard, dhole, Sunda pangolin, clouded leopard, Malayan tapir and the Malayan sun bear (Sagtia Siwan & Cheong, 2018).

Tourism, as a service sector that provides revenue for the state economy as well as the local communities, is the highest contributor to the Pahang state gross domestic product (GDP) of 47% in 2015 and has envisaged a growth to 63% by 2050 (JPBD, 2017). Ranked 12th on tourist arrivals among the 21 Pahang tourist destinations in the year 2018 (Tourism Pahang, 2019), its ecotourism niche is birdwatching and coupled with the cool and natural tranquillity of this hill station, makes it attractive to tourists who wish to escape the lowland heat and urban living.

1.2 Rationale

In order to entice the international ecotourism market, a healthy and thriving natural environment is the prerequisite for any sustainable and appealing ecotourism destination (Bramwell and Henry, 1996). When these ecotourism sites and activities are managed sustainably, and if coupled with the branding of a State Park; the Fraser's Hill Forest Complex will be an internationally sought-after ecotourism destination that is sustainable and enriching for the tourists.

1.3 Objectives

This study is one of the various studies to assess the value of ecosystem services to provide justification to the Pahang State Government on the economic viability they will stand to gain if Fraser's Hill is gazetted as State Park.

The objectives of this study are to:

a) Evaluate/determine the willingness-to-pay value of Fraser's Hill Forest Complex if gazetted as a State Park;

b) Provide economic justification in terms of the public's willingness to pay for its ecological functions (ecotourism, water provisioning, biodiversity) to the Pahang State Government to gazette the Fraser's Hill Forest Complex as a State Park.

The willingness-to-pay value derived via contingent valuation method is a representation of the non-tangible value in 'Ringgit Malaysia' based on the perception of respondents should the Fraser's Hill Forest Complex be gazetted as State Park.

Methods and Materials

2.1 Methods in Conducting Willingness-to-Pay Study in Fraser's Hill Forest Complex

Willingness-to-Pay (WTP), which is a CVM tool, is used to determine the maximum amount an individual is willing to sacrifice to procure a good/services or avoid something undesirable. The WTP of an individual is based on the stakes, income, awareness and knowledge about a particular item/services/place etc. which, in the case of this study is the gazettement of the Fraser's Hill State Park.

A total of two sets of survey questionnaires (named as 'Set A' and 'Set B') were designed to conduct the WTP survey. Set A was based on 'close-bidding' double dichotomous which starts at RM100 per year, subsequently increasing or reducing the bid by RM50 per year and the maximum amount they are 'willing to pay'. Set B was based on 'open-bidding' followed by a maximum amount willing to be paid. Other information such as socio-economic information, number of times they have visited main places of interest such as Fraser's Hill Town Board, Raub Town and Lata Lembik Forest Eco Park; and reasons on the willingness to pay were included in the survey.

2.2 Methods of Analysis

Linear regression calculation method was applied to determine the willingness-to-pay value. This value would also serve to provide guidelines for authorities to plan and manage fee structures for various economic activities and facilities in FHFC. As there were two sets of survey questionnaires, two different analyses will be carried out. Based on similar study with two different sets of questionnaires (close-bidding and open-bidding) by Puan *et al.* (2005) on contingent valuation on highland forest, the derived two values of willingness to pay, will be interpreted as a range to determine the final willingness-to-pay value.

Results and Discussion

3.1 Willingness to Pay (WTP) Value to Conserve Fraser's Hill Forest Complex

Due to invalid responses from 11 respondents, only a total of 554 surveys were accepted out of a total of 565 surveys garnered. Out of the total 554 surveys, a total of 287 respondents were administered with the Set A questionnaires while the remaining 267 respondents were administered with the Set B questionnaires.

Overall, based on the data collected (Figure 1), out of the 554 respondents, a majority of 398 respondents (72%) stated that they are willing to pay to conserve Fraser's Hill Forest Complex, regardless of the amount of the value, if Fraser's Hill is gazetted as a State Park. Prior to the WTP section in the questionnaire, respondents were presented and provided with an explanation by trained volunteers on the profile of Fraser's Hill and the forest complex; its rich biodiversity; and their important role in ecosystem services such as water provisioning and ecotourism. The respondents were also briefed about the advantages to gazette Fraser's Hill Forest Complex as State Park and in this case, a value is needed via a WTP survey.

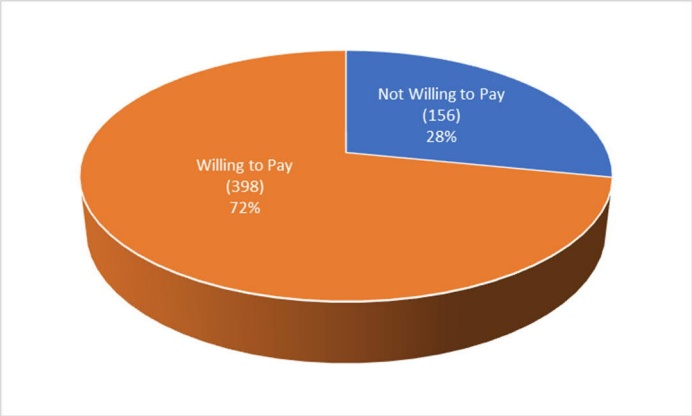


Figure 1: Overall Percentage of Willingness to Pay among Respondents (N=554)

The willingness-to-pay value for conserving the Fraser's Hill Forest Complex as a State Park was derived from the maximum amount of Willingness to Pay by using the linear regression calculation. The independent and quantifiable variables for the calculations were total monthly income, age, years of education, no of times been to Fraser's Hill, Lata Lembik Forest Eco Park and Raub Town, Pahang.

Based on the linear regression calculations, on an annual basis for the year 2018, Table 1 shows that the WTP Values to conserve FHFC if gazetted as a State Park are **RM101 per person per year** via Set A Close-Bidding method; and **RM193 per person per year** via Set B Open-Bidding method.

A similar study by Puan *et al.* (2005) was conducted with two different sets of questionnaires (close-bidding and open-bidding) on contingent valuation on highland forest, the derived two values of willingness to pay, was interpreted as a range to determine the final willingness-to-pay value. Similarly, in this study, the willingness to pay to conserve Fraser's Hill Forest Complex, if gazetted as a State Park, is **between RM101 to RM193 per person per year.**

Table 1: Value of Willingness to pay for conservation of Fraser's Hill Forest Complex in the year 2018

Year 2018	
Willingness-to-pay value of FHFC	
Set A (Close-Bidding method)	Set B (Open-Bidding method)
RM101 per person per year	**RM193 per person per year**

Conclusion and Recommendations

This study has managed to assess and establish a baseline on the willingness-to-pay value of the Fraser's Hill Forest Complex if it is gazetted as a State Park, via the contingent valuation method using the Willingness to Pay (WTP) tool. The value of conserving Fraser's Hill Forest Complex was obtained via a willingness to pay survey on the local community, international and local visitors and tourists. Independent significant tests have found that there was significance in the maximum amount of WTP for those who are residents of Fraser's Hill, property owner, nationality of respondents and those who are concerned about the current state of the environment. These significant results have shown that the respondents in these parameters are willing to pay to conserve the Fraser's Hill Forest Complex if it is gazetted as a State Park. The willingness-to-pay value derived can be used as a future guideline for management recommendations or planning of tourism-based fees

in Fraser's Hill. Due to the willingness to pay to conserve FHFC, we would recommend that FHFC be gazetted as a State Park.

It is recommended that updates on WTP studies could be conducted in the future as the willingness-to-pay value of this study is derived based on the year 2018 and there may be changes in the willingness to pay over time due to economic, political, environmental perceptions and health factors.

Acknowledgements

WWF-Malaysia would like to thank the authorities of Tourism Pahang/Fraser's Hill Development Corporation and Raub District Council for their support and permission to conduct surveys on the tourists and local communities of Fraser's Hill Town Board, Lata Lembik Forest Eco Park, Kampung Orang Asli Pos Buntu and Raub, Pahang. The study on the Willingness-to-Pay Value of Fraser's Hill was made possible with generous public donation to WWF-Malaysia. We would also like to express our gratitude to Dr. Puan Chong Leong from the Faculty of Forestry, Universiti Putra Malaysia for providing his expertise and advice on the Willingness to Pay Study, and Dr. Abdul Rahim bin Abdul Samad from Faculty of Economics and Management, being an economic expert, for verifying the validity of the results of this study. Not forgetting our fellow colleagues, Ms Saradambal Srinivasan, Lead of Policy Analyst and Ms Zara Phang, Sustainable Economy and Policy Analyst for providing feedback and comments for this report. Last but not least, a heartfelt appreciation to the graduates and undergraduate students from the University of Nottingham Malaysia Campus, Universiti Sains Malaysia, Universiti Malaya and Universiti Malaysia Sabah, who had volunteered in one way or another in the survey.

References

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., & Schuman, H. 1993. *Report of the NOAA panel on Contingent Valuation. National Oceanic and Atmospheric Administration (NOAA)* Publisher. Accessed on July 2018: <https://www.researchgate.net/publication/235737401_Report_of_the_NOAA_panel_on_Contingent_Valuation>

Bramwell, B., & Henry, I. 1996. 'A Framework for Understanding Sustainable Tourism Management' in Bramwell B. et al. (eds), *Sustainable Tourism Management: Principles and Practice*, Netherlands, Tilburg University Press.

Kiew, R. 1998. *The seed plant at Fraser's Hill, Peninsular Malaysia with special reference to its conservation status*. Forest Research Institute Malaysia, Kepong. Research Pamphlets No. 121.

JPBD. 2017. *Rancangan Struktur Negeri Pahang 2050*. PLANMalaysia@Pahang, Jabatan Perancang Bandar dan Desa Negeri Pahang.

JPS. 2011. *Review of the Natural Water Resources Study (2000-2050) and Formulation of National Water Resources Policy – Volume 12 - Pahang*. Jabatan Pengairan dan Saliran, Kuala Lumpur, Malaysia.

Puan, C.L., Mohamed Zakaria, Abdul Ghani A.N., & Abdullah Mohd. 2005. Contingent Valuation of a Malaysian Highland Forest: Non-market Benefits Accrued to Local Residents. *Journal of Applied Sciences,* 5, pp9 26-919.

Sagtia Siwan, E., & Cheong, K.M. 2018. *Phase 2 Biodiversity Assessment at Fraser's Hill via a Camera Trapping Study*. Petaling Jaya, Malaysia: WWF-Malaysia. Unpublished.

Tourism Pahang. 2019. *Statistics of Tourist Arrival (January to December 2018)*. Official Portal of Tourism Pahang, Tourism Pahang. Accessed on May 2019: <https://www.pahangtourism.org.my/index.php/about-us/downloads/file/96-tourist- arrival-2018>

SUS 03

PARTICULATE MATTER CONCENTRATION AT RURAL AND HIGH-ALTITUDE AREA: CASE STUDY OF FRASER HILL

Abd Hamid, H.H.[1]*, Uning, R.[2], Othman, M.[3], & Latif, M.T.[2]
[1]Faculty of Science and Technology, University Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[2]Centre of Earth Sciences and Environment, Faculty of Science and Technology, University Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[3]Institutes for Environment and Development (LESTARI), University Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
**Corresponding author email: haris@ukm.my*

Abstract

Particulate matter (PM) is one type of pollutant in the atmosphere that can affect human health. PM exists in several sizes and originates from anthropogenic and natural sources. This study aims to determine the potential origin and concentrations of PM by different sizes at Fraser's Hill Research Center Universiti Kebangsaan Malaysia as this area is undisturbed and has fewer sources of pollution. Continuous measurement of PM was conducted from April 2019 until September 2019 using continuous PM sensors which include PM with different diameters: < 10 µm (PM_{10}), < 2.5 µm ($PM_{2.5}$) and < 1 µm (PM_1) using AS-LUNG V.2 Outdoor. In addition, CO_2 concentration was also measured. The result shows that all PM concentration was below 90 μgm^{-3}. An increase in PM concentration was observed in August 2019 which was influenced by biomass burning and transboundary haze episodes that occurred in Peninsular Malaysia and those originated from Sumatra, Indonesia.

Keywords: $PM_{2.5}$, PM_{10}, PM_1, Fraser's Hill, high altitude

Introduction

Air pollution has been identified as a major risk factor of human health for all ages (WHO 2016, Hernández et al. 2018). Deterioration of air quality especially in developing countries and developed countries was suggested to be contributed by the increase of urbanisation and industrialisation processes such as the rapid increase in numbers of motor vehicles especially in the urban area (Vardoulakis et al. 2003, Hernández et al. 2018). Moreover, pollution caused by particulate matter (PM) especially PM with a size of less than 2.5 µm ($PM_{2.5}$) poses more serious air pollution problems in Southeast Asia (Ly et al. 2018).

Materials and Methods

PM monitoring was conducted at Fraser's Hill Research Center Universiti Kebangsaan Malaysia (latitude 3°43'5.87"N, longitude 101°43'44.93"E) from April to September 2019. Fraser Hill is located at the Pahang State at an altitude around 1500 m. Measurement of PM_{10}, $PM_{2.5}$ and PM_1 with carbon dioxide (CO_2) was performed using AS-LUNG Outdoor V2 optical sensor.

Result and Discussion

The highest concentration of PM_{10}, $PM_{2.5}$ and PM_1 was observed in September 2019 with an average value of 51.0 ± 12.8 μgm^{-3}, 43.4 ± 11.1 μgm^{-3} and 28.0 ± 5.90 μgm^{-3}, respectively. Moreover, in August 2019 the average concentrations were 67.2 ± 13.7 μgm^{-3} for PM_{10}, 56.8 ± 15.4 μgm^{-3} for $PM_{2.5}$ and 36.5 ± 8.77 μgm^{-3} for PM_1. The average 24 hr concentrations of PM_{10}, $PM_{2.5}$, PM_1 and CO_2 in September and August 2019 are exhibited in Figures 1 and 2.

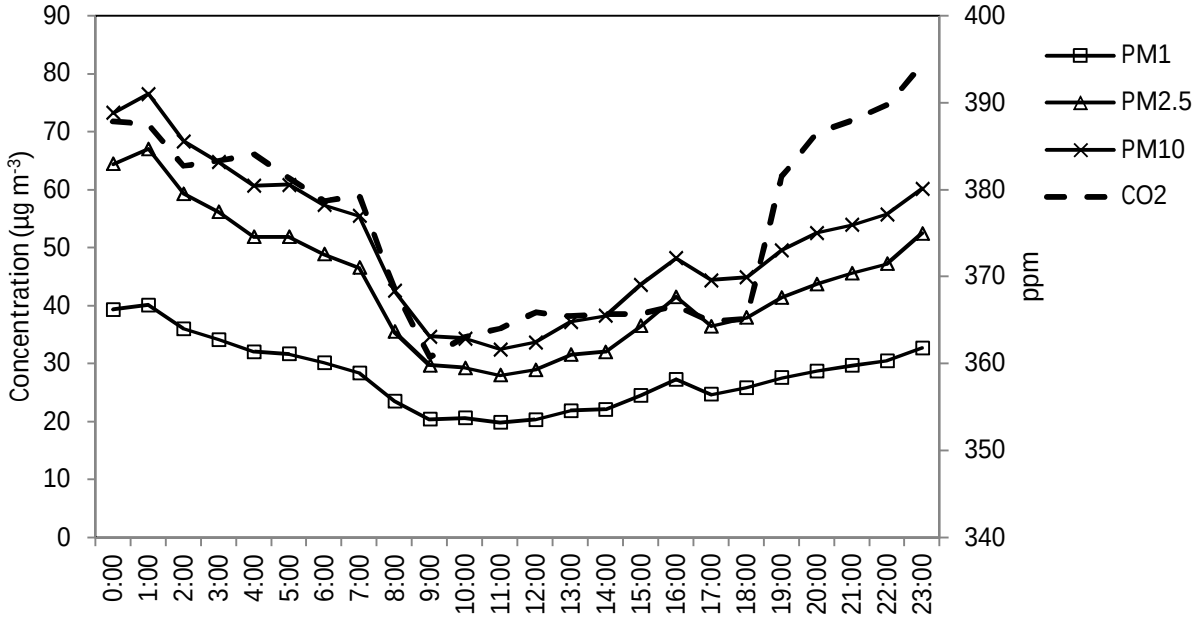


Figure 1. Trend of PM_{10}, $PM_{2.5}$, PM_1 and CO_2 in September 2019

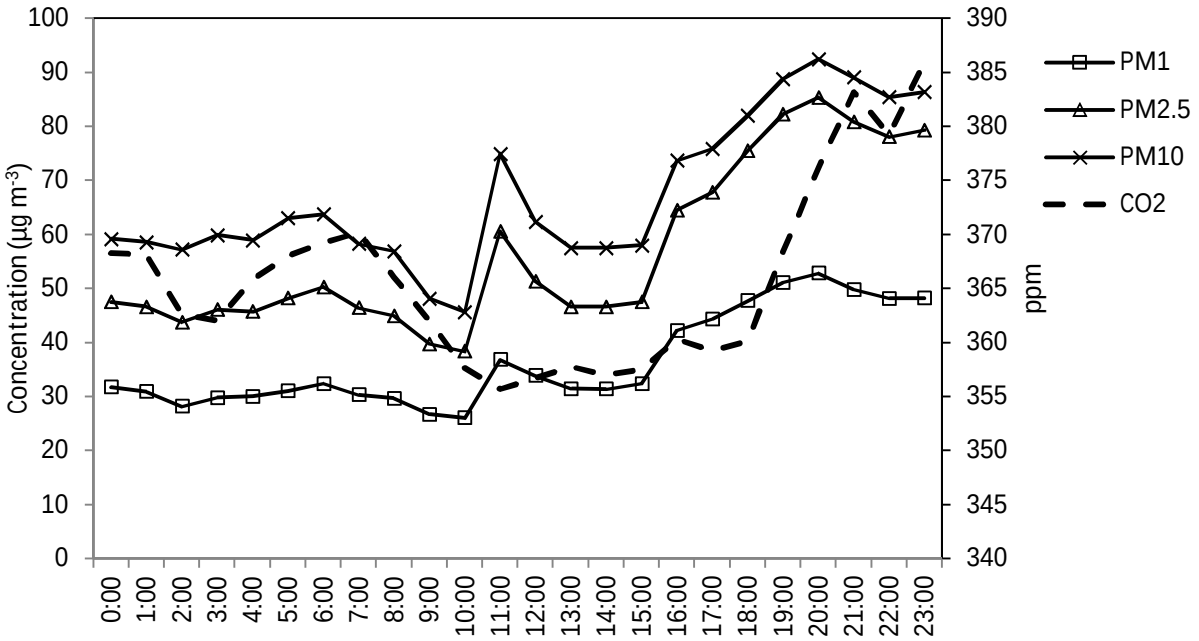


Figure 2. Trend of PM_{10}, $PM_{2.5}$, PM_1 and CO_2 in August 2019

Overall, all PM parameters measured in this study were lower than the New Malaysia Ambient Air Quality Standard for Interim Year 2 (2018) (DOE, 2013). However, increased concentration of PM was observed starting from August to September 2019 which suggested the influence by long-range transportion of air pollutants from Sumatra and Kalimantan in Indonesia due to biomass burning activity.

Conclusion

The concentration of PM had increased from towards the end of sampling period with highest PM concentration during mid-night. Highest concentration of PM_{10}, $PM_{2.5}$ and PM_1 in September was concluded to be influenced by long range transportion of pollutants particularly from Sumatra and Kalimantan.

References

Department of Environment DOE Malaysia. 2013. http://www.doe.gov.my/portalv1/wp-content/uploads/2013/01/Air-Quality-Standard BI.pdf, Last accessed: 8th January 2021

Hernández, R.O., Campa Verdona, A.M.S., Fulvio, A., Alejandra, R.C.J., Rojas, N., & Rosa, J.D. 2018. Chemical composition and source apportionment of PM10 at an urban background site in a high–altitude Latin American megacity (Bogota, Colombia). *Environmental Pollution* 233: 142-155.

Ly, B.T., Matsumi, Y., Nakayama, T., Sakamoto, Y., Kajii, Y., & Nghiem, D.T. 2018. Characterizing $PM_{2.5}$ in Hanoi with new high temporal resolution sensor. *Aerosol and Air Quality Research* 18(9): 10.4209.

Vardoulakis, S., Bernard, F. Koulis, P., & Norbert, G.E. 2003. Modelling air quality in street canyons: A review. *Atmospheric Environment* 37: 155-182.

World Health Organization WHO. 2016. *World Health Statistics*. Geneva, WHO.

SUS 04

THE IMPACT OF LAND-USE CHANGE ON AMPHIBIANS OF THE TITIWANGSA RANGE (PROJECT PLAN)

Butler, C.W.[1]*, Soh, M.C.K.[2], Puan, C.L.[3], Ahmad, N.[4], Belabut, D.[5], Razgour, O.[6], Doncaster, C.P.[1], & Peh, K.S.-H.[1,7]
[1]School of Biological Sciences, University of Southampton, Southampton, United Kingdom.
[2]National Parks Board, Singapore.
[3]Faculty of Forestry, Universiti Putra Malaysia, Serdang, Malaysia.
[4]School of Environmental & Natural Resource Sciences, Universiti Kebangsaan Malaysia, Selangor, Malaysia.
[5]Institute of Biological Sciences, University of Malaya, Kuala Lumpur, Malaysia.
[6]University of Exeter, Exeter, United Kingdom.
[7]Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, United Kingdom.
**Corresponding author email: C.W.Butler@soton.ac.uk*

Abstract

Southeast Asia's montane forests are understudied and there remains a global knowledge gap on the impacts of land-use change on montane species - particularly amphibians. This project will therefore investigate how changes in habitat quality affect montane amphibians in Peninsular Malaysia. To achieve this, we will survey amphibians across a habitat-disturbance gradient and collect genetic samples. We will model occurrence data with habitat covariates and determine the factors affecting the distribution of amphibians within the Titiwangsa Range. Additionally, this study will examine the genetic connectivity and resilience of sub-populations residing in montane forests across different geographic scales. Filling these knowledge gaps will provide the foundations for evidence-based management practices to best conserve these unique forests.

Keywords: amphibia, deforestation, titiwangsa, montane

Introduction

Anthropogenic activities, exacerbated by climate change, are destroying tropical rainforests globally at alarming rates. The conversion of primary forest into agricultural and human-dominated landscapes threatens biodiversity and the functions that underpin the ecosystem services they provide (Mace et al. 2012). This "sixth extinction wave" has seen the extirpation of species and populations, along with declines in local abundance (Dirzo et al. 2014). The extinction rate of vertebrates is notably up to 100 times higher than the background rate (Ceballos et al. 2015), with amphibians considered to be among the most threatened (IPBES 2019). A growing body of work has quantified the impact of land-use change on tropical ecosystems and has shown that responses vary across groups (Pineda et al. 2005, Rovero et al. 2014, Faria et al. 2007), disturbance type (Gibson et al. 2011, Palmeirim et al. 2017), and elevation (Peters et al. 2019, Sundqvist et al. 2013, Ferger et al. 2017). Conclusions derived from taxonomic groups in lowland forests may not be representative of those in high-elevation montane forests. Climatic environment varies with elevation and this may mitigate or exacerbate the effects of climate and land-use change on biodiversity (Peters et al. 2019). With the majority of terrestrial ecological studies in Southeast Asia undertaken in lowland forests (Peh et al. 2011) and a lack of amphibian ecological studies in Southeast Asia's tropical montane forests (Soh et al. 2020), there is a need to understand the impact of land-use change on amphibians in these unique montane ecosystems.

This study aims to answer the following questions: (1) How does the richness of montane amphibian species differ over a land-use gradient? (2) Which environmental factors are drivers of amphibian distribution? (3) Which landscape barriers are causing genetic isolation of populations?

Materials and Methods

Study Sites

This study is confined to areas above 1,000 m a.s.l. along the Titiwangsa Mountain Range in Peninsular Malaysia. The range runs continuously, like a spine, from the north to south of the country and encompasses the majority of Peninsular Malaysia's montane forest. In order to sample broadly across the habitat-disturbance gradient, we will sample 12 sites across three regions along the range: at Fraser's Hill, Cameron Highlands, and Lojing Highlands. These regions are selected because they have nearby road access and

contain a gradient of agricultural and forested habitats. Fieldwork is to be undertaken from April – December 2020.

Survey Methods

Visual encounter surveys (Crump & Scott, 1994) and pitfall trapping with drift fences (Bury & Corn, 1987) will be undertaken along 48 transects of 200 m length, distributed among existing trails at the sites. We will capture all amphibians and record weight, snout-vent length, and sex (where possible). Toe-clips will be taken to identify individual animals and to collect genetic samples for population genetic analysis.

Many anuran species in Peninsular Malaysia's montane forests have identifiable mating and territorial calls. This permits the use of bioacoustic methods to collect occupancy data. The limitation of this method is that commercial acoustic loggers are expensive and large ($800, 680 g without batteries). Many researchers and NGOs cannot afford to purchase and deploy the number of recorders needed to make a study worthwhile. A team at University of Southampton has taken up this challenge by developing a low-cost, open-source acoustic logger called 'AudioMoth', which is cheap and small ($49, 10 g) yet comparable to commercial devices in acoustic acuity (Hill et al. 2018, Prince et al. 2019, Pina-Covarrubias et al. 2018). We will therefore assess the feasibility of using AudioMoth recorders to study montane anurans in Malaysia.

Conclusion

The relatively steep terrain of tropical montane forests has historically given them protection, though as the encroachment of agriculture increases in lowland forests, deforestation has progressed into higher elevations. To understand the effects of this expansion, this project aims to determine the factors affecting the distribution of anurans in the montane forests of Peninsular Malaysia and provide recommendations for their conservation.

Acknowledgements

We thank the United Kingdom's National Environmental Research Council (NERC) and the University of Southampton's SPITFIRE Doctoral Training Program for providing the postgraduate research scholarship for C.W. Butler (NE/L002531/1) and to the Mohamed Bin Zayed Species Conservation Fund, Auckland Zoo, and Genetics Society for providing the funding for fieldwork. Additional thanks to the Economic Planning Unit (West Malaysia) for granting our research permit (Reference number UPE 40/200/19/3517).

References

Bury, R.B., & Corn, P.S. 1987. Evaluation of Pitfall Trapping in Northwestern Forests - Trap Arrays with Drift Fences. *Journal of Wildlife Management*, 51: 112-119.

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., Garcia, A., Pringle, R.M., & Palmer, T.M. 2015. Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science Advances* 1: e1400253.

Crump, M.L., & Scott, M.J. 1994. Visual Encounter Surveys. In: Heyer W. R., Donnelley, M. A. McDiarmid, R. W., Hayek, L. C. & Foster, M. S. (eds). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*, pp 84-91. Washington, USA: Smithsonian Institution.

Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J.B., & Collen, B. 2014. Defaunation in the Anthropocene. *Science* 345: 401-406.

Faria, D., Paciencia, M.L.B., Dixo, M., Laps, R.R., & Baumgarten, J. 2007. Ferns, frogs, lizards, birds and bats in forest fragments and shade cacao plantations in two contrasting landscapes in the Atlantic forest, Brazil. *Biodiversity and Conservation* 16: 2335-2357.

Ferger, S.W., Peters, M.K., Appelhans, T., Detsch, F., Hemp, A., Nauss, T., Otte, I., Bohning-Gaese, K., & Schleuning, M. 2017. Synergistic effects of climate and land use on avian beta-diversity. *Diversity and Distributions* 23: 1246-1255.

Gibson, L., Lee, T.M., Koh, L.P., Brook, B.W., Gardner, T.A., Barlow, J., Peres, C.A., Bradshaw, C.J.A., Laurance, W.F., Lovejoy, T.E., et al. 2011. Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature* 478: 378-381.

Hill, A.P., Prince, P., Covarrubias, E.P., Doncaster, C.P., Snaddon, J.L., & Rogers, A. 2018. AudioMoth: Evaluation of a smart open acoustic device for monitoring biodiversity and the environment. *Methods in Ecology and Evolution* 9: 1199-1211.

IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019. *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*.

Mace, G.M., Norris, K., & Fitter, A.H. 2012. Biodiversity and ecosystem services: a multilayered relationship. *Trends in Ecology & Evolution* 27, 19-26.

Palmeirim, A.F., Vieira, M.V. & Peres, C.A. 2017. Herpetofaunal responses to anthropogenic forest habitat modification across the neotropics: insights from partitioning beta-diversity. *Biodiversity and Conservation* 26: 2877-2891.

Peh, K.S.-H., Soh, M.C.K., Sodhi, N.S., Laurance, W.F., Ong, D.J., & Clements, R. 2011. Up in the Clouds: Is Sustainable Use of Tropical Montane Cloud Forests Possible in Malaysia? *Bioscience* 61: 27-38.

Peters, M.K., Hemp, A., Appelhans, T., Becker, J.N., Behler, C., Classen, A., Detsch, F., Ensslin, A., Ferger, S.W., Frederiksen, S.B., et al. 2019. Climate-land-use interactions shape tropical mountain biodiversity and ecosystem functions. *Nature* 568: 88-92.

Pina-Covarrubias, E., Hill, A.P., Prince, P., Snaddon, J.L., Rodgers, A., & Doncaster, C.P. 2018. Optimization of sensor deployment for acoustic detection and localization in terrestrial environments. *Remote Sensing in Ecology and Conservation* 5: 180-192.

Pineda, E., Moreno, C., Escobar, F., & Halffter, G. 2005. Frog, bat, and dung beetle diversity in the cloud forest and coffee agroecosystems of Veracruz, Mexico. *Conservation Biology* 19: 400-410.

Prince, P., Hill, A., Covarrubias, E.P., Doncaster, P., Snaddon, J.L., & Rogers, A. 2019. Deploying Acoustic Detection Algorithms on Low-Cost, Open-Source Acoustic Sensors for Environmental Monitoring. *Sensors-Basel* 19.

Rovero, F., Menegon, M., Fjeldsa, J., Collett, L., Doggart, N., Leonard, C., Norton, G., Owen, N., Perkin, A., Spitale, D., et al. 2014. Targeted vertebrate surveys enhance the faunal importance and improve explanatory models within the Eastern Arc Mountains of Kenya and Tanzania. *Diversity and Distributions* 20: 1438-1449.

Soh, M.C.K., Mitchell, N.J., Ridley, A.R., Butler, C.W., Puan, C.L., & Peh, K.S.-H. 2020. Impacts of Habitat Degradation on Tropical Montane Biodiversity and Ecosystem Services: A Systematic Map for Identifying Future Research Priorities. F*rontiers in Forests and Global Change* 2 (83): 1-18.

Sundqvist, M.K., Sanders, N.J., & Wardle, D.A. 2013. Community and Ecosystem Responses to Elevational Gradients: Processes, Mechanisms, and Insights for Global Change. *Annual Review of Ecology, Evolution, and Systematics*, 44: 261-280.

SUS 05

A COST-BENEFIT ANALYSIS OF STATE PARK STATUS FOR FRASER'S HILL FOREST COMPLEX

Mohamad, I.S.I., & Abdul Samad, A.R.*
School of Business and Economics, Universiti Putra Malaysia
**Corresponding author email: abdrahim_as@upm.edu.my*

Abstract

This concept paper aims to establish the economic and environmental valuation of Fraser's Hill Forest Complex (FHFC) towards achieving a State Park status. Fraser's Hill is a highland eco-tourism destination located among the mountains of Pahang in the central region of Peninsular Malaysia. The forest area within the Fraser's Hill Forest Complex includes six Permanent Reserved Forests. However, the fragile ecosystems within FHFC are being threatened by illegal collection of plants and invertebrates, pollution, climate change, logging, and deforestation activities. In order to overcome these issues, the gazettement of FHFC to a State Park will help improve the management effectiveness of the forested areas. Cost-benefit analysis (CBA) is an analytical tool to evaluate investments and supports policy decisions for society's welfare and environment. The main objective is to establish how CBA can be used to quantify the social costs and social benefits and whether the establishment of FHFC as a State Park is feasible or not. We would obtain the socio-economic and environmental effects associated with the State Park status. It is expected that the evaluation will contribute with empirical evidence on the underlying economic costs and benefits related to the establishment of a State Park. It is recommended that the social costs and benefits of economic and environmental values need to take into consideration in changing the FHFC status towards a State Park status.

Keywords: cost-benefit analysis, Fraser's Hill, state park, conservation, eco-tourism

Introduction

Malaysia has always been widely known for their travel and ecotourism attractions. It is also known that Malaysia is located in the equatorial region and has a tropical climate. The weather in Malaysia is hot, humid, and rainy throughout the year. According to the World Development Indicators, Malaysia has an immeasurable large quantity of biodiversity of flora and fauna species hence, makes it one of the richest countries in the world for their biodiversity. Therefore, Malaysia has always been widely known for their travel and ecotourism attractions which are dominating the service sector that contributes to the country's economy.

Malaysian rainforest eco-region consists of various types of forest. According to WWF-Malaysia (2020), there are lowland dipterocarp forests, hill dipterocarp forests, upper hill dipterocarp forests, oak-laurel forests, montane ericaceous forests, peat swamp forests and mangrove forests. These also include freshwater swamp forest, heath forest, forest on limestone and forest on quartz ridges. The Main Range or Titiwangsa Range is the main mountain range that forms the backbone of Peninsular Malaysia and is also an important source of water for the whole of the Peninsula. WWF-Malaysia (2020) reported that the rivers from highland forests supply nearly 90% of the peninsula's water needs. Some of the forests in Fraser's Hill Forest Complex (FHFC) also serve as water catchment areas to supply water for the two large river systems in Malaysia which are Sungai Pahang and Sungai Selangor.

Fraser's Hill is one of the major highland forests in Peninsular Malaysia. It is located on the mountains of the Titiwangsa Range in the central region of Peninsular Malaysia. It is also known for its highland resort destination and extensive birdlife. It is widely known as a premier birdwatching site and internationally acknowledged as an Important Bird Area (Birdlife International, 2020). Cheong (2013) claimed that Fraser's Hill is home to a diverse species of flora which comprises more than 10% of most plants found in Peninsular Malaysia. It is also home to a variety of fauna species comprising the endangered mammals such as Malayan tiger, Malayan tapir and Malayan sun bear.

However, the FHFC ecosystem is being threatened by illegal collection of plants and invertebrates, pollution, climate change and unsustainable development activities. This forest complex is vulnerable to other threats

including unsustainable deforestation and logging activities, tourism activities and unethical waste disposal. Slight changes in climate may greatly affect the wildlife abundance and biodiversity in the montane forest ecosystem. In order to overcome these issues, gazetting the FHFC to a State Park will ensure the improvement in the management effectiveness of the forest area. Hence, there is a need to conduct a study on the association of social costs and social benefits whether the establishment of FHFC as a State Park is feasible or not.

Materials and Methods

Data collection

This study will be using primary data that will be collected from Fraser's Hill in Pahang. The data required will be collected using a questionnaire survey and distributed to on-site visitors and local residents. Their perceptions will allow the assessment on the costs and benefits of the state park status of FHFC.

Cost-benefit analysis (CBA)

Once all the information needed is gathered, the data will be analysed using cost-benefit analysis. Cost-benefit analysis (CBA) will be used to evaluate investments and support policy decisions for society's welfare and environment. It is to assess the overall impacts on the change to state park status. Conducting CBA can be done in nine steps as shown below:

Step 1: Set the scope of study

The first step in conducting CBA is to identify primary stakeholders affected by the state park change of status and to understand their concerns and interests.

Step 2: Select the portfolio of alternative projects

The next step is to select the portfolio of alternative projects. For an example in this study, should we establish FHFC into a state park status or not? This option must be then compared against the "without project" to assess the difference in social costs and social benefits associated.

Step 3: Catalogue potential costs and benefits

Next is to identify the physical impact categories of the alternatives, catalogue them as benefits or costs and specify the measurement indicator of each impact category.

Step 4: Adjust financial process into economic prices

The economic analysis typically requires removing policy distortions by translating market prices into "shadow prices."

Step 5: Attach monetary values to environmental and social impacts

These values are measured in terms of "willingness to pay" (WTP). Many impacts are difficult to monetise as they are not traded or priced in markets.

Step 6: Discount costs and benefits to obtain present values

Costs and benefits that occur in the future need to be converted into present value terms. In most situations, analysts are given a specific discount rate that the public authorities apply to all public investment decisions.

Step 7: Compute net present value of each alternative

The net present value (NPV) equals the present value of benefits minus the present value of costs. Choose the alternative with the largest NPV as it represents a more efficient allocation of resources.

Step 8: Perform sensitivity analysis

Sensitivity analysis helps decision makers to assess how these uncertainties can affect the CBA results.

Step 9: Recommend an option

The last step is to select a recommendation with the highest NPV with taking into account the sensitivity analysis.

Results and Discussion

Upon completion of CBA, this study will be helpful to assess the feasibility of the state park gazettement by identifying and monetizing every potential cost and benefit, come up with a plan of action and request financial support that would endorse this decision. A literature review by Misuraca (2014) found that CBA is viable to help public administrators evaluate complex solutions, provide consistency in their analysis, and assist any alternative decisions comparison.

Conclusion

The outcome of CBA will determine which decision is the best for the society and the environment. If the decision of establishing FHFC as a state park has the highest NPV and assessed with sensitivity analysis, then the decision will be recommended as it is proven feasible. Therefore, it is recommended that the social costs and benefits of economic and environmental values need to be taken into consideration in gazetting the FHFC as a state park.

Acknowledgement

We would like to express our sincere gratitude to WWF-Malaysia and the Scientific Committee of Fraser's Hill Symposium for their willingness to provide guidance, comments, and suggestions throughout the study.

References

Cheong, C. 2013. *Fraser's Hill – A Lush Highland Hideaway*. WWF-Malaysia, Petaling Jaya.

WWF-Malaysia. 2020. *Fraser's Hill.* Retrieved from http://www.wwf.org.my/

BirdLife International. 2020. *Country profile: Malaysia*. http://www.birdlife.org/datazone/country/malaysia. (accessed 10 November 2020)

Ministry of Natural Resources and Environment. 2006. *Biodiversity in Malaysia*. Retrieved from http://www.kats.gov.my/

Misuraca, P. 2014. *The effectiveness of a costs and benefits analysis in making federal government decisions: A literature review.* The MITRE Corporation.

SUS 06

A TOTAL ECONOMIC VALUATION OF FOREST ECOSYSTEM SERVICES IN FRASER'S HILL FOREST COMPLEX

Azhar, M.Z., & Abdul Samad, A.R.*
Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia
**Corresponding author email: abdrahim_as@upm.edu.my*

Abstract

Total Economic Valuation (TEV) is a concept in Cost-Benefit Analysis (CBA). This framework is widely used in many studies to assess economic values of ecosystem services provided at one place. In this concept paper, we show that the TEV approach will be used to assess the total economic value of Fraser's Hill Forest Complex (FHFC). FHFC consists of six Permanent Reserved Forests within the area and has a huge flora and fauna diversity. It is a river basin and water provider of an area as big as 83 thousand hectares. FHFC also provides ecotourism services due to its vast flora and fauna diversity. The main objective of the paper is to develop a general profile of the various ecosystem services and establish the approach of TEV. The study will use market and non-market based valuation techniques to estimate the total economic value of the FHFC. This method can avoid under-valuation of Fraser's Hill forest resources since it includes non-market values, ecological functions, and non-use benefits. It is expected that this study would reveal the importance on the future use value and stakeholders would be willing to make investment for conservation and restoration of FHFC forest resources given its conservation significance.

Keywords: total economic valuation, ecological function, Fraser's Hill, conservation

Introduction

Policymakers and economic analysts need economic values to produce efficient and effective policies or regulations. Economic value of a country is often calculated using Gross Domestic Product or GDP. If the GDP of a country goes up, economists will assume that the economic value of that country is increasing. Total Economic Valuation (TEV) is a concept in Cost-Benefit Analysis (CBA). This framework is widely used in many studies to assess economic values of ecosystem services provided in one place. In this concept paper, we show that the TEV approach will be used to assess the total economic value of Fraser's Hill Forest Complex (FHFC).

The main objective of the paper is to develop a general profile of the various ecosystem services and establish the approach of TEV. The study will use market and non-market based valuation techniques to estimate the total economic value of the FHFC. This method can avoid under-valuation of the forest resources since it includes non-market values, ecological functions, and non-use benefits. It is expected that this study would reveal the importance of future use values and stakeholders would be willing to make investments for conservation and restoration of FHFC forest resources given its conservation significance in increasing and attracting more foreign investors. For environmental economists, they need to assess the economic values of natural resources, infrastructures that may harm the environment and man-made heritage resources. Since they do not have monetary value, several methods are developed by economists to put value on them so that the economic value can be calculated. One of the methods is Total Economic Valuation or TEV. TEV is a concept in Cost-Benefit Analysis (CBA) used by environmental economists to calculate the economic value of a given ecosystem. In the TEV concept the environmental value is categorised into several categories; use value, non-use value, and option value.

In this paper, we will use TEV to evaluate the economic value of Fraser's Hill Forest Complex (FHFC). FHFC is a forest complex located in Pahang, Malaysia. This forest complex consists of six Permanent Reserved Forests, Fraser's Hill Town Board and state land forests and covering an area of approximately 83 thousand hectares of land. FHFC is famous for its fauna diversity. According to Cheong (2013), there are three species of mammals within FHFC; Malayan Tapir, Siamang and Malayan Tiger that are endangered by IUCN Red List of Threatened Species 2013. Apart from that, other mammal species spotted in FHFC include macaques, langurs, Sunda slow loris and a variety species of squirrels (Baker, 2013). FHFC also has a large flora diversity in its ecosystem such as different species of pitcher plants, fossil ferns and many other species that can only

be found in certain places. FHFC is also the provider of not less than ten rivers available in Selangor and Pahang (Cheong, 2013). According to the Department of Statistics (2010), there are around 1,000 people living within the Fraser's Hill Town Board. With a large forest ecosystem and biodiversity, FHFC has been attracting local and foreign tourists to enjoy ecotourism at FHFC. The main tourism attraction is bird watching and other potential ecotourism activities such as jungle trekking, camping, and river rafting. Apart from that, within the land of FHFC, there are other land use for other activities such as logging, mining, agriculture and infrastructures.

The main objective of the paper is to develop a general profile of the various ecosystem services found with the study area. Each of the ecosystem services needs to be categorised according to their profile. After that, TEV can be established to determine the economic value of the FHFC within the scope of its ecosystem services. To calculate TEV, a monetary value of every benefit provided by FHFC needs to be established, and to do so, we need to assess every ecosystem service to put the right value so that there will be no issue in under-valuing or over-valuing.

TEV is expected to reveal the real economic value of FHFC and how FHFC is important both economically and environmentally to the state. This will attract many investors to invest in FHFC and also attract Pahang State's Government to conserve this precious forest complex as an investment and accept the proposal to gazette FHFC as a State Park.

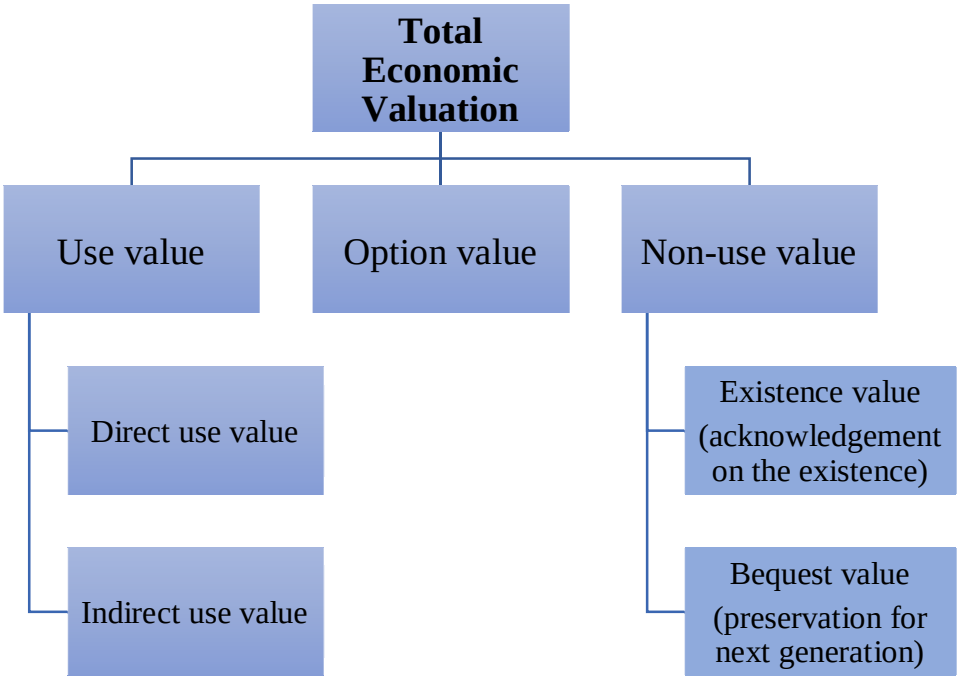
Materials and Methods

Primary data

The type of data that will be used in this paper is primary data. Most of the data to be acquired will be through a survey with the local communities. The preferences of the local communities will be used to examine the value of the ecosystem services of FHFC. After all the data has been acquired, TEV of FHFC can be calculated and analysed. Policymakers and economists can evaluate the FHFC value to make regulations or investments based on the findings. The result may support the proposal to gazette the FHFC as a state park.

Total Economic Value (TEV)

Total Economic Valuation method is used in this paper to assess the economic value of ecosystem services provided by FHFC.



(Note: Adapted from Grant et al, 2013.)

Figure 1. The Total Economic Value (TEV) framework for valuation of ecosystem services

Below are the six steps of performing TEV (Baral et al, 2016).

1. Listing all the values of FHFC; use value, option value and non-use value.
2. Sort the value according to the category.
3. After that, decide the appropriate and practical valuation method to use.
4. Select the dates and prepare the instrument for the survey.
5. Collect data using survey questionnaires.
6. After collecting the data needed, the ecosystem services can be quantified and analysed.

Results and Discussion

Upon completion of this TEV of forest ecosystem services of FHFC, this study will be helpful to assess the value of the ecosystem services provided by FHFC. The economic value is expected to be significantly large and will attract many local and foreign investors to invest in this forest complex. This paper also will help policymakers to make policies and regulations to avoid market failure. The result of this paper will support the proposal to change FHFC to a state park status so that exploitation of the resources within the forest can be controlled.

Conclusion

The outcome of this paper will support the decision of the establishment of FHFC as a state park. The result of this paper will show the economic value of FHFC ecosystem services which has been unaware of by the communities as well as the state government. Failure to recognise the existence of such economic value in the ecosystem services will result in market failure as there is no compensation paid for these services provided by FHFC. Therefore, we hope that the results of this study will encourage the Pahang State government to gazette the FHFC as a State Park which will benefit not only the surrounding communities' social and economic welfare but to the Pahang State government as well.

Acknowledgement

We would like to express our deepest appreciation to the Worldwide Fund for Nature, Malaysia (WWF-Malaysia) for their kindness to provide support, guidance and comments throughout the study.

References

Akhter, S. 2014. *Economic Valuation of Eco-Tourism Resources in Pulau Perhentian Marine Park, Malaysia*.

Baker, N. 2013. *The Nature of Fraser's Hill; Mammals*. Malaysian Wildlife Photography. http://malaysianwildlifephotography.blogspot.com/2013/05/the-nature-of-frasers-hill-mammals.html

Baral, S., Basnyat, B., Khanal, R., & Gauli, K. 2016. A total economic valuation of wetland ecosystem services: an evidence from Jagadishpur Ramsar site, Nepal. *The Scientific World Journal*, 2016.

Cheong, C. 2013. *Fraser's Hill-A Lush Highland Hideaway*. WWF-Malaysia, Petaling Jaya.

Grant, S.M., Hill, S.L., Trathan, P.N., & Murphy, E.J. 2013. Ecosystem services of the Southern Ocean: trade-offs in decision-making. *Antarctic Science*, *25*(5), 603-617.

WWF Malaysia. *Fraser's Hill*. http://www.wwf.org.my/

SUS 07

FRASER`S HILL RESEARCH CENTER, UNIVERSITI KEBANGSAAN MALAYSIA: POTENTIAL FOR RESEARCH COLLABORATION

Sulaiman, N.[1,2]*, Che Rose, R.A.[1,3], & Juhari, M.A.A.[1]
[1]Fraser's Hill Research Center, [2]Department of Biological Science and Biotechnology,
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
[3]Geography Programme, Center for Research in Development, Social and Environment,
Faculty of Social Science & Humanities, Universiti Kebangsaan Malaysia
**Corresponding author email: vozela@ukm.edu.my*

Abstract

Fraser's Hill Research Center (PPBF), Universiti Kebangsaan Malaysia (UKM) was established in 1990 after UKM was granted the land title by the Pahang State Government in 1989. The area covers 2.832 hectare and is located in Mukim Tras, Raub, Pahang. This area, located adjacent to the Jeriau waterfall, is populous with unique and attractive highland flora and fauna. Monthly rainfall of the area is between 20 to 410 mm with air temperature between 18 to 28°C and humidity of 85 to 95%. The areas of research are: Land use: fragmentation of forests, urban green patches and protected areas; Chemistry and Physical: hydrology & hydrogeology, engineering biology, sedimentation, erosion and air and water quality; Bio-ecology: biological diversity of flora and fauna, bioindicator, ethnobotany, ecological functions & ecosystem health; Social Environment: ecotourism, socio-economic, recreation, public health, sustainable development, history, culture and ethnicity. There are many facilities in PPBF which includes an office building with a display gallery and a meeting room, basic utilities such as toilets, bathroom, store and kitchen. There are also jungle trails or denai that includes Denai Puncak Jeriau (Point Rhu Bukit, Point Liparis, Puncak Jumaat, Point Anggerik Mutiara & Puncak Jeriau), Denai VIP, Denai Air, Denai Air Terjun and Denai Nursery as well as a campsite and an open-air mini theater. In addition, this area consists of a variety of research plots for bioengineering, insect and herb studies. There are a lot of opportunities for biodiversity research in PPBF. The center welcomes all researchers to carry out their research at PPBF.

Keywords: Fraser's Hill Research Center, biodiversity, environment, social, physical

Introduction

Fraser's Hill is one of the most popular highland retreats for local and foreign tourists in Peninsular Malaysia. It is an attractive destination with cool air as well as its past colonial features such as Tudor-style architecture and English village atmosphere. Hence Fraser's Hill is known as the *Little England* (Rosniza Aznie et al. 2019). Fraser's Hill Research Center (PPBF), Universiti Kebangsaan Malaysia (UKM) was established to meet the needs of research and provide research facilities to researchers and students, in particular SMEs and researchers from other universities within and outside Malaysia. The PPBF covers 2.832 ha. of land adjacent to the 45 ha. of research area (the land was granted by the Pahang State Government in 1989) including the indigenous montane virgin forest.

This research centre covers the edge of forest, riparian, stream, valleys and mountain ridges that contains a variety of habitats rich in flora and fauna that are unique and interesting. The centre is located at a latitude of 3° 40.6 'N, longitude 101° 42.99' E at an elevation of 1002 meters above sea level. PPBF is located near the Jeriau Waterfall. It is built on the embankment at an altitude of 950 m near the lower montane forest, covering hills as high as 1200 m. The daily temperature varies between 18 ºC to 28 ºC, thus a heaven for a cool respite. This area receives monthly rainfall between 20 to 410 mm with relative humidity between 85% to 95%.

History of the establishment of the Fraser Hill Research Center

In the early stage of establishment in the 1990s, some construction work was carried out, these included investigation sites, road pavement up to the Center for research and a gabion stone wall along 20 m to control erosion at the top. A single-storey building was built as an office and laboratory space with two bathrooms. Unfortunately, there was no electricity and water supply at that time. In 1997, construction was interrupted as a result of the economic downturn in Malaysia.

Between 1997 to 1999, all research activities and maintenance of PPBF was funded by the provisions of IRPA No 08-02-02-0007 for the project "Restoration of Degraded Upland Ecology Sites'. The project was led by Prof. Dr. Noraini Mohd Tamin, who was also the Chairman and Coordinator for PPBF then. During this period, the area around the laboratory building was cleared, soil erosion controlled and safety ropes installed all the way down to the Green River. In addition, several ornamental tree species were planted, including surian stone tree, palms and wild orchids. However, a huge landslide occurred in November 1999. The University had to rehabilitate the site in respect of the implementation and the provisions of the campus next to PPBF, which has become the focus of a rapid investigation.

The PPBF had several changes of chairman. From 2007 to 2013, the management of PPBF was taken over by Prof. Dr. Jumaat Haji Adam (2007-2013), Dr. Tukimat Lihan (2014-2016) and since 2017, Associate Professor Dr. Norela Sulaiman. PPBF had implemented various activities to achieve its objectives such as teaching, research and eco-tourism. Both undergraduate and postgraduate students were also engaged in various research activities. Community activity such as for school children around Fraser`s Hill and Raub to get to know the flora and fauna in the vicinity of PPBF was conducted through sponsorship from various agencies. Research networks including inter-faculty networks at UKM and intervarsity such as Universiti Teknologi Malaysia (UTM) were also established. Among the international research networks are the Smithsonian Tropical Research Institute, Panamá, República de Panamá, Czech University of Life Sciences Prague, The Czech Republic and University of Kassel, Germany.

The flora in Fraser's Hill is rich in diversity with a mosaic of flowering plants, mosses, ferns, gingers and parasitic plants. Thus far, a total of 36 endemic species (Kiew 1998) are found within Fraser's Hill. The relatively undisturbed jungle and cool climate attract over 257 species of migratory and residential birds (Strange 2004). Given the above scenario and the aims to enhance highland tourism in Malaysia, there is a need to study the prospects of Fraser Hill attractions in order to embark on potential research collaborations in the future.

Results and Discussion

Facilities

Since then, PPBF has been developed and upgraded with basic facilities for research and fieldwork students. Water supply is obtained from a nearby river with the construction of small dams where water collected is pumped into the collection tank before use. Many facilities had been developed such as kitchen, storeroom, extra toilet, pavilions, site huts, and trails for research purposes at PPBF. There are also several research plots for bioengineering (slope recovery studies involve *Syzygium campanulatum*, *Mucuna* sp, *Arundina graminifolia, Arachis pintoi, bambusa* sp.), Nepenthes species collection from all over Peninsular Malaysia, insects as well as for medicinal herbs.

There are five trails or denai in Fraser's Hill Research Center ranging from easy to difficult terrain. These include Denai Puncak Jeriau (Point Rhu Bukit, Point Liparis, Puncak Jumaat, Point Anggerik Mutiara & Puncak Jeriau), Denai VIP, Denai Air, Denai Air Terjun and Denai Nurseri (Figure 1). The purpose of these trails are meant for research, education and ecotourism. The different trails with varying levels of difficulty would cover nearly the entire spectrum of different fitness levels. Along these trails, many species of flora and fauna could be identified and would be a haven for nature lovers. The trails alone can be a distinct eco-destination but not much has been done to promote them either at the local or international ecotourism market with the exception of the International Bird Race. Most of them who do know about these trails are nature lovers. These five trails are well maintained and show very little signs of stress.

Flora and Fauna

The knowledge-based attractions allow Fraser's Hill to have its own identity in research and soft-ecotourism activities. In addition, education-based ecotourism activities can also be developed for Fraser's Hill. This center provides an indoor interactive facility to learn more about the highland's flora and fauna. The educational role of bringing public awareness on the beauty and the need to conserve the highland forest for the current and future generations is carried out effectively by our enthusiastic staff. This is especially so for school children who are often on school field trips. Apart from being a research site, Fraser's Hill can be a

venue for people to visit and observe the monuments related to the high officers of the colonial times at the tourist center.

Four types of birds can be found in PPBF, they are *Pycnonotus atriceps* (Headed Bulbul), *Zoothera interpres* (Capped Thrush), *Harpactes duvaucelii* (Rumped Trogon) and *Buceros rhinoceros (*Rhinoceros Hornbill). Apart from this, two species of frog, *Megophrys nasuta (*Malayan horned) and *Chiromantis marginis* (Border frog) can also be found here. The Rajah Brooke's birdwing (*Troides brookiana*) which is the national butterfly of Malaysia and tree nymphs or paper butterflies (*Idea stolli*) are among the protected butterfly species (listed under Appendix ii of CITES, i.e. international export is restricted to those who have been granted a permit) found at this site. *Attacus atlas* and *Lyssa zampa* which are amongst the largest moths in the world are also found here.

Besides that, flora such as *Labisia pumila* (Kacip Fatimah), *Zingiber sp.* (Tepus hutan), *Nepenthes sanguinea* (Periuk kera), *Anoectochilus albolineatus* (Mutiara orkid), *Dipteris conjugata* (Payung ali), *Arundina graminifolia* (Orkid buluh) are also found in PPBF. There are three types of moss, namely *Leucobryum aduncum, Ectropothecium buitenzorgii and Pogonatum neesii* and four types of fruits, *Lithocarpus sp.* (Mempening), *Castanopsis inermis* (Berangan), *Pinanga sp.* (Pinang hutan), *Barringtonia racemosa* (Putat air), and *Artocarpus* sp. (Keledang bangkong) found on this site.

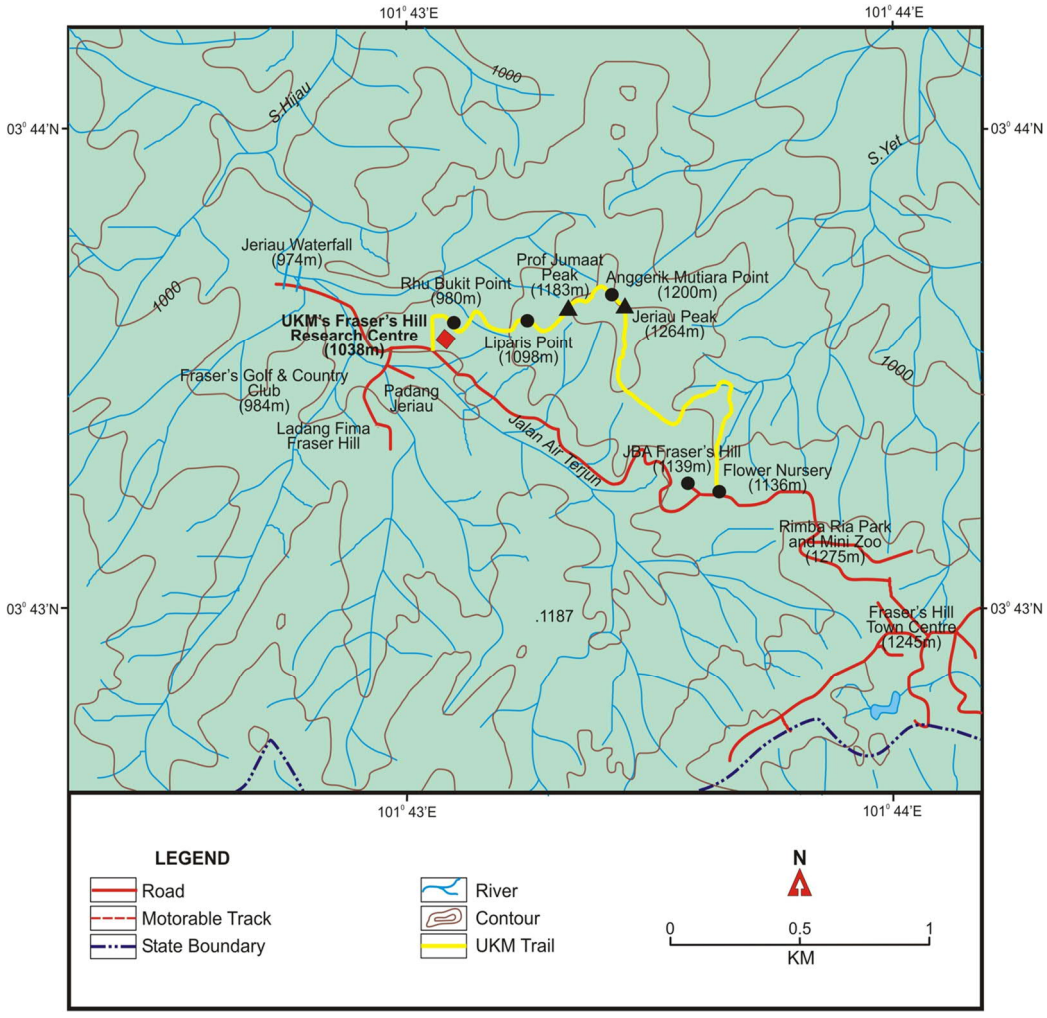


Figure 1: Location of trails and denai at Fraser's Hill Research Center

Eco-tourism at Raub-Bukit Fraser Corridor

Fraser's Hill has been positioned by Fraser's Hill Development Corporation as 'The Little England'. Its British colonial history and legacy has left behind quaint old stone cottages and a nine-hole golf course. The Tudor-styled architecture is left imprinted on almost all building facades in Fraser's Hill. Some of the bungalows have a charming garden which is reflective of an English country house.

Based on tourist arrivals to Pahang 2013-2017 (January to December) for Fraser Hill increased from 2013 (120,828 tourists) to 2017 (127,612 tourists) (Portal Data Terbuka Malaysia 2019). This has opened up more opportunities to generate income through ecotourism. Highland tourism is regarded as one of the potential prospects to accelerate growth in the tourism industry, which contributes 35% to our economy. Since the Ninth Malaysia Plan (2006-2010), the Malaysian government has continued to promote and develop ecotourism as outlined in the National Ecotourism Plan. The main focus is to ensure equal growth and sustainable development without depriving the location and types of attraction as well as the nature-based highland destination at PPBF. Therefore, ecotourism activities act as one of the activities for PPBF financial generation.

In PPBF, there are many studies carried out by researchers from all over Malaysia. These include Land use: fragmentation of forests, urban green patches and protected areas; Chemistry and Physical: hydrology & hydrogeology, engineering biology, sedimentation, erosion and air and water quality; Bio-ecology: biological diversity of flora and fauna, bio-indicator, ethnobotany, ecological functions & ecosystem health; Social Environment: ecotourism, socio-economic, recreation, public health, sustainable development, history, culture and ethnicity.

These studies have been published in local and international journals. Proceedings and books were also published through several scientific expeditions organised by PPBF which include social studies, diversity of flora and fauna and studies on the physical environment of Fraser's Hill. The latest books published are `Ekopelancongan dan sosioekonomi Bukit Fraser-Raub Pahang` (Rosniza Aznie & Norela 2019) and `Bukit Fraser Kepelbagaian Biologi & Persekitaran Fizikal (Norela & Mohd Afiq 2020). It is hoped that more expeditions can be carried out to increase the record of biological diversity and the current environment of Fraser's Hill be preserved.

Conclusions

In order to promote PPBF, Universiti Kebangsaan Malaysia as an education hub, Fraser's Hill can be gazetted as a highland learning destination. Besides working with local and international universities in monitoring climate change, new research on issues of highland tourism can be explored in this area, thus, permitting a wider collaboration between local and international universities. There are a lot of opportunities for biodiversity research in PPBF. The center welcomes researchers to join all research activities at PPBF.

Acknowledgements

This study was funded by Universiti Kebangsaan Malaysia through 'Geran Universiti Penyelidikan' (GUP-2017-038).

References

Kiew, R. 1998. The seed plants at Fraser's Hill, Peninsular Malaysia with special reference to its conservation status. *Research Pamphlet No. 121.* Forest Research Institute, Kepong, Malaysia, pp. 1-24.

Norela, S., & Mohd. Afiq, A. J. 2020. *Bukit Fraser Kepelbagaian Biologi dan Persekitaran Fizikal*. Penerbit UKM, Bangi, Selangor. 235 pp.

Portal Data Terbuka Malaysia. 2019. *Statistik kedatangan pelancong ke negeri Pahang bagi tahun 2013-2017 (Januari-December)*, quoted from https://www.data.gov.my (accessed 27 November 2020).

Pusat Penyelidikan Bukit Fraser. www.ukm.my/fraser/ (accessed 26 Nov 2020).

Rosniza Aznie, C.R., & Norela, S. 2019. *Ekopelancongan dan sosioekonomi Bukit Fraser-Raub Pahang*. Penerbit UKM, Bangi, Selangor. 111 pp.

Rosniza Aznie, C.R., & Norela, S. 2019. Ekopelancongan dan sosioekonomi Bukit Fraser-Raub, Pahang: Satu pengenalan. In Rosniza Aznie, C.R., & Norela, S. (eds.). *Ekopelancongan dan sosioekonomi Bukit Fraser-Raub Pahang*. Penerbit UKM. 111 pp.

Strange, M. 2004. *Birds of Fraser's Hill: An Illustration Guide and Checklist*, Singapore: Nature's Niche.

SUS 08

PERFORMANCE OF SELECTED PLANT SPECIES ON MAN-MADE SLOPE IN BIO-ENGINEERING APPLICATION AT FRASER'S HILL RESEARCH CENTRE, PAHANG

Ahmad Tarmidzi, S.N.[1]*, Ali Rahman, Z.[2], Idris, W.M.R.[2], Adam, J.[2], Abd. Rahim, S.[3], Lihan, T.[2], & Juhari, M.A.A.[1]
[1]Fraser's Hill Research Centre, Faculty of Science and Technology,
University Kebangsaan Malaysia, 43600 Bangi MALAYSIA.
[2]Center of Earth Science and Environment, Faculty of Science and Technology,
University Kebangsaan Malaysia, 43600 Bangi MALAYSIA.
[3]Environmental Science Program, Faculty of Science and Natural Resources,
Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu Sabah MALAYSIA.
**Corresponding author email: sitinorhafizah@ukm.edu.my*

Abstract

The aim of the study is to identify the performance of plant species after application of bio-engineering in Fraser's Hill Research Centre. Four experimental plots and one control plot with slope angles of 40º- 60º, weathering grade of IV-VI and barren slope were prepared. Plants used in this study are *Scindapsus hederaceus, Syngonium podophyllum, Piper sarmentosum* and *Arundina graminifolia.* The plant growth rate was measured by the production of new leaves and the percentage increase of plant cover; increment in height; and reproductive capacity (by an increase in the number of buds and seedlings). Results showed *A. graminifolia* performed the best amongst all plant species. This plant species was found to contribute the highest percentage (80%) of plant cover compared to other species; capable of producing many new buds, with fast-growing rate and with almost 100% survival rate. Other species showed a slower growth rate, higher mortality rate, inability to compete with weeds, and were not compatible with the surrounding environmental factors such as light exposure, water shortages and lack of soil nutrients. Bio-engineering approaches have been able to green the barren slope, improve the physicochemical properties of soil as well as reduce soil erosion on slopes.

Keywords: slope erosion control, *Arundina graminifolia,* plant growth rate, plant cover, plant reproductive capacity

Introduction

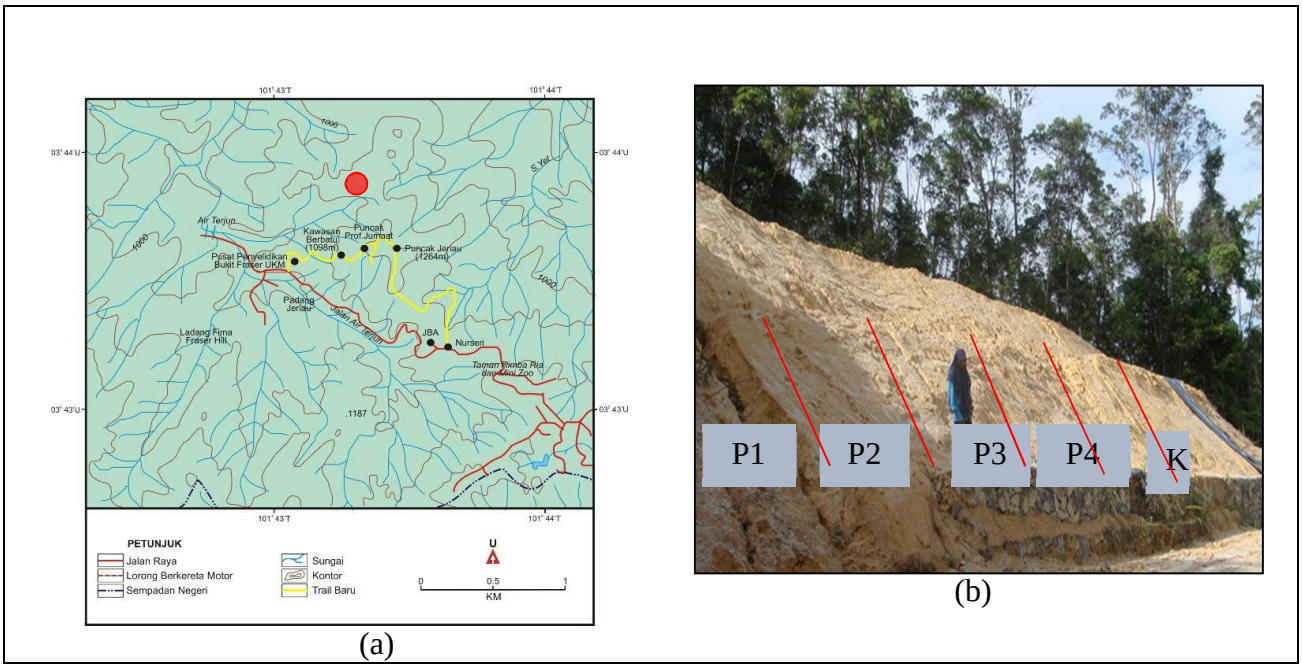
Bio-engineering approach applies suitable plants and combining with other engineering techniques can reduce environmental problems especially slope erosion (Lewis 2000). According to Greenway (1987), thick and dense vegetation have a strong root system to hold the soil structure and can improve slope stability and reduce water evaporation from the soil. Grass, shrubs and certain trees are used to control erosion on slopes and stabilise the landslide (Sati & Sundiyal 2007; Afaff et al. 2016; Afaff et al. 2020a & Afaff et al. 2020b). These advantages can be seen in *Scindapsus hederaceus, Syngonium podophyllum, Piper sarmentosum* and *Arundina graminifolia.* The criteria for the selection of these species used are plants that are widely distributed and easily adapted with slopes, especially barren slopes. Woody plant species can grow quickly while soft woody, small-sized trees and shrubs can be easily propagated through the germination of seeds, cuttings and propagating re-planting of seedling and sapling. These plants' characteristics can be potentially utilised as a biomaterial and be successfully adapted to the environmental condition with minimum maintenance (UKM Pakarunding 2007).

This paper presents the preliminary results using plastics mulching as surface cover material in controlling slope erosion. Plants used in this study are *Scindapsus hederaceus, Syngonium podophyllum, Piper sarmentosum* and *Arundina graminifolia.* The main objective of this study was to determine the performance of these plant species after application of bio-engineering.

Materials and Methods

Plot preparation and installation

The study area was located at Fraser's Hill Research Centre (FHRC) UKM, Pahang (Figure 1a). The site for the bioengineering study plot was set up on weathered granitic soil slope. The grades of weathering ranged between IV and V. The dimension of each plot was 6 m x 4 m with slope steepness of 35°. Four study plots provided with plastic mulch were prepared to study the performance of *Scindapsus hederaceus* (Plot 1), *Syngonium podophyllum* (Plot 2), *Piper sarmentosum* (Plot 3), and *Arundina graminifolia* (Plot 4) (Figure 1b). Another plot as a control, was prepared which was kept barren without any planted tree and no plastic mulching (Plot 5). This plastic mulching was installed to the slopes prior to the tree planting. This plastic sheet can reduce the direct impact of rainwater on the soil surface and subsequently decreases erosion of the slope because of water runoff.



(a) (b)

Figure 1: (a) Location of study area (FHRC UKM) and (b) study plot

Soil sampling

Soil samples were collected for physicochemical analysis in the laboratory. The soil samples were collected from depth of 10 cm below the ground surface and stored in the sealed plastic bag. All soil samples were air-dried for three days and then soil aggregates were broken down by using a pestle and mortar. Subsequently, the soil samples were sieved through a 2-mm sieve and the resulting samples were used to determine its physicochemical properties.

Soil analysis

The physical and chemical properties of soil studied were water content; particle size (Abdulla 1966); organic matter content (Avery & Bascomb 1982); pH (Metson 1956); electrical conductivity (Massey & Windsor 1967); available potassium and magnesium (FAAS model Perkin Elmer 3300) and cation exchange capacity (McLean 1965).

Monitoring program

Growth performance of the studied species were monitored monthly. The plant growth performances were measured based on the number of plants and percentage of plant cover; increment in height; and reproductive capacity in the number of buds and seedlings for every month for a year (June 2008 to June 2009). The results were compared between the control and bioengineered plots.

Results and Discussions

Soil physical properties

Sand content was the highest fraction followed by silt and clay (Table 1). In some slopes, the amount of silt is higher, but clay content was always the lowest. Low clay content is one of the indications that the chemical weathering state of the soil was still progressing. There was no clear pattern of sand fraction change with slopes. Most of the soil textures are sandy clay loam, followed by clay loam, loamy sand and clay. Low clay content may render the soil weakly bound thus may not be able to withstand dispersion due to the direct impact of rainfall and disturbance by moving water. Infiltration of water into sandy soil was faster than clayey soil.

The water content of the soil is low in range from 11.68 to 19.24 % (Table 1). Soil texture affects water content. The high content of clay and organic matter will bind the soil's ability to store water and trap water (Zulfahmi et al. 2001). High water content tends to reduce normal stress that will decrease the sheet strength of the soil. Besides that, it can cause obvious decreasing inside the particle cohesion especially for saturated soil. Also, the pressure of water pores will increase (Raj 2000). This condition encourages the movement between the soil particles causing the planes to become weak (Zulfahmi et al. 1999). The values of organic matter of soil are low in the range between 1.21 and 1.60 % (Table 1) and classified as very low to medium (Metson 1956). The low or medium values of organic matter can cause the structure and aggregate of soil to be not in good and stable condition.

Table 1. Data of soil physical properties

Parameter	Soil sample (%)				
	P1	P2	P3	P4	C
Particle size					
Sand	42.27	43.64	41.60	43.15	45.09
Clay	37.61	34.23	36.14	38.22	33.96
Loam	20.12	22.13	22.26	18.62	20.95
Water content	11.68	15.34	15.62	19.24	12.68
Organic matter	1.21	1.56	1.56	1.60	1.59

Soil chemical properties

The value of soil pH fluctuates in between 3.55 and 3.96 (Table 2). The range of pH values is normal in tropical areas where leaching of basic cation occurs intensively and is comparable to pH under forest structure. This pH value is classified as extremely acidic to strongly acidic (Metson 1956). The values of electrical conductivity are influenced by the presence of dissolved salt that is absorbed into the soil. Electrical conductivity (EC) has low values ranging from 2777.72 to 3046.69 µS/cm (Table 2). However, all the EC value is still within the index that is suitable for plant growth. The mean cation exchange capacity (CEC) values range from 4.00 to 4.81 meq/100 g (Table 2). The highest value occurs at the forest station whereas the lowest value occurs at river sediment station. Cation exchange capacity is linked to high clay and organic matter content in the soil.

Table 2. Data of soil chemical properties

Parameter	Unit	Soil sample				
		P1	P2	P3	P4	C
pH		3.91	3.55	3.76	3.96	3.86
EC	µScm-1	2806.48	3046.69	2826.78	2777.72	2860.61
Nutrients are available						
Magnesium	µg/g	271.50	304.00	89.50	164.50	65.50
Potassium	µg/g	920.00	788.00	664.00	662.00	382.00
CEC		4.48	4.00	4.69	4.19	4.81
Ca^{2+}	meq/100g	0.3360	0.2806	0.0875	0.1169	0.0713
Mg^{2+}	meq/100g	0.0757	0.0890	0.0415	0.0582	0.0365
K^{+}	meq/100g	0.0729	0.0574	0.0503	0.0619	0.0287
Na^{2+}	meq/100g	0.0978	0.1051	0.1118	0.1004	0.1103

H^+	meq/100g	1.5000	0.7667	0.7000	0.6333	1.1667
Al^{2+}	meq/100g	2.4000	2.7000	3.7000	3.2000	3.4000

Plant performance growth

Results obtained after one-year interval showed the highest percentage of survival rate in *A. graminifolia.* The plant species was found to contribute to the highest percentage of plant cover compared to other species, which is 75% (Table 3); capable of producing many new buds (Figure 2), with survival rate of almost 100% (Table 3) and fast-growing rate (Figure 3). Other species showed a slower growth rate, high mortality rate, inability to compete with weeds, and were not compatible with the existing environment that is exposed to light, water shortage and lack of soil nutrients. The survival rate of these plants differed between species and between different plants of the same species. These differences showed that the capability of these plants to establish are influenced by external environmental factors such as the nature of the soil, availability of water, slope inclination and degree of degradation of the soil (UKM Pakarunding 2008). Bio-engineering research in the slope at KM 36.2- Gerik-Jeli Highway planted with *A. graminifolia* on the barren slope showed higher rate than other plants (UKM Pakarunding 2008). Meanwhile, *S. hederaceous,* which is also used in this study, showed a low percentage of survival (50 %). Both studies showed that the species *S. hederaceous* is certainly not suitable for use as bio-engineering but *A. graminifolia* has good potential to be used in bioengineering for slope erosion control.

Table 3. Percentage of survival rate of species plants after one year application

Plot study	Plants species	Family	Planting methods	Number of plant	Survival rate	Survival percentage (%)	Plant cover (%)
P1	*S. hederoceus*	Araceae	Sapling plant	24	12	50	30
P2	*S. podophyllum*	Araceae	Sapling plant	92	65	71	12
P3	*P. sarmentosum*	Piperaceae	Sapling plant	34	20	59	13
P4	*A. graminifolia*	Orchidaceae	Sapling plant	332	329	99	75
C	None	None	None	0	0	0	15

Note: P=Plot, C= Control plot

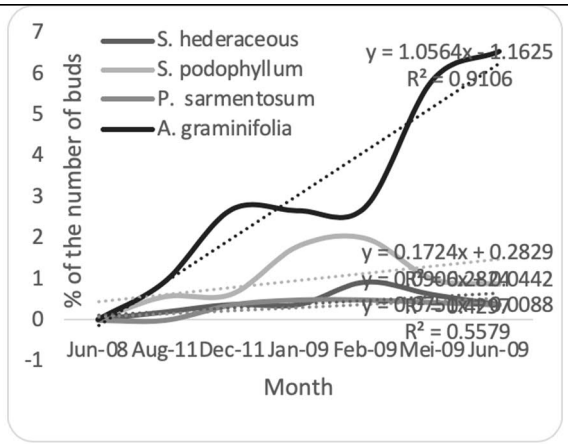


Figure 2. New bud production capability

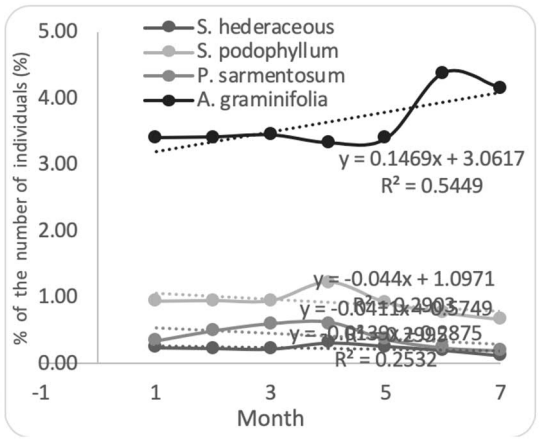


Figure 3. Percentage of the number of individually

Conclusion

The result showed that the successful species that grows well in the study plot was *Arundina graminifolia*. In the initial stages, the rate of growth was uneven because the plants were still trying to adapt to a new environment. Planting *A. graminifolia* using mature trees had shown that it can reduce tree mortality. It is because a mature tree can adapt to an environment where slopes are directly exposed to the sun and have a fast-growing rate. Also, mature trees are capable of producing many new buds.

Acknowledgement

The authors thank Universiti Kebangsaan Malaysia and Faculty Science & Technology, UKM for sponsoring this project through the research grants UKM-OUP-ASPL-6/2008, UKM-GUP-ASPL-07-06-136 dan UKM-GUP-ASPL-07-06-135 and the field assistance rendered by the officers and staff at the Fraser's Hill Research Center.

References

Abdulla, H.H. 1966. *A Study on the Development of Podzol Profiles in Dovey Forest*. Ph.D. Thesis, University of Wales

Afaff, E.O.E, Adam, J., Zulfahmi, A.R., Sahibin, A.R., Siti Norhafizah, A.T., Maizura, M., & Md. Pauzi, A. 2016. Preliminary study on selection from types of fertilization Brachiaria Decumbens (Signal Grass) growth. In *Proceedings of the 14th Symposium of Malaysian Society of Applied Biology*, pp. 38–45, Malacca, Malaysia,

Afaff, E.E., Zulfahmi, A.R., Wan Mohd Razi, I., Adam, J., Abd. Rahim, S., Ahmad Tarmidzi, A.T., & Lihan, T. 2020a. Root Tensile Resistance of Selected Pennisetum Species and Shear Strength of Root-Permeated Soil. *Applied and Environmental Soil Science*. https://doi.org/10.1155/2020/3484718

Afaff, E.E., Zulfahmi, A.R., Wan Mohd Razi, I., Adam, J., Abd. Rahim, S., Lihan, T., Ahmad Tarmidzi, A.T., & Mohd Azlam, N.A. 2020b. Growth performance of Mission and Kyasuwa grasses (Pennisetum sp.) under different NPK ratios as potential slope cover. *Australian Journal of Crop Science* 14(01):161-171. https://doi: 10.21475/ajcs.20.14.01.p2057

Avery, B.W., & Bascomb, C.L. 1982. *Soil Survey Laboratory Methods. Soil Survey Technical Monograph*. No. 6. Harpenden, England

Greenway, D.R. 1987. Vegetation and slope stability. In. Anderson, M.G., & Richards, K.S. *Slope Stability*. pp 187-230. Chichester: John Wiley & Sons.

Lewis, L. 2000. Soil bioengineering. *An Alternative to Roadside Management—A Practical Guide.* Technical Report 0077-1801-SDTDC. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. pp 44

Massey, D.M., & Windsor, G.W. 1967. *Rep. Glasshouse Crops Research Institute*. pp 72.

McLean, E.O. 1965. Aluminum. In Norman, A.G. *Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties.* pp 978-998. *American Society of Agronomy, Inc.* https://doi.org/10.2134/agronmonogr9.2.c16.

Metson, A. J. 1956. Methods of chemical analysis for soil survey samples. N.Z.D.S.I.R. *Soil Bureau Bulletin*. No. 12.

Raj, J.K. 2000. Rainfall and slope failures in the granitic bedrock areas of peninsular Malaysia. In *Proceeding Annual Geological Conference*, pp. 275-282, Penang, Malaysia.

Sati, S.P. & Sundiyal, Y.P. 2007. Role of some tree species in slope instability. *Himalayan Geology* 28 (1): 75–78.

UKM Pakarunding. 2008. Kajian Bio-engineering di Kawasan Cerun di KM 36.2 Lebuhraya Gerik-Jeli. *Final Report.* Bangi: UKM Pakarunding Sdn. Bhd.

Zulfahmi, A.R., Gopir, G., & Abdul Rahim, S. 1999. The physico-chemical characteristics of weathered soil slope in Bangi Lama, Selangor. *Prosiding Malaysian Science and Technology Congress* 99, 208-215.

Zulfahmi, A.R., Abdul Rahim, S., & Yaakob, J. 2001. Pemetaan Taburan dan Penilaian Potensi Kegagalan Cerun Kawasan Puchong dan Sekitarnya. *Laporan Akhir Penyelidikan UKM A/4/99*.

SUS 09

REGENERATION OF FRASER'S HILL: CONSERVATION, DEVELOPMENT AND MANAGEMENT PLAN

Johari, M.N.[1]*, Shariff, I.M.[2], Kamarudin, N.A.[1], Sahidan, N.N.[1], Taufik, N.F.N.[1], Che Ramli, N.F.[1], Ilyas, A.[1], Aziz, S.[1], Said, S.Y.[1], & Ramli, R.R.[1]

[1]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, UiTM Shah Alam, 40450, Selangor, Malaysia

[2]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, UiTM Puncak Alam, 42300, Selangor, Malaysia

**Corresponding author email: naqieyudinjohari@gmail.com*

Abstract

Between 852 to 1,456 metres above sea level, Fraser's Hill is the lowest and least disturbed of the three major hill stations along the Titiwangsa Range. Fraser's Hill a "little hamlet" of English reminiscence, famed for its verdant green and pristine forest with lush rolling hills and century-old buildings, it beholds wondrous natural treasures. This research aim is to provide a thorough analysis of Fraser's Hill condition and provide a glimpse of what Fraser's Hill has to offer and deliver proper planning. The objectives are to explore the heritage significance of Fraser's Hill, to establish Fraser's Hill branding and tourism product by positive manipulation of history, culture, nature and other values, and to produce conservation, development and management plan for economic development. The methods used are thorough literature review from various resources, on-site observation and interview with local people and authorities. Main findings are Fraser's Hill is blessed with untapped natural biodiversity, rich in history and abundance of heritage buildings. But at the same time, it lacks in management, poor transportation network, facilities, heritage conservation and activities that can be improved in the future through proper planning. From this research, the significant contribution is that the regeneration of Fraser's Hill will portray the facelift of Fraser's Hill that will create impact mostly economically through conservation of tangible and intangible heritage. More profound research on the other potentials of Fraser's Hill needs to be conducted that not only emphasise on the heritage value but also different significant values of Fraser's Hill.

Keywords: conservation, development, management, planning, economy

Introduction

The Titiwangsa Range is the backbone of Peninsular Malaysia and houses the largest continuous highland forest block in the Peninsula. A "little hamlet" of English reminiscence lies within that highland rainforest, Fraser's Hill. Famous for its green and beautiful forest with lush rolling hills and hundred-year-old buildings, it gazes at remarkable natural wonders. Fraser's Hill is the lowest and least disturbed of the three major hill stations along the Titiwangsa Range, also known as the Main Range. Seven rolling hills form it with peaks ranging from 852 meters (m) above sea level (asl) to 1,456 m asl (Cheong 2013). Fraser's Hill derives its name from Louis James Fraser, a solitary Scottish pioneer, who set up a tin ore trading post in Tras in the 1890s ("Journey Malaysia" 2018). This research aim is to provide a thorough analysis of Fraser's Hill condition and provide a glimpse of what Fraser's Hill has to offer and deliver proper planning. Fraser's Hill is rich with biodiversity, heritage value and untapped economic values to increase the income for Fraser's Hill. However, the extent that Fraser's Hill has been transformed into an eco-destination has yet to be answered. The objectives are to explore the heritage significance of Fraser's Hill; to establish Fraser's Hill branding and tourism product by positive manipulation of history, culture, nature and other values; and to produce conservation, development and management plan for economic development.

Materials and Methods

Three research methods were adopted for this research. The methods were thorough literature review from various resources, on-site observations and interviews with local people and authorities. The literature review conducted includes journals, articles, a guidebook from the Worldwide Fund for Nature (WWF-Malaysia), website and other reliable sources. On-site observations include photographic evidence, sketches etc. Primary informants were chosen from the public and local authority officers to get a balanced perspective. The primary informants listed for this research were Miss Nalini A/P Letchumanon, the Manager of Property and Hospitality Management who is a senior government official at the Fraser's Hill Development Corporation,

and ten local and tourist respondents. Incisive observations can be gathered in terms of Fraser's Hill growth as an eco-destination; the primary informant approach is of high utility. The data and information were collected via an open-ended questionnaire via direct interviews.

Results and Discussion

Strength, weakness, threat and opportunity of Fraser's Hill

There are significant strengths, weaknesses, threats and opportunities that can be found in Fraser's Hill. The most significant strengths are historical building values, variety of attractions and biodiversity in nature. There are many historical buildings and bungalows on the hill. Not to forget, the abandoned and now torn down landmarks such as Bishop's House and privately owned Victory Bungalow that reminds us of the old colonial days. Fraser's Hill is a treasure trove of nature, with rich repositories of plant life, a wide diversity of wildlife, and lush landscapes untouched by modern development.

There are also few weaknesses such as limited vehicle access, scarcity of resources and geological issues. The road system from the Gap to the peak, even though it was upgraded in 2001, still needs improvement in terms of the road condition, especially when it comes to bigger vehicles such as tourist buses - furthermore, there is only one ingress into and one egress out of Fraser's Hill. Fraser's Hill is not only scarce in resources such as food and other goods but its population is outnumbered by the tourist arrivals. There are around 1,000 people in 2017, but on the other hand, there are approximately 127,612 visitors to Fraser Hill in 2017 (Statistik Kedatangan Pelancong Ke Negeri Pahang – MAMPU 2019). The soil condition around this highland forest is permeable and highly erodible because it is covered predominantly by granite (Cheong 2013). There were occasional landslides that occurred throughout the year, especially along the main road of Gap-Fraser's Hill due to slopes cutting (Rahman et al 2009; Er 2013).

Other than strength and weakness, that are also a few threats that are, a decline in population and a rise in abandoned bungalows and abandoned areas reclaimed by the forest. Subpar maintenance due to difficult accessibility for heavy machinery and many layers of decision-making. Lastly, the opportunity for Fraser's Hill is that researchers and students can study species of flora and fauna on the mountains as it is the best place in Asia to observe birds, including some of the rare forest specialists.

Heritage significance of Fraser's Hill

The British colonial buildings found in Fraser's Hill owe their characters to the architecture of the British Tudor style. Tudor architecture is an architectural style which was developed in England from 1485 to 1558. It was a transitional style, combining elements of Renaissance architecture with a Gothic style mainly found in England called Perpendicular Gothic, because it emphasised vertical lines. Tudor architecture was in the British Isles, from Ireland and Scotland in England, and other parts (Bahauddin et al., 2010). Nonetheless, due to their location, some modifications have been made to those houses. The ones found at Fraser's Hill is known as the Tudor Revival, a theme rekindled by the rise of the arts and crafts. The most significant building typologies that can be found in Fraser's Hill are the Clock Tower, British Colonial bungalows, Post Office, Police Station, Puncak Inn and Shahzan Inn. The branding of Fraser's Hill as Little England adds to its charm as an eco-destination. Maintaining heritage-old stone cottages or bungalows along with their gardens is an integral part of ecotourism as maintaining historic sites is a crucial precept (Er, 2013).

Figure 1. Some of the British bungalows in Fraser's Hill (Bungalows: Fraser's Hill n.d.)

Physical and environmental values of Fraser's Hill

It has become a significant biological and ecological site, as the vegetation at Fraser's Hill is still largely pristine. Nearly 92 % of Fraser's Hill, with just 1.5% developed, is still covered with virgin forest. Cleared land that is now covered with secondary vegetation is the remaining 6.5% (DOE 2008; Cheong 2013). Lots of rare species of flora and fauna can be found here, and the montane forest that makes up Fraser's Hill plays a vital role in maintaining its high biodiversity. It is home to more than 10% of all plant species in Peninsular Malaysia. 952 native species with 36 endemic species of flora can be found here and 13 of those species might be extinct or has not been seen for more than 60 years (Kiew 1998; Cheong 2013).

Table 1. Number of species of animal that can be found in Fraser's Hill (Cheong 2013)

Species	Mammal	Bird	Amphibian	Reptile
Number of species	52	275	27	26
Percentage of total number of species found in Peninsular Malaysia (%)	24.19	42.44	12.62	29.55
Percentage of total number of highland species found in Peninsular Malaysia (%)	62.65	88.42	51.92	86.67

Legal Policies used at Fraser's Hill

Conservation and preservation are very important at Fraser's Hill to ensure that it is protected for its built and natural heritage. It is important to keep alive all the elements of heritage at Fraser's Hill for the future generations. Based on literature review, there are several policies and legislation applicable in Fraser's Hill. The policies are Tourism Industry Act 1992 (Act 482), National Heritage Act 2005 (Act 645), National Forestry Act 1984 and National Policy on Biological Diversity 2016 – 2025. Tourism Industry Act 1992 (Act 482) is An Act to provide for the licensing and regulation of tourism enterprises and for matters incidental thereto or connected therewith. National Heritage Act 2005 (Act 645) is to enforce the provisions of the Act for the conservation and preservation of the national heritage, cultural heritage, tangible and intangible, underwater cultural heritage and treasures as well as related matters. The National Forestry Act (1984) provides for the administration, management and conservation of forests and forestry development within the States of Malaysia. The Act serves to classify Permanent Reserved Forests and issues related to rights over forest produce, determination of licenses, and other conditions. It gives Malaysian States the authority to appoint officers responsible for designing forest management and restoration plans, handling annual forest development reports, and managing an annual budget. The National Policy on Biological Diversity 2016 – 2025, is aimed to include all walks of life (i.e. children and adults from diverse backgrounds) in the conservation of biodiversity, such as through programs of contact, education and public awareness (CEPA) and citizen science.

Heritage tourism plan

Heritage tourism is considered one of the key components of the tourism industry. In Malaysia, the popularity of this tourism requires attention with regards to hill resorts with British colonial architectural heritage. There are already diverse views and perceptions on heritage tourism. According to Prentice (1992), heritage tourism, i.e. tours and visits to historic sites, towns and villages, had large popularity across destination areas, perhaps representing the country's social composition. The heritage tourism plan comprises of three phases. Phase one focuses on adding, enhancing and upgrading amenities, facilities and infrastructures that comprise of roads, landscapes, public amenities, safety and security around Fraser's Hill. For example, basic infrastructures such as roads need to cater to the number of tourists and necessary facilities are provided to enhance the social living conditions in Fraser's Hill.

Phase two focuses on the development of new attractions, redevelopment of existing buildings, relocation of residential areas and preservation works on old and heritage buildings. It is accepted that the quality and uniqueness of the local architecture of historic buildings and monuments are significant in the tourism industry. Through proper planning, preservation of the British heritage values by using sustainable conservation methods could increase the productivity and economy of Fraser's Hill. The new development will create more job opportunities and attractions that will attract more visitors and tourists. British colonial architectural heritage found on the hill resort could be utilised to promote tourism development at Fraser's Hill further. Phase three focuses on maintenance plan, waste management plan, effective division of powers and jurisdiction and creating activities that can contribute and enhance Fraser's Hill economy. These activities will use existing attractions as the primary means and mediums to avoid over-development.

Conclusion

Fraser's Hill has all the potential to become a popular tourist spot. Cold weather, unique architecture, vast scenic landscape and green tropical forest with diverse flora and fauna. All the assets are priceless to Fraser's Hill and Malaysia in general. The regeneration of Fraser's Hill is one concept that comprises all aspects of development benefits and potentially distribute economic growth fairly. This concept plan will ensure that the development guidelines will be in line with the current regulation and policies. The benefits of this upgrading and development will benefit the local community, tourists, developers and investors, including the State and Federal Government. The new facelift of Fraser's Hill will contribute towards the prospect of this destination to be well known as a tourist attraction in Malaysia that is capable of generating lucrative income to the local community and revenues to the investors. The development of Fraser's Hill can contribute to all aspects such as domestic economic growth, socio-economy and the environment. Further research on other economic values through conservation needs to be done in the future to make sure that Fraser's Hill can become one of the powerhouses in heritage tourism and ecotourism.

Acknowledgements

The authors gratefully acknowledge and would like to thank Miss Nalini A/P Letchumanon, the Manager of Property and Hospitality Management of Fraser' Hill Development Corporation (FHDC) and the people of Fraser's Hill that help in providing insight and information about Fraser's Hill.

References

Bahauddin, A., Mohamed, B., Mat Som, A.P., Irwana, S., & Othman, A.G. 2010. *The British Colonial Architectural Heritage of Fraser's Hill and Cameron Highlands, Malaysia*, presented at 3rd Asia-Euro Conference 2010, Subang Jaya, Malaysia.

Bungalows: Fraser's Hill. n.d. retrieved on 15th October 2017 from https://www.fraserhill.info/bungalows.htm

Cheong, C. 2013. *Fraser's Hill-A Lush Highland Hideaway.* Petaling Jaya, Malaysia: WWF-Malaysia.

Er, A.C., Chong, S.T., Ahmad, H., Md Sum, S., & Ramli, Z. 2013. The Sustainability of Fraser's Hill as an Eco-destination. *International Journal of Business Tourism and Applied Sciences*, 1(2):109-115.

Journey Malaysia. 2018. Retrieved on 15th October 2017 from http://www.journeymalaysia.com/MH_fraser.htm

National Policy on Biological Diversity 2016 – 2025. 2006.
National Forestry Act 1984 (Act 313). 2006.
National Heritage Act 2005 (Act 645), ss 40, 45 & 46. 2006.
Prentice, R. 1992. Market segmentation and the prediction of tourist destinations. In Johnson, P., & Thomas, B. (Eds.), *Choice and demand in tourism* (pp. 73-92). London: Mansell Publishing Limited.
Statistik Kedatangan Pelancong Ke Negeri Pahang – MAMPU. 2019. Retrieved on 9th November 2020 from https://www.data.gov.my/data/ms_MY/dataset/statistik-kedatangan-pelancong-ke-negeri-pahang
Tourism Industry Act 1992, ss 20, 31 & 18. 2006.

SUS 10

RECENT LANDSLIDES AND INDICATORS FOR OCCURANCES OF LARGE SCALED-OLD-DORMANT LANDSLIDES IN FRASER'S HILL

Nazer, N.S.M.[1], Arifin, M.H.[1,2]*, Simon, N.[1], Sulaiman, N.[1], Hussin, H.[3], & Azmi, A.[1]
[1]Program Geologi, Jabatan Sains Bumi dan Alam Sekitar, Fakulti Sains dan Teknologi, Univeristi Kebangsaan Malaysia
[2]Pusat Penyelidikan Bukit Fraser, Fakulti Sains dan Teknologi, Universiti Kebangsaan Malaysia
[3]Program Geosains, Jabatan Geosains, Fakulti Sains Bumi, Universiti Malaysia Kelantan
**Corresponding author email: hariri@ukm.edu.my*

Abstract

Dormant landslides are inactive landslides that can turn into critical geohazard incidents if reactivated. Depending on the age and scale of distribution, they can either be categorised as young, mature, or old. Large-scaled and old dormant landslides can transform into geo disasters, especially when lives and socio-economic interests are involved. In wet tropical highlands, they are often hidden under thick and dense rainforest cover. Their identification and assessments become a significant challenge to geoscientists due to limited site reconnaissance. They are known to be highly susceptible to reactivation, especially when disturbed by development activities or in close contact with water (surface or subsurface). Due to particle alignment from the previous movement, old slides are generally at residual strength, meaning they are more susceptible to reactivation induced by head loading and/or toe removal. Therefore, the identification of old-dormant is crucial, and we employed geomorphological characteristics as indicative measures during the assessment of large-scaled-old dormant landslides in Bukit Fraser.

Keywords: dormant landslides, geo disaster, Fraser's Hill

Introduction

Fraser Hill is one of the famous highlands in Malaysia with unique biodiversity. It serves as a natural sanctuary for several endangered flora and fauna, especially birds and orchids (Er et al. 2013). Geomorphological-wise, Fraser Hill lies within a hilly and steep topography boundary and is therefore prone to landslide activation and/or reactivation. The evidence of shallow landslides (Arifin et al. 2020) indicates the existence of large-scale, old-dormant landslides within Fraser Hill's area. Their existence is often overlooked due to thick vegetation cover and prolonged human activities. This study's main aim is to present findings and indication of old dormant landslides that may be reactivated in the future from topography maps and Google images. Evident examples based on geomorphological characteristics proposed by Jamaluddin et al. 2020 were employed. In addition, indicators of visible instability prior to landslide events are also presented so that future recurrences may be minimised.

Materials and Methods

Geomorphological characteristics of landslides are used as indicative measures for the assessment of large-scaled-old-dormant landslides in Fraser hill. Topography maps, along with Google images, were employed for successive landslide identification. Distinctive features exhibited by landslides, i.e., an arcuate shape, hummocky were traced from contour lines in topography map and terrain surface changes from Google image. Field survey is employed after the above methods are completed.

Results and Discussion

Old dormant landslides in Fraser Hills are clearly visible on google map. Spoon and tongue shapes are common landslide morphological features as traced from the google map (Figure 1). These large-scaled landslides are typically of a debris flow-type with wide accumulation zone at a lower elevation. The upper part is usually exposed, ruptured rotationally, and material degradation occurs rapidly along this zone (Varnes, 1978). One of the factors that contributed to landslide occurrences in Fraser Hills is lineaments. Lineaments often cause rocks fragmentation, thus, making them unstable (Figure 2). The overall landslide locations obtained from the field along the main road in Fraser Hills are shown in Figure 3. These landslides were

shallow landslides formed as part of the reactivation of older dormant and larger landslides. They are multiple and superimposed bodies influenced by one of the pre-existing landslide phenomena (Borrelli et al. 2018).

Figure 1. Boundary of landslide scars on google map together with field evidence in Fraser Hill

Figure 2. Lineaments and shallow landslides in Fraser Hills with some photographs of landslides that have occurred on the ground

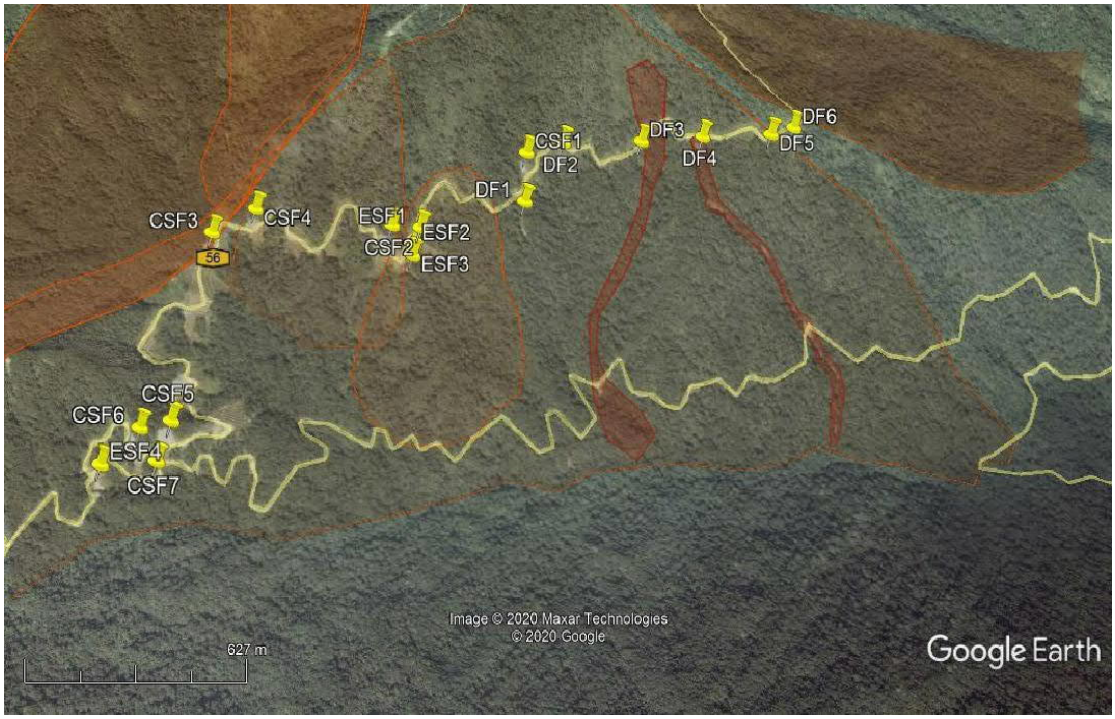


Figure 3. Landslides detected along roads in Fraser Hills with some are reactivation of older dormant landslides.
Note: D refers to debris flow, C for cut slope and E for embankment slope failures

Conclusion

Bukit Fraser lies along a geopotential zone for landslide movements. The geomorphological features correspond to the existence of large-scaled-old-dormant landslides with a positive sign of reactivation. They can be a geo-disaster, especially when lives and socio-economic interests are involved. Shallow landslide events that kept occurring within this area indicate the possible sign of imminent failure. These natural events can be controlled with proper mitigation measures such as installing slope fencing around rocky areas, trimming old and big trees along the soil slope areas, proper drainage system at the toe of the slope, widening of road access and regular maintenance of high-risk slopes.

Acknowledgement

Deepest appreciation to the late Associate Professor Dr. Tajul Anuar Jamaluddin for his undivided contribution in materializing this research. Special thanks to Universiti Kebangsaan Malaysia for funding this research under GGPM-2019-003 grant scheme.

References

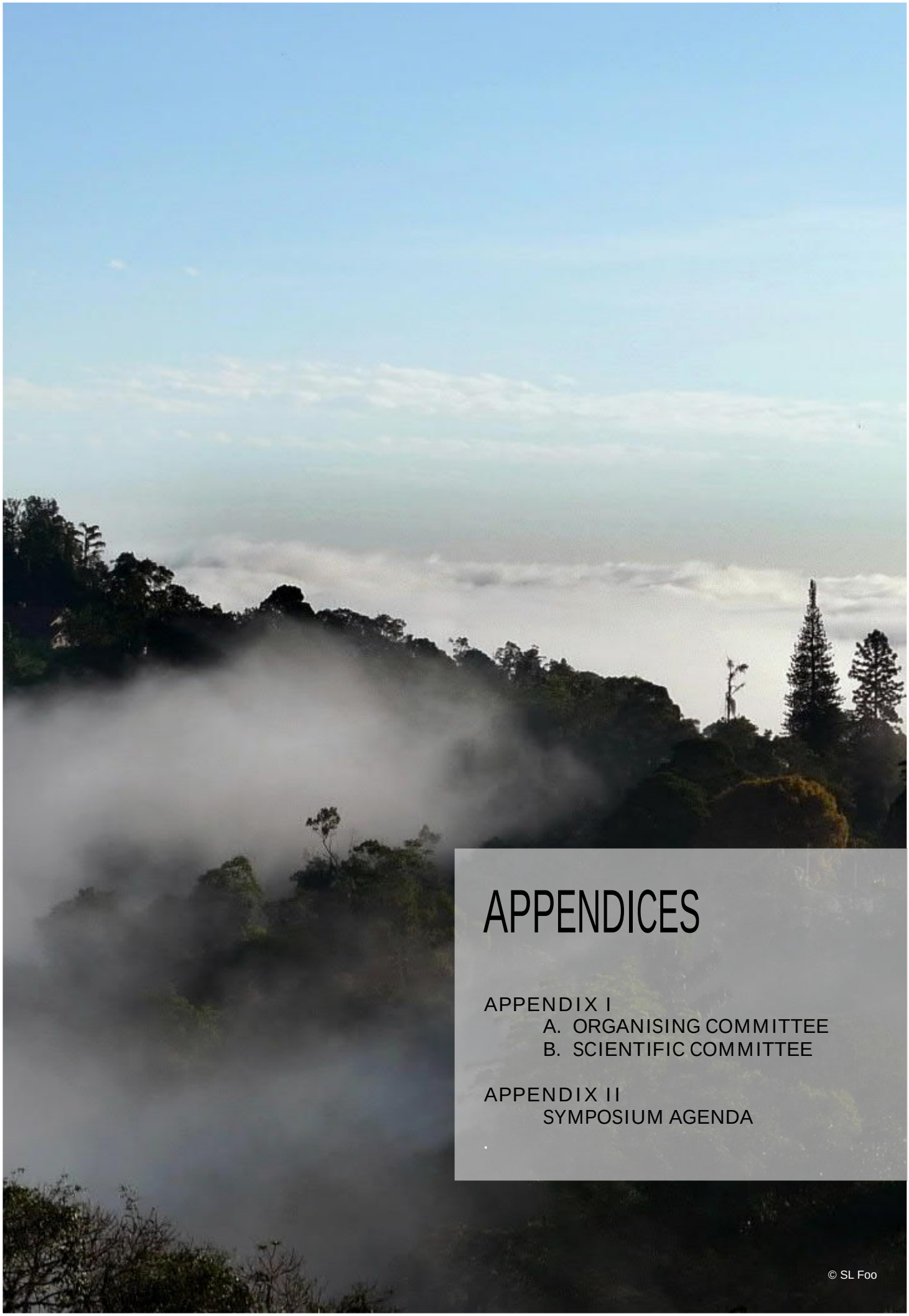
Arifin, M.H., Nazer, N.S.M., & Jalal, A.Q. 2020. Pengecaman mekanisme utama tanah runtuh cetek di Bukit Fraser, Pahang. *Bulletin of the Geological Society of Malaysia, 69*, pp.79-88.

Borrelli, L., Nicodemo, G., Ferlisi, S., Peduto, D., Di Nocera, S., & Gullà, G. 2018. Geology, slow-moving landslides, and damages to buildings in the Verbicaro area (north-western Calabria region, southern Italy). *Journal of Maps*, *14*(2), pp.32-44.

Er, A.C., Chong, S.T., Ahmad, H., Sum, S.M., & Ramli, Z. 2013. The sustainability of Fraser's Hill as an eco-destination. International Journal of Business Tourism and Applied Sciences, 1, pp.109-115.

Jamaluddin, T.A., Sulaiman, N., & Nazer, N.S.M. 2020. Penilaian geomorfologi tanah runtuh lama di tanah tinggi tropika-Kajian kes Cameron Highlands dan Kundasang, Malaysia. *Bulletin of the Geological Society of Malaysia*, *69*.

Varnes, D.J. 1978. Slope movement types and processes. *Special report*, *176*, pp.11-33.



APPENDICES

APPENDIX I
- A. ORGANISING COMMITTEE
- B. SCIENTIFIC COMMITTEE

APPENDIX II
- SYMPOSIUM AGENDA

APPENDIX I

A. ORGANISING COMMITTEE

Chairperson
Associate Professor Dr. Norela Sulaiman (Universiti Kebangsaan Malaysia)

Vice-chairperson
Ms Siti Zuraidah Abidin (WWF-Malaysia)
Dr. Shamsul Khamis (Universiti Kebangsaan Malaysia)

Secretary
Dr. Hong Chern Wern (WWF-Malaysia)
Mr Mohd Afiq Aizat Juhari (Universiti Kebangsaan Malaysia)

Treasurer
Puan Siti Norhafizah Ahmad Tarmidzi (Universiti Kebangsaan Malaysia)
Ms Carell Cheong (WWF-Malaysia)

Publicity
Dr. Raja Muhammad Zuha B Raja Kamal Bashah (Universiti Kebangsaan Malaysia)
Dr. Izfa Riza Hazmi (Universiti Kebangsaan Malaysia)
Assoc. Prof. Dr Salmah Yaakop (Universiti Kebangsaan Malaysia)
Ms Nur Fazrina Mohd. Ani (WWF-Malaysia)
Ms Hanis Zakiyah Maketab (WWF-Malaysia)
Ms Nadia Syahiera Mohamad Salleh (WWF-Malaysia)

Logistics
Dr. Nurul Wahida Othman (Universiti Kebangsaan Malaysia)
Dr. ‘Aqilah Mustafa Bakray (Universiti Kebangsaan Malaysia)

Technical Committee
Dr. Johari Jalinas (Universiti Kebangsaan Malaysia)
Dr. Hong Chern Wern (WWF-My)
Mr Mohd Afiq Aizat Juhari (Universiti Kebangsaan Malaysia)
Ms Norizan Mohd Mazlan (WWF-Malaysia)
Ms Zurinah Yaakop (WWF-Malaysia)
Ms Nur Fazrina Mohd. Ani (WWF-Malaysia)
Ms Cheng Yean Ni Munisha (WWF-Malaysia)

Protocol and Programme
Associate Professor Dr. Norela Sulaiman (Universiti Kebangsaan Malaysia)
Dr. Farah Shafawati Mohd. Taib (Universiti Kebangsaan Malaysia)
Ms Syahaneem bt Othman (WWF-Malaysia)
Ms Norizan Mohd Mazlan (WWF-Malaysia)
Ms Zurinah Yaakop (WWF-Malaysia)
Ms Nur Fazrina Mohd. Ani (WWF-Malaysia)
Ms Cheng Yean Ni Munisha (WWF-Malaysia)

B. SCIENTIFIC COMMITTEE

Head of scientific committee
Associate Professor Dr Wee Suk Ling

Committee
Associate Professor Dr Haja Maideen Kader Maideen
Dr Azlan Abas
Professor Badrul Munir Md Zain
Associate Professor Dr Choong Chee Yen
Dr Nik Norhazrina Nik Mohd Kamil
Associate Professor Dr. Norela Sulaiman
Dr Shamsul Khamis
Associate Professor Dr Zaini Sakawi

APPENDIX II

SYMPOSIUM AGENDA

Day 1: 16th December 2020 (Wednesday)
Opening Session (VENUE: MAIN ROOM)

Time (GMT +8)	Agenda
8.30am – 9.00am	Virtual 'Arrival' of Fraser's Hill Symposium Participants
9.00am – 9.10am	Welcoming Speech by Chairperson of Fraser's Hill Symposium, Assoc. Prof. Dr. Norela Sulaiman.
9.10am – 9.15am	Virtual Group Photography Session
9.15am – 9.45am	Opening Keynote BUKIT FRASER, PAHANG: JOURNEY TOWARDS A NATIONAL HERITAGE SITE AND STATE PARK by Prof. Emeritus Dato' Dr. Abdul Latiff Mohamad (Universiti Kebangsaan Malaysia)
PLENARY SESSION & SPECIAL PRESENTATION	
9.45am – 10.00am	Plenary Session 1 (Flora Biodiversity) ARE ECOTOURISM AND BIODIVERSITY CONSERVATION COMPATIBLE AT FRASER'S HILL? A BOTANISTS' PERSPECTIVE by Dr. Ruth Kiew (Forest Research Institute Malaysia)
10.00am-10.15am	Plenary Session 2 (Fauna Biodiversity) THE NEGLECTED PRIMATES OF PENINSULAR MALAYSIA AND PRIMATES SIGHTING AT FRASER'S HILL by Prof. Dr. Badrul Munir Md. Zain (Universiti Kebangsaan Malaysia)
10.15am – 10.30am	Plenary Session 3 (Ecosystem Services) THE FORGOTTEN FOREST PRODUCT: WATER by Dr. Siti Nurhidayu Abu Bakar (Universiti Putra Malaysia)
10.30am-10.45am	Plenary Session 4 (Sustainability Aspect) "WHAT DO WE NEED TO GET A FRASER'S HILL STATE PARK" by Mr Daniel Chin (ERE Consulting Group Sdn. Bhd.)
10.45am-11.00am	Special Presentation RANCANGAN STRUKTUR NEGERI PAHANG 2050 by Y.M. Raja Nor Azlina Raja Ahmad (PLANMalaysia@Pahang)
11.00am – 11.15am	Question & Answer
11.15am – 11.30am	Intermission/Short Break

Parallel Session 1		
11.30am – 1.15pm	Sustainability Aspects VENUE: ROOM A	Fauna VENUE: ROOM B
1.15pm –2.15pm	Break/Intermission	
2.15pm – 4.15pm	Sustainability Aspects (con't) VENUE: ROOM A	-
2.15 pm – 4.45pm	-	Fauna (con't) VENUE: ROOM B

Day 2: 17th December 2020 (Thursday)

Time (GMT +8)	Agenda	
8.30am – 9.00am	Virtual 'Arrival' of Fraser's Hill Symposium Participants	
Parallel Session 2		
9.00am – 10.30am	Ecosystem Services VENUE: ROOM A	Flora VENUE: ROOM B
10.30am – 10.45am	Break/Intermission	
10.45am – 12.15pm	Ecosystem Services (con't) VENUE: ROOM A	Flora (con't) VENUE: ROOM B
12.15pm – 2.15pm	Intermission/Break/Solat/Sign-in by virtual audiences	
2.15pm – 3.30pm	Expert Panellists Session – (VENUE: MAIN ROOM)	
3.30pm – 3.35pm	Closing Note by Ms. Sophia Lim, CEO/Executive Director of WWF-Malaysia	

Day 1: 16th December 2020 (Wednesday)

Parallel Session: SUSTAINABILITY ASPECTS (VENUE: ROOM A)

Time (GMT +8)	Title/Presenter
11.30am – 11.45am	01 - PERCEPTION OF SELECTED LOCAL AND INDIGENOUS COMMUNITIES ON THE ESTABLISHMENT OF A STATE PARK AT THE FRASER'S HILL FOREST COMPLEX Ms. Carell Cheong (WWF-Malaysia)
11.45am – 12.00pm	02 – THE WILLINGNESS TO PAY VALUE OF CONSERVING FRASER'S HILL FOREST COMPLEX VIA CONTINGENT VALUATION Dr. Hong Chern Wern (WWF-Malaysia)
12.00pm – 12.15pm	03 – PARTICULATE MATTER (PM) CONCENTRATION AT RURAL AND HIGH ALTITUDE AREA: CASE STUDY OF FRASER'S HILL Dr. Haris Hafizal Abd Hamid (Universiti Kebangsaan Malaysia)
12.15pm – 12.30pm	05 – A COST-BENEFIT ANALYSIS OF STATE PARK STATUS FOR FRASER'S HILL FOREST COMPLEX Ms. Intan Sofiatul Ilyana Mohamad (Universiti Putra Malaysia)
12.30pm – 12.45pm	06 – A TOTAL ECONOMIC VALUATION OF FOREST ECOSYSTEM SERVICES IN FRASER'S HILL FOREST COMPLEX Mr. Muhammad Zuber Azhar (Universiti Putra Malaysia)
12.45pm – 1.15pm	Question & Answer
1.15pm - 2.15pm	Break/Intermission
2.15pm –2.30pm	07 – FRASER`S HILL RESEARCH CENTER, UNIVERSITI KEBANGSAAN MALAYSIA: POTENTIAL FOR RESEARCH COLLABORATION Assoc. Prof. Dr. Norela Sulaiman (Universiti Kebangsaan Malaysia)
2.30pm – 2.45pm	08 – PERFORMANCE OF SELECTED PLANT SPECIES ON MAN MADE SLOPE IN BIO-ENGINEERING APPLICATION AT FRASER'S HILL RESEARCH CENTRE, PAHANG Ms. Siti Norhafizah Admad Tarmidzi (Universiti Kebangsaan Malaysia)
2.45pm – 3.00pm	09 – REGENERATION OF FRASER'S HILL: CONSERVATION, DEVELOPMENT AND MANAGEMENT PLAN Mr. Muhammad Naqiuddin Johari (Universiti Teknologi MARA, Shah Alam)
3.00pm – 3.15pm	10 – RECENT LANDSLIDES & INDICATORS FOR OCCURRENCES OF LARGE-SCALE, OLD-DORMANT LANDSLIDES IN FRASER'S HILL. Dr. Mohd Hariri Ariffin (Universiti Kebangsaan Malaysia)
3.15pm – 3.30pm	04 – THE IMPACT OF LAND-USE CHANGE ON AMPHIBIANS OF THE TIWIWANGSA RANGE (PROJECT PLAN) Mr. Connor William Butler (University of Southampton)
3.30pm – 4.00pm	Question & Answer
4.00pm – 4.15pm	Summary and Wrap up by Session Chairman
4.15pm	End

Day 1: 16th December 2020 (Wednesday)
Parallel Session: FAUNA (ROOM B)

Time (GMT +8)	Title/Presenter
11.30am – 11.45am	01 – DIVERSITY AND ABUNDANCE OF HARVESTMEN (ARACHNIDA: OPILIONES) IN FRASER HILL, MALAYSIA Dr. Izfa Riza Hazmi (Universiti Kebangsaan Malaysia)
11.45am – 12.00pm	02 – TEMPORAL CHANGES IN FOREST STRUCTURE AND RESOURCE ABUNDANCE AFFECT OCCUPANCY AND DIVERSITY OF TROPICAL MONTANE BIRDS Dr. Malcolm Soh Chu Keong (University of Western Australia)
12.00pm – 12.15pm	03 - CALLING SONGS OF CICADA IN FRASER'S HILL Dr. Johari Jalinas (Universiti Kebangsaan Malaysia)
12.15pm – 12.30pm	04 – BIODIVERSITY ASSESSMENT AT FRASER'S HILL FOREST COMPLEX VIA CAMERA TRAPPING STUDY Mr. Elangkumaran Sagtia Siwan (WWF-Malaysia)
12.30pm – 12.45pm	05 – DIVERSITY OF FRUIT FLIES (DIPTERA: TEPHRITIDAE), RAUB, PAHANG Assoc. Prof. Dr. Wee Suk Ling (Universiti Kebangsaan Malaysia)
12.45pm – 1.15pm	Question & Answer
1.15pm – 2.15pm	Break/Intermission
2.15pm –2.30pm	06 – FIREFLY (COLEOPTERA: LAMPYRIDAE) DIVERSITY IN FRASER'S HILL, PAHANG, MALAYSIA Dr. Nada Badruddin (Forest Research Institute Malaysia)
2.30pm – 2.45pm	07 – PRELIMINARY FINDINGS OF INTERESTING CASSIDINAE (COLEOPTERA: CHRYSOMELIDAE) SPECIES OF FRASER'S HILL, PAHANG Assoc. Prof. Dr. Salmah Yaakop (Universiti Kebangsaan Malaysia)
2.45pm – 3.00pm	08 – DIVERSITY OF SMALL MAMMALS AND THEIR ON-HOST ECTOPARASITES IN FRASER'S HILL, PAHANG, MALAYSIA Dr. Farah Shafawati Mohd Taib (Universiti Kebangsaan Malaysia)
3.00pm – 3.15pm	09 – UPDATED LIST OF SPECIES OF MOTH FAUNA (LEPIDOPTERA: HETEROCERA) OF FRASER HILL, PAHANG Ms. Lailatul Nadhirah Asri (Universiti Kebangsaan Malaysia)
3.15pm – 3.30pm	10 – BUTTERFLIES SPECIES (LEPIDOPTERA: RHOPALOCERA) IN THE VICINITY OF FRASER'S HILL RESEARCH CENTRE OF UNIVERSITI KEBANGSAAN MALAYSIA AND JERIAU WATERFALL AREA OF FRASER'S HILL, PAHANG, MALAYSIA Ms. Nur Khairunnisa Salleh (Universiti Kebangsaan Malaysia)
3.30pm – 3.45pm	11 – METABOLITE PROFILE OF HIGHLAND STINGLESS BEE HONEY Dr. Azira Muhamad (Malaysia Genome Institute)
3.45pm – 4.00pm	12 – ANURAN SPECIES ABUNDANCE DISTRIBUTION AND MICROHABITAT PREFERENCE AT SUNGAI JERIAU, FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA Prof. Dr. Norhayati Ahmad (Universiti Kebangsaan Malaysia)

4.00pm – 4.30pm	Question & Answer
4.30pm - 4.45pm	Summary and Wrap up by Session Chairman
4.45pm	End

Day 2: 17th December 2020
Parallel Session: ECOSYSTEM SERVICES (ROOM A)

Time (GMT +8)	Title/Presenter
9.00am – 9.15am	01 - ROOT TENSILE CHARACTERISTIC AND CONTRIBUTION OD SELECTED PENNISETUM SPECIES ON THE SHEAR STRENGTH OF SOIL Assoc. Dr. Zulfahmi Ali Rahman (Universiti Kebangsaan Malaysia)
9.15am – 9.30am	02 - A DOCUMENT ANALYSIS OF ECONOMIC VALUATION STUDIES ON ECOSYSTEM SERVICES IN FRASER'S HILL FOREST COMPLEX. Mr. Amir Sadiq Abd Rahman @ Ragam (Universiti Putra Malaysia)
9.30am – 9.45am	03 – THE RICHNESS AND UNIQUENESS OF DRAGONFLIES AND DAMSELFLIES OF FRASER'S HILL AS A TREASURE FOR ECOTOURISM Assoc. Prof. Dr. Choong Chee Yen (Universiti Kebangsaan Malaysia)
9.45am – 10.00am	07 – INCREASING VISITOR ARRIVALS TO FRASER'S HILL VIA HIGHLAND BIRDWATCHING AND PRIMATEWATCHING: A WIN-WIN APPROACH WITH GENTING HIGHLANDS Mr. Chan Teck Ling (Eddie) (Treks Event Sdn. Bhd.)
10.00am – 10.30am	05 – ABIOTIC FACTORS THAT INFLUENCE THE DAILY ACTIVITIES OF STINGLESS BEE, Tetrigona apicalis AT FRASER`S HILL RESEARCH CENTRE, UNIVERSITI KEBANGSAAN MALAYSIA Ms. Sarah Nadira Hurairah (Universiti Kebangsaan Malaysia/ Malaysia National University)
10.30am – 10.45am	Question & Answer
10.45am – 11.00am	Break/Intermission
11.00am – 11.15am	06 – NATURE THERAPY FOR LEARNING DISORDERS KID @ UKM FRASER'S HILL RESEARCH CENTRE Mr. Mohd. Razif Mamat (Malaysia Genome Institute)
11.15am – 11.30am	04 – ECONOMIC VALUES OF BIRD WATCHING IN FRASER'S HILL Assoc. Prof. Dr. Abdul Rahim Abdul Samad (Universiti Putra Malaysia)
11.30am – 12.00pm	Question & Answer
12.00pm – 12.15pm	Summary and Wrap up by Session Chairman

Day 2: 17th December 2020 (Thursday)
Parallel Session: FLORA (ROOM B)

Time (GMT +8)	Title/Presenter
9.00am – 9.15am	01 – MANAGING THE FLORA OF FRASER'S HILL TO MAXIMISE ITS VALUE AS VISITOR ATTRACTION Dr. Ruth Kiew (Forest Research Institute Malaysia)
9.15am – 9.30am	02 – A COLLECTION OF SAPOTACEAE IN FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA Ms. Nur Syamina Jamaluddin (Universiti Kebangsaan Malaysia)
9.30am – 9.45am	03 – DIVERSITY OF MACROFUNGI IN FRASER'S HILL Dr. Nur 'Aqilah Mustafa Bakray (Universiti Kebangsaan Malaysia)
9.45am – 10.00am	04 - SOME NOTEWORTHY MOSSES FROM FRASER'S HILL, PAHANG, PENINSULAR MALAYSIA Dr. Nik Norhazrina Nik Mohd Kamil (Universiti Kebangsaan Malaysia)
10.00am – 10.30am	Question & Answer
10.30am – 10.45am	Break/Intermission
10.45am – 11.00am	05 – NOTES ON THE GENUS DIPLAZIUM SWARTZ (ATHYRIACEAE) OF FRASER'S HILL Assoc. Prof. Dr. Haja Maideen Kader Maideen (Universiti Kebangsaan Malaysia)
11.00am – 11.15am	06 – COMPOSITION AND DIVERSITY OF SAPLING IN TRANUM FOREST RESERVE, FRASER'S HILL, PAHANG, MALAYSIA Mr. Ahmad Fitri Zohari (Universiti Kebangsaan Malaysia)
11.15am – 11.30am	07 – GUNUNG ULU SEMANGKOK: RELEVANCE OF EARLY BOTANICAL COLLECTION TODAY Ms. Aliaa Athirah Adam Malek (Forest Research Institute Malaysia)
11.30am – 12.00pm	Question & Answer
12.00pm – 12.15pm	Summary and Wrap up by Session Chairman

Established in 1972, WWF-Malaysia is part of WWF, the international conservation organisation. Working to sustain the natural world for the benefit of people and wildlife, WWF-Malaysia's efforts to conserve nature focus on six major goals – forests, oceans, wildlife, food, climate and energy, as well as freshwater – and three key drivers of environmental problems – markets, finance and governance.

WWF-Malaysia
1, Jalan PJS 5/28A,
Pusat Dagangan Petaling Jaya Selatan
46150 Petaling Jaya,
Selangor, Malaysia
Tel: +603-74503773
Fax: +603-74503777
E-mail: contactus@wwf.org.my
wwf.org.my

Working to sustain the natural world for the benefit of people and wildlife.
WWF
together possible
wwf.org.my