

BIODIVERSITY AND ENVIRONMENTAL CONSERVATION

RESEARCH UPDATE VOL. 15 NO. 2 | JULY 2019 | ISSN: 1675-5820



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Published by: UNIMAS Publisher, Universiti Malaysia Sarawak.

FOREWORD

It is my utmost pleasure to present to you our latest issue of Research Update. In every issue of Research Update, we aim to highlight the efforts by our researchers, hoping that the dissemination of knowledge through this publication will convey valuable information, generate interests and to potentially create research opportunities and collaborations that are impactful.

In this issue, themed “**Biodiversity and Environmental Conservation**”, it is our hope that it will strengthen our comprehension and enhance our appreciation of the works done by our researchers in the field of natural environment and biodiversity.

The articles in this issue were arranged in such a way that it addressed the research related to plants, birds, mammals, reptilians, fish and human interaction in understanding and preserving the environment. In demonstrating UNIMAS commitment in supporting the Sustainable Development Goals (SDG) adopted by the United Nations, all the works by our researchers highlighted in this issue were aligned to the goals of SDG. It is crucial that through our research, we are able to sustain our biodiversity and environment for the future generation.

Hence, I would like to express my appreciation to the researchers who contributed to this edition of Research Update. I wish for you to uphold your research initiatives and that the research projects expressed in this issue would encourage and stimulate interdisciplinary discussions and establish collaborations for the betterment of our biodiversity and environment.

Thank you.

PROFESSOR DR WAN HASHIM WAN IBRAHIM
Deputy Vice Chancellor (Research & Innovation)
UNIVERSITI MALAYSIA SARAWAK



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FOUNDATION IN SCIENCE STUDIES - BIOLOGICAL FIELD TRIP REPORT: BRIEF DOCUMENTATION ON SELECTED TIMBER-RELATED PLANTS SPECIES WITH COMMERCIAL VALUE IN KUBAH NATIONAL PARK, SARAWAK

Researchers: Mohamad Phaizal Mohamad Bukhori, Mohd Ridwan Abd Rahman, Muhamad Ikhwan Idris, Mohd Aminudin Mustapha, Mohamad Razif Othman and Noorazman Samsudin



Biology, Centre for Pre-University Studies, Universiti Malaysia Sarawak

In order to accommodate, enhance and accomplish the course learning objectives of ecology, biodiversity and environment in the class, in situ erudition remains the finest key to complement by conducting actual fieldwork experiments. The specific objectives of the fieldwork are to ensure sustainable learning, adopt the best practice in scientific documentation, and implement holistic and integrated learning approach in the course. Therefore, a related case study was given to the students and resulted with a few attributes. Seven different family with 12 different species of timber-related plants were identified and classified throughout the study. To date, timber-related plants species is known to provide several benefits and usage to human as well as other organisms. The information present is useful for research and education purposes, developing a conservation awareness, plan and management, and also helps in promoting ecotourism. The trip was conducted to introduce a comprehensive learning experience to the students in biodiversity-related discipline.



A. Hiking trail map in Kubah National Park. **B.** Students attending to Kubah National Park's safety rules and regulation briefing. **C.** Students at Serapi Summit Point.

This teaching and learning fieldwork activity was supported by the Centre for Pre-University Studies and Sarawak Forestry

TEN NEW ENDEMIC GENERA OF ARACEAE ON BORNEO



Researchers: Wong Sin Yeng

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Phylogenetic relationships within Araceae tribe Schismatoglottideae are elucidated based on nuclear ITS and plastid *matK*. Thirty genera are recognised, composed of 13 pre-existing genera (*Apoballis*, *Aridarum*, *Bakoa*, *Bucephalandra*, *Fenestratarum*, *Galantharum*, *Ooia*, *Phymatarum*, *Pichinia*, *Piptospatha*, *Schismatoglottis*, *Schottariella* and *Schottarum*), five resurrected genera (*Colobogynium*, *Gamogyne*, *Heteroaridarum*, *Hottarum* and *Rhynchopyle*) and 11 new genera: *Bakoaella*, *Bidayuha*, *Burttianthus*, *Gosong*, *Hera*, *Kiewia*, *Nabalu*, *Pursegloveia*, *Naiadia*, *Tawaia* and *Toga*. Except for *Kiewia*, all newly described genera are endemic to Borneo. *Schismatoglottis* remains imperfectly delineated despite resolution of a well-supported corpus defined by hapaxanthic stems and containing the nomenclature type. The research continues to show that Borneo supports extraordinarily rich and diverse aroid flora.

Fieldwork associated with this research was most recently under Sarawak Forestry Department Permission to Conduct Research on Biological Resources Permit No. NPW.907.4.4(JLD.14)-159 and Park Permit No. WL82/2017. The collaboration and support of the Sarawak Forestry Department, the Forest Research Centre (Kuching) and the Sarawak Biodiversity Centre are gratefully acknowledged



Typical habitat at Kubah National Park



Close up image of *Aridarum* on shale cascade

HORNBILLS IN SARAWAK



Researchers: Philoveny Anak Pengiran and Jayasilan Mohd-Azlan

*Animal Resource Science and Management (Zoology) Programme,
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak*

Hornbills are large birds in the family bucerotidae and are well thought-out as important ecological indicators on the success of forest regeneration. As they are relatively large in size, the hornbills require habitats that consist of large forest patch. This has made them become useful indicators of forest condition and human disturbance. There are eight species of hornbills in Sarawak that include the rhinoceros hornbill (*Buceros rhinoceros*), helmeted hornbill (*Rhinoplax vigil*), black hornbill (*Anthracoceros malayanus*), bushy-crested hornbill (*Anorrhinus galeritus*), white-crowned hornbill (*Berenicornis comatus*), wrinkled hornbill (*Rhabdotorrhinus corrugatus*), wreathed hornbill (*Rhyticeros undulatus*), and the oriental pied hornbill (*Anthracoceros albirostris*). All the hornbill species in Sarawak are totally protected under the Sarawak Wild Life Protection Ordinance (SWLPO) 1998. The conservation status of these hornbills by the International Union for Conservation of Nature (IUCN) ranges from least concerned to critically endangered, expressing concerns on these large birds. The helmeted hornbill (*Rhinoplax vigil*) ranks as critically endangered. The next species of concern are the recently uplisted species wrinkled hornbill (*Rhabdotorrhinus corrugatus*) and white-crowned hornbill (*Berenicornis comatus*) that are now both listed as endangered. The rhinoceros hornbill (*Buceros rhinoceros*) and wreathed hornbill (*Rhyticeros undulatus*) are under the category vulnerable. Black hornbill (*Anthracoceros malayanus*) and bushy-crested hornbill (*Anorrhinus galeritus*) are listed as near threatened while only the oriental pied hornbill (*Anthracoceros albirostris*) are considered as least concerned. Sarawak is also well known as “Bumi Kenyalang” or Land of the Hornbills. For the people of Sarawak, especially the Dayak, hornbill is considered as a bird of importance and it holds strong cultural symbol. The most known and majestic species of hornbill is the rhinoceros hornbill. It is used as Sarawak’s state emblem and is also frequently incorporated into carvings, motives and ceremonial dresses. Doubtlessly, the hornbills are considered as a state-pride species for the people of Sarawak.

This research was supported by the Faculty of Resource Science and Technology, Universiti Malaysia Sarawak through research grant No. NRGs/1087/2013/(01).



Rhinoceros Hornbill



Black Hornbill

COMMUNITY ECOLOGY OF UNDERSTOREY TROPICAL FOREST BIRD IN WESTERN SARAWAK



Researchers: Hanis Damia Elyna binti Lit and Jayasilan Mohd-Azlan

*Animal Resource Science & Management, Faculty of Resource Science and Technology,
Universiti Malaysia Sarawak*

Community ecology is concerned with explaining the patterns of distribution, abundance, interaction of species, and for the coexistence of similar species within ecological communities (Chave, 2004). Previous studies suggested that bird species diversity and richness is related to the size and extent of vegetation such as patchiness (Best and Stauffer, 1980). Therefore, bird assemblages based in species composition, abundance, richness and diversity along with other attributed as rarity and endemism are used to evaluate conservation values to sites (Fuller, 1980; Daniels et al., 1991). Many studies have demonstrated that avian diversity increase with increased levels of vertical and horizontal habitat structure (Zimmerman, 1971), and also responsive to changes in the land use patterns (Daniels et al., 1990). In this study, eight study sites located at western part of Sarawak were selected which were Bako National Park, Gunung Gading National Park, Kubah National Park, Santubong National Park, Semenggoh Nature Reserve, Samajaya Nature Reserve, Gunung Penrissen, and Telaga Air. Birds were sampled using a total of 20 mist-nets with three shelves (2.5 m x 9 m, 36 mm mesh) at every occasions. Vegetation and insects were sampled within 20 x 20 m plots. Regurgitation samples were obtained by orally administering tartar emetic to the birds following the methods of Tomback (1975) and Poulin et al. (1994). Based on the regurgitated samples examination, it shows that the order Coleoptera are highly consumed by insectivorous birds and followed by Hymenoptera. The findings suggested that there are differences in terms of species distribution and assemblages between mangrove forests, mixed dipterocarp forest and tropical heath forest where each of these forest has their own specialist. In addition to that, understorey bird species diversity differed substantially from forest edge. The distance which is less than 200 m from the forest edge showed highest species richness. Furthermore, differences in seasonality are also observed in terms of species richness and diversity. These patterns are probably due to the resource partitioning and diet of understorey birds which are related to their moulting and breeding patterns. Most Insectivores showed full brood patch from April to October which is suggesting that this period could be the breeding season. This was supported by the moulting data which is suggesting that January to April is the pre-breeding season and lasted from May to October.

This research was supported by the Ministry of Higher Education (NRGS/1088/2013(02)).



Scarlet-rumped Trogon (*Harpactes duvaucelii*) and Green Broadbill (*Calyptomena viridis*) are listed as Near Threatened species by IUCN Red list (2019).

INVASIVE URBAN BIRDS IN WESTERN SARAWAK



Researchers: Frances Hii Dai Sze, Nurul Ashikeen Ab Razak and Jayasilan Mohd-Azlan

*Animal Resource Science and Management, Faculty of Resource Science and Technology,
Universiti Malaysia Sarawak*

Invasive species or non-native species have been a threat to the biodiversity globally. Avian communities are widely spread from the forest to the urban areas with a reducing diversity gradient. Impacts of invasive avian communities on native birds in the urban areas have been little explored in Sarawak. This study attempts to investigate the distribution of invasive birds within the urban avian community by estimating the relative density of exotic species in urban bird assemblage. The birds were surveyed using transects from October 2015 until September 2016 (12 months) in selected areas of Western Sarawak. Bird surveys totalling 288 hours of observations along a total of 576km of transects provided 31,229 birds observations which have resulted in 24 families and 51 species during the study period. The invasive species observed consist of the Eurasian tree sparrow, Rock pigeon, Zebra dove and Common myna. The native species such as Cinnamon-headed Green pigeon, Chestnut munia and also Paddyfield pipit were in the low-density category if compared to the invasive species such as Common myna and Eurasian tree sparrow. Competition for food and aggressive behaviour may have displaced the native species. The preliminary data suggest that these invasive species may affect the native species in Western Sarawak due to the niche overlap. This includes competition for nesting sites and food source. Proper and prudent management of this invasive species is needed in order to prevent the native species being displaced or eliminated from the urban bird communities.

This research was supported by Universiti Malaysia Sarawak through research grant No. FRGS/STWN/10(03)/988/2013/(29)



One of the invasive species observed perching on the top of a tree



Identifying the species of the bird spotted and getting the perpendicular distance of the bird to the transect line by using TruPulse 360 laser rangefinder.

THE DIVERSITY OF BIRDS IN KUCHING AND KOTA SAMARAHAN AREA

Researchers: ¹Nurul Ashikeen Ab Razak, ²Mohd Azlan Jayasilan, ²Frances Hii Dai Tze, ²Mohamad Fizl Sidq and ¹Andrew Alek Tuen.

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Urbanization typically alters native bird communities which in return shifts the functional guilds which may have affected the ecological function in an area. These shift in species composition, however have benefited non-native species. Urbanisation particularly creates new habitat which can be successfully exploited by non-native species and exotic birds. Therefore, birds survey is important in urban landscapes to monitor local populations changes specially to detect potentially negative environmental impact on local bird species. Birds censuses totalling 1170 hours of observation along 195km of transects walk for 13 consecutive months yielded 27785 records consist of 52 species under 25 Families and eight Order in Kuching and Kota Samarahan area. Of all, five were exotic species, eight were migrant species, and others (39) were native species. The eight migrant species recorded were Asian koel, Barn swallow, Brown shrike, Common sandpiper, Pacific golden plover, Long tailed shrike, Richard's pipit, and Wood sandpiper. Based on the observation, the most abundant species is Rock pigeon with 24 %, followed by Asian glossy starling 20%, Eurasian tree sparrow 18%, Common myna 14% and Javan myna 8%. Family with the highest number of species is Columbidae and Ardididae with five species each. The common species observed in the transects are Asian glossy starling, Common myna, Eurasian tree sparrow, Pacific swallow, Spotted dove, Yellow vented bulbul and Zebra dove. The importance of studying urban birds should not be ignored as it provides early indication on the quality of the environment and potentially important in monitoring zoonotic disease in urban areas.

This research was supported by Fundamental Research Grant Scheme, Ministry of Higher Education through research grant No. FRGS/STWN/10(03)/988/2013/(29)



Migrant bird- Long-tailed shrike (*Lanius schach*)



Non-native bird – Javan myna (*Acridotheris javanicus*)

FREE-ROAMING DOG POPULATION IN SUBURBAN RESIDENTIAL AREAS OF WESTERN SARAWAK

Researchers: Arleen Hong and Jayasilan Mohd-Azlan



Animal Resource Science and Management, Faculty of Resource Science and Technology

Free-roaming dogs are common in urban landscapes. This recently have led to controversy regarding their potential impact on public health risk (zoonoses). Rabies, a zoonotic viral disease affecting central nervous system, transmitted to humans through saliva (bite and scratch) of infected mammals especially dogs, unfailingly fatal once symptoms appear. Rabies is widely distributed around the world, yet Malaysia was rabies free in the past 20 years. There are 62 areas have been declared as rabies-infected zones in Sarawak as in May 2019. As from July 2017, there were 25,907 cases of dog bites and 16 people were dead from rabies. There is a dearth of information in dog density in suburbs residential areas of western Sarawak. Free-roaming dog population control is crucial for the reduction of rabies, and dog population data can assist in management of rabies. Sarawak Disaster Information stated that there are 11 infected zones in Kuching (7) and Samarahan (4) districts. This study examines dog density in 13 selected suburbs residential areas of Kuching and Samarahan districts for a period of 13 months from Feb 2016 to Feb 2017 using distance sampling. Line transect was used to estimate the dog population. Distance 7.0 was used to estimate the density and detection probability of dogs in suburbs residential areas. Dogs observed in cages were excluded in this study. Dog censuses totaling 179.8 hours of observation along 290.2 km of transects yielded 1,193 records. One study site failed to estimate the density owing to insufficient data collection. Overall density of dog population was 1.66 individuals ha⁻¹ (SE = 0.096, CV = 5.77%) and detection probability was 4.4 percent. The density of dogs in each sites ranged from 0.52 individuals ha⁻¹ to 9.69 individuals ha⁻¹. Highest density of dogs was recorded in Taman Orchid (9.69 ind ha⁻¹) followed by Midway Link (4.78 ind ha⁻¹). However, the estimation of this study was based on preliminary data which potentially underestimated the true population of dogs.

This research was supported by the Ministry of Higher Education (NRGS/1088/2013(02)).



Wild dogs in suburban residential areas

ECOLOGICAL STUDIES OF MEDIUM TO LARGE MAMMALS IN OIL PALM PLANTATION, MIRI, SARAWAK



Researchers: Lisa Lok Choy Hong and Jayasilan Mohd-Azlan

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Good or evil? Palm oil has always been in the centre of a decade long controversy. While it contributes to the economy, alleviates poverty and is by far the most land-efficient oil crop, it comes at the cost of local ecosystems and devastates lands which are highly biodiverse such as Borneo (Laurence et al., 2014). Approximately 12.5% of the land in Sarawak has already been converted to oil palm plantations (MPOB, 2017). Monocrops have proved to be much lower in biodiversity compared to forested areas as it lacks necessary resources for many species. Despite efforts from the Roundtable of Sustainable of Oil Palm (RSPO) to push for sustainable oil palm practices such as maintaining High Conservation Value Forest (HCVF), knowledge gaps on the effects of management practices towards the local fauna still exists and comprehension on the carrying capacities of the oil palm are still limited. It is therefore critical to conservation to figure out how to improve oil palm plantation to be more hospitable to wildlife. Among the most threatened taxonomic group due to fragmentation are mammals as they are highly sensitive to anthropogenic pervasion to and into their habitats. Medium to large mammals were selected as a focus group in this study as they are regarded as keystone species and are excellent bioindicators for healthy ecosystems. A one-year long camera trap survey of medium to large mammals is currently being conducted to provide baseline data on mammalian diversity and its persistence within the HCV forest fragments and oil palm matrix in regards to management practices for management decision. We have recorded various species of conservation importance in forest fragments. This includes the Sunda Pangolin (*Manis javanica*), Sun Bear (*Helarctos malayanus*) and Sambar Deer (*Rusa unicolor*). An adaptive management plan and integrated conservation strategy will be formulated at the end of the project to contribute to the preservation, sustenance and enhancement of the HCVF areas and in the oil palm areas.

This research is supported by WILMAR-PPB Oil Palm Berhad via grant GL/F07/WILMAR/02/2018



Pig-tailed macaque



Vast areas of oil palm is carving the landscape in Sarawak

VERTICAL STRATIFICATION OF FELIDS IN WESTERN SARAWAK, BORNEO

Researchers: Sally Soo Kaicheen and Jayasilan Mohd-Azlan

*Animal Resource Science and Management, Faculty Resource Science and Technology,
Universiti Malaysia Sarawak*

Montane forest prominently occurs in elevation above 1000 m asl in Southeast Asia and covers less than 1% of Sarawak's topography. However, the unique topography, biotic and abiotic conditions of montane forest harbour higher levels of endemism that categorized them as "cool-adapted upland species". These upland or mountaintop species are especially fragile and precarious to the effect of climate change, potentially compound by local extinction if global temperature accelerate in an unprecedented rate. In fact, elevation gradients are the cornerstone in providing insights into the spatial distribution patterns of medium to large mammals, their tolerations and interactions with changes in the biotic and abiotic environments. The distribution of fauna is intertwined with floral composition, yet forest structure changes accordingly along elevation gradients with least biodiversity on the mountaintops. The elevation study on the cryptic and elusive felids species remained uniform compared to other taxa. This study examined the spatial distribution of felids along the elevation gradients in mix dipterocarp forest. At this extreme, this study stratified camera traps along seven elevation gradients (< 100 m, 101 – 300 m, 301 – 500 m, 501 – 700 m, 701 – 900 m, 901 – 1100 m, > 1100 m asl) in six selected regions that range from 800 – 1550 m asl that based in Western Sarawak. A total of four out of five species of felids were recorded throughout 29,449 camera trap efforts include leopard cat (*Prionailurus bengalensis*), marbled cat (*Pardofelis marmorata*), Bornean bay cat (*Catopuma badia*), and Sunda clouded leopard (*Neofelis diardi*). The peat swamp niche specialist, flat-headed cat (*Prionailurus flaniceps*) was not recorded in this study. The leopard cat was recorded throughout the elevation gradients with highest detections (n=174 independent photos), followed by marbled cat which only recorded above 500 m asl with 14 independent photos. The Sunda clouded leopard was only detected at the elevation above 900 m asl with four independent photos while the Bornean bay cat was restricted to the elevation range 301 – 500 m asl with only two independent photos. The occupancy probability of the recorded felids increased along the elevation gradients, yet the detection probability decreased. The recorded felids were estimated with higher relative abundance in the lowland forest than the lower montane forest. Additionally, the activity patterns of the recorded felids showed a high degree of overlap (Dhat 4 = 0.84) and primarily nocturnal in Western Sarawak. The fragility of the montane forests toward the climate change in the vulnerable locations, within Western Sarawak exaggerating the conservation efforts. This study is the first to provide information on the elevational distributions, relative abundances, detections and occupancy probabilities with the influence of altitudes on the occurrence of felids in the mountainous area of Western Sarawak.

This research was supported by the Malaysia Ministry of Higher Education under Niche Research Grant Scheme (NRGS/1087/2013(01))



The leopard cat which recorded in Mt. Gading at 447 m asl



The marbled cat that recorded in Mt. Penrisen at 1204 m asl



The Sunda clouded leopard that recorded in Mt. Pueh at 1044 m asl, this detection showed the utilization of fallen log by felids



The Bornean Bay cat was only recorded in Mt. Serapi at 311 m asl on a fallen log

GENETICS DIVERSITY OF CAPTIVE AND SEMI-WILD ORANGUTAN IN MALAYSIA



Researchers: Faisal Ali Anwarali Khan, Henry Bernard, Yuvarajan Manivannan, Muhammad Zahid Bin Zainal Abidin and UNIMAS Mammalian Research Laboratory team.

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Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah*

Orangutan is known to be genetically diverse than any other primates in the world. There are three species of Orangutan namely *Pongo abelii*, *Pongo tapanuliensis* and *Pongo pygmaeus*. The Bornean Orangutan, *P. pygmaeus* were further diverged into three subspecies, namely *P. p. pygmaeus*, *P. p. wurmbii* and *P. p. morio*. The wild populations are highly endangered due to habitat loss and hunting. As a result, all the species and subspecies of Orangutan were declared as critically endangered. Orangutans are also being kept in numerous captive and semi-wild centres around the world. However, not much data is available in term of genetic diversity of these Orangutan in captive and semi-wild facilities in Malaysia which is important for its management. This is because, each species as well as subspecies of Orangutan are geographically isolated in the wild. Further, studies have shown significant genetic differences among them. Therefore, it is critical to genetically assess all Orangutan in captive to maintain their species/subspecies genetic integrity. We used non-invasive samples from five captive and two semi-wild centres in Malaysia. The genetic diversity of Orangutan was determined using both mitochondrial protein coding (NADH Dehydrogenase Subunit 5) and non-coding (Hypervariable Region 1) DNA. Results revealed high genetic diversity among all the Orangutan in captive and semi-wild centres in Malaysia. Several misclassifications of Orangutan species and subspecies were also detected. However, all those misclassifications were resolved through our phylogenetic data with high confidence. Moreover, we have provided reliable species and subspecies information for all the Orangutans involved in this study.

This research was supported under research grants from Ministry of Higher Education (Grant no. NRGs/1087/2013(01)) led by Prof Andrew Alek Tuen and UMS-UNIMAS Collaboration Research Grant (Grant no. GL/F07/UMS/03/2017).



Hair samples collection from decayed nest of Orangutan



Searching feces samples beneath of fallen Orangutan's nest

GENETICS AND ECOLOGY OF THE SILVERED LEAF MONKEY (GENUS *TRACHYPITHECUS*) FROM MALAYSIA

Researchers: Faisal Ali Anwarali Khan, Henry Bernard, Wan Nur Syafinaz Wan Azman,
Lim Zhi Han and UNIMAS Mammalian Research Laboratory Team.



Faculty of Resource Science and Technology, University Malaysia Sarawak
Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah

Genetic information is major component in formulating a better conservation strategy of the Silvered Leaf Monkey. In Malaysia, there are three species under genus *Trachypithecus* namely *T. cristatus*, *T. selangorensis* and *T. obscurus*. This current study primary focus is on the Silvered Leaf Monkey which is the only member of this genus found in Borneo. The population trend of Silvered Leaf Monkey (*Trachypithecus cristatus*) is reported to be near threatened due to human activities such as deforestation. Recent study has separated *Trachypithecus cristatus* from Peninsular Malaysia as a separate species which is now recognized as *Trachypithecus selangorensis* that is endemic to Peninsular Malaysia. This study aims to better understand this separation as well as the population status in Borneo via molecular tools. Silvered Leaf Monkey faeces has been collected across multiple locality in Borneo to access their DNA to better understand genetic variation across multiple population in Borneo. Genetic variation is currently being assessed using mitochondrial (Cytochrome b, and Cytochrome Oxidase subunit I and II, control region and paternal (sex determining region -SRY) markers. Our preliminary genetic result showed that no geographic structure was observed within Borneo indicating high gene flow between populations. When compared to other species of non-human primates, the genetic diversity of silvered leaf monkey can be considered as moderate. The complete result of genetic and ecology of this species is expected to be completed upon sampling in Peninsular Malaysia earlier next year.

This research was supported under research grants from Ministry of Higher Education (Grant no. NRGs/1087/2013(01)) led by Prof Andrew Alek Tuen and UMS-UNIMAS Collaboration Research Grant (Grant no. GL/F07/UMS/03/2017)



Silvered leaf monkey observed at Bako National Park



Faecal of silvered leaf monkey found at Labuk Bay, Sandakan

ACTIVITY PATTERN, DISTRIBUTION, AND THREATS OF THE BORNEAN SUN BEAR, *HELARCTOS MALAYANUS EURYSPILUS*

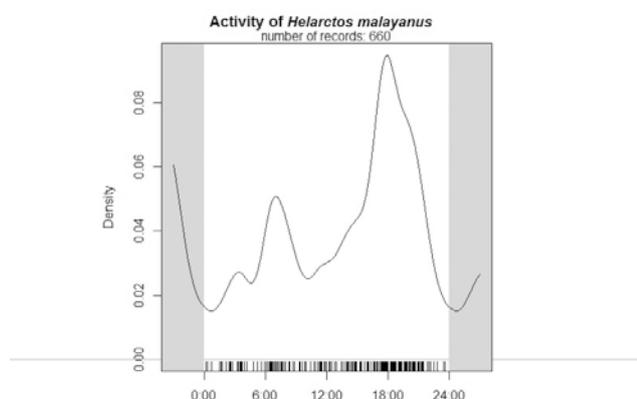


Researchers: Melynda Cheok Ka Yi and Jayasilan Mohd-Azlan

Faculty of Resource Sciences and Technology, Universiti Malaysia Sarawak

Being the smallest among the eight bear species in the world and the smallest subspecies of its own species, the “fun-sized” Bornean Sun Bears (*Helarctos malayanus euryspilus*) are facing multiple threats like most of the wildlife around the globe. Usually hunted for their gall bladders with the rise of opportunistic hunters or involved in a wildlife-human conflict, the seemingly cute and cuddly appearance of their cubs has become another by-product of exotic pet trade across the nation. Listed as ‘Vulnerable’ in International Union for Conservation of Nature (IUCN) Red List of Threatened Species due to deforestation that has reduced both area of occupancy and extends of occurrence, and has also reduced its habitat quality in remaining fragmented forest. Its distribution has also become increasingly patchy due to the major threats of habitat loss and hunting for its medicinal parts, which are used in traditional Asian medicines (Shepherd and Shepherd, 2012). It is only listed as ‘Protected’ under Sarawak Wild Life Ordinance (SWLPO) 1998 although it falls under Appendix I in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The SWLPO 1998 allows any person with license to have possession of any wild animal species, and with the outdated penalties against offenders the prosecution is much likely to be inefficient. Based on the recent study, the gall bladder of sun bears were usually kept or sold in the black markets for MYR150 each. They are recorded at low densities from selected localities (Baram, Baleh & Pelagus) in interior Sarawak (RAI= 1.414), and are periodically active during the day and night. Incorporating different management strategies is crucial, with the synergy between various elements (i.e. outreach, law enforcement, animal populations, and biodiversity) in order to produce a successful conservation strategy for this smallest subspecies.

This research was supported by the Sarawak Energy Berhad through the grant GL(F07)/SEB/2014/03(04)



Activity patterns of the Bornean Sun Bear in three localities: Ulu Baleh, Ulu Baram, and Pelagus in Sarawak



One of the ex-captive Sun Bear from Bornean Sun Bear Conservation Centre which was previously kept as pet

BIOACOUSTIC STUDY OF INSECTIVOROUS BATS



Researchers: Faisal Ali Anwarali Khan, Emy Ritta Jinggong, Praveena Rajasegaran, Chun Chia Huang and UNIMAS Mammalian Research Laboratory team

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The microbat has developed advanced echolocating ability compared to the megabats or old-world fruit bats that relies mainly on vision and olfaction for food hunting. The microbats orient and capture their prey by means of echolocation that involves ultrasonic calls $>20\text{kHz}$, in which a frequency beyond the range of human hearing. Their morphological features and echolocation calls are designed in correlate with their adaptability with the environment especially with their superiority maneuver, detection and localize targeted object in cluttered environment. In Borneo, there are a total of 100 bats' species with 85 species from Sarawak (15 Megabats and 70 echolocating microbats). The use of ultrasonic detectors in monitoring echolocation calls by using bat detectors has surged the researchers' interest to study on bats and their habitat relationship as well as addressing questions concerning their activity patterns despite the limitations in this method. Present study intends to build a call library comprising of different species call frequencies as well as bat activity patterns in Kubah National Park via acoustic measures. To date, higher elevations recorded the highest activity that is determined by the number of passes but lower by species richness as compared to the lower elevation. Acoustic monitoring provides additional data of bat species that occur at each elevation that were not caught during trapping. These data will be highly useful in studying effect of landscape changes in the future.



Portrait of Woolly Horseshoe Bat (*Rhinolophus luctus*)



Microphone of SM2 extended on a tree

This research was supported under research grants from Ministry of Higher Education (Grant no. NRGs/ 1087/2013(01)) led by Prof Andrew Alek Tuen and Soundscape Project via Asia Connect

PERSISTENCE OF MEDIUM TO LARGE TERRESTRIAL MAMMALS IN A PRODUCTION FOREST IN INTERIOR SARAWAK



Researchers: Marius Joscha Maiwald and Jayasilan Mohd-Azlan

*Animal Resource Science and Management, Faculty of Resource Science and Technology,
Universiti Malaysia Sarawak*

Sarawak has lost a significant portion of its primary forest mostly due to logging and land conversion to agriculture. While economic growth through timber industry is important for the advancement of human societies, this in turn may have shifted the species composition and ecosystem function in production forest. In general, logging has been perceived as destructive and resulting in negative impact on biodiversity. However, some species including those that of conservation importance have been reported to occur in production forest and very little is known on such extent in Sarawak. In view of this camera trapping was conducted from July 2017 until August 2018 in three logging coupes with different logging regime in the Kapit Forest Management Unit (FMU) to evaluate the implementation of Reduced Impact Logging (RIL) techniques. Preliminary results show that Kapit FMU is extremely rich in medium to large terrestrial animal diversity, harboring a community of at least 34 species from this category. This includes the critically endangered pangolin and several endangered and rare endemic species (e.g. Bornean Bay Cat, Hose's Civet). The study also revealed nine species that are totally protected and another 24 species protected under the Sarawak Wild Life Protection Ordinance 1998. Therefore, the protection of habitat through High Conservation Value Area (HCVA) for wild animal populations is vital in these production areas. Analysis on activity pattern and occupancy indicate that there is no significant difference in activity and occupancy between old growth forest, active RIL forest and RIL forest with a fallow period of two years. The findings suggest that the strict implementation of sophisticated logging techniques and the willingness of the industry to sustainably manage forest may aid biodiversity conservation in production forest which in the end can benefit human society environmentally and economically.

This research was supported by the Faculty of Resource Science and Technology, Universiti Malaysia Sarawak and Ta Ann Holding Berhad through research grant number GL/F07/ERTS/2017



Borneo Bay Cat (*Catopuma badia*), one of the rarest wild cat in the world, recorded early in the morning in a production forest in interior Sarawak.



Red Muntjac (*Muntiacus muntjac*), a relatively common species in secondary and primary forest appears widely distributed in the study area.

CROCODYLIAN DISTRIBUTION AND HABITAT USE IN WESTERN SARAWAK



Researchers: Anthony K. Pine and Indraneil Das

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Research was conducted within four river systems in western Sarawak, to identify and relate subaquatic habitat types to the distribution and abundance of two crocodylian species, *Crocodylus porosus* and *Tomistoma schlegelii*. Through the use of side-scan sonar, this study was able to peer into some of these turbid and mysterious riverways, providing some of the first glimpses into what exactly is beneath the waterline.

This study utilised eyeshine surveys, captures and sonar mapping to acquire data necessary to fulfill its research objectives. The results include outputs for density and distribution patterns for crocodiles in targeted rivers of western Sarawak, comprehensive sonar mosaics detailing river profiles and GIS habitat maps useful for categorizing and quantifying subaquatic habitat types in Sarawak. This research sets the foundation for long-term research and monitoring effort for the crocodylians in Sarawak.

In total, 62 crocodylians were captured, measured and weighed during this study, with genetic samples collected for next generation DNA sequencing in partnership with Sarawak Forestry Department and the Northern Territory Government in Australia. Over 673 crocodylians were surveyed during crocodylian eyeshine surveys, providing new insights into the population structure, densities and spatial patterns of crocodylians at study sites. Side-scan sonar mosaics yielded over 3,827 km² of georeferenced subaquatic habitat maps, useful for understanding habitat types and coverage areas of habitat within rivers of Sarawak. Alongside crocodylians eyeshine data, these maps have painted the first picture of subaquatic habitat associations for crocodylians in Sarawak.

This research was supported by funding provided by National Geographic Society, research grant number GL/IO0/NATGEO/01/2016



Boat survey crew during crocodylian release effort.



Juvenile Saltwater Crocodile (*Crocodylus porosus*).

SPATIAL BIOLOGY OF THE SPINY HILL TURTLE, *HEOSEMYS SPINOSA*

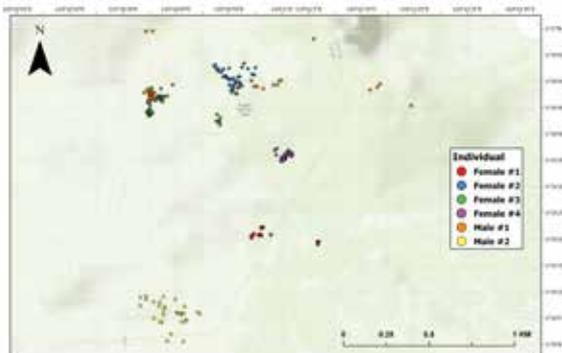


Researchers: Siti Nor Baizurah and Indraneil Das

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Despite being on the Endangered species list, the ecology of the Spiny Hill Turtle, *Heosemys spinosa* has remained unstudied. Such fundamental knowledge as spatial ecology, behaviour and habitat use are critical for understanding the conservation and management needs of the species. We employed radio-telemetry to understand its spatial biology, and six individuals were tracked for a period up to 17 months, and data on home range, movement pattern and microhabitat preferences obtained. Two important questions raised on the autecology of *Heosemys spinosa* relevant to its spatial ecology were: 1) how does sexual variation, body size and environmental factors relate to habitat utilization and movement and 2) are there specific spatial zones of importance for its life history and survival requirements. Home range estimates were 1.68–60 (mean 32.58 and 2.85 in males and females, respectively) hectares, using the 100% Multiple Convex Polygon (MCP) method. Although males showed larger mean home ranges compared to females (mean MCP: male 32.59 ha, female 2.85 ha), these differences are not statistically significant (Kruskall Wallis test: $p > 0.05$), suggesting sex is not a reliable predictor of home range size. Carapace length, here a surrogate of size and mass, correlated with increased mobility ($p < 0.05$), larger turtles obviously are able to roam over greater distances, presumably for foraging, finding mates or establishing new territories.

This research was supported by funding provided by a Niche Research Grant Scheme, from the Ministry of Higher Education, Government of Malaysia, research grant number IA010200-0708-0007



Waypoints of radio-tracked *Heosemys spinosa* at Kubah National Park, Sarawak.
Radio-telemetry was used to study movement patterns of free-ranging individuals of *Heosemys spinosa*.

COMPARATIVE ASPECTS OF THE ECOLOGY OF FOUR SYNTOPIC SPECIES OF ANGLE-HEADED LIZARDS, GENUS *GONOCEPHALUS*



Researchers: Wong Jye Wen and Indraneil Das

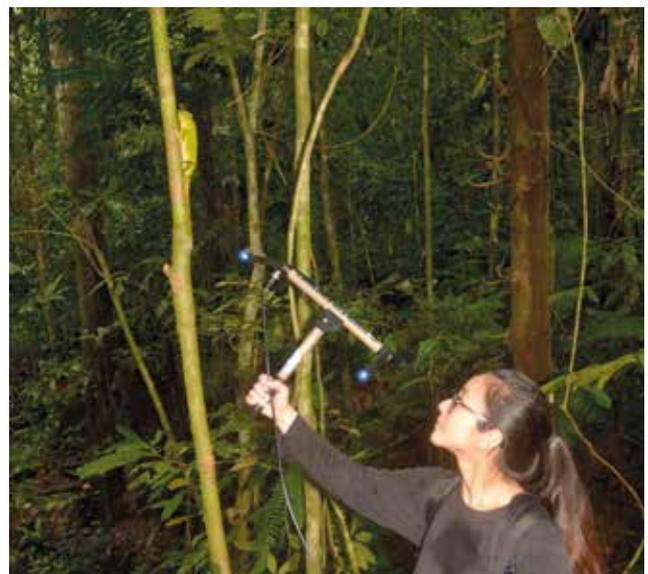
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Gonocephalus is a genus of arboreal agamid lizards, endemic to south-east Asia. Four syntopic species of *Gonocephalus* have been recorded in the lowlands of Sarawak- *G. doriae*, *G. bornensis*, *G. liogaster* and *G. grandis*. Most are associated with tree trunks, saplings and shrubs, sometimes occurring in syntopy. Morphologically similar and closely related species living in sympatry tend to avoid niche overlap by differing in one or more aspects of their ecology, which are presumably caused, maintained and/or reinforced by interspecific competition. Successful partition of resources within a system, thus, is vital in reducing competition and increasing feeding efficiency, thus facilitates coexistence. Ecological theory dictates that spatial, trophic and temporal dimensions are the main dimensions of ecological space. The four species of *Gonocephalus* can be broadly similar in their biology, so the question raised was, are there striking differences in their respective ecologies? Studies on comparative ecology at Kubah National Park has been ongoing since June 2018. The objectives of this study were to test whether tropical lizards partition resources spatially and trophically? In addition, we wanted to understand the thermal biology, habitat preference and home range of these species. Structural and thermal microhabitat characteristics were recorded. Stomach contents of individuals were removed via stomach flushing for identification to ordinal level. Temperature-sensitive radio transmitters were attached for 10–14 weeks to the dorsum of pelvic girdle of at least 16 individuals (that weigh over 27 gm) for thermal and home range studies. Towards the end of this project, new ecological data for the syntopic species of *Gonocephalus* are expected, of potential value for conservation and management.

This research was supported by funding provided by a Niche Research Grant Scheme, from the Ministry of Higher Education, Government of Malaysia, research grant number LA010200-0708-0007.



Gonocephalus liogaster with transmitter attached to pelvic girdle.



Field tracking *Gonocephalus doriae* at Kubah National Park.

SYSTEMATICS, ECOLOGY AND BIOGEOGRAPHY OF THE GEKKONID GENUS *CNEMASPIS* IN BORNEO (SQUAMATA: GEKKONIDAE)

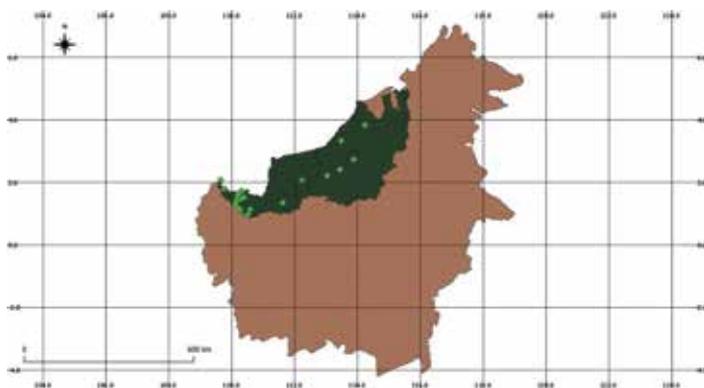


Researchers: Mohd Izneil Nashriq and Indraneil Das

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Cnemaspis Strauch 1887 is a genus within the family Gekkonidae, comprising ~131 species, including 13 from Africa, 50 in south Asia, and 68 in south-east Asia, and is one of the most speciose Old World gekkonid genera. Morphological adaptation within the genus is conservative, species being relatively small, cryptically coloured, bearing broad, flattened head, large, forward and upwardly directed eyes, flattened body, long widely splayed limbs and long, inflected digits. Bornean *Cnemaspis* are represented by five nominal species- *Cnemaspis kendallii* (Gray, 1845), *Cnemaspis nigridia* (Smith, 1925), *Cnemaspis dringi* Das & Bauer, 1998, *Cnemaspis paripari* Grismer & Chan, 2009 and *Cnemaspis leucura* Kurita *et al.*, 2017. Their habitat ranges from lowland dipterocarp forests to primary and old-growth forest in submontane regions, often within karst, granite or sandstone landscapes. The study is designed to identify Bornean *Cnemaspis* species using a phylogenetic systematic approach, in combination with taxonomy and ecology, looking into their phenotypic differences, and to summarize their ecology and biogeography. It also touches on adaptive radiation, dispersal pattern, habitat fragmentation, and geographical barriers in determining their distribution. Past studies have shown that their distribution as restricted to north-west Borneo, attributed to the existence of ancient rivers of Sundaland. Initial geodispersal analyses reveal fragmented geo formations in north-western Sarawak to hold additional undescribed species, as confirmed by phylogenetic analyses based on mitochondrial NADH dehydrogenase subunit 2 gene (ND2), especially from isolated karst outcrops. Human impacts have led to a number extinction and extirpation of tropical faunas in the recent past. Ergo, the discovery of undescribed species and description of their respective habitat is essential not only to better appreciate the natural history of Borneo, but also to suggest methods for their conservation.

This research was supported by funding provided by a Niche Research Grant Scheme, from the Ministry of Higher Education, Government of Malaysia, research grant number IA010200-0708-0007



Map of Borneo, showing distribution of members of the genus *Cnemaspis* within Sarawak State.



Cnemaspis nigridia, a granite-scrub specialist endemic to the Gunung Gading region of western Sarawak.

THERMOREGULATION, PREDATORY STRIKE AND ACTIVITY OF THE BORNEAN KEELED PIT VIPER, *TROPIDOLAEMUS SUBANNULATUS*



Researchers: Veronica Martin and Indraneil Das

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Body temperature of ectotherms depend primarily on heat absorbed from the environment through thermoregulation, which may be through heat absorbed from environment (habitat selection), via radiation, conduction, and convection. Given the significant sexual size dimorphism shown by the Bornean keeled pit-viper (*Tropidolaemus subannulatus*), aspects of life history such as reproduction, movement, growth, behaviour, etc, are expected to differ. In this project, we tested the effect of sex and size on foraging behaviour in captivity and thermoregulation, movement and habitat use in two free-ranging populations. This study is being conducted at Kubah National Park since May 2018. Laboratory experiments have used videography techniques, to understand sequence of behaviour involved in predation through the preparation of ethograms. Field studies will utilise radio-telemetry and temperature data logger implanted in the snakes. A total of 12 (sex ratio: 6:6) vipers will be tested, of which till date, half this number have been processed. The target species is arboreal, and all individuals found perched on some type of vegetation, a majority being on narrow tree branches, ca. 0.32–4.5m above ground. Behavioural studies focussed on feeding behaviour have been ongoing in the lab. Feeding action was recorded with on Sony HD handycam video recorder and will be analysed. The field was a 50 x 50 mm square grid, placed within a 900 x 450 x 450 mm glass tank. The lab mouse is used as prey, and feeding experiments are initially attempted monthly for all individual snakes, till the discovery from the feeding record of interest in prey once every 2–5 months. Sequences being recorded include prey perception, movement to position body prior to strike, predatory strike, prey immobilisation, prey ingestion till the passage of food bolus is no longer discernable in the first third of the snake's body. The next phase of the project will be implanting radio transmitters on snakes before release at the point of initial encounter and monitoring of their activities. It is expected that the new knowledge gained on their behaviour and habitat use will not only assist in broadening our appreciation of a till now neglected aspect of our biodiversity and assist conservation efforts, but also help laypeople avoid encounters with this venomous species.

This research was supported by funding provided by a Niche Research Grant Scheme, from the Ministry of Higher Education, Government of Malaysia, research grant number IA010200-0708-0007



Video set-up used to record predatory strike and prey processing behaviour.

TOWARDS THREE-DIMENSIONAL EXPERIMENTAL INVESTIGATION ON FISH SPERM MOTILITY IN OILY WATER BY DIGITAL HOLOGRAPHIC MICROSCOPY FOR ENVIRONMENTAL PROTECTION



Researchers: Dr Khairul Fikri Tamrin¹, Dr Mohammad Bodrul Munir² and Hawa Ringkai¹

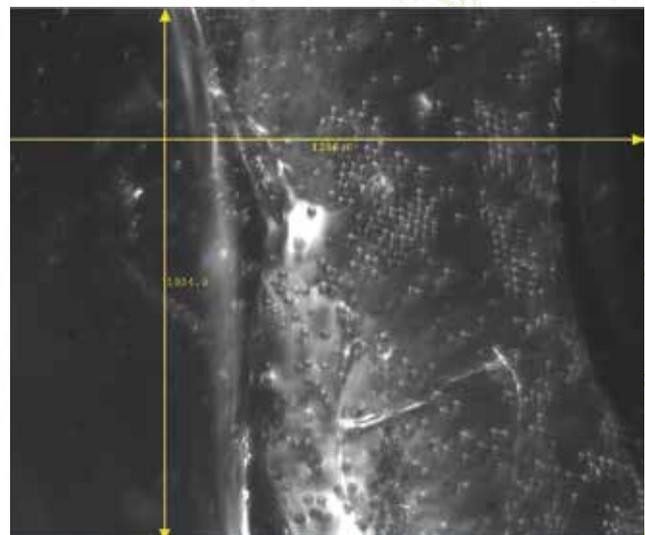
¹Department of Mechanical and Manufacturing Engineering, Universiti Malaysia Sarawak

²Faculty of Resource Science and Technology, Universiti Malaysia Sarawak

Fish is the primary source of protein and essential nutrients for growing global population. Fish and fisheries products provide sustainable income with multi-dimensional livelihoods for numerous communities across the world. The contribution of fisheries and aquaculture to food security and nutrition is largely affected by environmental quality. Addressing the growing demands for fish, conservation of natural resources and environmental protection are undeniably important. A large variety of studies have been conducted examining physiology of fish sperm, understanding the combined effects of heavy metals, inorganic and organic pollutants on sperm motility, to name but a few. However, there is a limited study concerning the dynamic behaviour of fish sperms in polluted environments and its consequences on historical sperm motility. In this research, a custom-made digital holographic microscope has been successfully designed, calibrated and tested. Digital holographic microscopy (DHM) is a promising three-dimensional fluid flow measurement technique as it can easily provide detailed three-dimensional microscale observation and visualization of flow field in real time. Initial preliminary experiments using 10 μm polystyrene microspheres as fish sperm substitutes flowing in oily water were performed and demonstrated promising results.



Digital holographic microscope for three-dimensional (3D) imaging recently developed



Digital image of 10 μm polystyrene microspheres (sperm substitutes) flowing in oily water inside a fabricated microchannel. Image size is 0.85x0.68 mm².

ASSESSMENT OF FISH AND MACROINVERTEBRATES IN STREAMS ASSOCIATED WITH MINERAL SOIL AND PEATLAND IN KUCHING AND SAMARAHAN DIVISIONS, SARAWAK



Researchers: Jongkar Grinang, Gabriel Tonga Noweg and Andrew Alek Tuen

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Understanding of carrying capacity of different habitats in supporting species richness of aquatic organisms is crucial for the success of biodiversity conservation programme. Study on habitat carrying capacity and species-habitat specialization is particularly important in Sarawak because many aquatic habitats (streams, rivers, lakes and swamps) had been degraded by land use activities. Habitat fragmentation is a common phenomenon, but assessment of carrying capacity of the habitat complex in supporting aquatic species richness has not been well studied. The questions rise would be (i) does the streams within fragmented forest of different soil type supports unique species of aquatic fauna?, (ii) how well does the fragmented forest represent (in term of aquatic biodiversity) the overall habitat within the plantation?, and (iii) what size should the forest patches be in order to meet the ecological needs of unique species? This project aims to (i) assess species richness of fish and macroinvertebrates in streams associated with mineral soil and peatland, (ii) assess the carrying capacity of the two habitats in supporting species richness of fish and macroinvertebrates (especially rare/endemic species), and (iii) determine environmental parameters that significantly influent community structure of the fauna. Thirteen physico-chemical parameters are measured in 18 streams. The 18 streams are habitats to more than 120 species of aquatic fauna include fish, crustaceans, mollusks and aquatic insects. The significant findings include discovery of a new semiterrestrial vampire crab, *Geosesarma larsi* (Image 1) and a blind gudgeon fish, *Pogoneleotris heterolepis* (Image 2).

The research was funded by Malaysian Palm Oil Board (MPOB), research grant no. GL/(I01)/MPOB/03/2016



Image 1: A new species of semiterrestrial vampire crab, *Geosesarma larsi* from high elevation habitat (see Ng & Grinang, 2018). A-D = male; E-F = ovigerous female



Image 2: A male blind gudgeon fish, *Pogoneleotris heterolepis* was first recorded from Borneo in 1863. It is a rare fish, being inhabit mud substrates in tidal influence of Batang Sadong. This is the second documented record, and the first descriptions of ecology of the fish (see Tan & Grinang, 2018). Top – lateral view; Bottom – dorsal view

EFFECTS OF MULTIPLE LAND USE ON FISH COMMUNITIES IN HEADWATER STREAMS, KUCHING, SARAWAK

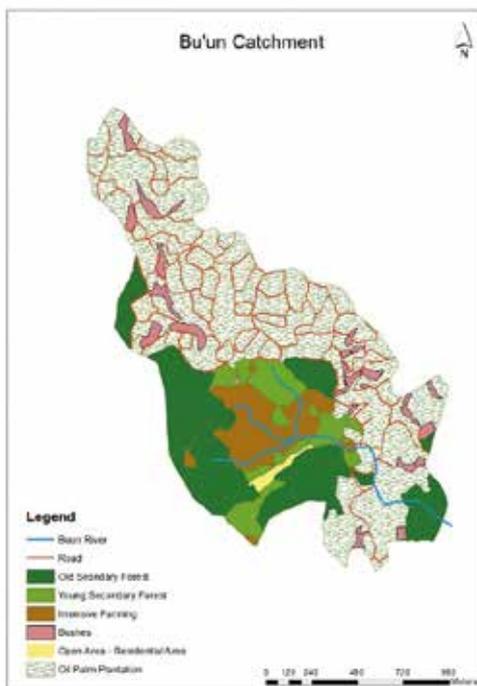


Researchers: Jongkar Grinang, Steffie Philip, Gabriel Tonga Noweg and Andrew Alek Tuen

Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Our understanding of effects of land use on fish communities is limited especially with regards to multiple agricultural activities within a watershed. The lack of this information has led to failure in preserving adequate ecological buffer zones along stream channel in each type of land use. This study investigates fish communities in three sub-catchments in Bau District, Sarawak. The sub-catchments have similar pattern of land use activities, which is dominated by oil palm plantation and subsistence farming. Fish fauna and environmental parameters including size of sub-catchment, type and size of vegetation cover, and above-ground biomass of each type of vegetation were assessed at downstream and upstream of each sub-catchment. The results show fish communities are significantly correlated with above-ground biomass. Effect of land use on fish communities is more severe in dry season. The results imply that size of ecological buffer zone along stream channel should be estimated by integrating information of above-ground biomass, precipitation and management program of each type of land use.

The research was funded by Malaysian Palm Oil Board (MPOB), research grant no. GL/(101)/MPOB/03/2016



Map of vegetation cover in one of the sub-catchments



High sedimentation had reduced aquatic habitat diversity and quality. This sedimentation is resulted from agricultural activities

THE IMPORTANCE OF SALT LICKS IN SARAWAK



Researcher: Nur Afiqah Mohd Dahan and Jayasilan Mohd-Azlan

*Animal Resource Science & Management, Faculty of Resource Science and Technology,
Universiti Malaysia Sarawak*

Salt lick are areas with high concentration of minerals that occurs naturally in the forest where many herbivorous animals uses these recources as supliment to their diet. Salt lick are protected in Peninsular Malaysia and Sabah by their wildlife protection legislation but not under the Sarawak Wild Life Ordinance 1998. Salt licks in Sarawak has been given reasonable attention in highlighting their importance, as the first recommendations documented to heed the status of salt licks was the Sarawak Master Plan in 1996. Although legislatively there are no specific sections in the State Ordinances to protect nor restrict hunting activities at or near salt licks, there are some directives, guidelines, criteria and indicators to encapsulate the salt licks to protection from disturbances under sustainable forestry practises by the Malaysian Timber Certification Council (MTCC) in the Malaysian Criteria and Indicators for Forest Management Certification 2002. Therefore, salt licks that lies within the production forests and protected areas are safeguarded withis this area. However, hunting for subsistence is allowed for the local communities, thus the outcome of continuous effort to protect the salt licks remained equivocal. Overlapping laws on subsistence hunting and hunting ban in production forests had left forest managers perplexed. The question now arises on the sufficiency of the current protection, or shall there be an effort to fortify the salt licks from the said risk lest it could result in depletion of wildlife in Sarawak. It is therefore important to understand the wildlife dynamics and synergy between local community and land use management from conservation policy both at the State and Federal level to facilitate long term protection of this vital resource.



Salt lick site in a production forest in Sarawak

DISSOLVED ORGANIC CARBON CONCENTRATIONS IN AN OIL PALM PLANTATION AT SOUTH SELANGOR PEAT SWAMP AREA, MALAYSIA



Researchers: Alexander K Sayok^{1}, Rory Padfield², Stephanie Evers³, and Zuriati Zakaria⁴*

¹*Institute of Biodiversity And Environmental Conservation, Universiti Malaysia Sarawak*

²*School of Earth and Environment, University of Leeds, Leeds LS2 9JT UK,*

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Dissolved organic carbon (DOC) is a complex collection of organic carbon molecules produced as a result of plant or animal materials decay and dissolved in water. The DOC concentrations were monitored from May 2013 until October 2014 at an oil palm plantation on peat swamp area in South Selangor, Malaysia. Bimonthly samplings were made on groundwater (GW) in piezometers installed at different ages of oil palm blocks (1- to 14-year old) and their respective nearby drains (DW), collection drains (CD) and main drains (MD). Based on the 13 months sampling, the overall average DOC was 89.44mg L⁻¹ which were higher by 85.1% and 31.5% respectively than those in severely drained disturbed peat swamp forest and intact peat swamp forest in Sebangau river basin, Central Kalimantan. Average DOC in GW at the 14-year-olds was the highest with 113.50mg L⁻¹ while the lowest at the 4-year-olds with 18.41mg L⁻¹. For the DW, average DOC was the highest at the 8-year-olds (107.15mg L⁻¹) and lowest at the one-year-olds (24.12mg L⁻¹). Overall average DOC in both GW and DW from blocks of less than 8-year-old were lower than those at the older blocks which could be due to higher biomass in older palms. Average DOC in DW at the 8-year oil palm area was also negatively correlated with dissolved oxygen (R²=0.85) and surface water temperature (R²=0.67) within the 1-year-olds. The DOC in DW was positively related to that in GW especially at the 8-year-olds (R²= 0.77) while DOC in GW were higher than those from nearby drains, as DOC in the latter were diluted by direct rainfall. Hydrological factors such as precipitation, evaporation and temperature coupled with soil properties especially moisture increase DOC in peat. The above show that DOC follow seasonal pattern and storm events, and groundwater depth which determines soil moisture and fluctuations of GW affects DOC concentrations. The above trends of DOC seem to agree with studies in temperate and tropical areas.

This research was supported by the Ministry of Higher Education Malaysia and made available to Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak through research grant MOHE Grant No:RACE/g(1)/887/2012(5)



Measurement of dissolved organic carbon in groundwater from (a) piezometer and (b) drainage channels in an oil palm plantation in the study area

PRODUCTION OF HIGH QUALITY SILAGE FROM SAGO FRONDS



Researchers: Muhammad Norhelmi Ahmad, Kopli Bujang and Dayang Salwani Awang Adeni

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak.

Sago frond is one of the most abundant by-products from the sago industry. Sago fronds are left on the ground upon harvesting of the sago palm for production of sago flour. Over 500 palms are harvested every day in the district of Mukah, Sarawak to feed the numerous sago mills. From here, it has been approximated that over 26 tons of sago frond is discarded as a rotting biomass. We see the potentials of sago frond to be developed as the alternative material for large-scale production of lactic acid and as a feed material for the livestock industries. Sago frond contains sap that can be extracted from the de-skinned white pith using a roller compressor, akin to sugar cane press. The sap contains 7% free sugars consist mainly of glucose and xylose. Both sugars are ideal substrates - and have been used - for the production of lactic acid utilising lactic acid bacteria (LAB) such as *Lactococcus lactis*. The residual fibre can be used as high-quality animal feed with minimal treatment. However, feed quality and palatability is very much improved through lactate fermentation during ensiling to produce silage. Ensiling process require anaerobic condition to inhibit the growth of moulds and fungi that can spoil the silage while concomitantly allowing the growth of lactic acid bacteria to produce nutrient and increase digestibility of the silage. The ensiling process takes only three weeks, whereby the pH of the silage is reduced to 4.4, a definitive condition that inhibits the growth of mould and fungi. Thus, addition of antibiotic and antifungal which usually entails the usual production of animal feed is unnecessary. This ensures that sago frond silage is much healthier and safer for consumption by the livestock. Silage from sago frond contains 9% carbohydrate and 18% protein, a balanced ratio of carbohydrate and protein highly recommended for growing and lactating stages of goats. Ensiling process of sago frond can be improved by using the LAB cells from the production of lactic acid on sago frond sap to boost the ensiling process. Adding LAB cells will hasten acidification to lower the pH, which will reduce duration of the ensiling process together with augmenting its digestibility. These findings are crucial in maximising the use of sago fronds – either disposed upon daily trimming or perpetual harvesting of matured logs – which proves to be a sustainable source for both the animal feed and lactate industries. With these possibilities, meagre income of the sago farmers can be enhanced, followed by development of new sago plantations which focus on zero wastes to protect our environment.



Silage made from fermented sago fronds



Preliminary testing on palatability of our sago frond silage to mixtures of young and mature goats at the Temudok Training Centre, near Sri Aman, Sarawak

FOOD PLANT KNOWLEDGE AMONG THE BIDAYUHS OF SARAWAK



Researchers: Ulrich Teucher¹ and Alexander K Sayok²

¹University of Saskatchewan, Saskatoon, Canada

²Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak

Much of the knowledge of food plants and their uses within local ecosystems is found in socio-cultural practices and sacred rituals of Indigenous people. Our study among the Bidayuh in Serembu area, Bau District, Sarawak reports on efforts to document Indigenous knowledge, with food plants as proxy, and to identify barriers as well as facilitators toward preserving and transferring traditional food and dietary habits across generations. Our results show that identification of traditional food plants was weakest, and that most of identified food plants had been seen in markets rather than in forests. While most participants were aware of traditional local plant knowledge linking plants and food plants to spirits, they could no longer remember such knowledge, except for the elderly headman. Most noted also was the Bidayuh's relationship with food plants had changed due to lack of time, and most are buying food plants at the market. In some cases, knowledge of traditional food plants did not derive solely from within the community. Others noted their availability at shops made food plants or plant-derived products. Much change has occurred and was acknowledged but not necessarily in negative terms. Some participants even welcomed assimilations into the Malaysian mainstream, with its promises of income, mobility, improved health care and more choices in foods according to market availability rather than local environments. Some suggested that traditional practices could be documented in writing or preserved in cultural centres. However, while material artefacts can be preserved in cultural centres, an important part of traditional practices was spiritual in nature. While it seems clear how to preserve the artefacts of the past; it seems much less clear how to preserve the once lived spirituality that breathed through, and gave life to our artefacts.

This research was supported by the University of Saskatchewan, Saskatoon, Canada and Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak through research grant No. L18403/I01/00/Food Plant



Documenting food plant knowledge among the elderly and the youths at Peninjau Village, Bau District, Sarawak

UTILIZATION OF NON TIMBER FOREST PRODUCTS IN MOUNT JAGOI FOREST, BAU DISTRICT, SARAWAK



Researchers: Alexander K Sayok¹ and Arlene Alicia Toaiang²

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Non-Timber Forest Products (NTFPs) are natural resources collected from forests apart from timber. The use of NTFPs based on traditional knowledge is widely known among the natives in Borneo including Bidayuh community in Sarawak. A study was undertaken in Kampung Duyuh, a village nearby community forest at Mount Jagoi of Bau District, Sarawak. The study recorded 61 NTFPs species belonging to 53 genera from 37 families. Close to 46.0% of them are edible, 37.7% species for medicinal purposes while the rest 32.8% for other uses. Among the edible species, 54% were fruits although most i.e. 89.2% were also used for medicinal purposes. Close to 10% of the households in the village sell these products at the village weekend market earning an average of RM400 to RM640 per month with higher income during the fruiting season (October to December) which can be as much as RM200 per day. Although a majority (more than 60%) indicated that they also grew the commonly used plants in their own land, substantial NTFPs (43.4%) sold such as wild vegetables and wild fruits were collected from nearby community forest. Because of their strong dependence on this forest, more efforts in conserving it are needed to ensure a more sustainable supply of NTFPs for domestic use and to supplement their income. Also, it was suggested that a longer-term study be undertaken to cover all seasons/periods of the year to understand more on the products being sold and their contribution to the local socio-economy.

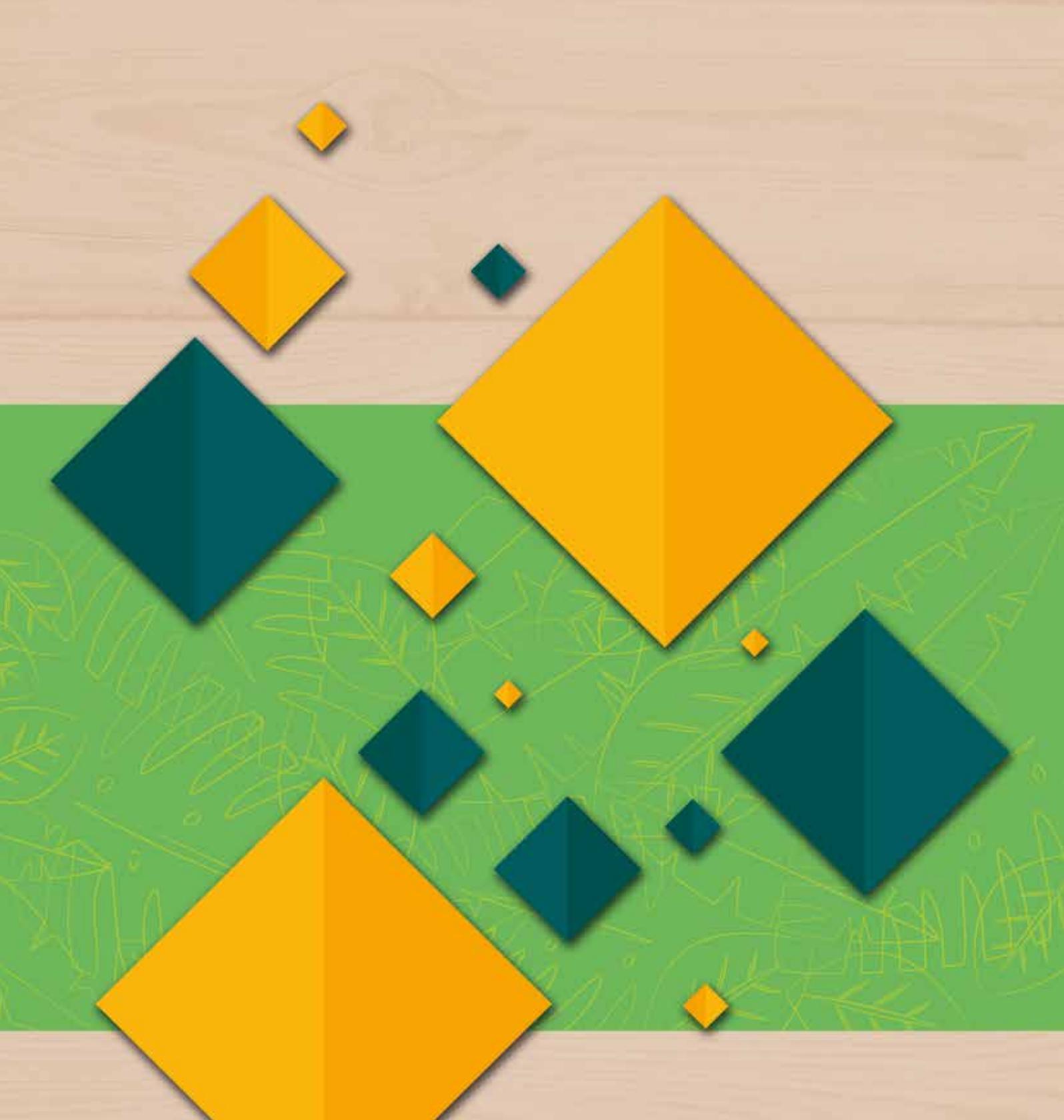
The study was financially supported by Institute of Biodiversity and Environmental Conservation (IBEC) of UNIMAS through the MYRA research grant, grant no: 101/00/ JAGOI



Inventory of non-timber forest products with informants in Mount Jagoi



Survey of non-timber forest products at the Weekend Market in Duyoh Village



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