

BIODIVERSITY AND ENVIRONMENTAL CONSERVATION



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FOREWORD



Greetings. It is my pleasure to welcome you to our latest issue of Research Update. In this issue, themed “Biodiversity and Environmental Conservation”, we highlight our researchers’ efforts in the field of natural environment and ecosystem. Biological diversity is considered as one of the niche areas of our university’s research and development initiatives.

Biological diversity or biodiversity is regarded as the vast range of life forms and natural marvels. This ecological process and its impacts of human beings formed biodiversity that evolved billions of years. Moreover, it develops the systems of life which we belong to and depend upon. Biodiversity plays such an important role that it is crucial for us to conserve our rich natural environment. It is imperative that through our research, we highlight the magnitude of ecological system and its impacts on our lives. Therefore, we strive to preserve the natural environment by sustaining this diversity.

Much of our lives depend on biodiversity as it provides us with oxygen, food, water, sources of medicine, shelter and natural energy to power our lives. Loss of biodiversity may have a detrimental impact on our lives, income and may result in human migration. This is apparent as biodiversity augments ecosystems’ resilience as more species in the environment would mitigate any damages to the environment, such as famine, drought, global warming and other disasters. Particularly, the genetic variety of plants, insects and microorganisms provides constant supply of agrarian ecosystem that would ensure ample source of food for future generations. Hence, it is vital that we emphasised in maintaining a well-balanced ecosystem that will safeguard the constant supply chains of precious ecology system that would be impossible to restore.

All the research endeavours exhibited in this issue will undoubtedly enhance our comprehension on biodiversity and their impacts. To our researchers who contributed to this issue, my appreciation for your tireless efforts and I congratulate you on your dedications to promote biodiversity. I sincerely hope that the research projects presented in this issue would encourage and inspire more scholarly discussions that will ultimately preserve our rich biodiversity and the natural environment.

Thank you.

A handwritten signature in black ink, consisting of a large, stylized loop followed by a horizontal line.

Prof Dr Kopli Bujang

Deputy Vice Chancellor (Research & Innovation)
Universiti Malaysia Sarawak

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HIGHLY ACTIVE HETEROGENEOUS NANO-CATALYST SYNTHESIS FROM TROPICAL BIODIVERSITY ABORIGINAL SEASHELLS FOR JATROPHA BIODIESEL PRODUCTION

Researchers: Abu Saleh Ahmed, Reddy ANR and Sinin Hamdan

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The particle size of the catalyst is one of the most important factors for their catalytic activity. In this study a highly active heterogeneous calcium oxide (CaO) nano-catalyst with a diameter and surface area of $66\pm 3\text{nm}$ and $90.61\text{ m}^2/\text{g}$, respectively, was synthesised from *Polymesoda erosa* (*P. erosa*) seashells through a calcination–hydration–dehydration technique. The nano-CaO catalysis impact was investigated in a two-step transesterification of triglycerides from crude Jatropha oil (CJO) as a biodiesel along with other reaction parameters such as catalyst concentration, reaction time and methanol to oil ratio. Fourier transform infrared (FT-IR) spectroscopy, transmission electron microscope (TEM), X-ray diffraction (XRD) and Brunauer-Emmett-Teller (BET) spectrographic techniques were utilized to evaluate the CaO nano-catalyst spectral and structural characteristics. The effects of the transesterification parameters on reaction kinetics and Jatropha biodiesel (JB) yield were analysed by employing a three-factor-five-level response surface methodology (RSM) model based on a full factorial, two block, central composite design (CCD). The adequacy of the predicted model was verified, and a 98.54 % JB yield was reported at optimal parametric conditions i.e., 0.02:1 (w/w) catalyst concentration, 133.1 min reaction time and 5.15:1 mol. of methanol to the pretreated oil. An avg. of 95.8% JB yield was obtained from the catalyst reusability up to the sixth cycle. Fuel property test results of JB were found to be highly commensurate with the biodiesel standard EN 14214.

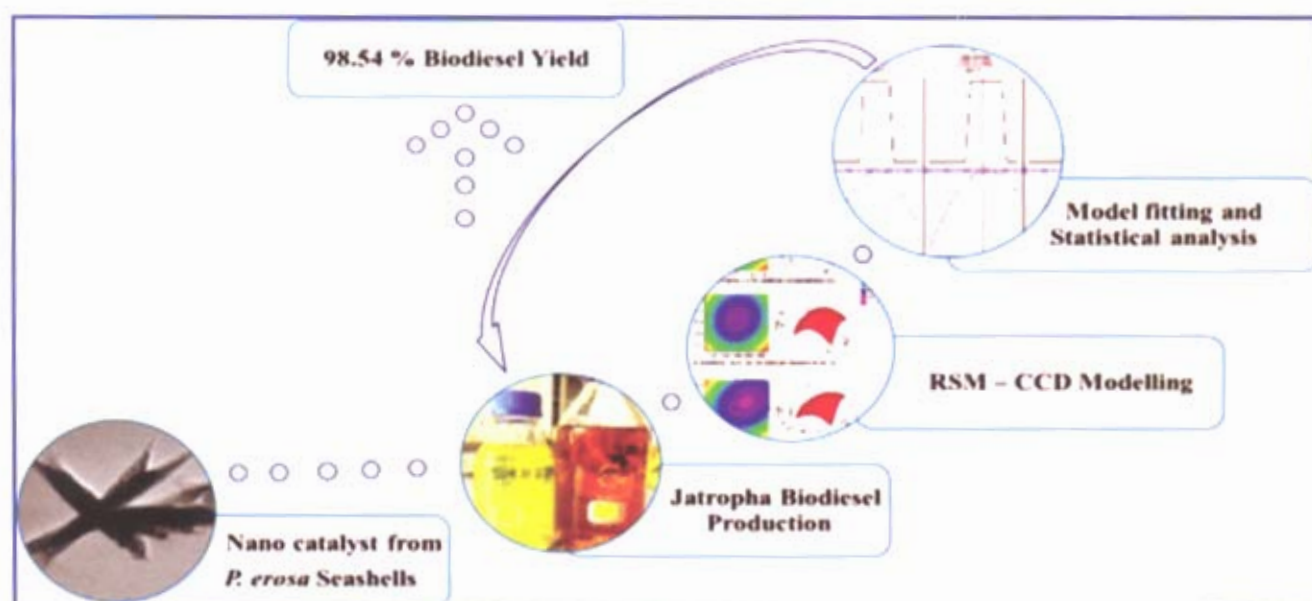


Figure 1: Synthesis Nano-CaO from Seashells for Efficient Production of Jatropha Biodiesel.

EVALUATION OF MULTIXENOBIOTIC RESISTANCE (MXR) ACTIVITY ON *Rasbora* spp. IN SARAWAK.

*Researchers: Chung Hung Hui, Lee Kui Soon, Badiozaman Sulaiman and Wee Boon Siong
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak*

Many aquatic organisms are equipped with multixenobiotic resistance (MXR) mechanism allowing them to thrive and reproduce in polluted waters exposed with natural toxins or anthropogenic contaminants. Such mechanism is analogous to multi-drug resistance phenomenon observed in mammalian tumour cell lines tolerant of anti-cancer drugs. MXR has been attributed primarily due to the elevated expression of transmembrane P-glycoproteins (P-gp) which function in an active expulsion of a wide variety of structurally diverse endogenous and environmental toxicants. Two major household contaminants with significant effects towards the aquatic system are silver nanoparticles and phthalates. Since surface epidermal tissues are considered the largest organ with constant exposure to the aqueous environment, it is very well suited for MXR study. The genus *Rasbora* is recognized as the most species rich genus in the subfamily of Danioninae with its geographical dispersion ranging within Asia, covering the Indian subcontinent, southern China, and Southeast Asia. Its habitats are among moderately fast flowing waters in forest stream to major river drainages. Hence, in this study, locally found *Rasbora* spp. of the Cyprinids family are employed as models for evaluating the ecotoxicological effects and synergistical potential of either single or binary mixtures using MXR activity as an endpoint. Thus far, several ATP-binding cassette coding sequences have been isolated and identified from *Rasbora sarawakensis* (Roberts, 1989). Effort is also underway for the establishment of epidermal tissue culture to serve as a model for evaluating MXR activity in these fishes. With the increased rate of urbanization

and industrialization in Sarawak, it is considered essential to establish such data for the evaluation of complex environment toxicants on the survivability and reproduction of local fish species.

This research was supported by the Ministry of Higher Education through research grant No. FRGS/SG05(03)/1148/2014(15) and permit from the Sarawak Forestry Department NCCD.907.4.4(Jld.13)-178 and park permit no. 126/2016.



Figure 1: Image of a *Rasbora sarawakensis* captured at Matang Wildlife Centre.



Figure 2: Primary epidermal tissue isolated from *Rasbora sarawakensis*.

AN OVERVIEW OF AUTOMATIC DEFECT CLASSIFICATION (ADC) IN SEMICONDUCTOR INDUSTRY

Researchers: David Chua Sing Ngie¹, Sharon Voon², S. Mohamaddan¹, and Nicholas Kuan Hoo Tien¹
¹Faculty of Engineering, Universiti Malaysia Sarawak
²X-Fab Sarawak Sdn. Bhd.

An automatic defect classification (ADC) for wafer inspection in semiconductor industries is referring to a system whereby various defects can be automatically classified into multiple categories according to its pre-defined defect groups. These defect groups are segregated in a form of visual distinctions. The application of the ADC system in semiconductor industry has become increasingly popular than ever due to its relatively high values as a tool in yield analysis and enhancement field. It is often being deployed in selective in-line process steps such as post lithography steps. Its rigorous application at each in-line process level is rather prominent as compared to outgoing post processed steps. A lot of studies are done on the application of inline ADC system but the application of the ADC on outgoing wafer inspection (post-fab environment) has been very limited and rarely found in literature. In general, wafer inspection process is carried out in 3 stages; defect detection, defect review, and defect classification. Once the defect is accurately classified, the analysis of specific defect trends can then be performed. Otherwise, the efficacy of analysis is poor which indirectly translates into an increase in cost of integrated circuit (IC) manufacturing. The advantages of the ADC include higher throughput, earlier detection that swiftly prompts to process excursion (preventing from continuous processing), human variation is kept at minimum, accurate, consistent, larger sample size and reduced resource overhead. The importance of the ADC is however marred by the cost incurred especially for a short term investment. Other concerns include multiple inspection systems of different suppliers and models (can pose problems to tool matching as it requires matching of inspection tools for both inspection and imaging optics), insufficient key defect examples, defects associated with the erroneous in classification due to recognition, and setting up classification and learning takes time. In overall, the ADC is still deemed as necessary especially for large scale wafer production.



Figure 1: Example of inspection tool and ADC*



Figure 2: Example of CMP defect in wafer*

* Courtesy of X-Fab Sarawak Sdn. Bhd.

DIVERSITY OF POLYPORALES IN KUBAH NATIONAL PARK

*Researchers: Mohamad Hasnul Bolhassan and Sepiah Muid
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak*

Macrofungi of the order Polyporales are among the most important wood decomposers and caused economic losses by decaying the wood in standing trees, logs and in sawn timber too. Despite their importance within ecosystems, Polyporales are often overlooked. As a result, the taxonomy and diversity of Polyporales are very poorly known compared with the majority of the other organism presents in forest ecosystem. Thus, in order to understand the diversity of Polyporales, the knowledge of their distribution and association with all organic and inorganic substrates are essential. Diversity and distribution of Polyporales in Kubah National Park was investigated by collecting basidiocarps from trunks, branches, exposed roots and soil. A total of 33 basidiocarps belonging to five families: Polyporaceae, Ganodermataceae, Fomitopsidaceae, Hymenochaetaceae and Meripilaceae were recorded. It is estimated that more species can be obtained from the Kubah



Figure 1: Field work activity



Figure 2: *Microporus xanthopus* is one of the common species encountered.

National Park and therefore, more species are expected to be encountered if more frequent and regular collections are carried throughout the year. Continuous and long-term research needs to be undertaken for a better knowledge and understanding of the Sarawak macro fungal diversity.

This research was supported by the Research Acculturation Grant Scheme (RAGS) No. E14099 F07 69 1044/2013(11).

TRAILING BORNEO'S SECRETIVE PEAT SWAMP CROCODILE, *Tomistoma schlegelii*: DISTRIBUTION, HABITAT USE AND MOVEMENT PATTERNS

*Researchers: Indraneil Das, Anthony Pine, Adam Kaeser and Engkamat Lading
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak*

This is an exploratory research project, focused on Sarawak's peat marsh forests and rivers in search of one of the rarest and least understood species of crocodile, the Tomistoma or Malayan False Gharial (*Tomistoma schlegelii*). The project employs newly-developed approaches in sonar and radio-telemetry to locate and track crocodiles in areas where they would otherwise be elusive to humans. Through the use of sidescan sonar, this project will also give an in depth look into the subaerial habitat structures and composition of peat swamp forests, rivers and marshes. With data acquired from our underwater sonar imaging, we will be able to map critical habitat, providing important three-dimensional habitat maps that can be used to explore, manage and conserve these aquatic ecosystems in the future. Through the use of VHF transmitters on captured *Tomistoma*, our project will provide the first glimpses into movement patterns and habitat used by the species in Sarawak. Findings from this project will provide a new and improved understanding for the distribution and ecology of the species. Alongside partnership between Universiti Malaysia Sarawak and the Sarawak Forest Department, this project aims to create a foundation for future work that can contribute to further research, exploration, and conservation in Sarawak.

This research was supported by the National Geographic Society, through research grant GL/I01/NATGEO/01/2016.



Figure 1: The Malayan False Gharial, *Tomistoma schlegelii*, an inhabitant of Borneo's peat swamps.

ECOLOGY AND DIVERSITY OF THE HERPETOFAUNA OF SECONDARY AND LOGGED FORESTS OF PELAGUS, UPPER BALEH AND ULU BARAM, SARAWAK

*Researchers: Indraneil Das, Pui Yong Min, Adi Shabrani Mohammad Ridzuan and Mohamad Paisal Wahab
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak*

This three-year project analyses life history and distribution data for the herpetological fauna of sites in central and northern Sarawak. The primary objectives are to evaluate gross habitat use, as well as fine microhabitat use by the local herpetofauna, as well as evaluate species richness and diversity of amphibians and reptiles at these sites prior to the construction of hydroelectric power dams, expected to be operational around the year 2019.

Habitat disturbance is known to affect biodiversity in many taxa. Amphibians particularly are sensitive to environmental change, and studies have demonstrated the effect of anthropogenic disturbance on populations. Several ecological traits within amphibians are vulnerable to landscape change, including reproductive strategies. We investigated how guilds of frogs respond to different degrees of disturbance, using proportionate canopy cover as a surrogate for disturbance and reproductive modes within lowland dipterocarp forests. Visual and Acoustic Encounter Surveys along transects were conducted and a total of 47 species, exhibiting 14 reproductive modes recorded. Sites with low species richness showed fewer reproductive modes. These findings suggest frog species richness and guilds are distributed according to habitat preferences by individual species. Anthropogenic disturbances may create additional breeding sites, which may be utilized by human-commensal species. Environmentally sensitive modes, such as phytotelm breeders, occur only in forested habitats. These results suggest that conservation plans should attempt at maintaining habitat heterogeneity in order to preserve both species and representatives with unique ecological traits.

This research was supported by the Sarawak Energy Berhad Hydropower Environmental Sustainability Program, through research grant number GL(I01)SEB/2014/02(03).

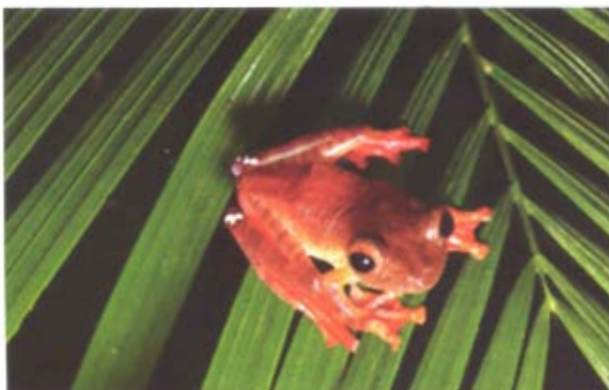


Figure 1: The Harlequin Tree Frog (*Rhacophorus pardalis*), a rhacophorid that breeds in standing waterbodies.



Figure 2: The Malayan Flat-shelled Turtle (*Notochelys platynota*), an inhabitant of lowland streams.

REMOVAL OF HEAVY METAL CONTAMINANTS USING ZIRCONIUM-BASED FERROMAGNETIC PARTICLES

*Researchers: Lim Soh Fong and Agnes Lee Yung Weng
Faculty of Engineering, Universiti Malaysia Sarawak*

Heavy metal contaminations in wastewaters is one of the major problems worldwide imposing serious threat to human health. Among several treatment technologies applied for heavy metals removal, adsorption process has been explored widely and magnetic particles have provided unique advantages in due course. In this research, zirconium-based ferromagnetic particles are explored as a potential sorbent for adsorptive removal of contaminants mainly divalent heavy metal ions e.g. Cu^{2+} , Zn^{2+} , and Cd^{2+} . The metal selectivity properties of the sorbent were studied and evaluated from the distribution coefficients of a series of divalent metal ions. This zirconium based ferromagnetic particles consist of zirconium-iron oxide compounds which are synthesized by co-precipitation technique of both ferrous and ferric materials in zirconium sulfate solution. The fabricated particles have excellent ferromagnetic property which enabled them to be easily recovered by magnetic separation technology after decontamination of heavy metal ions, which overcomes the disadvantage of separation difficulty of common powdered adsorbents (as shown in figure below). The interaction characteristics between the heavy metal ions and the ferromagnetic particles were elucidated by various instrumental analyses such as Fourier transform infrared spectroscopy (FT-IR), particle size analyser (PSA), and scanning electron microscopic-energy dispersive X-ray (SEM-EDS). All kinetics and equilibrium studies of the heavy metal ions removal using the ferromagnetic particles were performed in batch mode. The experimental and instrumental analyses have validated that the ferromagnetic particles are able to remove Cu^{2+} , Zn^{2+} , and Cd^{2+} from aqueous solution.

This research was supported by the Universiti Malaysia Sarawak through Special Grant Scheme (F02/SpGS/1404/16/5).

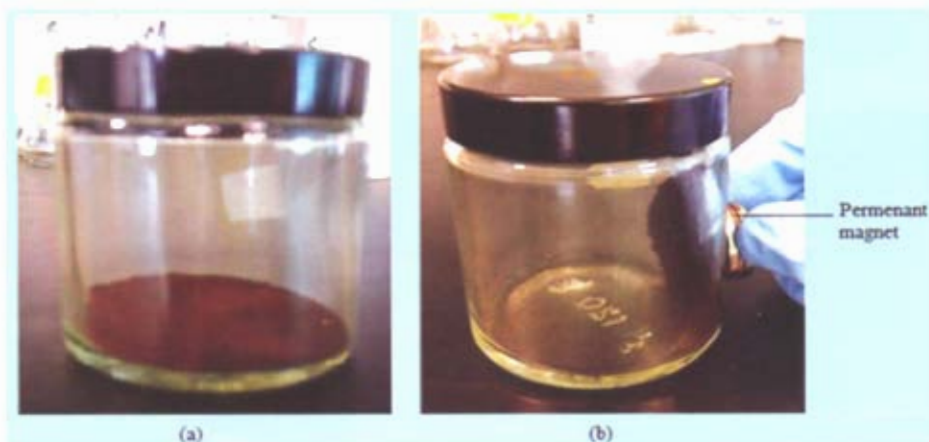


Figure 1: Zirconium-based Ferromagnetic Particles

THE ROLE OF MANGROVE HABITAT HETEROGENEITY IN SHAPING THE BIRD ASSEMBLAGES

Researchers: Jayasilan Mohd-Azlan ^{1,2}, Richard A. Noske ² and Michael J. Lawes ²

¹Faculty of Resource Science and Technology, Universiti Malaysia Sarawak.

²Research Institute for the Environment and Livelihoods, Charles Darwin University, Australia

Mangrove ecosystems are among the most threatened habitats in the world as they are under severe land use pressure throughout the world and Australia is no exception. Mangroves constitute the characteristic vegetation of the intertidal environment on sheltered tropical and subtropical coastlines. Understanding the ecological importance of habitat types is necessary to conserve mangrove bird species. We examined the role of mangrove habitat complexity in determining the richness of avian mangrove dependent species (MDS) and interior species, overall bird species richness and density. Although only a few bird species are confined to mangroves, the bird community can be spatially and trophically complex. In peninsular Malaysia, where the richness of mangroves is comparable to Northern Australia, 47 terrestrial bird species excluding aerial hunters and waterbirds were recorded, with six bird species restricted to mangroves. In Darwin mangroves of Northern Australia High species richness (overall and MDS) and density in the mangroves was associated with plant species richness, the density of the understory and food resource distribution. Furthermore, habitat

heterogeneity rather than patch area per se was a more important predictor of species richness in the mangroves. These findings stress the importance of habitat diversity and quality to the diversity and density of birds in mangroves. Thus, habitat heterogeneity within mangroves is a crucial patch characteristic, independent of mangrove patch size, for maintaining diverse avian species assemblages.

Mohd-Azlan Jayasilan was supported by Universiti Malaysia Sarawak (UNIMAS), Ministry of Higher Education (MOHE) and an ARC research grant LP0667619



Figure 2: Sonneratia flowers are frequented by many nectarivorous birds. Image showing *Sonneratia alba* being inundated by high tide near Nightcliff mangroves



Figure 1: The dense but low in plant diversity attract many mangrove specialist birds to undisturbed forest patches. The image illustrates *Rhizophora stylosa* stand in near Frances Bay



Figure 3: Red-headed Honeyeater (*Myzomela erythrocephala*) probing of the flower of *Bruguiera exaristata* in the mangrove areas of Darwin.

BIODIVERSITY: THREATS AND CHALLENGES

*Researcher: Prashanth Talwar
Faculty of Cognitive Sciences and Human Development,
Universiti Malaysia Sarawak*

Biodiversity is the diversity of species and ecosystems and the ecological processes. Ecosystem processes are driven by the number of species in an ecosystem. One of the biggest challenges to researchers is understanding the different species on earth. Example cats belong to Felidae family but differ in their size, colour and breed. Persian cat looks different from Siamese cat due to genetic biodiversity. Another aspect of biodiversity is interaction between species in the ecosystem. Diverse variety of vegetables provides food to animals and humans. Some medicines are made from herbal extracts to cure diseases. Due to human activities such as polluting the environment and killing rare species, these are major threats to biodiversity. Other factors include climate changes. These threats have put a serious strain on the diversity of species on Earth. According to the International Union for Conservation of Nature (IUCN), globally about one third of all known species are threatened with extinction. Environmental conservation is the only solution to extinction, which nurtures the goal of making life more sustainable for human race. Many people think that only governments should do something to conserve the environment. This is untrue. Every single individual can protect this planet from pollution. For example, batteries are dangerous for the environment if thrown away, unfortunately only a fraction of these batteries gets to be recycled. Trees are our source of oxygen and we cut them down instead of replanting them. If every person planted a tree, life would improve significantly. The air would be cleaner; the number of trees would get back to normal. Taking care of the environment should be everyone's responsibility to conserve the planet for the generations to come.



Figure 1: Borneo Jazz 2016 Tree Planting Ceremony



Figure 2: RAFFLESIA IN BLOOM NOW! May-2016

SAGOMCHAR: A VERSATILE AND ENVIRONMENTAL FRIENDLY MICROWAVE-INDUCED BIOCHAR

Researchers: Rafeah Wahi¹, Sharifah Mona Abdul Aziz Abdullah², Zainab Ngaini¹,
Sinin Hamdan³, Nur Fakhirah Qurratu'Ain Zuhaidi¹

¹Faculty of Resource Science and Technology, ²Center for Pre-University Studies, ³Faculty of Engineering,
Universiti Malaysia Sarawak

Continuous, improper disposal of sago bark waste could create environmental problems such as soil and air pollution. Thus, an efficient, systematic and environmental friendly utilization of sago bark waste is urgently required. Our research aimed to utilize sago bark waste by turning it into biochar, which is highly in demand as feedstock for wastewater treatment and agricultural applications. In our work, biochar was produced via microwave carbonization of sago bark waste in the absence of oxygen, at significantly reduced temperature and residence time compared to conventional carbonization. Microwave carbonization is time, cost and energy saving, as well as environmentally acceptable means for biochar production. By using microwave pyrolyzer, complete carbonization of sago bark waste was successfully achieved in only four minutes, at less than 400 °C pyrolysis temperature. The biochar obtained was named SagoMChar, and is a potential low grade fuel material (heating value 25.99 MJ/kg), precursor for activated carbon and soil amendment to enhance plant growth.

This research was supported by the Ministry of Higher Education through PRGS/TK04(01)/1268/2015(02) research grant.



Figure 1. Sago bark waste was converted into biochar (SagoMChar) via microwave carbonization

SAGOMOIL: MICROWAVE INDUCED BIO-OIL FROM SAGO FIBROUS WASTE AS ALTERNATIVE, ENVIRONMENTAL FRIENDLY FUEL

Researchers: Rafeah Wahi, Sharifah Mona Abdul Aziz Abdullah², Zainab Ngaini¹, Sinin Hamdan², Nur Rafikah Rosli¹, Syamila Aimi Yahaya¹

¹Faculty of Resource Science and Technology, ²Center for Pre-University Studies, ³Faculty of Engineering, Universiti Malaysia Sarawak.

The use of agricultural waste as renewable energy source is of growing importance in respond to the great demand of energy, the depletion of fossil fuel and the environmental concerns due to the use of fossil fuel and overabundance of agricultural wastes. In this study, sago bark fibrous waste from sago flour processing mill was used as feedstock to produce bio-oil (SagoMoil) via microwave pyrolysis technology. The production of SagoMoil is energy and cost saving, with 30-times faster pyrolysis time and 50% lower pyrolysis temperature in comparison to conventional pyrolysis. SagoMoil has a heating value higher than sub-bituminous coal at 21.99 MJ/kg, and significant phenol and phenolic compound contents. SagoMoil is also more environmental friendly compared to conventional bio-oil, with no content of carcinogenic polyaromatic hydrocarbon.

This research was supported by the Ministry of Higher Education through PRGS/TK04(01)/1268/2015(02) research grant.



Figure 1: Part of our research team with Datuk Dr. Abu Bakar bin Mohamad Diah, Deputy Minister of Science, Technology and Innovation during INTEX2016

WHOLE GENOME OF CHARLIE I: GENE OF A PROBOSICS MONKEY (*Nasalis larvatus*) FROM BAKO NATIONAL PARK

Researchers: Ramlah Zainudin¹, Nur Aida Md Tamrin¹, Mohd Haniff Riduan¹,
Yuzine Esa² and Mohd Tajuddin Abdullah³

¹Faculty of Resource Science and Technology, Universiti Malaysia Sarawak. ²Universiti Putra Malaysia, ³Institute Penyelidikan Kenyir, Universiti Malaysia Terengganu

The Proboscis Monkey (*Nasalis larvatus*) or long-nosed monkey is an endemic species to the island of Borneo in Southeast Asia and considered as a flagship species that acts as an icon or symbol for a well-defined habitat and environment. Proboscis Monkey have several unique and rare morphological, biological and behavioural traits that make it worthwhile as a candidate to have its whole-genome sequenced and documented. Studying Proboscis Monkey's genes especially the ones related to the diet preferences (since the monkey is very specialized in its diet) will give many new insights towards the endangered species. Recent next-generation sequencing (NGS) technology has made whole-genome sequencing a lot easier with accurate results. Thus, an adult male Proboscis Monkey from Bako National Park Sarawak, called Charlie I, named in honour of our previous UNIMAS Deputy Vice Chancellor (Research), was sequenced. The first draft genome of Charlie I was successfully sequenced and assembled using NGS platform with 290-fold coverage genome. The reported coverage and assembly statistics commensurate to those of previous successful draft genome of other species. This whole genome shotgun project has been approved and deposited at DDBJ/EMBL/GenBank under the accession JMHX00000000. There are 738 genes that are unique to Proboscis Monkey and 119 and 210 genes are shared with human and ape respectively. There are some deletions of nucleotides for the taste receptor genes that might explained for its adaptation to the harsh food resources in the wetland of Bako, Sarawak.

This research was supported by the Proboscis Genome Project, Universiti Malaysia Sarawak (PhD projects for Nur Aida Mohd Tamrin, Mohd Haniff Riduan, Madinah Adrus; MSc research for Ho Licia, Mohamad Kombi and Millawati)



Figure 1: Proboscis Monkey is feeding on



Figure 2: Predicted gene by Augustus 2.5.5 for Proboscis Monkey draft genome with chromosome size.

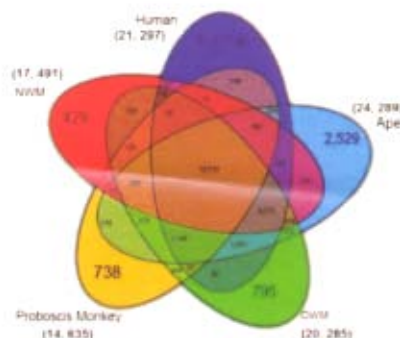


Figure 3: Venn diagram showing unique and shared genes between old world monkeys (including Proboscis Monkey), new world monkey, human and ape genomes. The number of genes is listed in each of the diagram components and the total number of genes for each group is given in parentheses.

SARAWAK WILDLIFE CORRIDORS: MEETING THE ASPIRATIONS OF FUTURE GENERATION

Researchers: Jedediah Brodie¹, Jason Hon² & Mohd Azlan Jayasilan³

¹Departments of Zoology & Botany and Biodiversity Research Centre, University of British Columbia, Canada,

²WWFM Sarawak Conservation Program, Kuching, Sarawak.

³Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Wildlife corridors are essential for long-term conservation. Most national parks and other protected areas are scattered and too small on their own to support viable populations of large animals. Even though Sarawak boasts the highest number of protected areas in Malaysia and has several important, large protected areas, each of these places is too small on its own to support populations of large wildlife species into the future. Therefore, it is important that animals, especially species of conservation importance, are able to disperse among parks in order to find food and mates, avoid inbreeding, and shift locations in response to climate change. Wildlife corridors facilitate this dispersal, and can prevent wildlife populations from becoming increasingly isolated in protected area, which could lead to extinction and the loss of some of Sarawak's world-renowned biodiversity. We have analysed the habitat selection of several Protected and Totally Protected wildlife species in Sarawak and surrounding areas using camera trap data and metapopulation models. Our goal was to identify the most important wildlife corridors in Sarawak –the ones that contribute the most to preventing extinctions. Our analysis shows that the most important dispersal route is between Kayan Mentarang and Betung Kerihun in Kalimantan. Protecting intact forest habitat along that route would greatly enhance wildlife persistence. Our camera trapping result suggest that the Hose Mountains in Sarawak are a very important wildlife area, with mammal diversity and abundance among the highest anywhere in Malaysian Borneo. Gazetting the Hose Mountains and Batu Laga National Parks remains a critical priority. Other important corridors in Sarawak are those connecting the Hose Mountains to Betung Kerihun and connecting Gunung Mulu, Ulu Temburong, and Usun Apau to Kayan Mentarang. Protecting the corridors that we

identify as the most important will greatly reduce the chances of extinction for wildlife, and showcase Sarawak's commitment to long-term conservation based on the best-available science. Additionally, it will help to meet the Sarawak Government's target of achieving 1 million hectares of Totally Protected Area in the State and meet the objective of Heart of Borneo Tri-National agreement.

This project was supported by NRGs/1087/2013(01) & FRGS (990/2013[31]/1/2013), Idea Wild, Mohamad bin Zayed Foundation, WILMAR International, the Denver Zoological Foundation, Panthera, the Natural Science and Engineering Research Council, and the Canadian Foundation for Innovation.

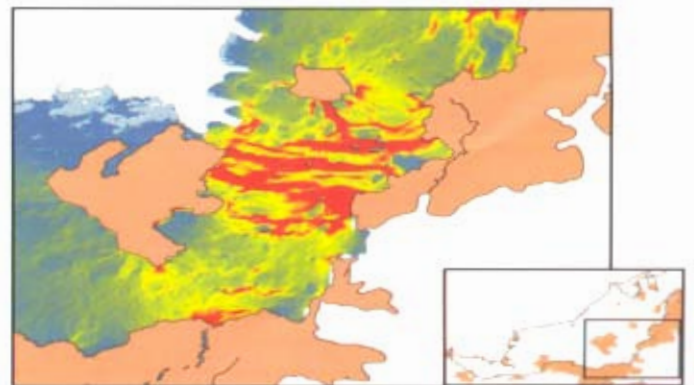


Figure 1: Predicted dispersal routes for wildlife moving between the house, Usun Apau National Park and Kayan Mentarang National Park, based on circuit theory algorithms. Yellow are areas that many animals will travel through, while blue are areas that few animals will use.

BORNEAN ORANGUTANS *Pongo pygmaeus* PLANTERS OF BIG TREES IN TROPICAL RAINFOREST

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Orangutans (*Pongo pygmaeus*), with a wide distribution across Borneo and Sumatra, are naturally limited to tropical rainforest. Orangutans have been reported to utilize more than 500 species of plants. The diet breadth of an orangutan is wide and they can consume more than 300 types of fruit available in forests. They are also known to forage on cultivated fruits such as durians, figs, rambutans and mangoes. They may play an important role in dispersal of seasonal tropical fruits in the wild. Seed dispersal and seed dissemination, which contributes to the spatial dynamics of plant populations, is important in forest ecology. The association of frugivory and seed dispersal has been consistently linked and theoretically framed on the idea of coevolution. Adult orangutans may travel from 300 m to 800m per day, with a home range of over 6 km². Primates are important seed dispersers because of their varied diet and their ability to travel far which leads to high dispersal distances. These functions are crucial in many of the degrading Bornean rainforests. A preliminary study to investigate the efficacy of Northwest Bornean Orangutans (*Pongo pygmaeus*) as seed dispersers and predators was conducted in Matang Wildlife Centre, Kuching, Sarawak from November 2012 to April 2013. Three adults and three juvenile

captive orangutans were fed with nine species of locally-available fruits. Approximately 1.5 kg of fruit was given once daily during the study period. Seeds from sieved faecal matter were collected and tested for germination. Three species of small-seeded plants germinated while two medium-seeded plants did not. The seeds from the other four species were damaged and not tested for germination. Fruit and seed-handling behaviour was also observed. A broad range of fruit-processing behaviour such as swallowing, spitting and masticating allows the orangutans to be both seed disperser and predator towards some large-seeded and small-seeded fruits. The morphological characteristics of seeds and age of orangutans appear to influence the fate of seed dispersal. This preliminary research suggest that orangutan plays an important role in forest dynamics and regulation where the absence of this species in tropical rainforest may limit the regeneration and dispersal large seeded trees which in turn may alter the species composition of regenerating tropical rainforest.

This research was supported by Sarawak Forest Department (NCCD.907.4.4.[Jld.8]-78:363/2012). Mohd-Azlan Jayasilan was supported by the NRGS-1087/2013(01) research grant.



Figure 1: Orangutans are important seed dispersers in tropical rainforest where their services in forest regulation is vital especially in degrading tropical rainforest.

ANTHROPOGENIC DEVELOPMENT IN RIPARIAN ZONES

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Based on the concept of reaction norms (phenotypic plasticity), this study investigates human-riparian interactions in the Nipah swamp ecosystem, focusing on the riparian widths of three diversely human-dominated sites located along the Kuap River in Kuching, Sarawak (see Figure 1 below). Factors that contribute to ecological health in riparian ecosystems are collected for analysis, namely human activities, vegetation cover, vegetation width, indigenous plant and occurrence of soil erosion. The instrument and method used in the study are Geographic Information System (GIS) and field investigations. Looking at functioning samples, the riparian ecosystems seem to have been affected by dynamics and plastics interacting with diverse levels of human disturbances. In other words, the ecosystems adapt and change within their immediate environment; at the same time, they continue to stay vibrant, co-existing with humans. The findings indicate that 40 to 80 m of riparian width exhibits the best interactions between humans and riparian ecosystems.



Figure 1: Study Sites. a) Riveria Housing Estate, b) Stampin Resettlement, and c) Tabuan Jaya Baru Housing Estate (<http://www.wikimapia.org>)

EXPLORING THE LEAST KNOWN SMALL MAMMALS IN BORNEO: SHREWS

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Ecological studies on the distribution and habitat affinity of shrew are very much limited in Malaysia especially in Sarawak. Taxonomic confusion due to cryptic morphology on the species limits within members of the genus further added to the challenge in understanding these mammalian group. This is also primarily due to lack of museum voucher specimens for comparisons. Species identification process solely based on morphological characters also can be difficult to accurately identify species due to overlapping measurements and characters within members of these shrews. Therefore, our first goal is to increase our sample size for these shrews especially in Borneo, to better understand their ecology and habitat where they are found. Our team has sampled in multiple localities in Peninsular Malaysia, Sarawak and Sabah. Sampling was performed using pitfall traps that were buried on the ground with fence for forest dwelling shrews (Fig. 1) and using cage trap baited with grill or fired chicken for urban shrews. All samples were collected and processed following standard museum voucher specimen preparation protocol including their measurements. In the lab, both morphological and molecular data were taken and generated for each specimen. Cranial and dental characters were measured and assessed to assign potential known species name. Later, this taxonomic assignment is verified through phylogenetic analyses using both mitochondrial and nuclear DNA genes that can provide different information on the evolutionary history, and biogeographical pattern that shape their diversity. To date, our finding suggests that there are hidden diversity within currently recognise shrew species in Borneo from the genus *Suncus* (House shrew) and *Crocidura* (Sunda shrew, Fig. 2). This finding was supported by both, genetic and the morphological data collected on these species. Our team is hoping to add more samples to better

understand the distribution of these unique lineages in Borneo. However, distribution of shrew in Malaysia is poorly known due to lack of information on their diversity. Given that some of this unique genetic lineages may possibly represent endemic species that is only found in Borneo, understanding on their distribution and predictive distribution modelling is important to better manage their habitat. To achieve this, we are currently exploring Maximum Entropy (MaxEnt) modelling technique to predict the distribution and population size of shrew that can highlight shrew's natural habitat which will aid in the conservation of this species. We hope this study can uncover hidden diversity within shrew species especially those from Sarawak.

This research was supported by the Faculty of Resource Science and Technology, Universiti Malaysia Sarawak through research grant No. NRGS/1088/2013(02) Led by Assoc. Prof. Dr Mohd Azlan Jayasilan.



Figure 1: Setting up the pitfall traps with canvas fence in the field



Figure 2: *Crocidura monticola* (Sunda shrew)

WATER QUALITY ASSESSMENT OF AN URBAN LAKE IN KUCHING: IMPLICATIONS FOR LAKE CONVERSATION

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The urban lake in Kuching Reservoir Park was selected for water quality assessment. The lake consists of two sections where the upper lake total area is 0.34 hectares and it is linked to the rainwater tank located at the upper hill of the park. The lower lake, approximately 0.80 ha of area flows to the drainage system that runs to the city. Due to its nature of lentic water, the water basically flows in a slow motion, with the water from the lower lake flows slowly into the drainage system that flows to the city area. The water quality of the lake has not being reported previously and this study aims to assess its water quality in order to provide information which could help in proper management of the lake. In this study, four sampling sites were selected. Water samples were collected and analyzed for pH, temperature, dissolved oxygen (DO), total dissolved solids (TDS), salinity, turbidity, biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), total suspended solids (TSS), ammoniacal nitrogen (NH₃-N), phosphate (PO₄³⁻), nitrate (NO₃), nitrite (NO₂-N), arsenic (As), chromium (Cr), lead (Pb) and zinc (Zn). Based on the data obtained from this study, the Water Quality Index (WQI) of the lake was classified as Class III, which is categorized as moderate water quality and it is able to protect common and moderately tolerant species. Trace elements (As, Cr, Pb and Zn) of the lake water were low and showed no potential impact to aquatic organisms. However, high levels of phosphorus (0.37 to 1.89 mg/L) were detected in the lake water which signifies that input from fertilizer runoff in the park. High level of phosphorus causes lake eutrophication due to excessive algae growth. Building of retention wall could help to prevent soil runoff from polluting the lake water during raining days and reduce nutrient loads in

the lake, which would reduce eutrophication. It is recommended that proper lake management measures should be undertaken in order to protect and sustain the aesthetic value of the lake. This will help to preserve the lake environment and prevent anthropogenic pollution of the lake.



Figure 1: Sampling locations at the urban lake at Kuching Reservoir Park

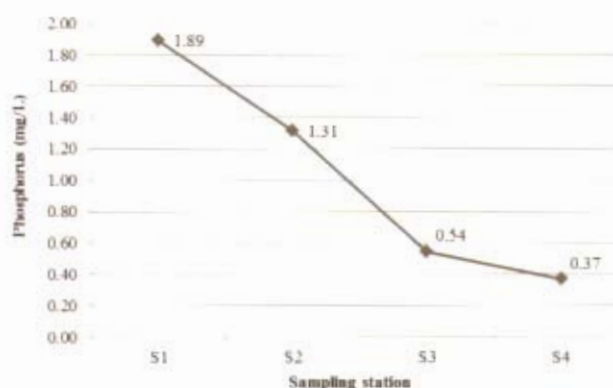


Figure 2: Phosphorus concentrations in lake water

HUMAN COMMUNITIES AND THEIR USES OF NATURAL RESOURCES

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In the interiors of Sarawak, the indigenous communities still rely on the abundance of natural resources for their livelihood as it carries significance to the locals in terms of culture, belief system, social value, medicinal uses and traditions. This study is aimed at identifying the various cultural uses of natural resources by the local community and make comparisons on economic, social and cultural values of these natural resources to them. At the moment, a total of 1,119 respondents of various ethnic groups from Telok Melano, Telok Serabang, Padawan, Ulu Engkari, Lingga, Banting and Sebuyau have been interviewed to identify different indigenous communities found in Western Sarawak ranging from the Sarawak River, Batang Sadong and Batang Lupar. On the other hand, information has been solicited on the various uses of flora and fauna currently available in their locality as well as the conservation methods practiced by the indigenous communities in this area. The preliminary findings suggest that local communities in this area generally still heavily rely on non-timber forest resources mostly for their own consumption and rarely are these jungle produce sold. The local communities blamed increasingly felt scarcity of timber resources on timber logging activities and mass clearing of forests for oil palm plantations in particular. Besides that, while some of the communities self-initiated conservation measures to preserve their surrounding natural resources, most communities do not take any measures in conserving their natural resources. Ongoing survey is still carried out to gain a more comprehensive picture on uses of natural resources by the local communities in Sarawak.

This research is funded by the Malaysian Ministry of Education through the NRGs/1090/2013(04) research grant.



Figure 1: Mengap ritual by the Tuai Rumah of Kampung Chabu Ili, Banting.



Figure 2: Wood fire stove in Annah Raus, Padawan.

NEW SPECIES OF BUCEPHALANDRA, A BORNEAN ENDEMIC GENUS

Researchers: Wong Sin Yeng, Ooi Im Hin, Nor Fathiah Abd. Rahim
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Twenty-one new species of *Bucephalandra* Schott (Araceae: Angiosperm) are described recently: *Bucephalandra akantha*, *B. aurantithecata*, *B. belindae*, *B. bogneri*, *B. chimaera*, *B. chrysokoupa*, *B. diabolica*, *B. forcipula*, *B. goliath*, *B. kerangas*, *B. kishii*, *B. micrantha*, *B. minotaur*, *B. oncophora*, *B. pubes*, *B. spathulifolia*, *B. sordidula*, *B. tetana*, *B. ultramafica*, *B. vespula*, and *B. yengiae*. Together these additional species take *Bucephalandra* to 29 species in total, all endemic to Borneo. It has become clear that a factor to the richness of these species (and doubtless other) species in Borneo is a high prevalence of geological specialization. We estimate that the genus *Bucephalandra* probably consists of more than fifty species.

Research work was funded by the Ministry of Higher Education Malaysia through Vote the NRGs/1089/2013-(03) and RACE/g(1)1329/2016(2) research grants.



Figure 1: *Bucephalandra pygmaea* (Becc.) P. C. Boyce & S. Y. Wong. The type species. From left to right: whole plant, inflorescence in bloom, spadix with the spathe removed, and infructescence.

A NEW GENERIC RECORD OF ZINGIBERACEAE (ANGIOSPERM) FROM SARAWAK, MALAYSIAN BORNEO

Researchers: Wong Sin Yeng and Ooi Im Hin

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Haniffia is a genus of three described species of terrestrial gingers hitherto restricted to the far south of Thailand and various localities in Peninsular Malaysia. The three described species are all seemingly locally endemic. The type species, *H. cyanescens* (Ridl.) Holttum, is restricted to Bukit Tanga (Negeri Sembilan, Peninsula Malaysia), with a variety, *H. cyanescens* var. *penangiana* C.K.Lim, occurring on Pulau Pinang and Kedah. The most recently recognized species, *H. flavescens* Y.Y.Sam & Julius (Sam et al. 2009) is known only from Endau Rompin N.P. (Johor, Peninsula Malaysia). The sole extra-Malaysian species, *H. albiflora* K.Larsen & J.Mood, is confirmed only from Nam Tok Chatwarin, Naratiwat, Thailand. *Haniffia santubongensis* S.Y.Wong, I.H.Ooi & P.C.Boyce is the fourth species of *Haniffia* and represents a new generic record for Borneo.

Research work was funded by Ministry of Higher Education Malaysia through the NRGS/1089/2013-(03) research grant.



Figure 1: *Haniffia santubongensis* A. Plant in habitat. B. Detail of ligule; note the blackish colour of the free portion. C. Inflorescence. D. Single flower; note the bifid tips to the lateral staminodes and the yellow callus in the middle of the labellum. E. Infructescence. F. Detail of single fruit; note the semi-glossy slightly warty surface, and the prominent floral remains.

THE ECONOMIC AND ENVIRONMENTAL FACTORS OF TAGANG SYSTEM ECOTOURISM IN SARAWAK

*Researchers: Nur Zaimah Ubaidillah, Rosita Hamdan, Rossazana Ab. Rahim and Farhana Ismail
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Tagang comes from Iban word which means regulation and conservation of river fish based on communities that was originally used to preserve the forest by the local community before being adapted to the conservation and management of rivers. Recently, Tagang system is one of the nature based tourism activities in Sarawak that contributes to a more efficient environmental management, contributing to economic and social development of communities. Due to the significant roles of Tagang systems to environmental conservation and community development in Sarawak, this study identifies the factors that influence in the development of Tagang system ecotourism based on the perceptions of visitors and local communities of the two different Tagang sites in Sarawak. The study of visitors' perception of Tagang system ecotourism was conducted at Tagang community project at Tengoa River, Long Lidung Village, Lawas. Meanwhile, the local community's perceptions were identified by the Tagang community project in Semedang Village, Serian. A total of 64 respondents or visitors of Long Lidung's Tagang site and 63 respondents from the Semedang village communities were involved in the questionnaire surveys. The factor analysis and reliability test results showed that based on the visitors, economic and sustainability, security and safeguarding the natural heritage and wildlife were importance to the Tagang system ecotourism. The community's perception showed that economic development and awareness of Tagang advantages were important factors for Tagang system ecotourism implementation. Similarly, both of the respondent groups agreed that biodiversity management and conservation of natural area where the most important factors that determined the success of Tagang system ecotourism in rivers' conservation.

This research was supported by the Research Acculturation Grant Scheme, Universiti Malaysia Sarawak through the RAGS/SS/07(2)/908/2012(09) research grant.



Figure 1: Notice of rules, regulation and enforcement of Tagang Area by Enforcement and Licensing Unit, Inland Fisheries Division, Department of Agriculture Sarawak.



Figure 2: Briefing on the Tagang eco-tourism activities (Semah fish feeding and dipping legs) by the operator of Tagang project.

VISUAL CONSERVATION OF PAGAN MELANAU CULTURAL ART FORM AND ITS PRACTICES

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This project focuses on the collection of information and visual especially about the cultural objects of Pagan Melanau in Sarawak by using visual ethnography method. This is extremely important because a large part of the Pagan Melanau cultural objects such as 'bilum', 'sariheng' and 'rabung' are currently extinct or nearly extinct. Apart from collecting data and visual documentation, the research will also focus on the history and cultural rituals of Pagan Melanau itself. This project focuses primarily on the study of cultural objects and its current development in the Melanau community from researcher observer's point of view, following several site visits to Dalat and Mukah covering Kampung Telian Tengah, Kampung Klid, Kampung Medong, and Kampung Plajau where rituals of paganism are still practiced. The findings were obtained through visual ethnographic methods to assess the effectiveness of visual analysis in ethnographic research and study the relationship between behavior and visual observation at the site. It is hoped that this research provides an opportunity for all to see the possibilities that could be explored in preserving the dying art form of the Pagan Melanau community. In conjunction with Universiti Malaysia Sarawak and Majlis Adat Istiadat Sarawak, this project aims to create a foundation for further investigation, exploration, and visual conservation of cultural objects in Sarawak.

This research was supported by the Ministry of Higher Education, through research grant No. FRGS/SSI09(01)/984/2013(25).



Figure 1: Two remaining 'Bilum' carvers from Kampung Klid, Dalat.



Figure 2: The making process of 'Rabung', one of the cultural objects in Kaul Festival at Kampung Klid, Dalat

ANTIMICROBIAL PROPERTIES OF SKIN SECRETION PEPTIDE FROM BORNEON FROGS

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Nature has endowed Borneo with rich natural resources and its tropical forests offer a safe haven for countless organisms. In many ancient traditions, amphibians are believed to possess medicinal properties. Various literatures cited on the usage of frog potions as aphrodisiacs, contraceptives as well as important ingredients in medicinal formula for many other illnesses. Since the last decade, researches on medicinal and pharmaceutical properties of various compounds from purified from frogs and toads have seen to be on the increase. Anurans endemic to many parts of the world have been used in the search of potential peptides and alkaloids for medicinal use and one of the major sources is their skin secretion. This study focuses on Bornean frogs of family Ranidae that inhabits the peat swamps and lowland forest of Borneo. Anhydrous ether was used to stimulate peptide release from the granular gland in the skin of the frogs and subsequently subjected to partial purification using Sep Pak C18. The partially purified peptides were tested for antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus* at various concentrations. All frog peptides tested showed antimicrobial properties against *E. coli* and *S. aureus*. The molecular mass of the peptides observed by SDS PAGE were between 1 to 3kDa. The findings generated from this study indicates that the Bornean frogs' skin secretion possess potential antimicrobial properties that can be further explored in various medical treatments especially during the emergence of multidrug resistance strains of pathogens.

This research was supported by FRGS, MOHE.



Figure 1: Bornean Frogs of family Ranidae

MACROINVERTEBRATES OF FRESHWATER ECOSYSTEM IN SARAWAK

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Macroinvertebrates serve as an integral part of food chains in the freshwater ecosystem. The fauna have also been widely used as biological indicators for stream quality assessment and monitoring programme. This study aims to document the species richness and distribution of macroinvertebrates in freshwater ecosystem in Sarawak including rivers, streams and man-made reservoirs. Macroinvertebrates were collected from 148 streams/stations in major rivers in Sarawak; 58 tributaries of Batang Baleh, 27 tributaries of Batang Rajang, 38 tributaries of Batang Baram, 10 tributaries in Murum Reservoir and 16 stations in Batang Ai Reservoir. Preliminary findings show that the composition of macroinvertebrates in these streams is dominated by gathering-collectors, filtering-collectors and predators such as *Baetis* sp., *Platybaetis* sp., *Thalerosphynus* sp., *Choroterpes* sp., *Habrophleboides* sp., *Camponeura* sp., *Thraulius* sp., *Rheonanthus* sp., *Drunella* sp. (Insect: order Ephemeroptera), *Hydropsyche* sp. (Insect: order

Trichoptera), *Phanoperla* sp. (Insect: Plecoptera) and *Simulium* sp. (Insect: order Diptera). In the older hydroelectric dam of Batang Ai, the dominant genera below the dam are *Macrostemum* sp. (Insect: order Trichoptera) and family Lynceidae (Crustacea: order Diplostraca), whereas the feeder streams are dominated by *Platybaetis* sp., *Choroterpes* sp., *Baetis* sp. and *Thalerosphynus* sp. (Insect: order Ephemeroptera). These preliminary findings indicated that the composition and distribution of macroinvertebrates are associated with their tolerance limit to the anthropogenic disturbances in the study areas.

The research was funded by the Sarawak Energy Sdn. Bhd. under research grants GL(I01)/SEB/1B/2013(13) Baleh, GL/(I01)/SEB/2B/2013(17) Pelagus, GL/(I01)/SEB/3B/2013(21), GL/(I01)/SEB/4B/2013(25) Murum and GL/(I01)/SEB/5B/2013(29) Batang Ai



Figure 1: Dragonfly nymph, Gomphidae (Odonata), a common predator in moderate flowing water.



Figure 2: Stonefly nymph, *Neoperla* sp. (Perlidae), a common predator in leaf-pack substrates.



Figure 3: Caddisfly larval, *Hydropsyche* sp. (Hydropsychidae), a filtering-collector.

BIOPHYSICAL VULNERABILITY IMPACT ASSESSMENT OF CLIMATE CHANGE ON AQUACULTURE SECTOR DEVELOPMENT IN SARAWAK, MALAYSIA

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This study is an assessment of the impact of climate change on the biophysical vulnerability of aquaculture production in Sarawak. The relationship between change in risk factors with the total aquaculture production and farmer's income is identified. It utilizes data from the survey done on 249 aquaculture farmers in Sarawak, as well as secondary data gathered from various government reports. The multiple linear regressions results verify that the mean minimum temperature has a positive significant effect on freshwater ponds, while relative humidity has a negative significant effect on brackish water ponds. The total aquaculture area has a positive significant effect on brackish water ponds and cages. The results are further supported by the bivariate Spearman's rho correlation results, which show that the increasing number of climate change events will decrease the aquaculture production and income of aquaculture farmers. It is found that water quality disturbance is the main biophysical vulnerability aspect of the aquaculture sector in Sarawak due to the impact of climate change. The impact of climate change through biophysical changes affects the water quality and poses a considerable challenge to small aquaculture farmers in Sarawak. Various adaptation strategies are urgently needed to mitigate the possible outcome of climate change risks in future.



Figure 1: The problem of erosion, sedimentation and altered flow patterns of river at cage aquaculture site in Loagan Bidang, Limbang due to environmental risks and degradation and economic activities.



Figure 2: The cage aquaculture farmers (the respondents) at Santubong river's aquaculture site that involved in the surveys

USING BIODIVERSITY AS A TOOL TO QUANTIFY ENVIRONMENTAL QUALITY IN GUNUNG JAGOI, BAU DISTRICT, KUCHING, SARAWAK

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Biodiversity has been regarded as a useful tool to quantify environment quality, although its application is complex and require substantial information inputs. Historically, biodiversity has supported livelihoods of local communities in Gunung Jagoi, western Sarawak. Over time, harvesting of natural resources at a local scale, a sometimes unregulated practise, has led to the endangerment of certain species of plants and animals in the area. Roles and functions of biodiversity may not be adequately acknowledged among the local communities, partly due to lack of information. In this study, biodiversity values were used to quantify terrestrial and aquatic environments in the area, with a hypothesis of high species richness of flora and fauna reflecting high environmental quality. Because of the complex nature of biodiversity of this tropical site, the study covers seven major components of biodiversity, specifically, the forest communities of trees, birds, mammals, amphibians, reptiles, freshwater fishes and crabs. The drainage system of Gunung Jagoi comprises first to third order streams, flowing within limestone and sandstone catchments. The stream fauna include 29 species of fish and four species of freshwater crabs. The latter group, comprising *Isolapotamon consobrinum*, *Parathelphusa oxygona* and *P. sarawakensis*, and *Perithelphusa borneensis*, and eight species of fishes are endemic to Borneo. Also recorded were the two fish species (*Puntius kuchingensis* and *P. lateristriga*), whose presence respectively in the upper reaches of Sarawak River and Sambas River in West Kalimantan can serve as a model for studying geographical distribution of aquatic life on Borneo.

The research was funded by the Special Funding for Research Institutes (SpFRI), research grant no. E14099/I01/69/SPFRI/1424/16/1



Figure 1: A snakehead, *Channa gachua*, one of major predators in small streams on Gunung Jagoi.



Figure 2: Two barb species, *Puntius kuchingensis* (top) and *Puntius lateristriga* (bottom). Their presence in upper reaches of Sarawak River and Sambas River in West Kalimantan serves as suitable model for studying the geographical distribution of aquatic life.



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