



**Faculty of Resource Science and Technology**

**Preliminary Study on Dispersal, Predation and Germination of Selected Seeds by  
Orangutans (*Pongo Pygmaeus Pygmaeus*)**

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**PRELIMINARY STUDY ON DISPERSAL, PREDATION AND GERMINATION OF  
SELECTED SEEDS BY ORANGUTANS (*Pongo pygmaeus pygmaeus*)**

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## DECLARATION

I hereby declare that no portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification to this or any other university or institute of higher learning.

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## **List of Abbreviations**

|                 |                    |
|-----------------|--------------------|
| cm              | - Centimetre       |
| kg              | - Kilogram         |
| km <sup>2</sup> | - Kilometre square |
| m               | - Metre            |
| °C              | - Degree Celsius   |
| %               | - Percentage       |

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# SEED DISPERSAL ABILITY IN ORANGUTAN (*Pongo pygmaeus pygmaeus*)

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## ABSTRACT

A study to determine the effectiveness and the ability of orangutans (*Pongo pygmaeus pygmaeus*) as an agent of seed dispersal was carried out in between January 2013 to February 2013 at Matang Wildlife Centre, Kuching Sarawak. A total of nine fruits from nine families were given. Approximately 2 kg of fruits were given to each adult while about 2 kg were given for three individuals of group juvenile at one time feeding per day. The retrieval seeds from fecal was collected and tested for germination. A total of three types of small-seeded plant species were germinated while two did not. Three broad range of fruit-processing behavior in orangutans such as swallowing, spitting and masticating was recorded. Orangutans act as an effective seed disperser towards some large-seeded and small-seeded trees. The maintenance of population of orangutan in wild is very important in regenerating and maintenance of tropical forest. The morphological of seeds are crucial aspects in determine the fate of seed deposited by orangutans.

**Key words:** Orangutan, seed dispersal, germination, fruit-processing behavior, tropical, seed morphology

## ABSTRAK

*Kajian untuk menentukan keberkesanan dan keupayaan orangutan (Pongo pygmaeus pygmaeus) bertindak sebagai ejen penyebaran biji benih dijalankan di antara bulan Januari dan Febuari pada tahun 2013 di Pusat Hidupan Liar Matang, Kuching Sarawak . Sejumlah sembilan jenisbuah yang terdiri daripada sembilan famili telah diberikan kepada orangutan. Anggaran buah yang diberikan kepada setiap individu dewasa orangutan adalah 2 kg manakala 2 kg diperuntukkan untuk tiga individu orangutan yang masih juvenil untuk setiap masa makan yang diberi hanya sekali sehari. Hasil kutipan biji benih yang diperolehi daripada najis akan disimpan dan diuji untuk daya percambahan. Ada tiga jenis biji benih yang bersaiz kecil telah berjaya bercambah manakala dua lagi tidak berjaya. Terdapat tiga cara tingkah laku pemprosesan-buah oleh orangutan iaitu dengan menelan, muntah dan mengunyah telah direkodkan. Orangutan bertindak sebagai penyebar biji benih yang berkesan dan berkeupayaan ke arah biji benih yang bersaiz besar dan juga biji benih yang bersaiz kecil. Pemeliharaan populasi orangutan di hutan adalah amat penting dalam pertumbuhan semula dan pemuliharaan hutan tropika. Morfologi biji benih adalah aspek penting dalam menentukan nasib benih yang dikeluarkan oleh orangutan.*

**Key words:** Orangutan, penyebaran biji benih, tingkah laku pemprosesan buah, hutan tropika, morfologi biji benih

## Chapter 1

### Introduction

#### 1.1 Research Background

In the past, orangutans dominating tropical rainforest and they have wide distribution in land of Borneo and Sumatra which are somehow their population in a wild severely depleted because of exploitation and destruction of forest (Nadler *et al.*, 1990). According to Bennett (1998), many myths, legends and beliefs had developed based on the ecology of orangutan. One of the most known back from the century is that human was descended from orangutan. Even, phylogenetic tree of evolution show that human is very close relative to primate. In Borneo, there is a famous taboo that said Iban's woman cannot look at an orangutan face during her pregnancy or even after giving birth which it is believed that she will have an ugly baby resemblance to that particular species and laughed at one might bring unlucky event to the community staying at longhouse (Bennett, 1998).

During year 1700s, orangutans are known as '*Simia satyrus*' and renamed '*Pongo pygmaeus*' on 1998 century. According to Bennett (1998), '*Simia*' means ape and '*satyrus*' means a sylvan deity given to merriment and insatiable lasciviousness. Somehow, '*pongo*' deviated from African '*mpongwe*' which in definition known as local ape and '*pygmaeus*' is dwarf-like.

There are generally has two subspecies of orangutan which is the Sumatran Orangutan (*p. abelii*) and Bornean Orangutans (*p. pygmaeus*). By referring to IUCN

Redlist (2012), there are found three subspecies of Bornean Orangutans namely *P. p. pygmaeus*, the Northwest Bornean Orangutans, *P. p. wurmbii*, the Central Bornean Orangutans and *P. p. morio*, the Northeast Bornean Orangutans. Orangutan comes from the Malay and Indonesian languages which mean 'man of the forest' (Bennett, 1998). In Borneo, orangutans have variety of names in which Malay and northern Sumatran called as 'mawas', 'maias' among the Iban and Bidayuh, 'Kahui' by the Muruts and 'Kohui' or 'Kisau' among the Kadazans and Orang Sungai (Bennett, 1998; Payne & Andau, 1989).

Most orangutans are generally frugivores or fruit-eaters and living in tropical rainforest and peat swamp forest. Fruit is important for orangutans as it covered 50-60 percent of their diet (Redmond, 2008). In tropical rainforest, there quite a range of fruiting trees where it is scattered and bearing fruit in seasonal (Redmond, 2008). During mast-fruiting, orangutans will increase weight to carry them covering the period when foods are scarce. When fruit is not enough, orangutan might consumes leaves, bark, flowers, birds' eggs, honey, small lizards and some insects ( Bennett, 1998 ; Redmond , 2008).

Orangutan favorite's fruits in a wild are commonly durians, figs, rambutans, and mangoes (Kaplan & Rogers, 2000; Bennett, 1998; Payne & Andau, 1989). Most of their choices of fruits are from large seeded tree. The diet breadth of an orangutan is wide and they can consume more than 300 types of fruit available in forests (Harrisson, 1962). Hereby, they are much closed related to the dispersion of seasonal tropical fruits in a wild.

Dispersal of seed by means the movement of seed away from their natal origin (Clobert *et al.*, 2001). Seed dispersal is important in ecological forest and seed

dissemination which contributes to the spatial dynamic of plant population (Cousen *et al.*, 2008). Without seed dispersers, the seed might grow and disperse nearby to their parental which is in contrast with the concept of dispersion. Primates are important as an agent of seed dispersal because their diet are not constrained only on certain type of species nevertheless, tropical forest have a wide range of fruit trees species (Wehncke *et al.*, 2003). However, the movement, diet preferences and defecation patterns applied by primates may therefore become a major factor influencing seed dispersion patterns and seedling recruitment to success (Wehncke *et al.*, 2003).

Orangutans are the largest-bodied primate that feed generally on fruits on earth (Harrison, 1962). Hence, orangutans need large quantity of food to gain nutrition and energy for their daily activities. Orangutans travel at least 300 m to 800 m per day (Bennett, 1998), they can be main agent in seed dispersion in tropical rainforest ecosystem. According to Harrison (1962), the home range of an adult orangutan often more than 6 km<sup>2</sup> daily, therefore, within a distance, they might have dispersed the seeds by defecation and thoroughly spitted larger seeds away. Known that, the orangutans travel for foraging food and they instantly continued travelling until the sunset.

The dispersal of seeds by vertebrate frugivores is a process where implies the consumption of fruit pulp and the ability of internal system in defecation of viable seeds (Ridley, 1930). In primates, since they occupied large distance in forest, the pattern of foraging and seed handling itself determine the success of seed dissemination in forest. Nevertheless, there are some others aspects to determine the seed fate such as the adequacy of light intensity, humidity and demography where the seeds deposited by the disperser. Some seeds may arrive at non-potential

recruitment site thus no succession of germination, this phenomenon referred to seed limitation (Zobel *et al.* 2000; Pacala & Levin 1997; Hurtt & Pacala, 1995; Tilman 1994).

The relationships of frugivory and seed dispersal has been proportionally linked and conceptually framed on the idea of coevolution (Ehrlich and Raven, 1964; Futuyama and Slatkin, 1983; Herrera, 2002). This two conceptual termed meet intentionally where animals actively disperse seeds (Masson, 2011). Primates are amongst important group in seed dispersal since they mostly feed on fruits in tropical forests (Eisenberg & Thorington, 1973). This indicated that the presence of orangutans is crucial for the regeneration of tropical forests. Furthermore, seed passage through mammalian's gut may enhance the possibilities of seed dormant to germinate (Willson, 1993). However, gut passage of orangutans may harm certain type of seeds cause it unable to germinate and damaged.

Most mammals may not act as seed dispersers where in most cases causing the seeds damaged and not viable and this situation called as seed predatory. The predatory of seed implied on the pattern of handling. Most primates especially orangutans, handle their foods with hands and mouth. The processing can varies in many way but the most common are seed spitting and seed swallowing (Lambert, 2002). The vary sizes of the seeds may project on how they handle the seed. Seed-spitting is intentionally may lead to seed dispersal. Therefore, this project proposed to investigate: a) the effectiveness of an orangutan as a seed disperser, and b) towards what fruits orangutan act as seed disperser and seed predator.

## **1.2 Problem Statement**

Much study relates to seed dispersal ability on large vertebrates such as sun bear, gibbons, chimpanzees and spider monkeys, even small mammals such as rats were examined as disperser of seeds. However, not much study has been well documented on orangutans. Most studied orangutans in Sarawak are based on their behavioral aspect.

Orangutans are listed as endangered species in IUCN Red List and listed under Appendix 1 of CITES (Convention on International Trade of Endangered Species of wild flora and fauna) (IUCN, 2012). Recently, researchers begun to assume that these fruiting trees rely based on frugivores for seed dispersal and the maintenance of frugivore population is critical for the regenerations of tropical forest (Chapman & Onderdonk, 1998).

Orangutans are omnivorous and dominantly feed on wild fruits of large seeded trees. Orangutans have the capability to disperse the seed. It is crucial for maintaining the population of orangutan in wild forest for regeneration of tropical forest. Population of large vertebrates such as orangutans need to be maintained in wild forests of Sarawak as only 2% of orangutan's natural habitat are protected.

The important and role of orangutan in forest ecology and maintenance of ecosystem are little known. Most of the orangutans found in Borneo are in captivity and the in sites conservation of wild orangutans needs improvement to arise their population thus providing spaces for their survival in wild.

### **1.3 Objectives**

The objectives of this study are:

- i. To examine the effectiveness of orangutan act as an agent of seed dispersal for selected plant species
- ii. To examine the fruit-processing behavior of orangutans
- iii. To compare seed predation, dispersal ability of adult and juvenile orangutans
- iv. To test the ability of germination of selected seeds consumed by orangutans

## **Chapter 2**

### **Literature Review**

#### **2.1 Role of non-human primate in forest ecology**

Primates are important in their social complexity. Primates are extremely of high cooperation and altruism which means act that have a net loss of evolutionary fitness to the actor but net gains fitness to the receiver in their social interactions (MacKinnon & Fuentes, 2011). Primates are participating complex social niche construction where this complexity social acts as a niche construction tools causing the interface between individual and other components factors providing large areas of future studies on specific organisms (MacKinnon & Fuentes, 2011).

Primates are also known as an umbrella species (Lambert, 2010). An umbrella species is whose representing the structure of biodiversity. They are able to be a counter measure for conservation management of tropical forests. This is because primates have extraordinary demography which sensitive to hunting and deforestation or exploitations of forests (Rijksen & Meijaard, 1999).

The role of primates in wild mainly played as a crucial effective agent as a seed disperser which gives great impact and importance in ecological construction and dissemination of large-seeded trees (Chapman & Oderdonk, 1998). According to Chapman and Oderdonk (1998), forest without primates will decrease or even eliminate potentially important seed dispersers. Seed dispersers are very important

and have contributed for the maintenance of tree diversity in tropical forests (Harrison *et al.*, 2013).

Diversity of plant trees is important in ecosystem services. Primates which are mostly large-bodied animals are capable of dispersing seeds to distances and this ability is required for plants to maintain the pace with changes climates (Corlett, 2009). Failure to maintain the population of plants with changing climates may lead to major biodiversity declines and reduction in carbon fixation (McConkey *et al.*, 2012).

## **2.2 Distribution of orangutans**

Orangutans are the largest arboreal mammals. Bornean Orangutans are tree-living organisms which are semi-solitary but complex social networks of loose relationship are maintained with members in the society (IUCN, 2012). Orangutans are diurnal animals which active during the day (Bennett, 1998; Redmond, 2008).

Orangutans live in trees almost all the time during the day (Schaik, 2004). Bornean Orangutans are slow-moving arboreal apes, foraging in small areas of the forest each day and feeding in wide range of plants, especially fruits (MacKinnon, 1974). They are able to use of various tools to construct their own sleeping nest in trees each night (MacKinnon, 1974; Bennett, 1998; Redmond, 2008). The sleeping nests are made from branches platforms.

According to Steiper (2006), orangutans became known as existence species around 2 to 3 million years ago on the Asian mainland, and had dispersed southwards throughout South East Asia and the Sundaland region. The vast majority of Bornean Orangutans are within Indonesia-Malaysia borders, where the decreasing in population trends are due to hunting and habitat loss, degradation and fragmentation of forests (Marshall *et al.*, 2005). The natural habitats of orangutans are in the tropical rainforest and peat swamp forest (Redmond, 2008).

In Malaysia, orangutans occur mainly in lowland forest in the Bornean states of Sabah and Sarawak. Wild orangutans usually can be found in the uppermost treetops layer (Kaplan & Rogers, 2000). Meanwhile, orangutans are scarce at altitudes of more than 500 m above the sea level and absent above 1000m for uncertain reasons (Payne & Andau, 1989). Males tend to dispersed further than

females at maturity (IUCN, 2012). Females have an overlapping home range of 1-5 km<sup>2</sup> (Redmond, 2008).

Orangutans are endemic to the island of Borneo and Sumatra at which, in Sarawak, there are only about 1,300 individuals of Bornean Orangutans (*P. p. pygmaeus*), where almost all located at the Lanjak-Entimau Wildlife Sanctuary and Batang Ai National Park, and south next to West Kalimantan, Indonesia. According to Husson *et al.* (2009), the current distributions of wild orangutans are only found in 17 fragmented habitats in Borneo and 3 in Sumatra. The distributions of orangutans in Sarawak are highly at Batang Ai and Lanjak-Entimau which covered with lowland to sub-montane dipterocarp forest and at Ulu Sebuyau which covered with swamp forest to mixed dipterocarp forest (IUCN, 2012). Orangutans also occurred in several habitats including heath forest (kerangas) on sandy soils (Payne, 1987) and limestone-karst forest (Marshall *et al.* 2006, 2007).

### **2.3 Fruit-processing behaviour in orangutans**

Definition of fruit-processing is the behavioural methods by which an animal removes nutritive or energy-rich pulp from a seed (Lambert, 1997). Nevertheless, orangutans are generally fruit-eaters and may feed on leaves, bark, flowers, bird's nests, various on small mammals and invertebrates when the foods are scarce (Bennett, 1989; Redmond, 2008) and they spend most of the day finding, processing and eating. There are generally 3 broad categories of oral processing by orangutans: swallowing, spitting and masticating or chewing seeds (Corlett & Lucas, 1990).

Larger-bodied animal such in this case, orangutans, are capable of ingesting a broader range of seed sizes (Peres & Roosmalen, 2002). Orangutans are not strictly seed predator, seed swallower and seed spatter, indeed the fruit-processing behavioral are depends on the fruit and seed size, ripeness and pericarp morphology (Corlett & Lucas, 1990).

#### **2.4 Seed dissemination**

Seeds are valuable resources as food compared to ripe fruit pulp both in terms of their nutrient composition, and their abundances through space and time (Norconk *et al.*,1998). Although seed might disperse by winds but it is relatively sufficient when the interactions of its consumer are stronger thus the consumer relatively dispersed the seed more distantly from the origin. Dispersal or dissemination refers to the movement of individual organisms away from their natal origin and of their parental (Clobert *et al.*, 2001). Fruit-eaters are best known as seed disperser because of their behaviour on processing of food, some might cause the damaged but most of them had known to disperse the seeds away through defecated and spat out. A fruit eating event by animals can be determined when the animal picked a fruit and ended when that fruits either was digested in gut passage, dropped, spat, swallowed or destroyed (Lambert, 2002).

Dispersal of seeds away from their origin is therefore important for the successful recruitment in a large number of tropical forests (Howe & Smallwood, 1982). The continual of distribution may lead to have a fruit-mass events even larger thus increased the diversity of plant in tropical forest. Wide dispersal of a huge

numbers of seeds provides the species to multiple its population and maintaining its population size (Bradbeer, 1988).

## **2.5 Frugivory and seed dispersal**

The relationship between frugivory and seed dispersion thus very close related to each other. Referred to Paine (1966) and Terborgh (1986), if the interactions are strong, loss of one another will affect abundance of other species in community. The methods and mechanisms of handling fruits in their nature are very important where the seeds may be dispersed, thrown and dropped by spitting, all may be not viable or destroyed. Thus, fruit-processing behavior fundamental in determine both the distance of seed dispersed from their parental and the number of seed per deposition (Lambert, 2002).

The patterns of fruit-eating, seed treatment and seed dispersal are representing three crucial components of animal-plant-environment interactions (Garber & Lambert, 1998). However, dissemination of seed by disperser depends on the various factors such as the effect of seed handling, scarifying and digestion in gut passage, in which determine the germination potential and the suitability of the soil or sites where the seed deposited.

Avians are widely known as browser and disperser of seeds in tropical forest such related study is hornbills by Kitamura (2011). Hornbills are frugivory and they have the efficiency in dispersal of seed. Kitamura (2011) mentioned that the important of hornbill as crucial successive “farmers of the forest” when high fruit chosen and consumption. There are lots of potential animal that can act as seed disperser, not only in birds, but insect too can help in manufacturing seeds in forests.

The relationship of insects and mammals are highly needed when related to ecological functional in the forest. One examples of the study is that the role of dung beetle as a secondary seed disperser after it dispersal by frugivore mammal in deciduous forest (Koike *et al.*, 2012).

Elephants are one of the large mammal that had documented by Arceiz and Blake (2011) as a seed disperser which also known as mega gardeners of the forest which has studied. Even sloth bear, sun bear and cattle had also been successfully studied and recognized as seed disperser in forest ecosystems. Indeed, small mammal such as rodents (Gomez *et al.*, 2007) has been recognized as local seed disperser.

Primates have a greater and wide range of abilities as seed dispersal in forest as most of primates group are generally consuming on fruits and are tree-living. Most primates group that has been recognized on their importance in seed dispersal was gibbon, howler monkey, chimpanzees, spider monkey and very few on orangutans. For example, Wrangham *et al.* (1994) documented that chimpanzees in the Kibale National Park, Uganda, had dispersed of 59 seeds and fruit-processing behavior recorded are by swallowing.

The study on the primary seed generated by gibbon at Barito Ulu, Central Borneo by McConkey (2000) also strengthens to prove that primates have the ability in dissemination of seeds in forests. McConkey stated that there are 81% of the fruit species consumed by gibbons in the rainforest has dispersed and act as seed predator to only 12% of the seeds. This is to prove that mammal has the potential and crucial roles in dispersal of seed when the chosen of feeding types demanded generally in fruits.