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The Propagation, Cultivation and Importance of Plants Found in Malaysian Borneo

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Abstract

The original aim of the trip to Borneo was to write a piece based entirely on the propagation and cultivation of plants endemic to Malaysian Borneo. Over the course of the trip abroad it became apparent that this was far too great a task to be undertaken over a three week period; that amount of time would not be sufficient in order to research and then write any decent report on so wide a topic. Therefore the boundaries and goals of this report had to alter, resulting in a piece focusing on just one non-cash / food crop genus of plant found in Borneo; *Rafflesia*.

Alongside this the importance of the Bornean rainforests survival, the importance of the native plants found there, both endemic and not will be looked into. Also investigated was the possibility of a direct link between the survival of these plants and the survival of indigenous peoples of Malaysian Borneo in both a physical and cultural way. Although the project looks in brief at the people of Borneo, the emphasis remains on the plants of the area and their usefulness or relevance to the people who live among them.

One focus will be on the comparison of past and modern day relationships between members of the Iban tribe [See App. A] and plants of their native forests, how these relationships have changed, if at all and the cultivation, propagation and use of specific plants found within these areas by the modern day Iban. This looks at plants from economic, cultural and food perspective when related to the Iban.

Secondly research into the propagation by Malaysian conservationists hoping to propagate *Rafflesia* in an ex-situ environment, the reasons they hoped to achieve this goal with regards to the plants importance both culturally and scientifically, and the methods in which the propagation has been successful.

The following research has been carried out primarily using field based, qualitative research, mainly in the form of interviews and conversations as is laid out in the methodology section of this report.

Introduction

The island of Borneo is the third largest island in the world covering an area of 287,000 square miles. Of this area over 165,000 square miles is covered by lowland rainforest and the forest found here is the oldest in the world at around 130million years old (Visit Borneo 2012). Of the plants found within these rainforests, there are over 15,000 species of flowering plants, 3000 of which are trees. The Bornean rainforests have the highest percentage of dipterocarp species in the world hence the forests in northern Borneo, or Malaysian Borneo, often being referred to as Dipterocarp Forests (WWF 2012).

There are many initiatives now in place to aid in the protection of these ancient forests (Haynes 2013 / BBEC 2012), but despite this, huge sections are still destroyed in order to create space for rubber farming, palm oil plantations or just for the rare, desirable timber itself(WWF 2012).

More than 400 species of new plants have been discovered in Borneo by researchers since 1994 (Butler 2002) and of these many are endemic to Borneo. The existence of many of these plants has however been known to large groups of indigenous peoples for hundreds of years. This alone perhaps reminds or highlights the importance of the plants to the indigenous tribal population.

Whilst in Borneo, the issue of the rainforests conservation was constantly apparent; a twelve hour bus journey with a view of palm oil plantations for the entire length of the trip is but one example. It became clear that the indigenous populations of Borneo play a key role in the protection of its forests as many of them still live among the trees in quite traditional ways.

In recent years many of the indigenous people, Iban in particular, have turned to farming cash crops of pepper, cocoa and palm oil in order to survive financially (see App. B and App. C), the following work looks at the way in which their relationship with the plants around them has altered over the years.

This project aims, in part, to look at the way in which tribal communities still rely on plants in the forest to provide them with income, food and building materials and to discover if the relationship between these people and the jungle they live in is still as relevant and apparent and necessary as it is known to have been in past years (Jensen 2010). In order to try and establish this, wild plants in the local area (within 2 miles) of the longhouse will be documented and listed alongside a list of their primary uses to the Iban, the way in which the plants are propagated, cultivated and harvested.

As well as 'useful' edible or medicinal plants, the forests of Borneo are filled with incredible ornamental plants, most famously orchids, *Nepenthes* and *Rafflesia*. Having been asked during the first year of a horticulture foundation degree to choose and research the propagation of any plant with a difficult propagation method, the idea of visiting Borneo first arose. During that project it became apparent that not only were plants belonging to the *Rafflesia* genus difficult to propagate ex-situ, they were also in desperate need of a successful propagation method in order to aid their conservation. Whilst researching the propagation of these plants, limited information was available from book or internet sources, this lead to a desire to visit the home of these plants only successful ex-situ propagation in order to more fully understand the methods used and the problems encountered.

Rafflesia are, at first glance, an ugly, stinking, parasitic, unpleasant sort of a plant and many would wonder why conserving them is necessary or even advisable, however on further reflection, the importance of these plants becomes more apparent. They are record breakers with *Rafflesia arnoldii* boasting the largest individual flower in the world (Barkman 2001), they are part of a thriving tourist industry in South East Asia, Malaysian Borneo in particular where the plant even appears on the currency and where people flock from across the globe drawn by the possibility of sighting a rare glimpse of one of these flowers and they are, perhaps most importantly, incredible awe-inspiring works of nature.

In the year 2000 it became apparent that experiments attempting to propagate *Rafflesia keithii* carried out in Sabah Parks by the parks director Dr J Nais and Dr C Wilcock had been successful. This report looks in some detail at the methods, results and difficulties encountered during these experiments.

Methodology

Plan

- Field research - this is to be carried out in the following manner:
- Visit specific sites dedicated to the conservation of *Rafflesia* plants throughout Malaysian Borneo specifically:
 1. The *Rafflesia* Information Centre, Tambuan, Sabah
 2. Poring Orchid Centre & Rafflesia Garden
 3. Kinabalu National Park
 4. Sarawak's National Parks
- Talk to workers at the Rafflesia Garden and information centre regarding the cultivation, if any, of their plants
- Hire an indigenous guide/ translator to arrange a:
- Stay in an Iban longhouse for a period of days & nights with a section of the indigenous population
- Document daily routines and activities of the longhouse inhabitants in relation to plants both farmed and in their natural habitat
- View the relationship of the Iban people with the local flora and where possible make notes on their daily routines
- Interview key members of the tribe including:
 1. The Chief
 2. Head 'Warrior' / hunter
 3. Rubber Farmer
 4. Rice Farmer
 5. Cocoa Farmer
 6. Tour Guide / Translator

Asking their opinions and personal experiences regarding 1) their relationship with plants and that of their ancestors 2) the amount of food they buy, the amount cultivated and the amount foraged 3) cultivation and propagation of these plants 4)

- Locate and record the plant genus and species found within a two mile radius of the longhouse and where possible record the uses and value of these plants for the Iban tribe members

Methodology Part II

Method

- A walk around the two mile radius of the longhouse will be undertaken with a translator and Iban with in-depth knowledge of the plants found there
- Farmed crops will be listed and recorded in a table noting the following:
 - That crops use
 - Number of people involved in the farming of this crop
 - Whether that plant species is indigenous to Borneo / South East Asia or not
- Wild plants will be listed and recorded in a table noting the following :
 - The plants common name
 - The plants scientific name (wherever possible)
 - The plants use
 - Whether the plant is edible or not
 - Whether that plant species is endemic to Borneo / South East Asia or not
 - Whether the plant is ever cultivated or propagated to ensure its proximity to the longhouse
- Interview key members of the longhouse (See Methodology Part I) asking:
 1. Their age / length of time in the longhouse
 2. Number of their direct family in the longhouse
 3. Their job(s) within the longhouse
 4. If they think they will stay in the longhouse or at some stage will move to the city / towns 'nearby'
 5. If they hope their children will move to cities or stay in the longhouse
 6. Which crops other Iban tribes in Sarawak cultivate (this will be recorded in a table format)
 7. Who taught them about the plants (if anyone)
 8. How much they know about the cultivation of specific plants
 9. What they known about the propagation of specific plants
 10. The importance of the forest to them
 11. How they think the Ibans relationship with plants has changed over time
 12. How and in what way or if at all, they have seen the forest around them change over their time at the longhouse
 13. How much of their food is bought from shops
 14. How much of the food they eat is farmed by Iban

15. A list of items which are in the longhouse and either made from or sourced from the surrounding forest
16. Where and how the tribes income is made

This information will then be tabled or written up and added to the appendices of this project.

The Propagation, Cultivation and Importance of Plants Found in Malaysian Borneo

Borneo is a land rich in flora. The sheer size, area covered and number of plants living on the island is overwhelming to a first time visitor and this despite the mass deforestation which has occurred in recent years.

Rafflesia plants have long been admired and revered by the indigenous peoples of Borneo. As parasites of species of the *Tetrastigma* vine, the plants are almost impossible to detect prior to budding at which point a large red/brown bud erupts from the surface of the hosts stem (Herman 2008).

Rafflesia is a parasitic flower found only in South East Asia, with the most species being found in Borneo and Sumatra. The most famous of the genus is the *Rafflesia arnoldii* named after Sir Thomas Stanford Raffles and Dr Joseph Arnold who are reported as being the first Europeans to discover the flower in 1818. It has the largest single flower known to man reaching up to 1 meter in diameter and is the heaviest, weighing up to 10 kilograms (Brown 2010). Although 18 species of *Rafflesia* are currently recognised (Nais 2001) the species most commonly found in Borneo are *R.hasseltii*, *R.keithii* and *R.priceii*.

The plants have many interesting characteristics. They have few features that distinguish them as a plant at all; they have no leaves and therefore no chlorophyll and no stalk or visible roots. They are endoparasites meaning that they live almost entirely inside their hosts, spreading haustoria (parasitic roots) through the host plants tissue without breaking the host's cell walls. Because of *Rafflesias* inability to photosynthesise, it relies entirely on its host vine for nutrition and the only section of the plant to protrude from the vine is its bud and then if all goes well, the flower itself. *Rafflesia* will only live in the *Tetrastigma* vine which is a member of the Vitaceae family. The plants take 9 months to bud and many buds rot before they reach maturity as the *Tetrastigma* can't support them in large numbers. It is this nine month period prior to flowering which led tribes people of Borneo to believe that the flower could aid fertility, the phrase that it's 'like a baby' is often heard when being told about the lifecycle of these plants.

When *Rafflesia* flowers open they are made up of 5 large fleshy red petals, although some have been seen to have six petals (Nais 2001), in the centre of which is a large hollow. Inside the hollow sits a large flat disk covered in spines known as processes, the underside of this disk is home to the ovary or anther depending on whether the plant is female or male. *Rafflesia* are unisexual and therefore in order to propagate in the wild there must be both a male and female flower occurring in the same area at the same time to allow pollinators to visit both sexes (Nais & Wilcock 1999). Unfortunately and inexplicably, most flowers seem to occur in same sex areas and all the flowers only have a lifespan of 5 days which leaves little time for successful propagation. The plant relies mainly on Carrion Flies to pollinate it and it is said to attract these by emitting the strong stench of rotting meat. This stench must vary from plant to plant or be dependent on times or external conditions as when viewing some *Rafflesia* they hardly smell at all. When the flies have been attracted they enter the flower crawling under the flat disk and pollen, which has been dehisced into a sticky liquid, will stick to the insects back (Brown 2010). Once a flower has been successfully pollinated it will fall apart and become a black, slimy, pulp, in the centre of which is a 15cm fruit

containing up to 270,000 seeds (Nais 2001). It is thought that these seeds pods are consumed by forest rodents such as squirrels who distribute the seeds in their faeces .

Attempts to propagate *Rafflesia* have been made by people since 1929 and all had ended in failure until two recent studies, one undertaken at the Pouring Orchid Centre, Sabah, Borneo in 2000 and more recently at the Tenom Agricultural Park, Sabah in 2004. The exact details of both successful propagations are heavily guarded secrets probably due to fears that the *Rafflesia*'s natural habitat could be at risk from plant hunters, keen to collect seeds and attempt propagation themselves. As the plants grow in a delicate ecosystem this could be disastrous. There were two styles of propagation methods initially trialled by Dr Nais and Dr Wilcock:

The first method is seed germination in which seeds were taken from two species of *Rafflesia*, *R. keithii* and *R. pricei*. Seeds were placed in two petri dishes at room temperature, one containing filter paper soaked in water and the second containing filter paper with a mashed tissue extract of the *Tetrastigma* vine in the hope that the seeds required stimulation from the vine itself in order to germinate.

These seeds were observed for four weeks and no germination was recorded from either method.

The second experiment performed was the seed inoculation method. For this seeds were again taken from the *R. keithii* and *R. pricei* species and three methods of inoculation were carried out.

Firstly seeds were smeared onto the undamaged surface of the root and stem of the *Tetrastigma* plant. For the second two methods, 1.5cm long incisions were made in the *Tetrastigma* plants root and stem. In method two the seeds were smeared on the surface of the wounded areas and in method three, inserted into the wounds (Nais & Wilcock 1999).

The inoculation experiments spanned over 11 years with new experiments being started at different dates throughout that period. The inoculated plants were then checked yearly for a minimum of 5 years without success. However in 2000 reports came that *Rafflesia* had been successfully propagated at Sabah using the second method; inoculation.

When in Borneo, attempting to view a *Rafflesia* plant can feel like a difficult task. It is claimed that these plants flower only during the wet season, October -March. Fortunately, due to its location in the world, Borneo is often wet regardless of the season enabling these plants to flower more often thus increasing the chances of a sighting. As soon as a plant flowers, or even buds, homemade hand-painted signs spring up along road sides pointing visitors in the direction of the flower and the guide who will lead them to it for a small fee. Once a fee has been decided and agreed on, the guide will then lead visitors down muddy tracks through the jungle to view the elusive flower.

More established sites are known as 'Rafflesia Gardens' at which small booths are erected to house the fee taker and a register of visitors is made. Arguably the most impressive of these gardens can be found at Poring, near the popular tourist destination of the Pouring hot springs. Here 'Vivien's Rafflesia Garden' can be found containing multiple buds and regular flowering sites. If it happens to be raining during a visit, a surly woman in a booth will hand visitors umbrellas adding a slightly surreal element to a visit to the rainforest and making an English visitor feel a little more colonial than is perhaps desired.

At the Poring *Rafflesia* site it is difficult to glean information on whether these plants have grown on the site naturally or whether they have been propagated. Two contradicting answers were given when garden workers were asked, one openly saying that they had been propagated elsewhere and relocated to the site, the other answering that the plants had just appeared naturally and have always grown at the site (See Images). Either way, the cultivation of the plants at this site is clear. Low brick or wooden walkways have been put into place to allow visitors to view the plants without treading on newly forming buds, canopies of tarpaulins have been erected to shield the flowers and unopened buds from heavy rains and large chicken wire fences surround the site to protect the plants from both people and animals.

The palm oil plantations which cover Borneo have similar fences, although these are often much taller and it is clear that visitors are much less welcome at these thanks to the road-sign style pictures of people being shot at. It is perhaps unsurprising that the farmers of these crops are keen to protect them as the palm oil plants bring in large amounts of money. There are mixed feelings over these plantations among the indigenous Iban population of Borneo. Some feel that the plants are necessary to provide wealth to the modern generation of Iban whom are now plantation owners themselves, others believing that the plants remove wildlife and variety from their forests. Iban palm oil plantation owners usually no longer live in their traditional longhouses and instead have taken up residence in the cities, longhouse dwellers it would seem in general farm different crops. Most commonly these are black pepper plants *Piper nigrum*, rubber trees and cocoa plants *Theobroma cacao*. Occasionally pepper farmers will grow loofah vines, *Luffa acutangula*, over their pepper plants once the pepper crop has been picked in order to make the most of the available space.

The propagation methods used for all of the above mentioned crop plants are very simple. In the case of rubber trees rubber tappers living in traditional longhouses will often let the seeds fall and grow at random. Lan, a rubber tapper interviewed, believed this to be the most time-effective method and therefore the only sensible method of growing the trees. Despite multiple rubber tappers often living in one longhouse, arguments over which trees in the surrounding forest belongs to which person are prevented by tappers marking their own trees within an agreed, allocated area.

Iban pepper and cocoa farmers plant crops in more regimented rows (see Images), but again propagation is kept simple as these plants are, wherever possible, sown directly into the ground. In the case of pepper, a supporting plant which will die back to provide a sturdy cane up which the pepper can grow is planted in situ to avoid the need for canes.

Once harvested, the pepper and cocoa are sun dried on woven mats outside the longhouse. If the pepper is to be sold as white pepper corns, a more valuable crop than black, after drying it is bundled into bags and left in the river for 4 to 6 days until the pepper corn skin has been dislodged and washed away. These white corns are then re-dried in the sun.

Aside from crops to sell, the Iban hardly farm at all with the exception of rice. Rice is the staple diet and therefore is grown in vast quantities. All other foods from the jungle are gathered rather than propagated and cultivated. Fruits from plants such as *Passiflora foetida* and *Musa sp.* (See Images) grow without help from the Iban and although cultivating such plants could save them a walk in general little to no interest is shown towards this idea. However despite or perhaps because of, the lack of cultivation carried out here, plants native to the Island thrive in the areas surrounding longhouses; this could be due to the Iban harvesting fruits only when and in the quantities in which

they are required. When fruits are eaten, seeds and waste are often dropped on the forest floor, which, even if unintentional, aids propagation of these plants in the surrounding areas.

Iban longhouses consist of many families, usually upwards of 35, living in one building. The longhouse itself comprises of one long corridor type room with many small rooms radiating from this main corridor. A family is allocated one room per family which is usually made up of three generations. Even more modern longhouses with concrete floors and corrugated iron roofs still follow this formula and contain elements of older longhouses such as hand carved ironwood masks leering from the walls, woven rattan mats covering the floors and human skulls from the bygone era of headhunting, although these are usually hidden away now under floorboards or in loft spaces due to the influence of missionaries and Christianity.

The view of the many members of a longhouse community living by the side of the Lemenak River, Sarawak, seems to be that the relationship between Iban people and the plants of Borneos rainforests has altered hugely in the last sixty years. Of course originally no crops were farmed for commercial purposes, only rice was cultivated to feed the members of the longhouse, but now the emphasis of this has shifted and commercial crops take priority as if rice is short food can be bought. Money is necessary now when before it was not. Now it is required to fuel the outboard motors which now power longboats up rivers, to buy uniforms for children attending schools and to supplement food when enough doesn't grow or which the longhouse members cannot farm.

Because of these reasons, the knowledge of propagation and cultivation of commercial crops has become invaluable to the longhouse families. Fortunately the farming methods used by many of the Iban farmers remain sustainable where possible e.g. rubber being left to grow where it falls instead of mono-cropping. Their reliance on the plants found in the forest surrounding them, be they edible or useful, such as spines from the Sago Palm used for tattooing or bamboo used as a cooking pot (See Images), creates an inherent need to protect the surrounding forests despite their need to create a financial income.

Conclusion

The ability to carry out successful propagation and cultivation of plants throughout Malaysian Borneo is incredibly important for many reasons, primarily the survival of the rainforests they can be found in.

Although there are many reports and much information to be found regarding the mass deforestation of rainforests worldwide and the damage caused by this, it seems near impossible to fully comprehend the scale of such activities without seeing it happening first hand.

The knowledge and ability to propagate rare species such as *Rafflesia* is perhaps key to the forests survival and further raising awareness of the importance of these incredible places and the wonders they hold within them, as without this knowledge there is little to no hope for the rare, endangered and disappearing species found there.

It would seem that scientists, horticulturists and the indigenous population of the country all play important roles in continuing the lifespan of the forests and the fantastic plants found there. Hopefully, with further work like theirs, the remaining primary forest will remain and still further reasons will be found to protect these incredible places.

Images of the Trip



Rafflesia kethii in Poring, Sabah. Day 4 of the plant flowering



Pepper plants at Lemenak Iban Longhouse, Sarawak



Loofah plants growing above a harvested Pepper plantation



Cocoa plant farming at Lemenak, Sarawak



Black pepper and cocoa beans drying, Lemenak, Sarawak



Rubber seeds, rubber tapping and tapped rubber, Sarawak



Edible plants, including *Passiflora foetida*, found within 2 miles of Lemenak longhouse, uncultivated but regularly harvested



Sago palm, Sarawak



Cooking with Bamboo containers, Sarawak

Appendices

Appendix A. Iban (*ee-bhan*) Tribe: Sometimes known as ‘Sea Dayak’, a ‘sub-section’ of ‘Dayaks’, the original word for indigenous populations of Borneo, although this terminology is now looked at as verging on insulting by modern Iban. Iban are one of a number of indigenous tribes located in the Sarawak area of Malaysian Borneo and neighbouring Kalimantan, Indonesia. These tribes are again broken into ‘sub-sections’ where in the tribes are named with regards to the area they live in e.g. Lemanak Iban; Iban tribes found living along the Lemanak River, Sarawak. There are three other main tribe categories within Sarawak and Sabah, namely (1) Penan (2) Bajau (3) Orang Ulu, and these are again broken into ‘sub-sections’ depending on the area in which they are found.

Appendix B. Results Tables Relating to Propagation of Plants by the Iban:

Plants farmed by the Lemanak Iban in their area:

Plant	Endemic to Borneo Y/N	Use	Number of people from the longhouse involved in the farming of this product
<i>Oryza sp.</i>	N	Feeding the families of the longhouse, production of rice-wine or rice-whiskey	38
<i>Caesaipinia echnata</i>	N	Rubber tapping	22
<i>Theobroma cacao</i>	N	Cocoa beans: sold primarily to ‘Milo’ company for use in their drink products	17
<i>Zingibar Sp.</i>	N	Consumption within the longhouse	6

<i>Piper nigrum</i>	N	Pepper corns black and white	24
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Plants (commercially with the exception of rice) farmed by other Iban tribes of Sarawak:

Plant	Endemic to Borneo Y/N	Use
<i>Oryza Sp.</i>	N	Feeding longhouse families
<i>Caesalpinia echinata</i>	N	Rubber tapping
<i>Theobroma cacao</i>	N	Cocoa beans
<i>Elaeis guineensis</i> <i>Elaeis oleifera</i>	N	Palm oil
<i>Luffa acutangula</i>	N	Loofah Sponges

Edible / useful plants found growing wild within a two mile radius of the Lemanak longhouse:

Plant		Endemic to South East Asia	Use	Cultivated (Y/N)
Common Name	Scientific Name			

		Y/N		
Passion Fruit	<i>Passiflora foetida</i>	N	Edible fruit	N
Sago Palm	<i>Cycus revoluta</i>	N	Edible heart & spines used as needles for traditional tattoos	Y
Banana	<i>Musa sp.</i>	N	Edible fruit & leaves used to wrap food prior to cooking	N
Durian	<i>Durio zibethinus</i>	Y	Edible fruit	N
Tapioca or Iban Spinach	<i>Manihot esculenta</i> <i>Manihot Sp.</i>	N	Edible leaves and root	Y
Pineapple	<i>Ananas comosus</i>	N	Edible fruit	N
Bamboo	<i>Gigantochloa scortechini</i>	Y	As a cooking vessel & drinking cup among other practical uses	N
Katuk	<i>Sauropus androgynus</i>	Y	Edible leaves & shoots	N
Iron Wood	<i>Eusideroxylon zwageri</i>	Y	Building material & used for sculpting	N
Malay Guava		Y	Edible fruit	N

Malay Blueberry		Y	Edible Fruit	N
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Appendix C.

Appendix C.1 Write up of Interview with longhouse Chief

Aged 49, the chief was born in the Lemanak longhouse. As a teenager he went to college in the city of Kuching and following this worked in engineering and building. He had no intention of returning to his long house but a crippling injury to his right foot lost him his job and forced him back. At the time he was devastated, but his father, the then chief choose him with his college education, to take his place. He believes that education is key to keeping the Iban peoples traditions alive and helping them move with the modern times and because of this he would be happy for his children to move to the city if they chose to. Although the tribes people are now Christian, thanks to missionaries, they hold true to their original Animist beliefs 'Yes we know there is one God Jesus, but it would be foolish and dangerous to completely ignore the jungle spirits', the chief is the head of the longhouses Christian church. His grandfather is not a Christian convert and is in fact the longhouse Shaman (medicine man / Animist spiritual leader).It is the chiefs grandparents and parents who taught him about the plants which surround the longhouse before he left for the city. Never in formatted lesson style learning, but just by being around them all of the time. He can 'of course' propagate and grow anything required and for him to say this is quite something as modesty is of high priority in within the longhouse. The main changes the chief has noticed in within the forest are the waters of the river becoming muddy rather than clear and the lack of animals, in particular birds, near the longhouse. Very little of his food is bought from shops or markets; usually it is only that which is brought by visitors (tourists). The rest is grown or hunted. Growing, aside from rice crops includes the rearing of pigs in a compound outside the longhouse and rearing chickens which run free outside. When the chief was young, pre-teen, he remembers most of the things in the longhouse being from the forest with the exception of mosquito nets. Now there are many things which are made from the plants, but less than before. The longhouse is built from Iron Wood, it burnt down fifteen years ago and was rebuilt with a concrete walkway up to it. Most weapons and tools are still made in traditional ways although some younger tribe members have bought pellet guns to hunt with. The longhouses primary income is from the sale of crops they grow, harvest and sell. White pepper is the most lucrative, then black pepper and cocoa followed by rubber. Visitors to the longhouse also provide a mall income as the tour companies pay him a small fee for allowing them to visit. Since returning to the longhouse the chief enjoys living there. He hopes that the traditional ways of living can be maintained but believes that the longhouse members must move forward with the times in order to survive.

Appendix C.2 Write up of Interview with Iban Tour Guide / Translator

Joe, aged 25, was born in a longhouse in the Batang Ai region of Sarawak and now lives in Kuching, the capital city of Sarawak with his wife and their daughter. Joe is fatter and considerably taller than the other Iban, he says the weight is due to living in the city giving him easy access to any food at any

time, his height he cannot explain but wonders if it may be diet related. All Joes food is bought from shops and local markets unless he's staying in a longhouse. Despite no longer living in a longhouse, his time spent there as a child means that his knowledge of the plants and their uses is vast. He is able to propagate and cultivate any of the plants. He believes that a move towards city living and easier access to towns provides better health care and medicine for the Iban in longhouses. He thinks schooling is very necessary for the young people of the longhouses. Although he enjoyed growing up in the longhouse, he far prefers living alone with his wife and daughter in the city. The close knit community way of longhouse life is not for him, although taking tourists to the longhouses means he gets the best of both worlds and remains in constant contact with the forest. He notices that there are less animals in the area of the longhouses than before and puts this down to increased tourism scaring them away. Joe views the Ibans farming of crops, including palm oil, as very good and productive. 'Until recently the farms were owned by Malays and Chinese, now Iban can earn money from their land also and with oil palm the jungle goes on forever'.

Appendix C.3 Write up of Interview with Warrior / Rubber Farmer

Lan is 36 years old and the third in command of the longhouse. He is the head 'warrior' should there be times of unrest either national or tribal. He is also a fisherman, hunter and rubber tapper. Due to the relatively small amount of rubber trees he taps, he has time to hunt and fish. Lan was born in another Lemanak longhouse upstream and moved to this one when he married his wife ten years ago. He has one child, a seven year old daughter who lives in a boarding school down river and returns at weekends to the longhouse. Like all other members of the tribe, Lan is able to grow and tend plants but he has no need to do this as it's not his role within the community. He has no desire to move to the city and never intends to do so. Lan relies almost entirely on the forest for food, very little is brought in from elsewhere as he catches and grows all he needs. He says that more people farming rubber means more completion, but it's not too bad. His income is from the rubber he taps and occasionally ferrying tourists up the river in his long-boat for a small fee.

Appendix C.4 Write up of Interview with Cocoa Farmer

Rosalyn is 26 years old and has lived in the longhouse all her life. She has a husband and one daughter. She farms cocoa outside of the longhouse and again has a great knowledge of all the plants in the area. Unlike rubber, cocoa is farmed in a more traditional manner in that it's propagated by seed or occasionally by cuttings, planted in neat rows and tended until mature. The pods are harvested and the cocoa nib dried in the sun before sale. When her father asks her, she helps him tend his pepper plants, usually during harvest. Very little of Rosalyn's food is shop bought. She loves living in the forest and intends to do so for the rest of her life.

Appendix C.5 Write up of Interview with Rice Farmer / Longhouse Accountant

Janie is 49 and was born in the longhouse where he now lives with his wife and their two sons, one of whom he thinks will soon move to the city for work. He was taught about plants by his family and their friends as a child and became a rice farmer as that was his father's job previously. Janie is also the longhouses accountant and so helps the community work out their incomings and outgoings. He often makes rice wine and rice whiskey from the harvested rice and this is shared between the longhouse families. Janie says that the Iban now rely on farming more than ever before and therefore larger areas of forest are cleared than previously. This he thinks is because the farming

used to be just for the tribe, but now it is on a commercial scale. Janie would not like to move to the city but he understands the draw for the younger tribe members. Less than half of his food is shop bought.

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