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Reintroduction of Orangutans: A New Approach

A Study on the Behaviour and Ecology of Reintroduced Orangutans in the Sungai Wain Nature Reserve, East Kalimantan Indonesia

Gabriella Fredriksson

December 1995

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PREFACE

The orangutan has been recognized as an endangered species since the early 1960s and has been under formal protection by the Indonesian law since the 1930s. At that time its distribution covered extensive parts of forest in Northern and Central Sumatra and Borneo (Indonesian and Malaysian provinces).

As economic development in Indonesia expanded, large areas of the orangutans' habitat were and are still being cleared to make room for increasing population numbers and to sustain the growing (inter) national demand for timber. The combination of massive habitat loss and hunting pressure could drive the orangutan to extinction within a few decades.

Efforts are being made by the Indonesian Government to ensure the orangutans survival through the establishment of reserves so as to protect its habitat and measures are being taken to curb the illegal pet-trade.

In the 1970s several rehabilitation centres were established in order to increase the efficiency of law enforcement by creating a place where confiscated ex-captive orangutans could be brought to. It was also thought that the release of these ex-captive orangutans would have a positive effect on the resident wild population by giving a boost in breeding potential and compensate for some of the suffered losses.

After several years it became clear that there were certain negative aspects involved with the rehabilitation process, such as disease transfer, social stress and competition for food, which could endanger the remaining wild population. Therefore a new protocol for releasing ex-captive orangutans was designed. The confiscated orangutans would be released in groups after a strict period of quarantine, into areas devoid of wild orangutan populations and with a minimum of human interference after release.

The new method for reintroduction of orangutans was first attempted in East-Kalimantan in 1991.

This report presents the results of a study on the adaptation of the first groups of reintroduced ex-captive orangutans, following this new method, in the Sungai Wain Nature Reserve in East-Kalimantan.

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Several people from the Wanariset Station have helped in various aspects of our stay whom I would like to thank: Ir. Daud Leppe, Ir. Mulyana Omon, Ir. Adi Susilo, Wim & Dita Tolkamp, Kris Warren, Pak Udin, the orangutan technicians and people from the herbarium- especially Dr. Paul Keßler (Rijks Herbarium Leiden) for identification of the plant material.

In the forest we were assisted by Dolin, Purnomo and Andy whom I especially thank for their friendship and all the expeditions they made with us. In the beginning of our stay we were initiated in forest life by Pak Lambai. Several people from the Pertamina facilities always pleasantly welcomed us when we passed the village: Pak Sutrisno and his wife, Pak Nasran and family. People from the village: Pak Juadi and family, Pak Arsat and Pak Rashid and the technicians from Wanariset who worked in the forest: Zainal, Toheri and Ujang. I also thank Erik Meyaard for all the pleasant visits he made to the forest.

I would like to thank several people from Unocal in Balikpapan: Dr. Joe Cuthbertson, Dr. Allen and assistants from the clinic, Yoska & Wietze de Boer and Mary Schwing.

Here in Holland I would like to thank Dr. Helmut Albrecht and Dr. Boudewijn Heuts for their help with writing this report. I also thank Marjolijn Das for her willingness to explain the basics of computers and statistics to me and Serge Wich for his patience to copy numerous articles for me and discussing the paper. I want to thank Einar and Zosia for always supporting me throughout the study and their visit to the forest and my friend Chris Fairgrieve who made life, next to writing up, a pleasant thing.

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CHAPTER 1: INTRODUCTION

1.1 *History of Orangutan Rehabilitation*

The reintroduction of ex-captive orangutans (*Pongo pygmaeus*) is part of a comprehensive conservation program to preserve this species and it's habitat. During the last decades the orangutan has been under severe threat throughout it's range- Northern Sumatra, Kalimantan and East Malaysia- due to massive habitat destruction, hunting pressure and the illegal pet trade.

The predecessor of orangutan reintroduction was 'rehabilitation' of the ex-captive apes. Rehabilitation has been described as "the training of behaviourally inadequate animals in skills which allow them to survive with greater independence" (Hannah and McGrew 1985). The first attempt to rehabilitate ex-captive orangutans came from Mrs. Barbara Harrisson in the 1960s in Sarawak (Harrisson 1962) when it was first realized that the orangutan was threatened with extinction. In 1964 a rehabilitation centre for orangutans- Sepilok- was set up in Sabah by the Wildlife Department (de Silva 1971). In 1971 a rehabilitation centre was established in addition to a research project on the wild orangutan population in the Ketambe area in the Gunung Leuser National Park, Northern Sumatra (Rijksen 1974, 1978). That same year a rehabilitation centre was initiated for Bornean orangutans in the Tanjung Puting Reserve in Central Kalimantan together with a long term study on the wild population (Galdikas-Brindamour 1975). In 1973 the Frankfurt Zoological Society sponsored another rehabilitation project also in the Gunung Leuser National Park (Aveling 1982; Borner 1979). Then in 1977 the Semenggok centre (originally for gibbons) was opened in Sarawak (Aveling and Mitchell 1982).

The main objective of these stations was to enhance law enforcement by providing the Indonesian and Malaysian Governments with a place where confiscated orangutans could be brought to so as to help decrease the capture and trade in young orangutans (Aveling and Mitchell 1982; MacKinnon 1977; Rijksen and Rijksen-Graatsma 1975; Rijksen 1978).

These rehabilitation stations were all set up in forest areas where wild orangutans already occurred, as it was thought that integration with wild conspecifics would help the rehabilitation process of ex-captive animals (Rijksen and Rijksen-Graatsma 1975) and that it would boost the dwindling numbers of the wild population (Aveling 1982; de Silva 1971).

Several years later, due to an increased understanding of population structure, potential threats and the possible negative effects which rehabilitation was found to have on the wild orangutan population- e.g. disease transfer, social stress and overpopulating an area

(MacKinnon 1977; Rijksen 1978)- it became clear that the methods used for the rehabilitation of ex-captive orangutans had to be changed (Aveling 1982; Aveling and Mitchell 1982; Borner and Gittens 1978; MacKinnon 1977; Rijksen 1978, 1982).

It was decided that ex-captive orangutans should be reintroduced into forested areas devoid of wild populations but still within the historical range of the species (Aveling and Mitchell 1982; Borner and Gittens 1978; MacKinnon 1977; Rijksen 1978, 1982, 1986) and the established centres were advised to put a halt to the rehabilitation activities.

This proved not to be so easy as tourism development had become a major component of the centres- e.g. 17,000 visitors in Sepilok (Sabah) in 1978 (Aveling and Mitchell 1982), more than 16,000 in Bohorok in 1990 (Warren, Smits and Heriyanto 1995, unpubl. rep.), and several hundreds a year in Tanjung Puting (Rabenstein and Gorzitze 1992)- and generated a large income for the centres and the provinces where they were situated.

In 1991 a new concept for the rehabilitation of ex-captive orangutans was initiated in East Kalimantan; in order to distinguish it from rehabilitation it was called 'reintroduction'.

1.2 *Reintroduction: General Guidelines and Approaches*

Reintroduction is the release/ translocation of animals of any origin (wild- or captive born) into an area of suitable habitat preferably within their original geographic range, where populations of that species have severely declined or disappeared due to natural catastrophies or human interference (Konstant and Mittermeier 1982).

The reintroduction of rare or endangered species is a much debated issue. When looking at the costs involved, the logistical difficulties and the shortage of habitats the desirability of reintroduction projects as a conservation strategy has been questioned (Borner 1985; Brambell 1977; Kleiman 1989).

In some cases though, reintroduction of captive mammals as part of a more comprehensive conservation effort could be considered appropriate (Caldecott and Kavanagh 1983; Kleiman 1989). The success of a reintroduction program depends on the goals- whether it is part of an overall conservation program for an endangered species including habitat protection/ restoration, public education, whether it is for genetic manipulation or recreational purposes alone (Kleiman 1989).

The behaviour and ecology of the species must be well studied in order to know the habitat requirements and the reintroduction should never imperil the wild population through disease (Aveling and Mitchell 1982; Brambell 1977; Caldecott and Kavanagh 1983), social disruption and stress (Aveling and Mitchell 1982; Borner 1985; McGrew 1983). Pre- and post release training of some survival skills might be necessary for some

species like the lion tamarin (Dietz et al. 1987; Kleiman 1989), and developing a social group with good social bonds and organization before a release has been a major concern for many programs (Beck et al. 1988; Hannah and McGrew 1985; Kleiman et al. 1986; Lindbergh 1987).

Several measures have to be taken before a reintroduction can take place. In the first place a suitable habitat must be found with a sufficient carrying capacity (Brambell 1977; Caldecott and Kavanagh 1983; Konstant and Mittermeier 1982) to sustain growth of the reintroduced population. The site must be effectively protected (Aveling and Mitchell 1982; Borner 1985; Campbell 1980; Konstant and Mittermeier 1982), and the proximate factors that caused the decline of the species must be eliminated before the reintroduction takes place (Anon. 1979; Brambell 1977; Caldecott and Kavanagh 1983).

The choice of the most appropriate animals (age- and sex classes) for the reintroduction depends on the goals of the project (Kleiman 1989). The size of the group, timing of release and distance between the release sites should also be considered. Furthermore education about the reintroduction program and government support are important to ensure continuity on the long term (Brambell 1977; Kleiman 1989). Another problem that might be encountered is that the reintroduced animals could leave the release area (Brambell 1977; Campbell 1980).

Reintroductions have been attempted with reptiles, birds and mammals including several ape and primate species. These projects have had a varying degree of success- a few ape and primate examples will now be discussed.

1.3 *Reintroduction Attempts with Primates: A Few Examples*

The reintroduction of gibbons (*Hylobates muelleri)* in Sarawak- Semenggok- showed a very high mortality rate (90%) when a survey was organized to monitor the results of this project (Bennet 1992). The main factors which were likely to cause this high mortality rate were starvation, disease, territorial disputes and hunting due to inadequate planning and supervision. The project was advised to discontinue the reintroduction of gibbons as it had proven to be highly inefficient and did not contribute much to the conservation of the species (Bennet 1992).

There have been five projects which have attempted to rehabilitate/ reintroduce ex-captive chimpanzees (*Pan troglodytes)* in Africa (Borner 1985; Brewer 1978; Hannah and McGrew 1985). Difficulties encountered with these projects varied from extensive pre-training (Brewer 1978) to finding suitable habitat without a resident chimpanzee

population, from the establishment of a balanced social group to high levels of aggression towards humans after release which made tourism/ education projects impossible.

Although the results of these projects show that at least some chimpanzees can be reintroduced (Hannah and McGrew 1985), the desirability of such projects has been debated and it was suggested to concentrate funds and efforts into conservation of chimpanzee habitat. For confiscated chimpanzees other possibilities were suggested (captivity in large enclosures, euthanasia) (Borner 1985).

In Brazil a reintroduction project was established for captive-bred Golden Lion Tamarins (*Leontopithecus rosalia*), together with a comprehensive conservation program to save this species from extinction (Kleiman et al. 1986). The project involved major habitat restoration, conservation education and genetic exchange between captive-bred tamarins and the remaining wild population (100 animals within the reserve).

Although the results of the reintroduction program itself were not so promising: of the 15 captive born animals transported to Brazil only 3 individuals survived the reintroduction, the entire conservation program improved the survival chances for the wild population (Kleiman et al. 1986).

1.4 *Results with Orangutan Rehabilitation*

When considering the reintroduction projects with other primate species the results do not look encouraging. Although each project has some successfully reintroduced/ rehabilitated animals - thus showing that it is possible to reintroduce primates- it's success usually depends on the wider goals of the program and on organization and planning.

In the case of the orangutan, none of the former rehabilitation projects have carefully monitored the orangutans' progress after release. Nor is it publicly known exactly how many orangutans have passed through the different projects.

Payne (1987) states that the Sepilok station has received more than 200 orangutans over the years, of which 'only a small proportion' have fully adapted to forest life. In an unpublished report from 1995 by Warren, Smits and Heriyanto it is mentioned that the Bohorok centre has presumably received 160 orangutans throughout its' history, but Borner (1979) states that during the first four years already more than 100 individuals had been successfully rehabilitated between the Ketambe and Bohorok stations together. Rijksen (1978) on the other hand mentions that from the 31 orangutans he received between 1971 and 1974 in Ketambe, 8 were killed by a clouded leopard, 4 died, 6 disappeared, 4 were transferred to another area in the forest and that only 2 animals were known to have successfully integrated into the wild population. In Tanjung Puting,

Rabenstein and Gorzitze (1992) mention that approximately 65 orangutans were rehabilitated of which half of this number lives independently in the forest and the other half still lingers around the station.

Despite the vagueness and controversy about exact numbers, almost every project has successfully rehabilitated some animals. These past experiences have also generated some knowledge about the rehabilitation process and where the difficulties lie.

Rijksen (1978) stated that 'ecological rehabilitation' (e.g. finding food, nest building) was easily achieved and that the ex-captive orangutans quickly adjusted to the rainforest environment. What seemed to be causing more problems was the integration into the wild community. The same thing was experienced with the orangutans at Bohorok (Aveling 1982).

1.5 *Orangutan Reintroduction: A New Method*

The new methodology for the reintroduction of orangutans was developed by H. Rijksen, Widodo S. Ramono and W. Smits (1991) and has been incorporated into the policy of the PHPA (Directorate General for Forest Protection and Nature Conservation (PHPA) division of the Ministry of Forestry).

Reintroduction of orangutans differs in several ways from rehabilitation projects:

- Reintroduction must be carried out in areas where no wild conspecifics occur [any more], or in areas where reintroduction can save the original forest structure and community including an isolated population of wild apes.
- The orangutans must be raised together as a group.
- After release the group will be abandoned at the site where they are reintroduced.
- No free access of visitors is allowed (for some feralised groups well controlled eco-tourism could be considered later).

The new protocol for reintroduction of orangutans avoids most of the possible negative effects which were present in the old rehabilitation projects: endangering the wild population by overpopulating a certain area, surpassing the carrying capacity and the risk of disease transfer. The positive effect of law enforcement by offering a place where confiscated apes can be brought to is still present (Ministry of Forestry 1994).

In principle all areas which lie within the 'historical' distribution range of the orangutan (from Southern China, Western Indian border to the Great Sunda Islands, including Java)

(von Koeningswald 1982) and which are still under wildland-forest cover, meeting special habitat requirements, could be considered as suitable for reintroduction.

Areas of suitable habitat for orangutan reintroduction will not primarily be sought in already established conservation areas but rather in forest areas which can be added to the protected area network, regardless whether they are currently utilized under commercial lease by large industrial corporations (e.g. oil and gas exploration areas, and timber concessions). The orangutan will be used as an 'umbrella' species in order to protect new forested areas so as to expand the existing protected area network (Ministry of Forestry 1994).

Before a group of orangutans can be released a careful ecological assessment of the forest has to be made. Hereby a calculation should be made of the carrying capacity of that area by looking at densities of orangutan food items occurring here and at the densities of sympatric species living there (Ministry of Forestry 1994).

1.6 *The Wanariset Reintroduction Project*

The new method for reintroduction of ex-captive orangutans is being carried out for the first time by the Wanariset I Samboja research station, located approximately 38 km. north of Balikpapan in East Kalimantan. The reintroduction project was initiated in 1991 by Ir. Dr. Willie Smits and is carried out as a cooperative effort between the Indonesian Ministry of Forestry and the Dutch Tropenbos Foundation.

The location of the project in East Kalimantan seemed to be appropriate as orangutans were still frequently hunted in this province in the early 1990s. It was thought that a research project on orangutans could contribute to raising public awareness on the threatened situation of the orangutan and help the Ministry of Forestry confiscating illegally kept orangutans by providing good facilities to prepare them for return to the forest.

The station received the status of official quarantine centre and reintroduction project from the Directorate General for Forest Protection and Nature Conservation (PHPA) of the Ministry of Forestry in 1994.

In the four years that the project has been running 165 confiscated orangutans were brought to the station.

1.7 *Orangutan Procedures at Wanariset*

When a new orangutan arrives at the station it is at first kept in quarantine for several weeks and a thorough health and physical examination is carried out. Blood and faecal

samples are sent to a laboratory and checked for intestinal parasites, Hepatitis (A,B,C) and TBC. Fingerprints and hair samples are taken to test for subspecies difference (Sumatran (*Pongo pygmaeus abelii)*/ Bornean (*Pongo pygmaeus pygmaeus*)). All technicians, veterinarians and researchers employed by the reintroduction project have to undergo a thorough health screening and have received vaccinations for Hepatitis B, rabies, tetanus and get regular check ups for TBC.

When the animal is proven healthy it is put into an enclosure, with one or two other new orangutans, within a large socialization cage. When the orangutans from the large group and the newcomers have become accustomed to each other the new orangutans are put into the large socialization cage.

Here in the socialization cage the orangutans are free to interact with each other and develop friendships and bonds until a hierarchical social structure is established. During the socialization phase the orangutans are trained to feed on forest fruits, build nests, (re-) develop climbing skills, lose their attachment to humans (by minimal contact) and get accustomed to conspecifics again (behavioural rehabilitation). The socialization period is meant to stimulate the learning process through imitation and play and to facilitate adaptation in the forest as the orangutans have created social bonds before release.

Juvenile orangutans under normal circumstances would in this stage still be travelling together with their mother and be learning all the necessary survival skills from her. The juvenile\ adolescent period in a wild orangutans' life is the most socially oriented and in the wild associations of young orangutans are often seen (Galdikas 1978, 1985; Rijksen and Rijksen-Graatsma 1975; Rijksen 1978). Under captive conditions young orangutans also tend to be very social (Edwards 1982; Edwards and Snowdon 1980; van Hooff 1986; Poole 1987). Horr (1977) states that social experience is critical to the developmental process and that the input from conspecifics could be very important for survival.

Then ideally a selection is made of orangutans (with at least an equal female/ male ratio) who have formed stable social relationships and are considered healthy and behaviourally rehabilitated to be released into the forest. The mean group size of orangutans that have been released is 12 individuals.

From the 165 orangutans that were brought to the station, 32 were repatriated from Taiwan, but most of the orangutans were confiscated in East and West Kalimantan and a few came from a Zoo on Java . One adult male orangutan was translocated from a coal mining area in East Kalimantan and was immediately released in the Sungai Wain area. The orangutans brought to the station vary in age from 2 months to approximately 15 years, with most of them between 3 and 5 years of age (Smits 1992).

1.8 *The Reintroduction Site: Sungai Wain*

The Sungai Wain Nature Reserve, located approximately 15 km. north of Balikpapan in East Kalimantan, was selected as the first site for the reintroduction of orangutans. The forest comprises of 11.000 ha. of mixed primary Dipterocarp rainforest, large swamp areas and some secondary forest.

The Sungai Wain area has been selected for several reasons. In the first place the forest meets the habitat requirements of the orangutan. After vegetation assessments had been made it was calculated that the area could accommodate approximately 100 orangutans (Smits 1992).

Secondly there are no wild orangutans in the area or in adjacent forests. Areas of lower forest quality have some potential for restoration. An area of approximately 200 ha. has been replanted with 'orangutan fruit trees'. Several other species of primates inhabit the area, including pig-tailed macaques (*Macaca nemestrina*), long-tailed macaques (*Macaca fascicularis*), at least two species of leaf monkeys (*Presbytis rubicunda, Nasalis larvatus*) and gibbons (*Hylobates muelleri*).

Furthermore the forest has a formally protected status now and is of great economic value for the city of Balikpapan and its industry. The Sungai Wain forest is being used as a water catchment area for the city of Balikpapan and the oil industry. Sweet water from the rivers is collected in an artificial lake at the forest edge and the Indonesian oil company Pertamina has permanent personnel working there at the water intake facilities. The forest has been positively affected by the economic value attributed to it and the reintroduction project, and as a result the army and the oil company now take measures to protect it.

In addition the Wanariset research project, which manages the reintroduction program, is located approximately 30 km. north of the forest, allowing for easy transfer of the orangutans.

During the initial phases of the Orangutan Reintroduction Project several measures had to be taken in order to enhance the protection of the forest. The forest is situated close to the town of Balikpapan and a stretch of 5 km. of the eastern border of the area lies next to the Balikpapan-Samarinda 'highway'. Human encroachment, illegal logging activities, firewood collection, hunting and collection of rattan (a palm species used for various handicrafts) were some of the problems that had to be solved before orangutans could be released.

Several families that have encroached into the protected area will have to move outside the boundaries. The forest is surrounded by human settlements on the southern and eastern side, by a concession area on the north and production forest on the western border.

Meetings were organized by the project with village heads and local police, army and forestry officials to inform people about the project and the legal status of the forest.

The southern area of the forest is well controlled by an army checkpoint (near an ammunition depot) and a Pertamina security post, where every person entering the Pertamina compound near the water facilities has to register.

Around the whole forest permanent boundary markers have been placed and signs stating the regulations and protected status of the forest were installed at obvious points as well as two watchtowers. Near the main Balikpapan-Samarinda road, bordering the forest, several security posts were built.

In addition to the reintroduction of orangutans, several vegetation studies were conducted by the Wanariset project in the Sungai Wain forest as well as a bird census by Indonesian students.

There are future plans to reintroduce orangutans in the Meratus area, on the border of East and South Kalimantan (pers. comm. W. Smits and H. Rijksen).

1.9 *Orangutan Procedures in the Sungai Wain Forest*

The selected group of orangutans, which have completed the socialization process, is transferred to the forest and brought to a release site. Here they are put into a large wooden cage on stilts (8 x 5 m.) for a couple of days to relieve transfer stress and to let them get accustomed to the forest sounds and smells. After a few days the cage is opened and the orangutans are free to disperse on their own in the forest.

From May 1992 until December 1994 five groups of orangutans (60 individuals) have been released .

For each release -except the last one- a new release site was used in order to avoid crowding in one specific area. The release-cage is later used by technicians from the project as a feeding site for the newly released orangutans. The period of additional feeding varies with each group and season in which the release takes place. The technicians bring only bananas in order to stimulate the apes to search for other natural foods.

If an orangutan is found wounded or in poor physical condition it is put into the cage and a veterinarian from the project is called in or the individual is taken back to the Wanariset station for treatment.

1.10 *Aims of this Research*

The major goals of this research were to study the adaptation of reintroduced orangutans in the forest and to give an evaluation on the feasibility of reintroduction of ex-captive orangutans by using the new strategy.

Major questions to answer were how long it takes for the orangutans to learn certain skills necessary to survive in the forest, by what process these changes occur and what effect the release in groups has on them. In order to find an answer to these questions, the ecology and social behaviour of several individuals from the different groups was studied.

Several hypothesis posed were:

1) Individuals from groups that have spent more time in the forest were expected to have a wider dietary composition than groups which have spent less time in the forest.

2) The activity patterns of the groups released at different time intervals were expected to differ, with groups which have spent more time in the forest showing a pattern more closely resembling the pattern observed for wild orangutans.

3) A shift in time spent at different heights in the canopy was also expected. Orangutans which have been longer in the forest are supposed to spend more time higher in the canopy as they would have had more time to develop their locomotor skills and as many of the preferred food items of orangutans are found in the higher canopy (Galdikas 1988; MacKinnon 1974; Rijksen 1978).

Other questions asked were:

4) Whether the orangutans were able to shift their dietary pattern to the availability of seasonal food items during the different periods of the year, where groups that have spent more time in the forest were expected to be more flexible than newly released groups.

5) What their (home) ranging pattern would be like and

6) How their social structure would develop after release.

Nesting behaviour, specific social interactions and handling of the most important food items were also recorded and will be discussed.

CHAPTER 2: RESEARCH METHODS

2.1 *Study Area: Sungai Wain*

This study was carried out in the Sungai Wain Nature Reserve (see fig. 2.1). The area comprises of approximately 11.000 ha. containing a mosaic of primary Dipterocarp forest, extensive swamp areas near the rivers and some secondary forest. The altitude varied from sea level to approximately 150 m. above sea level.
The area had an annual rainfall of 2107 mm in 1994 (fig. 2.2) with one dry period (July-October) and a rain period (November- June).

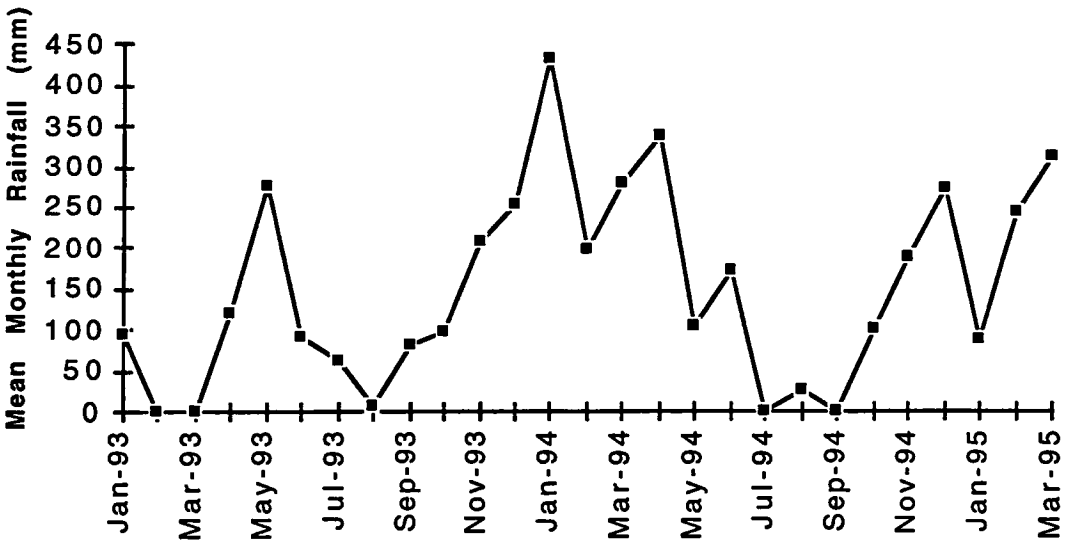


Fig. 2.2: Mean Monthly Rainfall recorded at the Wanariset Station.

The whole forest area was used for our study but most observations were made in a core area of 5 km^2 (see fig. 2.1).

Before this research was conducted, notes were taken by the technicians from the project on which orangutans came to the feeding site.

Our base camp, a small wooden house, was situated in the forest approximately 30 min. walk from the nearest village and the Pertamina water facilities. A second house was later built further in the forest and was occasionally used. Most of the time two assistants from the village lived with us in the forest and helped with various chores. A tall watchtower (54 m.) had been constructed near the house. Orangutans could sometimes be found in near proximity to both houses.

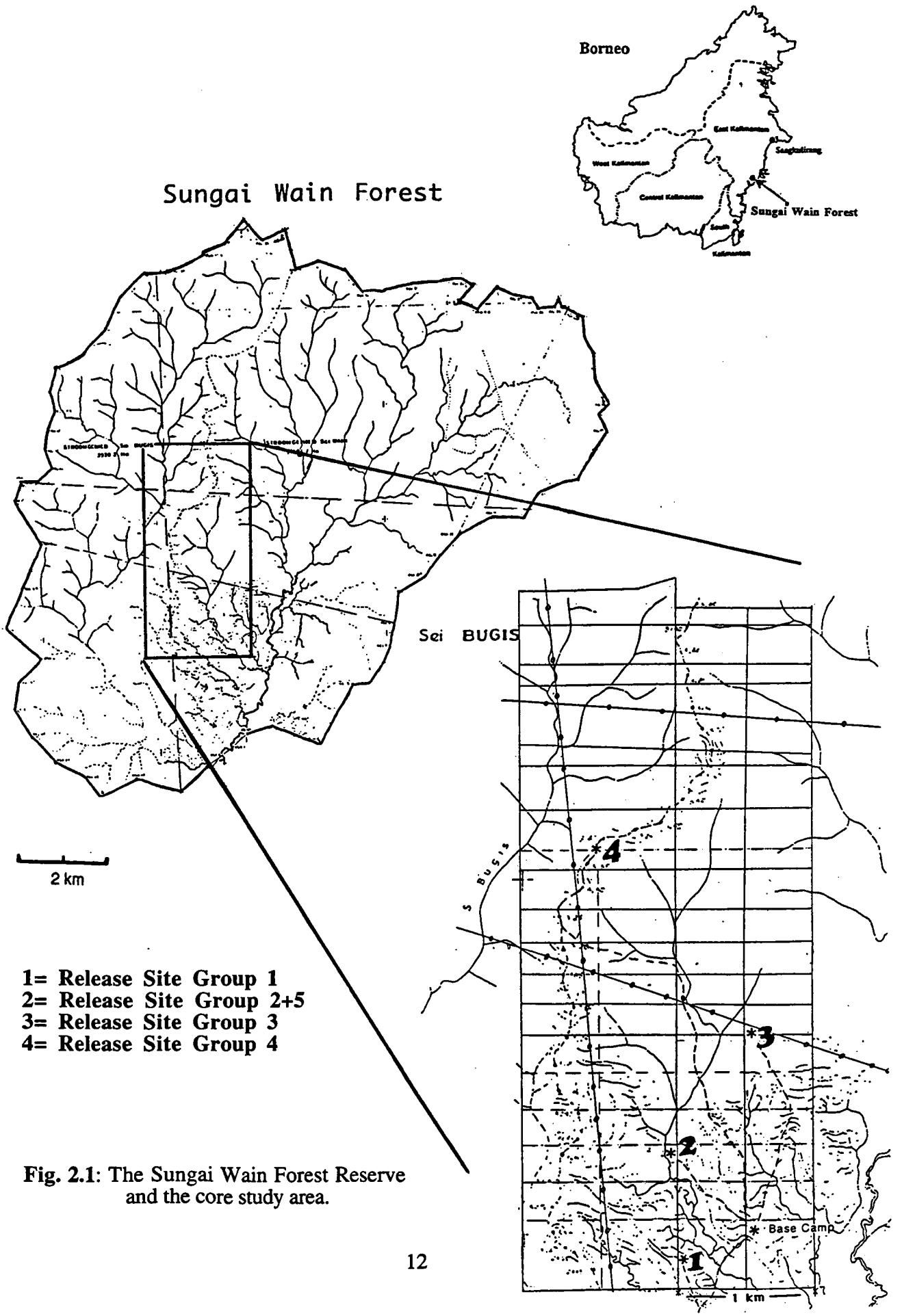


Fig. 2.1: The Sungai Wain Forest Reserve and the core study area.

2.2 *Study Subjects*

The subjects of this study were reintroduced orangutans, of the Bornean subspecies (*Pongo pygmaeus pygmaeus*) in the Sungai Wain Nature Reserve.

Before we started with this study, 38 orangutans, divided in three groups, had been released in the forest. During our stay another 22 individuals, divided in two groups, were released (see Appendix 1 for a list of the reintroduced orangutans).

All orangutans underwent the same reintroduction procedures at the Wanariset Station but their history and background varied greatly. Seventeen of the released individuals were repatriated from Taiwan. The amount of time the orangutans had spent at the Wanariset Station varied between two weeks and three years. Most orangutans were juveniles/ adolescents when released, with a few exceptions (see Appendix 1).

The orangutans we studied were strongly habituated to humans and showed little disturbance when being followed. Some of them allowed us to observe them from short distance (a few metres), which favoured the accuracy of the observations and made the collection of food items more reliable.

There is a bias in our observations towards animals who ranged in the vicinity of the release sites or our base camp.

A photo file was composed of all orangutans from photographs taken during their stay at Wanariset. This was thought to be of help for recognition but most apes changed their appearance drastically in the forest, growing a long coat of hair (most orangutans had short hair at the time of release as their hair would break on the concrete floor of the socialization cage at Wanariset). If an orangutan could not be identified by ourselves, the technicians from Wanariset who came into the forest every day to feed the newly released orangutans would usually help us with an accurate identification. They had worked with the animals at the station before their release and knew individuals by sight.

2.3 *Study Methods*

The first month (April 1994) was spent at the Wanariset station, where we familiarized ourselves with the orangutans and looked at the 'social structure' (interactions between animals) of the group of orangutans that were going to be the next to be released in the Sungai Wain forest.

In the forest several surveys were made with local assistance, in order to get an idea of the topography of the area. Major vegetation types were mapped and a list was made with local names for some orangutan food plants.

As it was never certain where and if an orangutan would be found, any encountered individual would be followed for the rest of that day until it made a nest for the night. The next day observations were resumed from the nest-site (dawn to dusk follows). We tried to follow an orangutan for at least two successive days in order to get a complete sample of its daily pattern encompassing all hours of the day, after which the process of locating a new individual would start or the same orangutan would be followed for more days.

If more than one orangutan would be encountered, one focal animal (Altmann 1974) was chosen and followed the rest of the day. If the focal animal would interact with another orangutan, additional data on this animal would also be collected. If no orangutan could be found within a reasonable time span in a specific area, we would usually randomly search along paths walking slowly and pause every 25 m. listening and looking for any signs of orangutan activity. In the same fashion surveys were made in specific parts of the forest.

Observations were carried out using binoculars (8x20 Leica) and data were recorded on standard observation sheets which we had composed after several trials. Scans were taken every minute and additional notes were taken whenever something of particular interest happened.

At every minute scan we recorded the following major activities;

Locomotion / Travel : This encompassed all movements (walking, climbing, descending- causing a change in the position of an individual within a tree or between trees). If an orangutan made a longer movement (more than a small shift in position) within a tree when it was feeding at a minute scan this was also noted as a movement.

Feeding: This also encompassed food handling. Sixteen main food items were given abbreviations (see table 4.1 in Chapter 4 on Feeding Ecology). Whenever possible plant-food items were collected, labelled, further preserved and brought to the Wanariset station for further identification. When an orangutan was seen drinking it was noted if it was from a hole in a tree, or rain water licked from the fur or leaves, or straight from a river.

Resting: When an orangutan was not engaged in any activity [no locomotion, eating, nest building etc.] at a minute scan it would be noted that the animal was resting. The posture would be noted as well (hanging, sitting, lying).

If an orangutan was engaged in any of the following activities it was noted under the category miscellaneous Activity: The building of a nest or a rain shelter; Vocalizations; Intensely looking at something; Searching in leaves on the ground; Urinating, defecating; Self grooming; Displaying towards the observer or something else.

Behaviour would be scored as Social when an individual was playing, chasing or physically in contact with another orangutan. Sexual behaviour, food sharing and any other interaction (e.g. touching, grooming) would be recorded in more detail. If the focal orangutan was in association with one or more orangutans, we would record, at every minute, their distance from the focal animal and who the other orangutans were. If an orangutan would be engaged in self-play (Ps) this would be recorded here as well but was later extracted from this data.

At every minute scan the orangutan's height from the ground was also noted and the height of the tree/ plant substrate he was in. This was visually estimated and classified into a 5 metres height category from 0-6:

H-0 = Ground
H-1 = 1-5 m.
H-2 = 6-10 m.
H-3 = 11-15 m.
H-4 = 16-25 m.
H-5 = 26-35 m.
H-6 = ≥ 36 m.

If it wasn't possible to make a positive record of what an orangutan was doing at a minute scan, 'not visible (nv)' was noted for that minute.

Weather conditions were recorded every half hour as well as the beginning and ending of rain showers.

Food specimens were collected for identification. All items were numbered on our sheets and a rough description and drawing were made. Plants were 'dried' in news papers and fruit and flowers were preserved in (70%) alcohol. All collected material was taken to the Wanariset Herbarium as soon as possible where the specimens were further stored and preserved for identification.

Most observations were made on our own or together with one of our assistants if it wouldn't disturb the orangutans behaviour. A compass and parang were used as travel aids.

2.4 *Trail System*

At first several long trails were made through the whole forest to improve travel and orientation. Later an already existing grid system was made accessible again and sufficiently extended so as to encompass all four release sites. The grid system consisted of approximately 60 km. of trails (250 m. x 250 m./ 500 m.) which were labelled every 25 or 50 metres with metal identification tags and bright ribbons. The total area of the grid was 10 km^2. The path system was used to facilitate location of the orangutans and to make mapping of their movements and home ranges more accurate (see fig. 2.1). It was further used for surveys and as a tool for orientation.

All trails, the grid system and release sites were mapped in addition to three oil 'bridging' trails that passed through the forest. These oil bridgings (two from east to west and one from south to north) were also useful coordination points as they were numbered every 20 m. and ran through the whole forest.

2.5 *Data Preparation*

Preparational work was done from May 1994 until September 1994. Data were collected by G.Fredriksson from October 1994 and broken off at the end of November 1994 due to an accident. Additional data from H.Peters (October 1994- February 1995) were used for analyses.

Observations were made on several individuals of each group. In total observations were made on 17 target (focal) orangutans. In table 2.1 the focal animals from each group are listed and the number of observation days on each individual.

Data from the 17 different individuals were obtained in unequal numbers of observation days (varying between one day to thirteen days). The individuals from the 5 different release groups were often not observed during the same days or not even during the same months. Most analyses carried out were aimed at examining differences between the groups of orangutans released at different times (group 1 (23 May 1992); group 2 (1 February 1993); group 3 (1 February 1994); group 4 (3 September 1994); group 5 (3 December 1994)). In order to improve the reliability of the analyses of the differences between the 5 groups and in order to express these differences, possibly caused by the difference in time spent in the forest, the data of group 1 and group 2 (resp. 30 months and 20 months in the forest at the beginning of this study) were lumped. The data from group 4 and 5 (resp. 2-3 months and 1 month in the forest) were lumped in order to avoid the contrasting of the few

group 5 data to the data of the other groups, and also to obtain a combined data set of group 4 and group 5, that encompassed approximately the same overall observation period (October-February) as the other groups. The data were also lumped in order to treat these two groups combined as the most recently reintroduced orangutans.

Observations on group 3, which had spent 9 months in the forest at the beginning of this study, provided enough data and covered almost the whole observation period, to allow for statistical significance if contrasted to the other groups.

	Oct	Nov	Dec	Jan	Feb
Group 1					
Charlie	2	3	X	X	1
Uce	3	6	1	X	3
Sri	X	X	X	X	2
Group 2					
Tuti	X	6	1	X	5
Bento	X	1	X	X	X
Group 3					
Saryem	4	X	X	X	4
Enggong	4	2	X	2	X
Group 4					
Shawban	1	1	X	X	X
Smits	2	1	X	2	X
Bona	X	1	X	X	X
(Otong)	3	4	X	X	X
Group 5					
Ramon	X	X	1	X	X
Beben	X	X	1	X	X
Ludah	X	X	1	X	X
Paul	X	X	X	1	X
Semoi	X	X	1	3	1
Bawdi	X	X	1	X	X

Table 2.1: Number of observation days on focal orangutans.

Wherever possible non-parametric tests (two-tailed) were used (Siegel 1988) and the statistical package Statview for the Macintosh.

CHAPTER 3: ACTIVITY BUDGETS and DIURNAL ACTIVITY PATTERN

3.1 *Introduction*

In the wild orangutans spend more than 95% of their waking hours feeding, resting, and moving between resting and feeding sites. The remainder of time is divided between nest building and limited social behaviour (Rodman 1988).

The activity pattern between adult male and female orangutans seems to differ significantly at some study sites. Rodman (1973) found that males spend more time feeding and less time resting compared to females. Galdikas (1978) on the other hand states that males on average spend less time foraging. Rijksen (1978) and MacKinnon (1974) did not find large differences between males and females.

The only published data on the activity patterns observed for wild adolescents comes from Galdikas (1978) who reports on two females, and Rodman (1979) who followed one female.

There are several factors which affect the activity budgets of wild orangutans like the weather (MacKinnon 1974), seasonal variation in fruit availability (Galdikas 1978,1988; MacKinnon 1974; Mitani 1989; Rodman 1977) or associations with conspecifics (Galdikas 1988; Horr 1975; MacKinnon 1974; Wrangham and Smuts 1980).

3.2 *Methods: Activity Budgets*

In order to see if (and where) there were differences between the groups of orangutans (newly released and older released groups) their activity budgets over all observations days (October-February), including days in association with other orangutans, were calculated.

For all days the percentages of time for each category of activity (feeding, resting, locomotion, social and miscellaneous activities) were calculated separately for each orangutan. The median percentage value across days were then calculated for each orangutan, and mediated for all orangutans belonging to each (sub) release group.

The data of one orangutan (Otong, n=7 days) were excluded from the analysis on activity budgets and daily activity patterns as it was not clear into which group the observations should be placed. She was first released in group 1 (23-5-1992), but later she was taken back to the Wanariset station after she had been sighted at a plywood factory approximately 25 km. from the forest. She was then re-released in group 4. Her activity

pattern differed significantly from that found for individuals from group 1, but also from orangutans that had just been released.

Only the three major activities (feeding, resting, locomotion) will be discussed here as the miscellaneous activities (e.g. nest building) and the social behaviour will be dealt with later on.

3.3 *Results: Activity Budgets*

In fig. 3.1 the activity budgets are shown for each (sub) group.

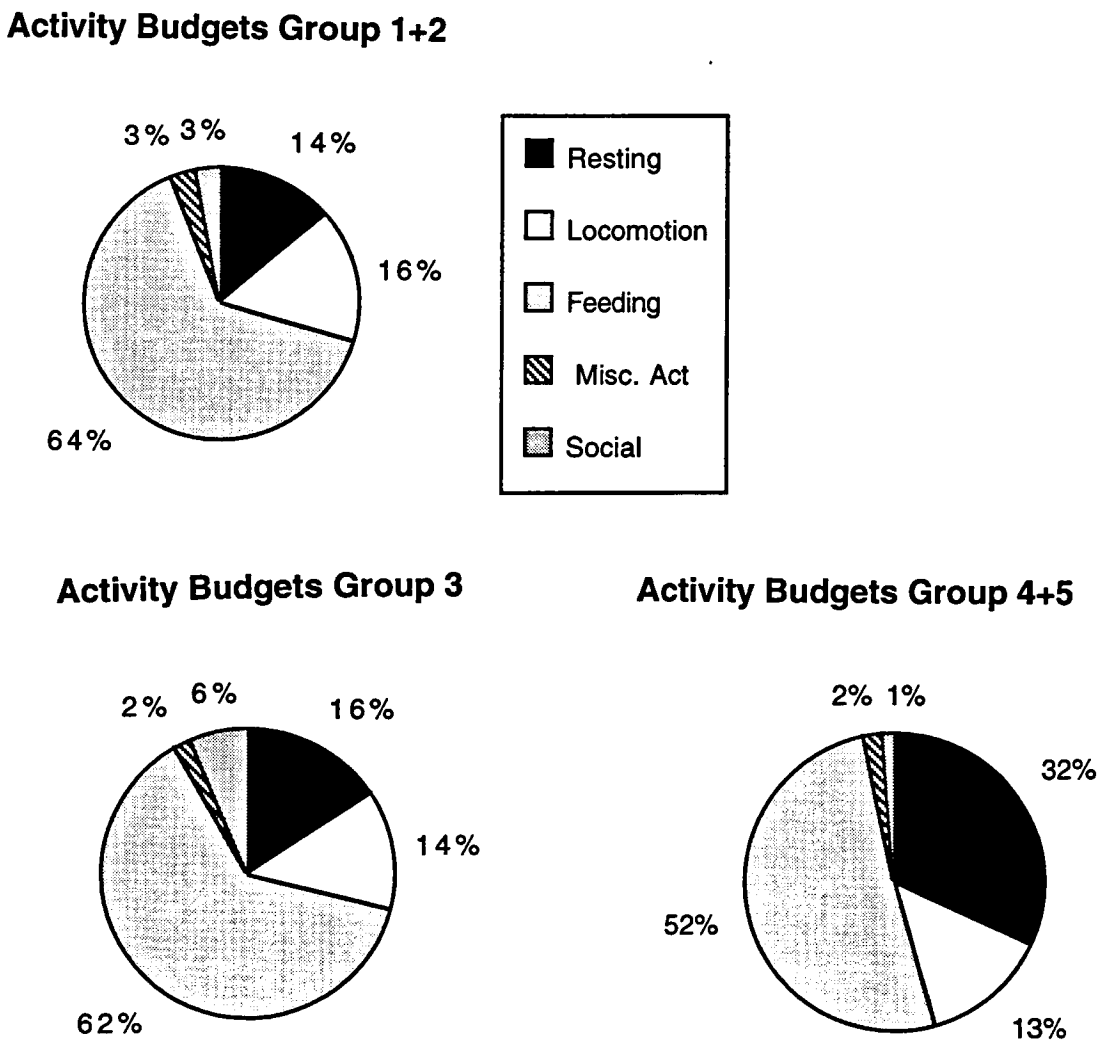


Fig. 3.1: Activity budgets for the three sub groups.

* Percentages were calculated as explained in the text above.

Figure 3.1 shows that the groups (1+2) and 3 are very similar to each other in overall pattern. Group (4+5) on the other hand shows a much higher figure for time spent resting and lower figure for time spent feeding.

The activity patterns of the three sub groups were compared to each other with the Mann-Whitney U test (table 3.1).

Resting	Group 3 n=16	Group 4+5 n=18
Group 1+2 n=32	Z=-0.569 ns	**Z=-5.033 P<0.01**
Group 3 n=16	X	**Z=-4.071 P<0.01**

Locomotion	Group 3 n=16	Group 4+5 n=18
Group 1+2 n=32	Z=-0.7 ns	Z=-0.04 ns
Group 3 n=16	X	Z=-0.173 ns

Feeding	Group 3 n=16	Group 4+5 n=18
Group 1+2 n=32	Z=-0.744 ns	**Z=-4.628 P<0.01**
Group 3 n=16	X	**Z=-3.519 P<0.01**

Table 3.1: Mann-Whitney U test. Z values for comparison of activities between the different groups. ns= not significant.

No significant differences were found for any of the three activities between group (1+2) and group 3. But both groups showed significant differences when comparing their activities to group (4+5). The newly released orangutans spent significantly more time resting (twice as much) and less time feeding compared to the other groups (1-3).

3.4 *Discussion: Activity Budgets*

The activity budgets of group (1+2) and group 3 are very similar. The activity pattern of the last two release groups differs a lot when compared to that of the first three release groups. The newly released animals spend twice as much time resting compared to the orangutans from other groups. They also spent significantly less time feeding compared to the other release groups.

When comparing these findings with data collected on wild juvenile/ adolescent orangutans (Galdikas 1978; Rodman 1973, 1979) the figures from groups which have spent more than 9 months in the forest show the strongest similarity with the findings of

Galdikas from Tanjung Puting. In table 3.2 below the percentages of time spent on the major activities from two studies on wild adolescent orangutans and this study are shown.

	N (days)	M/F	Resting	Locomotion	Feeding
Galdikas	9	F	14.8 %	17.3 %	66.3 %
(1978)	9	F	7.1 %	19.2 %	72.3 %
Average			10.9 %	18.2 %	69.3 %
Rodman					
(1973, 1979)	3	F	42.0 %	12.6 %	42.1 %
This Study					
Group (1+2)	32	M/F	13.9 %	15.9 %	64.1 %
Group 3	16	M/F	15.3 %	13.5 %	61.2 %
Group (4+5)	18	M/F	32.2 %	13.3 %	51.2 %

Table 3.2: Percentages time spent on the major activities obtained for juvenile/ adolescent animals from two studies on wild orangutans and this study.

* The percentages presented for this study were obtained as described in the text above. For the other studies it is not clear how these numbers were calculated. M/F- male or female orangutan.

The data from Rodman (1973, 1979) and Galdikas (1978) vary a lot which could be due to differences in recording methods. Galdikas used waking hours for a base while Rodman used time between 05:30 and 18:30 as a base, thus including prewaking rest and postsleeping rest at the beginning and end of the day (Rodman 1988) which gives a large bias towards resting time.

Data for this study were gathered from October till February but it is not clear from which period of the year Galdikas' data are. There could be quite some variation in activity budgets due to seasonal variation (Clutton-Brock 1977; Mitani 1989).

When comparing their pattern to that found for two juvenile/ adolescent females in the wild (Galdikas 1988) there seems to be considerable similarity, although the reintroduced orangutans seem to spend a bit more time on resting and less on travel and feeding.

As the pattern of group three bears much resemblance to that of group (1+2) and less so to that of group (4+5) it seems that the activity pattern of the reintroduced orangutans can change in a period of nine months following release, after which it remains stable and similar to that found for wild adolescents.

3.5 Seasonal Variation in Activity Budgets

This study commenced during the dry season (Oct) and ended when the rain season was still going on (Feb). The distinction between the dry and wet period was quite noticeable in fruit production as well as in the amount of rainfall. In Galdikas' study site (Central-Kalimantan) the highest numbers of fruits were also found during the wet season (Dec-May)(Galdikas 1988). As seasonal variation in fruit availability might affect the activity pattern of wild orangutans (Galdikas 1978, 1988; MacKinnon 1974; Mitani 1989; Rodman 1977), I compared the activity pattern of six reintroduced orangutans during the dry (Oct-Dec) and wet period (Jan-Feb). The results are given in table 3.3.

	Sex	Group	Period	N days	Resting Time	Locomotion/ Travel	Feeding Time	Foraging Index
Charlie	SaM	1	Dry	n_1=4	18.03	13.41	59.60	4.44
			Wet	n_2=1	24.21	23.68	40.88	1.73
Uce	aF	1	Dry	n_1=9	10.27	8.74 *	78.4 *	8.97
			Wet	n_2=3	10.54	17.79 *	67.5 *	3.80
Tuti	aF	2	Dry	n_1=7	17.6 *	15.86	56.11	3.54
			Wet	n_2=5	7.47 *	19.04	63.04	3.31
Saryem	aF	3	Dry	n_1=4	17.70	9.51	71.8 *	7.55
			Wet	n_2=4	18.26	15.03	57.7 *	3.84
Enggong	aM	3	Dry	n_1=6	14.09	12.79	55.62	4.35
			Wet	n_2=2	8.92	12.64	69.40	5.49
Smits	aM	4	Dry	n_1=3	37.82	11.39	48.41	4.25
			Wet	n_2=2	33.71	15.25	46.64	3.06

Table 3.3: Mann-Whitney U test. Comparison between activities and foraging index during the dry and wet period.

A * indicates a significant difference between the dry and the wet period ($P<0.05$, two-tailed). Others are not significant. SaM= Subadult Male, aF/M= adolescent female/ male. n_1 = Dry period, n_2 = Wet period.

Both females Uce and Saryem from group 1 and group 3 show a distinctive decrease in feeding time and an increase in travel time during the wet period (higher fruit availability), which can also be seen in the difference in the foraging index between the dry and the wet period. The foraging index is the ratio of time spent feeding to time spent moving (MacKinnon 1974; Rodman 1973).

The foraging index Galdikas (1988) reports for two adolescent females is 3.8 but again it is not clear during which period this data was gathered. The foraging index found during the wet period of this study for the individuals given in table 3.3 corresponds with the index presented by Galdikas for adolescents. The foraging index found here for the dry

period for the two females Uce and Saryem is quite high but Mitani (1989) mentions an increase in feeding/ foraging time when animals had to feed on permanent food items (leaves and bark) during periods of low fruit availability. This was also observed by Rodman (1977) who mentions an increase in feeding time associated with lower proportions of fruit in the diet. Hladik (1977) states that feeding on the vegetative parts usually takes a longer time to process thereby increasing the total time spent feeding. The female Uce was also found travelling significantly less during the dry period. Galdikas (1979) found that orangutans in Tanjung Puting decreased their day ranges when they had to feed on permanent food sources compared to periods when they concentrated on seasonal foods.

MacKinnon (1974) on the other hand found an increase in feeding time and less time spent on travel when fruit formed a major part of the orangutans' diet during his study.

Another explanation could be that the two animals spent most of their observation days during the wet period in association with other orangutans. Grouping could impose costs on an animal that may manifest itself in the activity budget as a decrease in feeding time (Wrangham and Smuts 1980), or as an increase in travel and resting time (Galdikas 1988).

Tuti on the other hand only shows a decrease in resting time during the wet period (when she was also in association with other orangutan(s)). Mitani (1989) mentions that one adult female during his study showed an increase in feeding time and a decrease in resting time when a favourite food tree was in fruit.

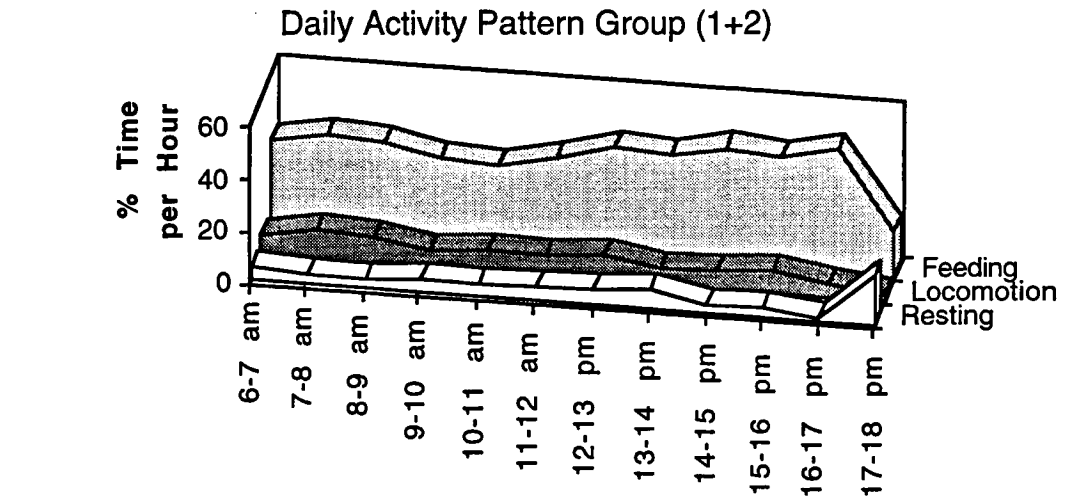
3.6 *Introduction: Daily Activity Pattern*

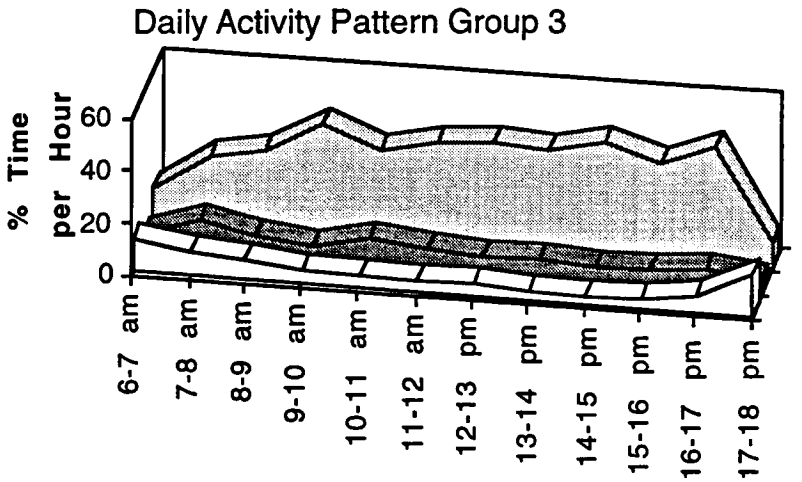
The activity pattern of wild orangutans is influenced by the time of day. Rodman (1979) found that orangutans during his study showed two distinct feeding peaks (in the morning and afternoon), a clear midday rest period and an increase in movement in the afternoon. This is also roughly what MacKinnon (1974) found at the Segama study site, and Rijksen (1978) reports that feeding activity was most marked in the morning while travelling activity was higher in the afternoon. Midday was usually spent in a resting position.

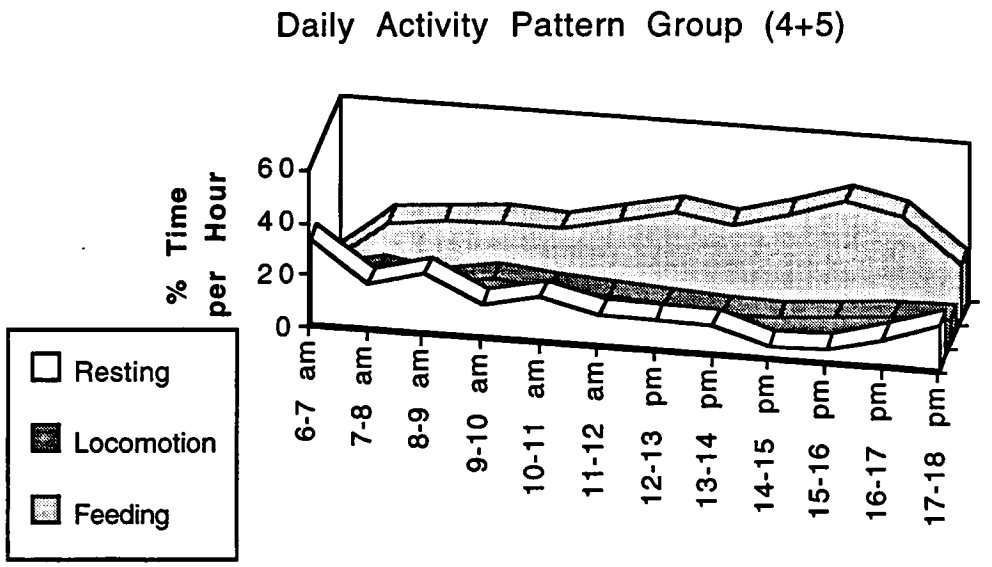
3.7 *Methods*

In order to see how the different groups of orangutans distributed their time for the three major activities (feeding, resting and locomotion) on a day, their diurnal cycle of activity was calculated. This was done for each (sub) group by calculating the median for each hour for all individuals followed from that group over all observation days (Oct-Feb).

3.8 *Results*


Daily Activity Pattern Group (1+2)
% Time per Hour
60
40
20
0
6-7 am
7-8 am
8-9 am
9-10 am
10-11 am
11-12 am
12-13 pm
13-14 pm
14-15 pm
15-16 pm
16-17 pm
17-18 pm
Feeding
Locomotion
Resting


Daily Activity Pattern Group 3
% Time per Hour
60
40
20
0
6-7 am
7-8 am
8-9 am
9-10 am
10-11 am
11-12 am
12-13 pm
13-14 pm
14-15 pm
15-16 pm
16-17 pm
17-18 pm


Daily Activity Pattern Group (4+5)
% Time per Hour
60
40
20
0
6-7 am
7-8 am
8-9 am
9-10 am
10-11 am
11-12 am
12-13 pm
13-14 pm
14-15 pm
15-16 pm
16-17 pm
17-18 pm
Resting
Locomotion
Feeding

In the first place I compared the activities for the different groups with the Wilcoxon Signed Ranks test (table 3.4).

Resting	Group 3	Group 4+5
Group 1+2	Z=-1.007 ns	**Z=-2.824 P<0.01**
Group 3	X	**Z=-2.94 P<0.01**

Locomotion	Group 3	Group 4+5
Group 1+2	Z=-1.493 ns	Z=-0.825 ns
Group 3	X	**Z=-2.674 P<0.01**

Feeding	Group 3	Group 4+5
Group 1+2	Z=-1.569 ns	**Z=-2.904 P<0.01**
Group 3	X	**Z=-2.119 P<0.05**

Table 3.4: Wilcoxon Signed Ranks test (two-tailed). Z values for comparison of activities between the groups (N=12). ns = not significant.

3.9 *Discussion*

There was no significant difference between group (1+2) and group 3 but both groups differed significantly in diurnal activity pattern from group (4+5), where members of the last group fed less during all hours of the day and rested significantly more than the other groups. Members of group (4+5) travelled more during all hours of the day than orangutans from group 3.

These results support the hypothesis that the longer the groups have lived in the forest the more their pattern should look alike (the pattern of group 3 resembles that of group (1+2) more than that of group (4+5)) but when comparing these findings with daily activity patterns found for wild orangutans there is still a large discrepancy.

The reintroduced orangutans do not show distinctive feeding peaks in the morning or afternoon nor a midday resting peak.

Group (1+2) tended to feed more during the midday and afternoon hours while resting and movement seemed to be evenly spread throughout the day (this was not tested for significancy). Group 3 shows a slight feeding 'peak' between 9-10 and 14-15 hours. And group (4+5) rests a lot in the morning and show an increase in feeding activity during the afternoon.

The daily activity pattern was also tested between the different months to see if there was a difference due to seasonal variation. The only significant differences found were within group 1, where there was more locomotion in February compared to October/ November

and there was less feeding in February compared to November. Group 3 spent more time feeding throughout the day in October compared to February.

The fact that the reintroduced orangutans do not show a daily activity pattern which bears much resemblance to the pattern found for wild orangutans could be caused by several factors.

The orangutans of this study were all juveniles/ adolescents while data gathered on wild orangutans were mostly on adult animals (MacKinnon 1974; Rodman 1979). It is not clear whether juvenile/ adolescent orangutans in the wild show such a distinctive diurnal pattern as well.

Furthermore I took the median over all orangutans observed from each sub group, from a short period of time (Oct-Feb) but with a marked difference in fruit availability. The data also consisted of more observation days in the dry period than in the wet period (G (1+2) 21 days dry vs. 11 days wet, G (3) 10 days dry vs. 6 days wet, G (4+5) 11 days dry vs. 7 days wet). MacKinnon (1974) found a marked difference in daily activity pattern for dry and for wet days.

Additionally there may also be inter-individual and intra-individual variation between the different apes within a group.

However rising time seemed to be earlier for individuals from the groups 1-3 than for newly released animals. Orangutans from group 1-3 started their day between 5:45 and 7 am while newly released animals tended to sleep longer in the morning and break their day off earlier than individuals that had spend more time in the forest (see fig. 3.2). The average day length for the different groups of orangutans was between 9 and 12 hours.

CHAPTER 4 : FEEDING ECOLOGY

4.1 *Introduction*

Although no detailed information is available on the feeding behaviour and ecology of ex-captive orangutans from previous rehabilitation projects, Rijksen (1978) mentions that the rehabilitant orangutans in Ketambe learned to utilize most of the food items that were eaten by their wild counterparts in two to six months. How the rehabilitant orangutans learned which food items were edible was not entirely clear although Rijksen noticed that the newly released animals occasionally tasted food items eaten by older rehabilitants and that they 'readily learned' from other rehabilitants. Rijksen (1974) also mentions that they tried 'anything that looked edible'. Several food items eaten by rehabilitants were not found in the diet of wild orangutans (Rijksen 1978).

De Silva (1971) mentions that ex-captive orangutans at the Sepilok station, when provisioning was stopped during the fruit season, would start foraging independently and when fruit became scarce they would wander off into the forest and feed on 'whatever they could find'.

The diet of wild orangutans mainly consists of fruit, leaves, bark, other vegetational parts including flowers and shoots, and insects (e.g. Galdikas 1978, 1988; Horr 1975; MacKinnon 1974; Rijksen 1978; Rodman 1973).

Wild orangutans are strongly opportunistic foragers (Galdikas 1988; MacKinnon 1974), with the composition of their diet varying considerably from month to month (Galdikas 1988) and also between the different research sites (Rodman 1988).

In the Ketambe area, which tends to be very rich in large strangling figs (*Ficus* spp.) Rijksen reported that 54% of observations made on wild orangutans feeding on fruit were on figs (Rijksen 1978). Galdikas (1988), on the other hand, mentions that only 0.4 % of all feeding observations involved feeding on figs in Tanjung Puting, as hardly any large fig trees grow in that area.

Several researchers reported a dietary shift during periods of low fruit availability (Galdikas 1978, 1988; MacKinnon 1974; Rijksen 1978; Rodman 1977).

Leighton (1993) mentions that in the Mentoko area (East Kalimantan) preferred fruit types were highly seasonal. There was a brief period of high fruit availability (2-4 months, from February till April) during which almost exclusively fruit was eaten, followed by a long period of low fruit availability which could consist of almost 80% of the time. During these periods of 'scarcity' the orangutans tended to feed more on permanent resources as bark, leaves and shoots (Galdikas 1988; Leighton 1993; MacKinnon 1974).

Davenport (1967) reports from his study in the Lokan area in Sabah, which took place during the dry season, that in 90 % of observation time on feeding the orangutans fed on leaves and shoots.

Wild orangutans seem to have an extremely good knowledge of the topography of the area they range in, frequently monitoring potential fruit trees (Horr 1977; MacKinnon 1974; Rijksen 1978).

There seems to be quite some variation between the different research sites in feeding ecology due to the complex phenological patterns of the tropical rain forest and differences in densities of food trees due to geographical (micro habitat) conditions. Strong annual variation and between year variation in the number of trees fruiting, fruiting species and fruit crop size (Foster 1980; Medway 1972) adds to the divergence in results from the different field studies but the basic feeding habits have been fairly well documented.

4.2 *Methods*

The data collection for this study commenced in October, towards the end of the dry season (June-November) and lasted till February in the midst of the wet season. The beginning of the wet period also indicated the onset of the 'fruit season'.

Unfortunately no phenological data were gathered. Thus dietary patterns or changes cannot be interpreted in relation to confirmed fluctuating availabilities of seasonal food items or to densities of food items.

In the field 16 main food categories were classified and are listed in table 4.1. Several of these were later lumped for analysis.

Table 4.1: Food categories used in the field.

Ff	Fruit (all species)
Ffl	Flowers (all species)
Fx	Inner core of the leaf stem of the palm *Borassodendron borneensis*
Fxd	Leaves of *Borassodendron borneensis*
Fdb	Soft underparts of young leaves of the palm *Licula spinosa*
Fd	Leaves (from trees, lianas, etc)
Fc	Climber leaves
Fv	Fern leaves- *Asplenium nidus*
Fb	Bark (all species)
F r	Inner core of rattan plants and soft under parts of leaves
Fp+pk	Banana's and peels (supplementary feeding)
Ftt+a	Termites and ants
Fh	Inner core of shoots
Fsap	Latex of trees (all species)
Fo	Miscellaneous (e.g. soil, honey, fungi)
Minum	Drinking of water or urine

Food items that were eaten occasionally will also be discussed.

The feeding data was again divided for analysis into the three sub groups (G (1+2), G3 and G (4+5), the latter being the most recently released group). The data of one orangutan (Otong), for whom it was difficult to decide in which group category her data should be placed, were excluded from the analysis.

Time spent feeding on the pith of the leaf stem of the palm *Borassodendron borneensis* is found in the graphs and table under 'palm pith'. The leaf category in the graphs and table includes leaves from ferns, climbers, palms and other vegetation.

4.3 *Results*

4.3.1 *General Diet*

One of the aims of this study was to determine the diet of the reintroduced orangutans. For this purpose samples of all food items which we were able to obtain were collected. Unfortunately most samples of the dry period were not identified, thus the list of food items which is given in Appendix 2 is just a part of the species eaten and mainly of those items collected during the wet period.

The reintroduced orangutans reached a similar 'general' diet as wild orangutans (bark, leaves, fruit, flowers, insects, shoots, etc.) a couple of months after release. Additionally to these main food categories several individuals were also observed eating small quantities of soil, fungi, honey and cobwebs.

The orangutans seemed to learn which food items could be eaten by either following the example of other newly released animals, or those of more experienced orangutans or by trial and error. The orangutans which had spent more time in the forest were very tolerant of the newly released animals and frequently food begging and sharing was observed.

On one occasion a newly released orangutan (Smits) from group 4 travelled together for several days with a more experienced individual (Otong) who was primarily released in the first group (May 1992). Several times when she (Otong) had started feeding on a new food item, Smits would come close to her and beg for some of the food, which she then gave and she would start feeding on a new part. On one day she shared shoots of the palm *Licula spinosa* with him, as well as rattan shoots and young shoots of the *Borassodendron borneensis* palm. These were food items I had not previously seen Smits feeding on. In the same way he was observed begging for bark on another day, the leaves of the

B.borneensis palm and termites. (More on food begging and sharing in Chapter 6 on Social Behaviour).

A hundred species were identified belonging to 42 families. When comparing the families identified from this study with a compiled list given by Rodman 1988 (from five studies) there is quite some overlap. From the top 20 families listed there, 19 families were also represented with some genera/ species as food items during this study.

A list of identified food items is given in Appendix 2, and a comparison is made with the list given by MacKinnon (1974) from his study in Sabah, and with the list of food items eaten by orangutans from Tanjung Puting (Galdikas 1988).

Several species which were important food items for wild orangutans at the different study sites were not found to be eaten during this study like *Dracontomelon mangiferum* and *Koordersiodendron pinnatum* (Fam. Anacardiaceae) which Rodman (1973) mentioned were very important fruiting species during his study. Whether this was because these species did not fruit during this study or whether it was due to other reasons remains to be studied. On the other hand the reintroduced orangutans were observed feeding on several plants which were not observed as food items for wild orangutans like *Ancistrocladus tectorius* (Fam. Ancistrocladaceae), *Adenia sp.* (Fam. Passifloraceae) or *Madhuca sp.* (Fam. Sapotaceae).

Between 3 and 23 different species of food plants were eaten daily with an average of 12 species over all groups (n=65).

4.3.2 *Monthly Dietary Pattern*

One of the main aims of this study was to see whether the orangutans were able to find enough food during the different periods of the year and if they were able to adapt to differences in food availability during the different seasons.

Firstly the differences in the feeding pattern between the months for each of the three sub groups will be discussed and then the differences between the groups.

In order to find out if the orangutans changed their dietary pattern, I compared the feeding pattern during the different months with the Sign test, before lumping food categories.

With the Sign test, the transition from one food category to the next, as shown in table 4.1, put in a random order, was compared between two months or for the same month between two sub groups. If the transition from one food category to the next would change in the same direction a (+) was noted, if the transition would not be corresponding, a (-) was noted. When there was no usage of two food categories in a row and thus no transition

found for both months or groups, this transition would be subtracted from the n value. The maximal number of transitions between the 16 food categories was 15 (n=15). If there was a strong corresponding pattern (many +'s) this meant that there was a similar change in usage for the different categories. This test does not express the magnitude of the change but the pattern.

Only the months November and January for group 3 and (4+5) showed a similar pattern (Sign test, n=14, $P<0.05$ and $P<0.01$ resp.). The other months did not show a corresponding pattern according to this test.

When looking at the same months for the different groups only January for group 3 and (4+5), and February for group (1+2) and 3 has a similar pattern (n=14, $P<0.01$ and $P<0.05$ resp.).

Description of the Monthly Feeding Pattern:

In table 4.2 (p.30) the percentages of time spent feeding on the main food categories, for each month the three sub groups were observed, is shown. The 'leaves' category includes all kinds of leaves (climber, fern, leaves of *B.borneensis* and the young leaves of *Licula spinosa*). The category 'others' includes the inner core of shoots, latex, miscellaneous food items and drinking, which were all observed to be fed on in small amounts of time.

Group (1+2)

In October orangutans from the first two release groups spent most of their feeding time on leaves (25.75%), bark (23.5%), rattan (14.1%), the pith of the leaf stem of the palm *Borassodendron borneensis* (13.6%), and flowers (8.8%). Fruit made up only a small proportion of their diet (3.84%). (See table 4.2 for all percentages).

In November by far the most time was spent feeding on flowers (52.75%). These were mostly flowers from *Madhuca sp.* (fam. Sapotaceae), of which also the bark was consumed. There was a high density of this tree species in the area where the observed orangutans from group 1-3 ranged (pers. obs.). At first the closed flower buds were eaten but later on also the open flowers were consumed. I have not been able to find whether wild orangutans were observed feeding on this species (bark, flowers nor fruit) at other study sites (Galdikas 1978, 1988, 1994; MacKinnon 1974; Rijksen 1978; Rodman 1973, 1988).

A large amount of time was spent feeding on leaves (23.38%), which mainly constituted of young leaves from strangling figs (*Ficus* spp.). The bark from these trees was also

Group	Mth	Days N	Min. Obs.	% Time Feeding	Fruit	Flow-ers	Palm pith	Leaves	Bark	Rattan	Banana	Ter-mites/ Ants	Others
G 1+2	Oct	5	2171	69.06	3.84	8.76	13.62	25.75	23.51	14.06	1.27	1.01	8.18
G 1+2	Nov	16	9936	65.34	2.93	52.75	7.41	23.38	4.91	4.69	0.00	2.40	1.54
G 1+2	Dec	2	1210	70.82	23.63	0.74	9.45	37.39	19.96	8.24	0.00	0.30	0.30
G 1+2	Feb	11	7441	61.37	79.61	0.00	1.51	9.13	1.27	4.72	0.16	1.26	2.34
G3	Oct	8	4198	61.65	0.22	1.88	12.26	35.78	5.92	21.79	2.85	18.21	1.10
G3	Nov	2	1194	66.48	14.58	0.26	0.00	35.63	6.71	14.48	3.09	24.63	0.74
G3	Jan	2	1363	68.51	59.52	0.00	0.11	5.29	0.34	18.64	0.00	13.32	2.76
G3	Feb	4	2565	55.71	70.87	0.00	5.46	7.38	1.81	8.86	2.07	2.89	0.65
G 4+5	Oct	3	1755	38.95	0.15	0.96	0.00	20.42	0.00	0.00	17.56	59.81	1.10
G 4+5	Nov	3	2081	49.25	3.74	1.57	0.20	30.11	2.89	2.69	6.71	45.22	6.87
G 4+5	Dec	5	2499	47.99	11.62	3.58	3.81	41.67	0.09	2.75	6.69	19.63	10.16
G 4+5	Jan	7	4751	49.27	21.08	1.05	14.60	25.40	5.30	10.06	6.46	12.33	3.72

Table 4.2: Percentages of time spent feeding per food category for each sub group for the months observed.

* October -December were later lumped as the 'dry' period and January and February as 'wet' period. The percentage time feeding in the table is the average amount of time spent feeding on a day, over all observation days of all focal animals from one sub group during that month.

eaten. The rest of the feeding time was divided between the pith of the leaf stem of the palm *B. borneensis* (7.41%), rattan (4.69%), some fruit (2.93%) and termites (2.4%).

Notice that the three food categories (palm pith, rattan and bark), which together in October accounted for 51.2% of their feeding time, were reduced to 17% in November when flowers and young leaves became abundant.

The data for December consist of two observation days from two focal animals (both females from the same age class) which were ranging in the same area. The proportions of time they spent on the various food categories varied a lot (not tested for significance). The time spent feeding on the main categories is shown in table 4.3 for the two orangutans.

December	Fruit	Leaves	Palm pith	Bark	Rattan
Uce (G 1)	37.2 %	9.11 %	13.28 %	38.14 %	2.28 %
Tuti (G 2)	10.1 %	65.68 %	5.62 %	1.78 %	14.2 %

Table 4.3: Percentages time spent feeding on the main food categories for two individuals from group (1+2) in December (n=2 days).

The total amount of time spent feeding varied as well (Uce 82.3% and Tuti 59.3%). Due to the small sample size no conclusions will be drawn for December except that there is quite some inter-individual variation in the time spent feeding on the different food categories and in the activity pattern of the two animals on that day. The orangutans were both travelling solitary on that day.

In February there was a major shift in feeding pattern towards almost exclusive feeding on fruit (79.61%). Time spent feeding on leaves was reduced to 9.13%.

The remainder of time (11.26%) was spent feeding on rattan, palm pith, bark, termites and some miscellaneous items.

Group 3

The data gathered on group 3 came from two focal animals (one female Saryem; one male Enggong, with the female being a bit older). There was quite some inter-individual difference between the two orangutans but only for October has their data been lumped. November and January were observation days on the younger male and February were on the female.

In October group 3 spent most of its' time feeding on leaves (35.78%). On the second place came rattan which accounted for 21.8% of the feeding time.

The young male spent 33.7% of his time feeding on termites compared to 2.7% for the female (average 18.2% in table 4.2). The rest of the feeding time was divided between palm pith (12.26%), bark (5.9%) and bananas (2.85%) which were still provisioned. Fruit and flowers were hardly present in the diet (resp. 0.2% and 1.9%).

In November (n=2 days) leaves were still the main food category with 35.6% feeding time spent on them. Most of the leaves eaten came from strangling figs (*Ficus* spp.) which produced fresh young leaves in October/ November.

Termites came next with one day 44% of time spent feeding on them (average 24.6% for two days). An equal amount of time was spent feeding on fruit and rattan (both on average 14.5%). Further 6.7% of feeding time was spent on bark and 3.1% on bananas.

In January the feeding pattern changed drastically. Time spent feeding on fruit increased to 59.5% and feeding on leaves decreased to 5.3%. Time spent feeding on rattan remained almost the same (18.6%) and 13.3% of time was spent feeding on termites. Time spent feeding on bark, palm pith and bananas decreased to 0.45% combined for the three food categories.

In February feeding time was mainly divided between fruit (70.9%), rattan (8.9%), leaves (7.4%), palm pith (5.5%) and some bark, bananas and termites (6.8%).

Group (4+5)

In October (n=3 days), towards the end of the dry season, group 4 had been in the forest for one month. The first food item the newly released animals learned to eat were termites. Termite mounds on the forest floor were abundant in the release area of group 4. Between 54% and 65% of feeding time was spent on termites that first month. The next thing they learned to eat were young leaves of small understory trees and saplings on which they spent between 0.8 and 28% of feeding time. One orangutan (Smits) spent 10% of the time he was observed feeding on the leaves of an epiphytic tree fern (*Asplenium nidus*, Fam. Polypodiaceae).

In November several new food categories were discovered. Provisioning with bananas was still done but in such amounts that the orangutans were definitely forced to find more food on their own.

One orangutan (Bona) spent 10% of his feeding time on fruit. Between 2 and 21% of feeding time was spent on eating the leaves of the palm *Borassodendron borneensis* .

Several food items which were eaten by a more experienced orangutan (Otong), who was re-released with this group were tried by the newly released animals. Rattan leaf stems and shoots which had been eaten by this orangutan and discarded were later manipulated

and tried by newly released animals. Also the soft underpart of young leaves of the palm *Licula spinosa* were tried in this way. Bark, which was first eaten by the more experienced orangutan, was immediately afterwards tried by Smits who spent 8.7% of his feeding time on this food category. Several small food items were tried as well like the ant *Campanotus gigas*, an unidentified fungus, and cobwebs which were scraped from under a leaf with the lips. Most time was still spent feeding on termites (average 45.2%).

The feeding data for December for group (4+5) consists only of individuals which had just been released in the fifth group. Group 5 was released at the same site where group 2 had been released in February 1993. In December the rain period had just started and several trees were starting to bear fruit.

Time spent feeding on fruit ranged between 0 and 18%. Flowers made up between 0 and 7.5% of the feeding time.

The leaf stem and leaves of the palm *B.borneensis* were tried by several orangutans in low quantities. Most time was spent feeding on leaves (between 3% and 60%) and termites (between 3% and 39%). Rattan was also tried by four of the five focal animals (between 0 and 9% of feeding time).

Observations for January are made on one orangutan from group 4 (Smits), and two orangutans released in the fifth group.

Smits' diet constituted mainly of termites (24%), fruit (22.6%), bark (18.4%), rattan (11.2%), leaves (11.1%) and bananas (7.9%).

Individuals from group 5 (Semoi and Paul) spent their feeding time on fruit (20.5%), the leaf stem and leaves of the *B.borneensis* palm (resp. 20.4% and 25.3%), leaves (5.8%), rattan (9.6%), termites (7.6%) and bananas (5.9%).

4.4 *Discussion*

Orangutan from the first three release groups spent a considerable amount of time during some months in the dry period (Oct-Dec) feeding on the palm *B.borneensis*. Leighton (1983) reports that when fruit becomes scarce orangutans may take refuge in areas with high densities of the palm *B.borneensis* and that during lean fruit periods the exploitation of this palm increased in the Kutai area (East Kalimantan). The palm *B.borneensis* was found in most areas of the forest (pers. obs.) but unfortunately no density figures were gathered.

The time spent feeding on fruit in October and November for group 1-3 was quite low when compared to time spent by wild orangutans on this food category. Galdikas (1988) reported that even during the period of least fruit availability (August 1973) the orangutans in Tanjung Puting still spent 16% of their foraging time on fruit. Davenport (1967), who

studied orangutans in Sabah during a dry period, reports that in ± 90% of the observed instances of feeding the animals fed on leaves and shoots but he gives no figure for the minimal fruit intake.

In November individuals from group (1+2) spent more than 50% of their feeding time on flowers. Galdikas (1988) mentions that flowers are not significant sources of food and that they are more seasonal than either leaves or fruit but in February 1975 they accounted for 41% of the feeding time in Tanjung Puting.

Group 3, on average, spent a lot of time feeding on termites especially when compared to group (1+2). In the wild, orangutans have also been also observed feeding on termites but never in such quantities. Galdikas (1988) reports that termite eating represented 4% of the average foraging time in Tanjung Puting. Adult males, which spend more time on the ground due to their large body size, could spend 10% or more of their foraging time on termites (mostly on the ground). Rijksen (1978) reported that orangutans spend 14% of their feeding time 'in search for insects'.

Time spent at different heights linked with time spent feeding on different food categories will be discussed in Chapter 5.

The time spent feeding on rattan (several species) was also high during some months in the dry period. On some days in October, 35% of feeding time was spent on rattan by group 3. Galdikas (1988) includes rattan in the category 'other foods' which accounted together with all other items in this category for about 4% of foraging time. She reports that the 'bases of young rattan shoots' were eaten. During this study most orangutans that were observed feeding on rattan consumed the soft inner core of the stem which could have a diameter of 5 cm. They also fed on the bases of the leaf stems but most time was spent feeding on the inner core. This could account for some extent to the large amount of time spent feeding on this food category. To open the stem of a large rattan in order to reach the soft inner core was quite a precarious job because of the thorns which protect the plant. (Detailed description of handling of several main food items is discussed in § 4.6).

Sugardjito (1986) reports that when there is a decrease in fruit (non-fig) availability orangutans make up for this by spending more time eating leaves. The same rough pattern was observed during this study for the groups 1-3 and is shown in fig. 4.1.

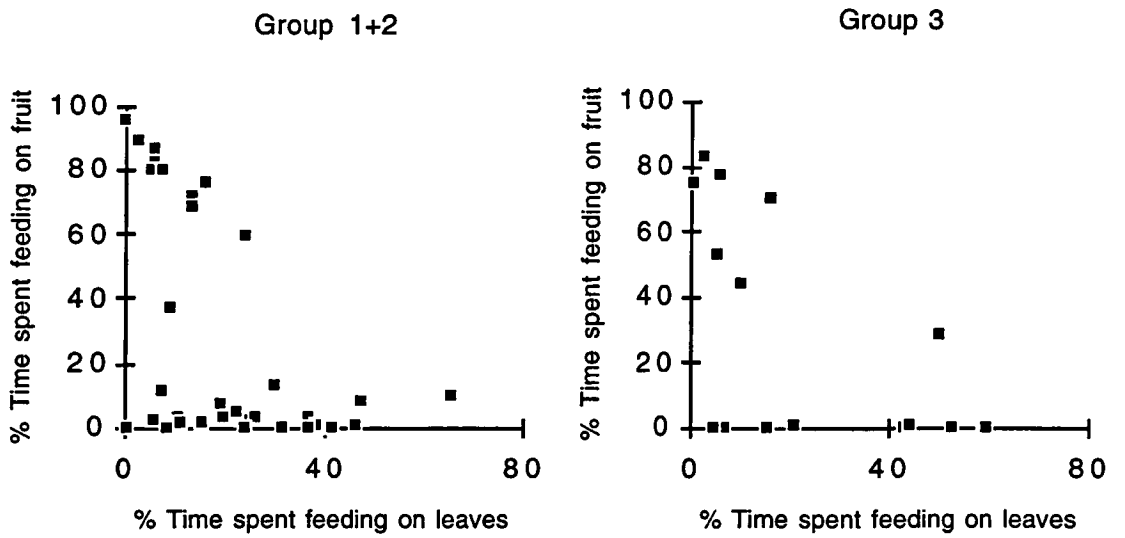


Fig. 4.1: Percentage time spent feeding on leaves and fruit for group 1+2 (n=34 days) and group 3 (n= 16 days).

4.5 *Differences between the Dry and Wet Periods in Feeding Pattern*

4.5.1 *Methods*

In order to compare the feeding pattern between the dry and wet period within one group and between the groups all feeding data of the dry period (October-December) and the wet period (January-February) were lumped for the three sub groups.

I will emphasize here on the differences between group (1+2) and group 3 as they have spent a reasonable amount of time in the forest. The differences between the dry and wet period in feeding pattern for group (4+5) will also be discussed.

4.5.2 *Results*

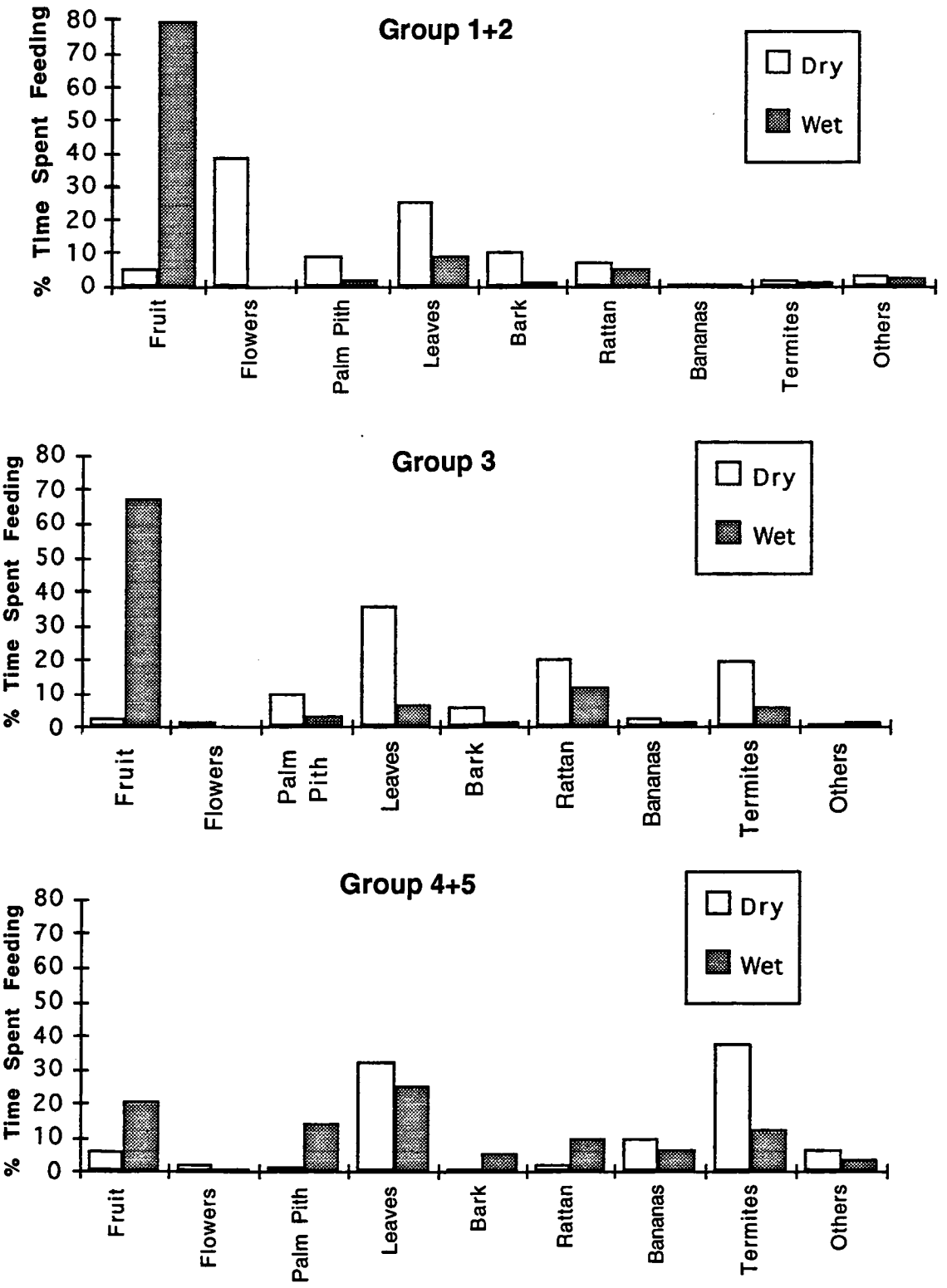


Fig. 4.2: Percentages time spent feeding on the main food categories for the three sub

groups during the dry and the wet period.

Firstly the dry and wet periods for each group were compared for differences in time spent feeding on the different food categories using the Mann-Whitney U test (corrected for ties). The results are presented in table 4.4.

	Group (1+2) Dry:n_1=23/Wet:n_2=11	Group 3 Dry:n_1=10/Wet:n_2=6	Group (4+5) Dry:n_1=11/Wet:n_2=7
Fruit	Z=-4.664**(W>D)	Z=-3.341**(W>D)	Z=-2.586**(W>D)
Flowers	Z=-4.198**(D>W)	Z=-1.432 ns	Z=-1.887 ns
Palm pith	Z=-1.057 ns	Z=-1.311 ns	Z=-1.848 ns
Leaves	Z=-3.037**(D>W)	Z=-2.495*(D>W)	Z=-2.672**(D>W)
Bark	Z=-2.576*(D>W)	Z=-1.274 ns	Z=-1.203 ns
Rattan	Z=-0.258 ns	Z=-1.627 ns	Z=-3.066**(W>D)
Termites	Z=-1.223 ns	Z=-0.881 ns	Z=-2.4*(D>W)

Table 4.4: Mann-Whitney U test. Z values for comparison between Dry and Wet period for food categories eaten by each sub group.

** = P< 0.01, * = P< 0.05, ns= not significant. (D>W) significantly more time spent on the food category during the dry period than during the wet period. (W>D) more time spent feeding on the food category during the wet period.

Group (1+2) spent significantly more time during the dry period feeding on flowers, bark and leaves than in the wet period. During the wet period significantly more time was spent feeding on fruit. The other food categories did not show a significant difference.

Group 3 spent more time feeding on leaves during the dry period, and more time on fruit during the wet period. Non of the other food categories differ significantly from each other.

Group (4+5) spent more time feeding on leaves and termites during the dry period than during the wet period, and during the wet period more time was spent on fruit and rattan than in the dry period.

Next group (1+2) and group 3 were compared for the dry period and for the wet period for time spent feeding on the different food categories again using the Mann-Whitney U test (corrected for ties). The results are shown in table 4.5.

	DRY n_1=23; n_2=10	WET n_1=11; n_2=6
Fruit	Z=-2.155* (G(1+2)>G3)	Z=-1.709 ns
Flowers	Z=-3.635** (G(1+2)>G3)	X
Palm pith	Z=-0.978 ns	Z=-0.955 ns
Leaves	Z=-1.332 ns	Z=-0.905 ns
Bark	Z=-0.755 ns	X
Rattan	Z=-3.411** (G3>G(1+2))	Z=-1.609 ns
Termites	Z=-2.142* (G3>G(1+2))	Z=-0.809 ns
Bananas	Z=-3.178** (G3>G(1+2))	X

Table 4.5: Mann-Whitney U test. Z values for comparison between group (1+2) and group 3 for the Dry and Wet periods for food categories eaten.

n_1= Group (1+2); n_2= Group 3. * = P< 0.05, ** = P< 0.01, X= hardly eaten, ns= not significant.

Group (1+2) spent significantly more time feeding on fruit and flowers than group 3 during the dry period. Group 3, on the other hand spent significantly more time feeding on rattan, termites and bananas during the dry period.

For the wet period no significant differences between the two sub groups in time spent feeding on the different food categories was found.

4.5.3 *Discussion*

When looking at the feeding pattern of group (1+2) during the different months, and the distinction between the dry and the wet period it seems that they have developed quite an opportunistic diet.

When preferred food items (fruit) were scarce they concentrated on permanent food sources such as leaves, bark, rattan and palm pith. But as soon as more preferred and seasonal items were to be found they immediately switched their diet to those items (at first flowers and young leaves, later fruit), still supplementing with permanent food sources but spending considerably less time on these items.

When fruit became plentiful they almost exclusively fed on this nutritious food source as was also found by Leighton (1993). The permanent food sources were still eaten but in low quantities.

This feeding pattern seems to be quite similar to that reported from some study sites for wild orangutans (Galdikas 1988; Leighton 1993; MacKinnon 1974).

The fact that they fed very little on fruit during the dry period could be caused by several factors. Unfortunately no phenological data was gathered to support the assumption that

very little fruit was available during the dry period. The dry period in 1994 was a very long and harsh one, with hardly any rain in July-September and forest fires.

Another explanation could be that the orangutans had more difficulty finding fruit when it was scarce as they might not yet have developed good knowledge of the distribution of potential fruit trees which could offer fruit even in the lean periods.

The feeding pattern for group 3 looks very similar to that of group (1+2) during the wet period but during the dry period they concentrated more on other food categories. They spent much more time feeding on termites and rattan when preferred food items were not available, compared to group (1+2). They also fed less on fruit and flowers during the dry period. This could imply that members of the first two groups were better able to locate such seasonal items when they were rare than individuals from group 3.

They also tended to feed more on permanent food items (rattan, palm pith and bark) even when fruit was abundant (17.1% compared to 7.5% of group (1+2)) during the wet period (not significant).

During the dry period the two observed individuals from group 3 were both still occasionally feeding on bananas near their release site. It must be mentioned that these were the only two orangutans from group 3 that were observed near the release site 9 months after release. None of the other released orangutans from group 3 was seen on a regular basis near the release site.

When looking at the feeding pattern of groups 4 and 5 there seems to be a large difference between these two groups in the first month after release.

Group 4 mostly fed on termites and leaves, while individuals from group 5 fed on a large variety of food items the first month after release. This distinction could be caused by several factors. In the first place group 4 was released in the midst of the dry season when preferred food (fruit) was scarce. Permanent food sources were available but most of them needed some handling before they could be consumed. Probably because food was scarce the orangutans immediately dispersed away from the release site and only three individuals remained near the site.

Group 5 was released at the beginning of the wet season when more food items were available and in an area where other groups had been released previously. This could mean that they had more 'role models' around from whom they could learn which food items were edible and how to handle them.

When comparing the feeding pattern of group (4+5) during the wet season with the other groups there is a large difference. The newly released orangutans fed on the same

food categories but divided their time more equally between these categories. Even when fruit was more abundant they only spent on average 21.1% of their feeding time on this category compared to almost 80% feeding time spent on this food category by group (1+2).

When looking at the amount of time spent feeding on termites between the different groups there is a major difference. This could be partially explained by the fact that newly released orangutans spent a substantial amount of their time on the forest floor where also many large termite mounds were to be found. Termites were an easily accessible protein source and the newly released animals probably had little knowledge about other edible food items. Individuals from groups (1+2) spent very little time on the forest floor and fed very little on termites. They occasionally fed on termites found on the forest floor but usually termites or ants were located in the trees. Orangutans with more forest experience had found other food sources which could probably better meet their daily requirements.

4.6 *Food Handling*

Leaves and Leaf Shoots

Feeding on leaves from trees and vines needed little preparation or handling. The orangutans mostly removed young leaves immediately with their lips or incisors or when eating larger leaves they first ripped them off, or pieces of the leaf, with their hands and then ate them. The leaves of *Dischidia* and *Hoya* sp. (fam. Asclepidiaceae) were usually chewed and the fibres were discarded.

When feeding on the leaves of the palm *B.borneensis* they usually ripped off pieces of the leaf, while suspended on a tree nearby to reach them, and then ate them without discarding any part of the leaf.

Feeding on the inner core of the leaf stem of this palm required more skill. In the first place the leaf was pulled down so as to reach the middle part of the stem. Then the stem would be split open with the incisors until a large enough hole was made so that either it could be split open with the hands by stronger orangutans or sometimes it would be pushed open by smaller animals by inserting their hind legs into the split. Then strips of the inner core of the leaf stem would be pulled loose either with their teeth or manually. Such a strip was then put into the mouth by bending it in a zig-zagging manner and then the whole strip would be chewed for several minutes until a wadge of fibres was spat out and a new strip would be pulled loose again. Quite often the orangutan would be sitting on the bottom part of the inner leaf stem that was split open. Feeding bouts on this palm during the dry period sometimes lasted several hours.

Rodman (1977, 1988) also reports that orangutans were observed feeding on the palm *B.borneensis* but on the immature leaves which were pulled from the plant's centre. It was only once observed during this study that an orangutan fed on the base of a young leaf which was pulled out from the middle of this palm. Leighton (1983) also reported that orangutans increased the exploitation of the 'leaf base' of *B.borneensis* during fruiting lows.

The bases of the young leaf shoots of the palm *Licula spinosa* were eaten by some orangutans but others were never observed feeding on it, even in areas where the palm was abundant (pers. obs.). The young unopened leaves of this palm grow out of the middle of the base, and quite some strength was needed to pull them out. The orangutans would either stand bipedally on the ground and pull with both hands or hang from a nearby treelet and pull from above, sometimes standing with their hind legs on the mature leaves. When a leaf was secured, the soft base of the leaf was chewed off and the rest was thrown away.

Leaves of the epiphytic tree fern *Asplenium nidus* (fam. Polypodiaceae) were sometimes eaten in large quantities. Usually the orangutan would be seated or lying on top of the tree fern and either feeding on a leaf which was still attached to the base, ripping off pieces of the leaf or the ape would pull out a leaf and eat around the middle nerve.

The soft bases of large pandanus leaves were eaten occasionally. The orangutan would pull out one leaf, chew on the soft white base and discard the rest of the leaf.

Rattan

Several species of rattan palm were observed being eaten during this study. Occasionally the leaves were eaten and the soft underparts of a leaf stem, which would be pulled off the main stem. More often orangutans fed on the soft white inner core of the stem of the rattan palm which needed quite some handling because of the protective spines of the plant. Usually the orangutan would be suspended from a treelet or liana nearby. Then several leaves near the stem would be pulled back so that a part of the stem, without spines, could be reached. Breaking back the leaves often caused the stem to split open a bit. Then the orangutan would open the stem with its teeth until the soft inner core could be reached. Sometimes blood could be found on the rattan plant after such a feeding bout.

Bark

To obtain the inner layer of bark the orangutans would usually hold on tightly to the tree and, while holding the head bent, they would bite vertically down the trunk until a strip

was loosened which could then be taken off. Sometimes just an incision was made with the teeth and a piece of bark was then ripped off with the hands. Depending on which tree species, they would then scrape off the inner cambium layer with the teeth, chew on the wadge and either swallow it or discard the fibres. Sometimes the bark was taken off in order to reach the inner growth layers of the tree stem. These layers were then scraped of with the teeth.

Most trees from which the bark was eaten had a lot of latex. Sometimes the orangutans were only after the sap and then they would brake off a small branch and lick the sap from the wound. Once it was observed that an orangutan bit vertically down a trunk and then licked the sap which was dripping from the line of wounds it had made. One orangutan was observed feeding on the bark of the aerial roots of a strangling fig species.

Fruit and Flowers

Considerable time was spent feeding on the flowers and fruit of *Madhuca* sp.(fam. Sapotaceae). Usually the flowers were taken directly from the stem with their mouth or with their fingers. Usually the whole flower buds were eaten but it was also observed that an orangutan squeezed the contents out of the bud and discarded the bud covers.

Two orangutans from group 1 and 3, when observed feeding on the fruit of *Ficus lowii*, selected for the ripest fruit. They consumed the fruit by either bending (and often breaking) the branches towards them and directly handling them with their lips or fingers. Several unidentified fruit species were tried before they were ripe but they were not eaten in large quantities.

Once it was observed that an orangutan tried some small fruits but spat them out and did not try anymore of them. On another occasion a newly released orangutan found some large fruits from a Leguminous plant (unidentified) on the forest floor. He ate the seeds of one but left the rest and moved on.

Termites and Ants

Termites were quite abundant in most higher elevated parts of the forest. Not much time was spent searching for these termite mounds, which were mostly found on the forest floor. Newly released orangutans would usually just sit on the forest floor and break off a piece of the mound. Then they would rapidly suck out the termites. They would often bite pieces off the chunk of mound they kept in their hands in order to get access to new channels. Sometimes they would turn over logs to find some termite infested wood and

they were also observed digging up mounds which were placed under the ground. Once an orangutan was observed scraping off layers of a termite 'mound' plastered on a tree trunk with her nails, she then quickly sucked the termites from the tree trunk.

On one occasions an orangutan was seen eating a part of a root bulb from a *Hydnophytum* plant which was infested with ants. Only once was it observed that an orangutan ate a large ground living ant *Campanotus gigas.*

Miscellaneous Food Items

On a few occasions orangutans (from all release groups) were observed feeding on small quantities of very fine soil. One time an orangutan deliberately descended from a tree to a patch of uprooted soil, he ate a small amount of it and then climbed up a tree and resumed travelling.

Once it was observed that an orangutan climbed very high up into a tree and found a bee nest. She disrupted the nest and fed for a short while on the honey before she fled from the bees. On another occasion an orangutan from group 3 found an old honey comb high up in a tree. He took several pieces in his mouth and chewed on them for a while before he discarded a wadge of wax.

Drinking of water was observed a few times. Once an orangutan drank from a stream. On another occasion an orangutan was observed drinking from a hole in a tree, scooping out the water with her hand.

CHAPTER 5 : VERTICAL RANGING PATTERNS

5.1 *Introduction*

Orangutans in the wild spend most of their time in the middle and upper canopy of the forest although there are differences in strata use between and within the different age-sex classes (Sugardjito 1986).

MacKinnon (1974) reported that 95% of food items eaten by orangutans were collected from the middle and upper canopy. Galdikas (1988) also reported that, with the exception of termites and ground plants, almost all food sources were found in the canopy. Rijksen (1978) states that 'esteemed' fruits occur in large proportion in the two highest strata (10-45 metres) and that 'less important' food species are found in the lowest storey (0-10 metres).

Several other aspects might play a role in the differential use of forest strata as predation pressure (van Schaik et al. 1983), body size (Sugardjito 1986) and different nutritional requirements (Gautier-Hion 1980).

In Kalimantan there are two predatory animals which could be of danger for juvenile/ adolescent orangutans, the clouded leopard (*Neofelis nebulosa*) and the bearded pig (*Sus barbatus*). Galdikas (1988) reported that wild pigs have killed and eaten several infant and juvenile rehabilitant orangutans, which were moving on the ground. Rijksen (1978) reported that a clouded leopard had killed seven juvenile rehabilitant orangutans and injured several adolescents. Horr (1977) also states that the clouded leopard could be a threat to 'independent and unwary juveniles'.

Galdikas (1988) reported from Tanjung Puting that adult male orangutans tend to spend quite some of their moving time (sometimes up to 40%) on the forest floor, while adult females hardly ever descended to the ground. Sugardjito (1986) observed that the more vulnerable classes (e.g. adolescents) both travelled and rested high (± 20 m.).

Several researchers have reported a difference in diet between the sexes (Rodman 1977; Sugardjito 1986) but this could not explain for the difference in travel heights according to Sugardjito (1986).

5.2 *Methods*

At every minute scan the height of the orangutans position in the canopy was recorded. This was estimated by eye and classified into seven categories of five metres (0= ground, 1= 1-5 metres, 2= 6-10 metres etc.). For analysis several height categories were lumped so

that four main categories remained (ground, 1-10 metres (low), 11-25 metres (middle) and 26 metres and above (high)). These four categories were chosen as the division of food items eaten by orangutans has also roughly been categorised in these storey heights (Rijksen 1978). The ground category was added as the newly released animals spend a considerable amount of time there.

5.3 *Results*

5.3.1 *Usage of Height Categories*

Firstly overall (Oct-Feb) percentages of time spent at the different heights were calculated for the three sub groups. The results are shown in fig. 5.1.

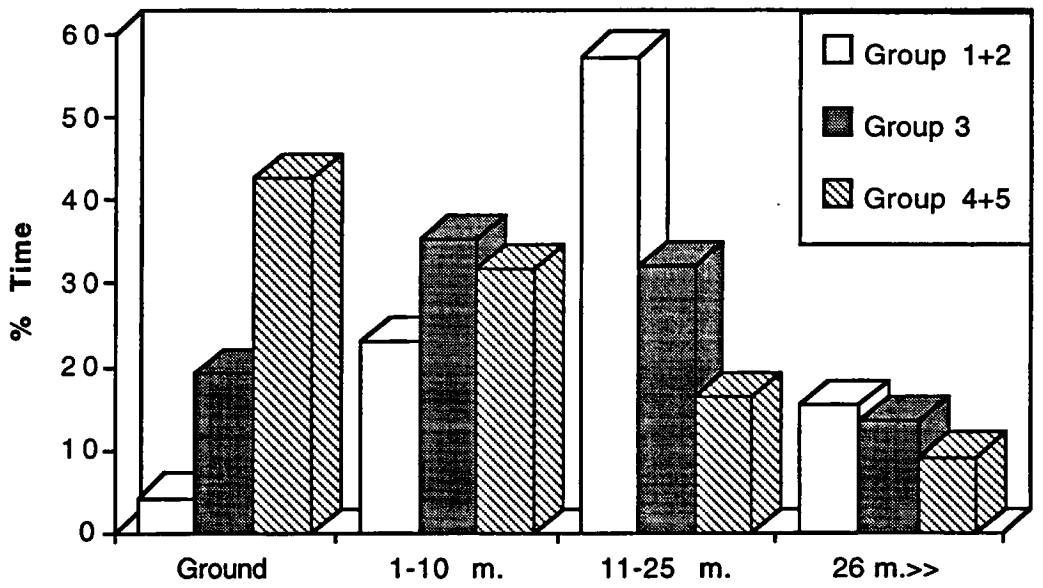


Fig. 5.1: Percentages of time spent at different height categories for the three sub groups. Group (4+5) most recent release groups.

The time spent at the different height categories was compared for each (sub) group with the Wilcoxon-Signed Ranks test (table 5.1).

Heights	Group 1+2 n=34	Group 3 n=16	Group 4+5 n=18
Ground vs. 1-10 m.	Z=-5.086**	Z=-2.327*	Z=-1.633 ns
1-10 m. vs. 11-25 m.	Z=-4.385**	Z=-0.103 ns	Z=-3.027**
11-25 m. vs. 26 m.>>	Z=-4.813**	Z=-2.741**	Z=-2.012*

Table 5.1: Wilcoxon-Signed Ranks test. Z values for comparison between different height categories.

* = P< 0.05, ** = P< 0.01, ns = not significant.

Group (1+2) spent most of its time (57.3%) in the middle canopy (11-25 metres) whereas individuals from group (4+5) tended to spend most of their time on the ground (42.8%) and in the lower (1-10 metres) canopy (31.8%). Group 3 spent most of its time in the lower canopy (54.6%) of which a considerable percentage was spent on the forest floor (19.3%).

Then the different amounts of time spent at each category between the groups was compared with the Mann-Whitney U test (table 5.2).

	Ground	1-10 m. Low	11-25 m. Middle	26 m. >> High
G(1+2)-G 3	Z=-2.596* (G 3 > G (1+2))	Z=-2.787* (G 3 > G (1+2))	Z=-3.785* (G (1+2) > G 3)	Z=-0.61 ns
G 3-G(4+5)	Z=-2.899* (G (4+5)> G 3)	Z=-0.897 ns	Z=-2.588* (G 3 > G (4+5))	Z=-0.537 ns

Table 5.2: Mann-Whitney U test. Z values for comparison of time spent at each category between the groups.

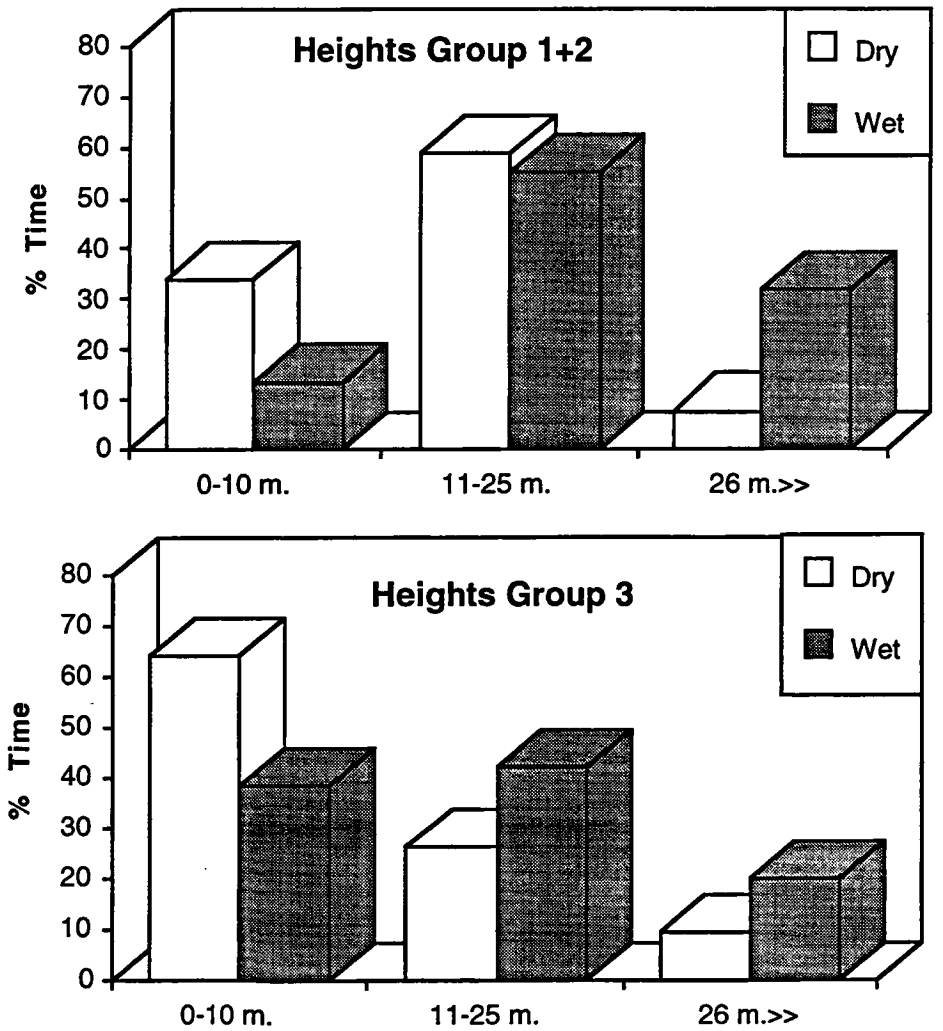
* = P< 0.01, ns = not significant.

Group 3 spent significantly more time on the forest floor than group (1+2) but significantly less so than group (4+5) and vice versa for the middle canopy where group 3 spent less time than group (1+2) but significantly more than group (4+5).

The longer established groups (group (1+2)) spent significantly less time on the forest floor and significantly more time higher in the trees than the later released groups. The same significant difference was found when group 3 was compared to the even later reintroduced orangutans (group (4+5)).

5.3.2 *Differences in the use of Heights between the Dry and Wet Periods*

In order to see if there was different use of the forest strata for the three sub groups between the dry and wet periods, the data of the heights for the dry period (Oct-Dec) and the wet period (Jan-Feb) were lumped. The percentages of time spent at each height category during the dry and wet periods were calculated for each sub group and are given in fig. 5.2. Time spent on the forest floor is included in the lowest storey (0-10 m.).



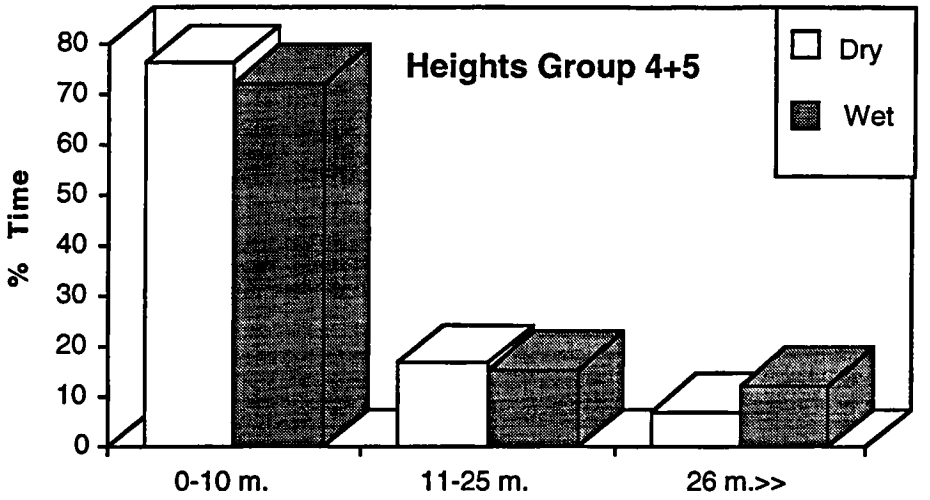


Fig. 5.2: Percentages time spent at different height categories during the dry and wet periods for the three sub groups.

Differences in the use of strata between the dry and wet periods were tested with the Mann-Whitney U test (table 5.3).

Heights	Group 1+2 Dry: n_1=23 Wet: n_2=11	Group 3 Dry: n_1=10 Wet: n_2=6	Group 4+5 Dry: n_1=11 Wet: n_2=7
(low) 0-10 m.	Z=-2.558* (D>W)	Z=-1.968* (D>W)	Z=-0.408 ns
(middle) 11-25 m.	Z=-0.534 ns	Z=-1.519 ns	Z=-0.136 ns
(high) 26 m. >>	Z=-3.736** (W>D)	Z=-0.891 ns	Z=-0.711 ns

Table 5.3: Mann-Whitney U test. Z values for comparison of time spent at different height categories between the dry and wet periods for each sub group.

* = P<0.05, ** = P<0.01, ns = not significant.

Group (1+2) spent significantly more time in the lowest storey (0-10 metres) during the dry period than in the wet period, and more time in the highest strata during the wet period than during the dry period.

Group 3 also spent significantly more time in the lowest storey during the dry period. They tended to spend more time during the wet period in the middle as well as in the highest storey although no significant difference was found for the usage of these height categories between the dry and wet periods.

For the newly released animals there was no difference between the dry and wet periods in the use of heights. They spent most of their time in the lowest storey in both periods.

5.4 *Discussion*

There seems to be a distinct difference in the use of forest strata between the different release groups. Orangutans from group (1+2), which have spent the longest time in the forest, tend to spend the majority of their day time in the middle canopy (11-25 metres). This corresponds to the use of heights reported for wild orangutans by several researchers (MacKinnon 1974; Rijksen 1978; Sugardjito 1986). They show a significant difference in the use of the low and high strata between the dry and the wet periods. They spent more time during the dry period in the lowest strata, and during the wet period they spent more time in the highest storey.

When looking at the food availability during the dry and wet period (see Chapter 4) the change in strata use for group (1+2) seems to be according to what one would expect. In the dry period the orangutans spent more time in the lowest strata where several of the permanent food items (e.g. rattan, palm pith) were to be found. During the wet period group (1+2) spent more time in the highest storey where most fruit is found.

Group 3 shows similarities to the pattern found for group (1+2) but they still spent most of their time in the lowest storey, especially during the dry period. The fact that they did so more than group (1+2) could be partially explained when looking at their feeding pattern during the dry period. They spent half of their feeding time on rattan, palm pith and termites from mounds found on the forest floor. During the wet period they also made a shift towards spending more time in the higher strata although this change was not significant.

Group (4+5) shows no difference in the use of strata for the dry or wet period. They spent most of their time in the lower storey during both periods.

The risks of predation thus seem to be the highest for the newly released animals and one orangutan from the first release group has supposedly been eaten partly by a bearded pig after he got injured when he fell from a tree, three months after release.

Nine months after release the members of group 3 already show distinct differences when compared to the last two release groups (newly released animals) but also with the orangutans from the first two release groups.

The difference in strata use can also be seen in the differences in feeding pattern between the groups. It seems logical that the orangutans would feed more on food items found in the storey where they tend to spent most of their time (see Chapter 4: group (4+5) spent

much more time feeding on termites for example) but the nutritional requirements are the same for all release groups as the orangutans are all in the same age category, and thus a shift towards a more arboreal life is necessary to meet the feeding standards observed for wild orangutans.

The climbing/ locomotor skills of the newly released animals still have to develop. Most of the newly released orangutans did not seem to be afraid of heights but due to the lack of experience with the characteristics and strength of branches some of them have been observed to fall down occasionally from the trees and two orangutans got injured in the process. Hence some animals might feel more secure in the lower storey.

The orangutans from the last group (5) were released in the beginning of the fruit season as opposed to group 4 who was released in the dry season. The height data from two orangutans (one from group 4 and one from group 5) for the first two months after release were tested for differences with the Mann-Whitney U test. The orangutan from group 5 spent significantly more time in the high canopy (26 m.>>) ($Z=-2.249$; $P< 0.05$; $n_1= 3$, $n_2= 5$ (days)) than the orangutan from group 4. No significant difference was found for the other height categories.

It could be that when the orangutans are released in the wet period, when fruit is more abundant, they will be more encouraged to learn that esteemed food items are to be found in the higher canopy. For group 4, which was released in the midst of the dry period, there seemed to be less motivation for some animals to use the higher strata in the first months after release.

CHAPTER 6: SOCIAL BEHAVIOUR

6.1 *Introduction*

The population structure of wild orangutans usually consists of solitary adult males, lone adult females accompanied by one or two dependant offspring and independent immatures (Galdikas 1978; Horr 1975, 1977; MacKinnon 1974; Rijksen 1978; Rodman 1973).

Sugardjito (1986) reports that during periods of food abundance the sociality of orangutans increases and a high occurrence of groups and travel bands was to be found during that period. When fruit was scarce the orangutans usually avoided each other in order to escape food competition.

Sometimes long lasting consortships can be formed between two animals for breeding purposes (MacKinnon 1974; Rijksen 1978; Schürmann 1982). But the most stable relationship is that between a mother and her still-dependent offspring (Galdikas 1978; Horr 1977; MacKinnon 1974). As adult animals lead a rather semi-solitary life, a young orangutan needs to learn a lot from the encounters his mother has during the years they travel together (Horr 1977).

When an adolescent orangutan starts to live independently of his mother he enters a period in the wild orangutans' life that seems to be the most socially oriented. In the wild associations of young orangutans were often seen (Galdikas 1978, 1985; Rijksen 1975, 1978). Rijksen (1975) reports that of all observations, adolescents were seen in 'real' social groups in 33% of the time (consisting of animals moving about together and showing coordinated movements) and in another 35% of the time in temporary associations (animals feeding in the same tree but, but splitting up again into independent units after feeding). Rijksen also mentions that during this relatively social phase the adolescents and subadults seem to establish relations of dominance. Sugardjito (1986) also suggests that the development of social skills would be an important aspect of grouping in adolescents and that grouping allows observational learning of 'adaptive solutions to ecological problems'. Horr (1977) states that social experience is critical to the developmental process and that the input from conspecifics could be very important for survival. Galdikas (1985) reports that adolescent females were the most social, spending most of their social time with other adolescent females. She also mentions that peer relationships were very important and that these were strongest when the age differences were the least.

The effect of grouping on the activity budgets of wild orangutans has been discussed by several researchers. Horr (1975) and MacKinnon (1974) state that 'group living'

orangutans would have to travel more, over longer distances and would have to visit more food sources than a lone individual. Galdikas (1988) found that orangutans, when in association, tended to show an increase in the use of day length, day range and time spent moving. Resting time usually increased while foraging time decreased. She also states that the effect is dependent on the age and sex of the individuals. Most of her findings were based on associations between adult male and female orangutans. Mitani (1989) found that the activity budgets of two subadult males, when in association with adult females did not differ compared to when they were alone. For one adult male his activity budget did change when he associated with a female. His travel time increased while resting time decreased. The feeding activity remained the same.

The orangutans brought to the Wanariset station have varying backgrounds. Some have lived for several years imprisoned in small cages, while having had contact only with their human keepers. Others had been brought to the station still as infants and some orangutans were only recently taken from the forest.

Most orangutans arriving at the station had an incomplete 'upbringing' from their mother and siblings. The socialization period at the station is therefore meant at least to stimulate social integration with other conspecifics and to stimulate the learning process by imitation and play. Freeman and Alcock (1974) mention that play might have some adaptive significance for orangutans, especially such playbouts which feature climbing and swinging. Social bonds between the animals are hopefully created and a dominance pattern is developed. This is also meant to relieve some of the stress after release so that the animals can concentrate more on gaining knowledge about the habitat and learning other necessary survival skills.

The orangutans that were released together in a group had spent varying amounts of time together in socialization at the Wanariset station. No exact data are available on the social relationships that were developed there from the first three release groups. Observations were made on the fourth group by Dr. Anne Russon and technicians. She wrote a report with recommendations on the group structure and on individuals who seemed fit for release based on these findings.

6.2 *Methods*

One of the questions asked during this study was how the groups of reintroduced orangutans would disperse after release and how their social structure would develop.

For this end all social interactions were described in detail, and if another orangutan was in the proximity of the focal animal this was recorded as was the distance between the

animals. This was estimated and noted in three categories of less than one metre (within arms length), between one and ten metres and more than 10 metres and still visible to us. If the orangutans were interacting, this would be recorded in more detail and the kind of behaviour described (e.g. play, sexual, food sharing/ begging). Such interactions will be referred to as 'active social' whereas time spent in each others proximity but without active physical contact as 'passive social'.

Most of the reintroduced orangutans were from the same age category and as it was known in which group they had been released it was possible to discriminate between new 'bonds', created after release in the forest, or old 'ties' between animals from the same release group.

6.3 *Results*

6.3.1 *Time Spent in Association and Distances*

In the first place the total amount of time spent in proximity of other orangutans was calculated, based on observations of the focal animals for each sub group, for all observation days (table 6.1).

	% Time spent *not* alone	<1 m.	1<10 m.	>10 m.
Group 1+2	46.26	12.00 (2.97)	55.98	32.02
Group 3	46.42	27.58 (13.41)	45.17	27.25
Group 4+5	45.96	11.00 (3.77)	48.77	40.23

Table 6.1: Percentages time spent in association and distances from the focal animal specified in three distance categories.

The numbers given in brackets under the category <1 m. is the percentage of this time spent 'active' social, the rest of the time was spent 'passive' social.

The total amount of time that the focal animals from each sub group were not alone, was almost the same for the three sub groups. But when looking at the division of this social time over all observations, three female orangutans from group (1+2) had all of their social days during the wet period when food was abundant.

The subadult male from group 1 spent all of his observation days, both during the dry and wet periods, with other orangutans in the proximity. For the other groups the 'social' time was constant during the whole observation period.

It also appears, when looking at the data, that the associations of the orangutans from the first two release groups usually lasted for the whole day or even for several days on end during which they fed and travelled together. This could also be due to the fact that the observations on their social days were during periods of relative food abundance and because the subadult male formed 'consorts' with one female for several days on end.

6.3.2 *Social Encounters between Orangutans from Different Groups*

The first three release sites were situated relatively close to each other (see fig. 2.1 with the map of Sungai Wain). Thus the possibility existed that individuals from the different groups would meet each other. In table 6.2 all social encounters (temporary associations and prolonged groupings) observed during this study between focal orangutans are listed. Additionally encounters observed on days when no data was being gathered are also listed.

	Group 1			Group 2			Group 3		Group 4				Group 5						
	Cha	Uce	Sri	Tut	Ben	Wil	Sar	Eng	Ot	Bo	Sm	Sha	Beb	Pau	Se	Lud	Ra	Ba	Dai
Charlie	X	*1		*1	◊1		•6	◊2					◊1	◊1	◊2	◊1	◊1		*1
Uce		X	•1	•5	*1														
Sri			X	•2															
Tuti				X															
Bento					X		◊1	•6											
Willie						X								◊1					
Saryem							X	*2							•2				
Enggong								X								◊1	◊1		
Otong									X	•1	•7	◊7							
Bona										X	•1	◊1							
Smits											X	◊4							
Shawban												X							
Beben													X				◊1	◊1	
Paul														X	◊1		◊1		
Semoi															X				
Ludah																X			
Ramon																	X	◊1	◊1
Bawdi																		X	
Daidai																			X

Table 6.2: Encounters between individual orangutans.

* = Seen together but not on an 'observation day'. • = Two animals observed travelling together for the whole day. ◊ = Encounter observed between the two animals but just for a brief period of time on a day (temporary association). The numbers behind the symbols are the number of days the animals were seen together or the number of times an encounter was observed.

These associations were not tested for differences because a significant difference would not allow a conclusion for the preference of certain individuals. The reason for this is that the distribution in space was not 'random'. Group 4 was released further away from the three other release sites and until now they were only seen together with individuals released in the same group. Most focal orangutans from group 1, 2, 3 and 5 were seen together with animals released in other groups.

The largest association observed, apart from aggregations at release sites, consisted of 3 animals that were travelling together. Mostly the orangutans were seen in pairs when in association. Some animals showed a clear preference for each others company.

6.3.3 *Effects of Grouping on the Activity Budgets*

For three orangutans the activity budgets between a 'social' day and a 'solitary' day, during the same week, were compared. The percentages of time spent on the different activities during the 'social' and solitary days are given in table 6.3.

	Date	Min. Obs.	Soc.	Resting	Loc./ Travel	Feeding	Socially Active
Enggong (Group 3)	6-Nov	413	Yes	6.54	14.29	70.22	7.99
	5-Nov	404	No	17.82	16.09	66.09	0.00
Saryem (Group 3)	26-Oct	580	Yes	8.62	9.14	77.59	2.07
	27-Oct	630	No	26.19	9.21	61.75	0.00
Saryem (Group 3)	6-Feb	600	Yes	17.00	17.67	57.50	5.83
	9-Feb	540	No	24.81	13.52	57.22	0.00
Semoi (Group 5)	1-Feb	780	Yes	24.10	13.08	46.41	5.64
	28-Jan	780	No	36.41	10.64	48.72	0.00

Table 6.3: Percentages of time spent on the main activity categories on solitary days and days in association within the same week.

The time spent on each activity was compared with the Wilcoxon Signed Ranks test between the social and the solitary day. All individuals seemed to spend less time resting on a 'social' day when compared to a solitary day, but the only significant difference ($N=9$, $P<0.05$) was found in resting time of Saryem (26/ 27 Oct).

6.3.4 *Play Behaviour*

Play behaviour was the most frequently observed physical interaction between the orangutans. There were several forms of play which we divided into three groups:

i) Play wrestling: The animals would be lying/ sitting on the forest floor while slapping, gnawing and pulling each other, emitting play grunts and usually having a 'relaxed open mouth' expression on their face (see Rijksen 1978).

ii) Play chase: This would usually be alternated with play wrestling. The animals would run after each other over the forest floor or swing after each other in the lower canopy trying to grab each other.

iii) Play gymnastics: Here the orangutans would not have any physical contact but they would be engaged in swinging, dangling and brachiating in the trees.

The subadult male Charlie who was released in the first group ranged over a large area which encompassed the first three release sites. Whenever he met other smaller male orangutans (from other release groups) he initiated a 'play wrestling' session with them. The smaller animals would play along for a short while but usually it would get too rough for them and they would try to escape or they would start squealing after which he would release them. The subadult male never behaved aggressive towards them or really insisted on continuing the play. These play bouts never lasted longer than a few minutes and probably had a function of reconfirming his dominance over the smaller animals. Rijksen (1978) mentions that the highest ranking rehabilitant subadult male used to initiate 'gnaw' wrestling with all rehabilitant males, and sometimes older females as well, and that in the rehabilitant group in this way the social status of each individual became established and maintained.

The subadult male of this study was seldom observed wrestling with female orangutans. Once it was observed that he initiated a play session with a female, with whom he had been travelling for a few days, but she immediately started screaming. At that point he let her go and they continued travelling and feeding together.

When the last group was released (group 5), Charlie arrived at the site right after the release and play wrestled with several of the newly released orangutans during the course of a couple of days and inspected the females.

Two small males, one from group 2 (Bento) and one from the third release group (Enggong), were often seen together and intermittently they would be engaged in long play wrestling sessions which sometimes lasted over an hour. They would then travel and feed

together as well. Rijksen (1978) mentions that play was more frequent and of longer duration if the animals formed a 'bond' (individuals which were more often seen together than with other individuals and who had an affiliative relationship).

Female orangutans from the first two release groups were also observed engaging in short play wrestling sessions when they were travelling together for several days.

6.3.5 *Food Sharing and Begging*

Food sharing and begging were frequently observed in all three sub groups. In total at least 30 instances of food sharing were observed and 45 instances of food begging. There was no real structure to be found in who was begging or who was sharing the food. There were no consistently begging or consistently sharing individuals. Orangutans from group (1+2) were engaged in food sharing and begging as frequently as orangutans from the other release groups. Almost all food items that the orangutans were observed feeding on were shared and begged for, ranging from termites, rattan, palm pith, bark, bananas, to fruit and leaves.

On several occasions the subadult male from group 1 was observed travelling together with a female from group 3 and they alternately shared and begged food from each other. Once he was observed ripping off a piece of bark which she took from him and he commenced loosening another piece for himself. On another occasion they were both feeding on the leaves of a tree fern when he 'gave' her a leaf which he had pulled out of the crotch, he then ripped off another leaf for himself.

Frequent food sharing was also observed between two males (Bento and Enggong) from different release groups and between females from different release groups (Uce, group 1 and Tuti, group 2).

Sometimes the food was begged for by extending the hand under the mouth of the other orangutan or by mouth to mouth contact. At other times the begging orangutan would gently pull on the food item the other was eating and this would then be released or not. Occasionally food would be stolen from each other, after which the 'thief' would run away to feed on the item. The reaction of the other animal would not be recorded as 'sharing' in this case.

In the wild food sharing has not been observed so frequently among orangutans, other than mother with offspring (Horr 1977). Galdikas (1981) reported that during eight years of her study only three instances of food sharing were observed. These instances were all females taking some termites, on which their male travel companions were feeding.

6.3.6 *Sexual Behaviour*

Several female orangutans were observed rubbing their genitals over a branch while they were travelling alone and occasionally young males were seen masturbating briefly as well. Once a larger female orangutan was observed sniffing the genitals of a smaller male who didn't seem interested in more.

The subadult male (Charlie) who was released in the first group was the only male orangutan who was sexually active. Several times he was observed travelling together with a female (Saryem) from group 3 for several days. During one of these 'consortships'- which was defined as a relationship in which a male and a female travel together for several days in succession and show varying degrees of coordination and cooperation in their behaviour (MacKinnon 1974; Rijksen 1978)- it was observed that the two orangutans mated. The duo had been travelling together for at least two days and continued travelling together for at least another day after they had mated. The orangutans had been feeding together and stayed close to each other all morning. The male had made a day nest where she had joined him but after a few minutes he left the nest and they continued feeding on some leaves. Then the male disappeared into a tree and the female kept on feeding for about 15 minutes after which she joined the male again. After a few minutes they started mating as he mounted her from her back side, while she was suspended horizontally hanging onto several branches. While they were mating she changed position several times to face the male ventrally and back again, and changed the way she was holding on to him and the branches. The male held on to her thighs with his feet but also changed the position of her legs several times (e.g. putting her leg on his shoulder) and sniffed and touched her genitals several times. They kept on mating like this for one hour. After about half an hour the female started biting on a liana and whimpering softly which changed into screaming and wailing which were described by MacKinnon (1974) as 'mating cries'. Although the female seemed quite agitated she did not try to get away . After one hour the male let go of the female and they both left the tree and resumed feeding together in another tree. They were not observed mating again that day but the male shared food with the female and they nested in the same tree that evening, in separate nests.

The same male was also observed 'raping' a newly released female from group 5. Immediately after that group had been released the subadult checked out the newcomers. He inspected the females and mounted one who struggled to get away. Rijksen (1978) also mentions that newly arriving adolescent females at the Ketambe rehabilitation station were usually raped by rehabilitant subadult males.

One of the Indonesian assistants also reported that he had seen the subadult male 'rape' another female from group 2.

6.3.7 *Grooming*

The orangutans were hardly ever observed grooming each other except for one occasion when a female groomed a wound of a male for almost one hour. These animals had been recently released and were still roaming around the release site.

6.3.8 *Other Social Interactions*

It was twice observed that an orangutan helped another one to cross a difficult section in the forest.

The subadult male orangutan from the first group (Charlie) and a female from group 3 (Saryem) had been travelling and feeding together for at least two days (no sexual behaviour was observed). The male at one point had already climbed up a liana and the female wanted to come after him but from the tree she was in she couldn't reach the liana. The male then climbed down the liana and bridged himself between the liana and the tree so that the female could cross over. She then climbed up the liana first after which he followed her.

The second instance when such behaviour was seen was when a female orangutan (Otong) which had been re-released with group 4 but originally came from the first release group was travelling together with a smaller male (Smits) from group 4 for at least two days. The smaller male was much less experienced and occasionally had difficulty keeping up with her. When he at a certain point wanted to sway with a small treelet to the next she 'helped' him by releasing the treelet, which she was holding from above while sitting in another tree, at the right moment so that he indeed landed in the next tree.

The previous night they had slept together in a nest she had constructed. The two had been travelling and feeding together all day during which the newly released animal closely followed the feeding pattern of the more experienced female and often fed on her remainders. Late in the afternoon the female started making a nest for the night. The small male climbed into the same tree and sat down several metres above her nest looking down at her. He showed no intention of making his own nest but the observations were stopped then and the next morning the female was observed climbing out of the nest first and after several minutes the male emerged from the nest as well.

Schürmann (1982) mentions that the non-sexual 'consort' probably represents an early phase in the establishment of socio-sexual relationships.

Another unusual instance of social behaviour was observed when Charlie and Saryem were travelling and feeding together on a day in October. Late in the afternoon Charlie was feeding on some climbers while she moved away a distance. A few minutes later she made several 'kiss squeaks' after which he climbed down and moved over to where she was. She was found feeding in a small fig tree which bore fruit and he joined her there and they fed on the fruit until the ripe crops was finished. It was the first time they had been observed feeding on fruit as it was in the midst of the dry season. Shortly afterwards they both made a night nest in the same tree.

6.4 *Discussion*

On average the reintroduced orangutans from all groups tended to spend half of the time they were observed in association with other orangutans. Three females from the first two release groups were only observed in association with other orangutans during the wet period when food was more abundant, whereas associations between animals from more recent release groups were also observed during the dry period, usually in the proximity of the release sites.

The individuals from the different groups mixed freely after release and most associations observed were between individuals from different release groups, which means that new bonds and relationships are created in the forest after release.

On several occasions newly released animals were found to associate with orangutans from older release groups. Such associations could be very beneficial for the newly released orangutans, as animals from older release groups have more forest experience, a better knowledge of food sources and their distribution, and other necessary survival skills. These associations allowed close observational learning for the new orangutans.

Food sharing and begging was a common activity during associations.

One subadult male from the first release group, who also was the largest orangutan, tried to establish a dominance pattern by having play wrestling sessions with almost all orangutans he encountered. He also established socio-sexual relationships with the female orangutans by forming 'consorts' with one female orangutan, and by 'raping' newly arrived females.

Grouping did not change the activity budgets of three observed orangutans except for the resting time of one female, who did so more when she was alone.

CHAPTER 7: RANGING PATTERNS

7.1 *Introduction*

The ranging pattern of adult wild orangutans is a complicated process, not yet clearly understood, but probably related to ecological factors, relationships and mating strategies.

The home ranges of wild orangutans have been discussed by several researchers. There seems to be some variation in the home range sizes at the different sites which could be related to the differences in the dispersion of food among the study areas (Rodman 1988).

Galdikas (1978) reported female ranges of 5 to 6 km^2 with a core area of 2 to 3 km^2 in Tanjung Puting. Horr (1975) found home ranges of 0.6 km^2 for females and 5.1 km^2 for an adult male in the Lokan area (Sabah). Mitani found home range sizes larger than 1.5 km^2 for adult females in the Mentoko area (Rodman and Mitani 1987), while Rijksen (1978) reports that one adult female occupied a range of 1 km^2, and another female of 2 km^2.

Female ranges seemed to be stable according to Galdikas (1979) and overlapped extensively. Adult males ranged over much larger areas overlapping the ranges of several females (Horr 1977).

Several researchers suggested that a distinction between resident and non-resident orangutans could be made (Galdikas 1978; MacKinnon 1974; Rijksen 1978; Sugardjito et al. 1987). This was further examined by te Boekhorst et al. (1990), who mention that in the Ketambe area both non-resident males and females are attracted to the area when there is an increased fruit availability.

Juvenile offspring, when becoming independent, travelled within the boundaries of the mother's home range (Galdikas 1979). Rodman (1973) mentions that a juvenile female travelled entirely within her mothers range, but that independent males move out of their mothers range. Horr (1977) mentions that young males leave their mother earlier than juvenile females.

Van Schaik and van Hooff (unpublished manuscript) reported that in the Ketambe area two rehabilitant females, who were released as juveniles in the late 1970s, were now still using the same area, together with two adult daughters of one of them. Several young males were never seen again after increasingly long intervals between visits to the feeding place. They also mention that there are clear sex differences in attendance records of rehabilitant animals observed in Ketambe during the 1970s. Males often disappeared for prolonged periods, sometimes never returning, while females 'remained more faithful visitors'.

7.2 Ranging Patterns of Reintroduced Orangutans

It was difficult to determine the ranges of the orangutans during this study as most of the focal animals were only observed for limited periods of time. Furthermore there is a bias in observations towards those animals that were found near the release sites and our camp.

From the newly released animals from group 4 only three animals remained near the release site after one month (two males and one female). All the other animals disappeared and it is impossible to say whether they ranged further away from the release site or that they started wandering over large distances. One orangutan (Bawdi) moved out of the forest, not long after release, into a neighbouring concession area where he was found near a small village. The distance covered was at least 10-15 km. and he travelled for over a month. Another female (Otong) moved even further away (± 25 km.) and was found near a plywood factory approximately two years after her release. She was transferred again to the research station and re-released with group 4. She remained near the release site for at least two months but when supplementary feeding stopped there she wandered off and was again found near the plywood factory after a couple of months.

Another orangutan (Smits) disappeared a week after release but reappeared after one month in good condition and remained near the release site. He would travel short distances from the release site but as long as technicians brought bananas there he came back almost every day.

Another male, Enggong from group 3, has left the forest several times after release and was caught near the village at the forest entrance. He was taken back to the forest and when he "befriended" another orangutan Bento (group 2) he remained in the forest. They both roamed near the third release site but when supplementary feeding was halted there they both went their own way, and Enggong was again sighted near the village but did not leave the forest. He was then seen again near the second release site when a new group (5) was released there. Several orangutans apparently knew the way to the release sites, our base camp and the village.

For four orangutans that were most observed (Uce, Charlie (group 1), Tuti (group 2) and Saryem (group 3)) the approximate ranges during this study were plotted (see fig. 7.1). Two females (Uce and Tuti) were only observed within a small area (0.75 km^2) not too far from their respective release sites. The 'ranges' of Uce and Tuti overlapped and they have been observed travelling together for two consecutive days. A third female Saryem was observed in a larger area (1.5 km^2) than the other two females. The subadult male

Charlie was seen in a much larger area (at least 2.5 km^2) which encompassed at least the first three release sites and the ranges of these females.

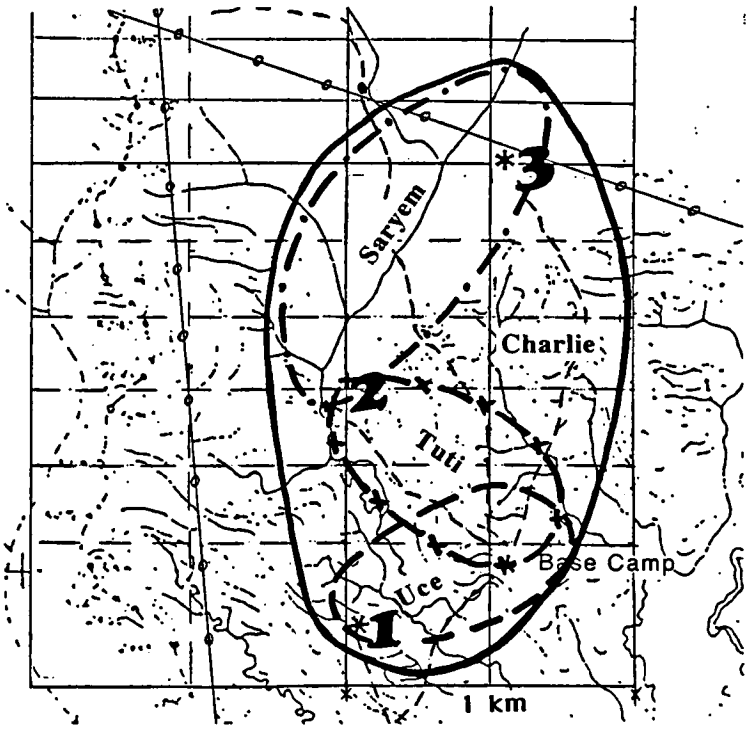


Fig. 7.1: The approximate ranging patterns of four orangutans.
Charlie and Uce (group 1); Tuti (group 2); Saryem (group 3).

The fact that Uce and Tuti were observed only in a small area does not imply that they did not range outside that area as well.

The total number of orangutans that have been sighted within the core area around the first three release sites, before group 5 was released at the same site as group 2, adds up to 13 individuals (five from group 1, four from group 2 and four from group 3). Seven of these orangutans were only seen once or twice.

Most individuals seen near our base camp were from the first release group and it seems that several individuals have established their 'ranges' there, although two orangutans (Aming and Imelda) were only observed a few times near our camp during the course of one month.

7.3 Discussion

Three female orangutans from the first three release groups, which were observed on a more regular basis, were mainly sighted within a specific area of the forest not far from their respective release sites. It could be argued that they had established their 'home ranges' there. The most 'dominant' males' home range was much larger and encompassed the ranges of several females with whom he associated from time to time (see Chapter 6).

For the other animals it was not clear whether they were just moving through that area or if they temporarily or even permanently ranged there.

Some newly released orangutans gradually increased their range around the release sites, not returning to the feeding site every day. For some others the halting of supplementary feeding seemed to be the onset for wandering over larger areas.

For wild female orangutans it has been suggested that they have a preference for remaining in their natal area. Galdikas (1979) and Rodman (1973) have reported that young females usually remain within their mothers range, and Horr (1977) mentioned that young males usually leave their natal area. In long term field studies new subadult males have often been reported while new females have been seen less frequently (Galdikas 1984; Mitani 1985). From the first two release groups more females (4) were sighted near the area of their release site than males (2).

The fact that some of the orangutans were sighted again at certain places (usually release sites), after prolonged periods of absence, could indicate that they start gaining some knowledge of the topography of the area.

It is not clear why, and where to, almost all orangutans from the fourth release group disappeared to a couple of weeks after release. Whether this happened because they were released during the dry period (when food was scarce and the food supply around the release site was quickly exhausted) forcing them to move further away to find enough food, or, whether this was due to other factors, remains to be further studied.

The distance between the different release sites could be an important factor as well in the establishment of home ranges, depending on the number of animals released at each site. At the first three release sites, together, a total number of 48 orangutans was released. This has certainly put large pressure on the food availability in the area around the release sites and the carrying capacity of the area might have been exceeded. Some animals would be forced to move away. If the newly released orangutans were driven away immediately after release this could have caused additional stress which could be detrimental to their survival. Gradual exploration of the new surroundings would seem more beneficial for these orangutans, as they already have to concentrate on learning many new survival skills.

CHAPTER 8: NESTING BEHAVIOUR

8.1 *Introduction*

Wild orangutans usually build a nest every night which is used for sleeping. Sugardjito (1986) reports that the night nests are usually build close to the food tree which was last visited but that the more vulnerable classes (females with infants and adolescents) were more careful with the selection of a nest site, choosing more cryptic sites higher in the trees and further away from the last food tree. Rijksen (1978) mentions that orangutans preferred to nest at vantage points from which they could look out over a large section of the forest. He also states that they usually build a new nest every night, but sometimes they reused an old nest and added some new foliage. Rodman (1979) reported that a juvenile female often used an old nest.

Horr (1977) hypothesizes that the building and selection of a suitable nest site might be an important factor for orangutans in the adaptation to their requirements. Certain tree species with the right characteristics for nest building were carefully chosen and selected for. This was also observed by MacKinnon (1974) who stated that certain trees were not used for nesting as they were too tall or lacked the right nesting materials.

Sugardjito (1986) mentions that adult males and females usually build nest between 10 and 20 metres but that the more vulnerable classes (females with infants and adolescents) build their nests between 20 and 30 metres. Rijksen (1978) mentions that the preferred height for nest sites in the Ketambe area usually was between 13-15 metres above the ground although this depended on the forest structure at the site. MacKinnon (1974) reported that the orangutans nested between 3 and more than 27 metres above the ground with a mean height of 19.5 metres.

Harrisson (1969), who studied two ex-captive orangutans for their nest building capacities, mentions that one rehabilitant male who was captured from the wild at 1.5 years of age and released at 2.5 years was quite capable of building arboreal nests but another female who was captured at 1 year of age and released a year later slept on the ground, with or without a nest.

One subadult rehabilitant orangutan in Tanjung Puting did not learn to build nests until 1.5 years after his release (Galdikas cited in Tuttle 1986, p.145).

8.2 *Nesting Behaviour of the Reintroduced Orangutans*

Of the newly reintroduced orangutans several individuals seemed to be able to build nests high (> 30 m.) up in the trees immediately after release while other individuals remained near the forest floor and constructed crude night nests there. A newly released individual was once observed to sleep on top of a epiphytic tree fern, on which he had been feeding, without adding any nest material. Orangutans from older release groups were also observed sleeping on top of tree ferns or other clusters of epiphytes in the forks of trees.

Orangutans from the first three release groups often built new nests in the late afternoon but certainly not every day. They were often seen to reuse old nests (not known whether these were constructed by themselves or by others previously) occasionally adding some new nest material.

Once it was observed that a small male orangutan Enggong (group 3) built three nests in the late afternoon but left each of them after a few minutes. He then tried to enter the nest where another male Bento (group 2) was lying, with whom he had been travelling and feeding all day. Bento chased him away after which he finally laid down in one of the nests he had previously constructed. Another small newly released orangutan (Smits) was once observed emerging from a nest where he had spent the night together with a more experienced female (Otong) who was seen to have built the nest the previous afternoon.

On a few occasions it was observed that two orangutans who formed a 'consort' constructed individual nests in the same tree.

When the orangutans built their nests this was usually very near or within the tree where they had been feeding last.

Individuals from the first three release groups constructed or slept in old nests between 5 and 30 metres or more, with most nests at approximately 20 metres from the forest floor (n=27). They were never observed sleeping on the forest floor.

Several times it was observed that orangutans from the first three release groups built nests in the morning or midday to rest or play.

Nest building usually took a few minutes ranging from 3 to 11 minutes with a mean of 5 minutes. A basic nest was built first, by breaking several branches toward themselves, after which this would be rearranged and improved, sometimes adding nest material gathered from another tree.

8.3 *Discussion*

In general the nesting behaviour of the reintroduced orangutans corresponds to that described for wild orangutans.

Most of the observed reintroduced orangutans seemed to be able to construct nests without much difficulty. They did so usually in the middle canopy although they were also seen building nests in the canopy of high emerging trees. Sometimes nest material was brought to the nest from a distance.

Contrary to what Sugardjito (1986) found for wild adolescents in the Ketambe area, the reintroduced orangutans usually nested very near or within the last tree where they had been feeding.

Most of the newly released orangutans were also able to construct nests although one animal was observed once sleeping on the forest floor.

Orangutans from all release groups were also quite often observed sleeping in old nest or on top of epiphytic tree ferns.

CHAPTER 9 : ENCOUNTERS WITH OTHER SPECIES

9.1 *Encounters with other Animals*

On several occasions orangutans from the first three release groups were observed in the presence of terrestrial mammals, which passed by underneath the tree where they were remaining. No reactions were observed when a bearded pig (*Sus barbatus*) was wandering nearby and when two barking deers (*Muntiacus muntjac*) passed by, the orangutan looked down but kept on feeding.

Twice it was observed that groups of red leaf monkeys (*Presbytis rubicunda*) moved very near to an orangutan but on both occasions the orangutans continued feeding without showing any signs of disturbance.

Once a female orangutan (Uce) was feeding on flowers in a tree when an adult pig-tailed macaque male (*Macaca nemestrina*) entered the same tree. She remained feeding for a moment but when he came close to her (5 m.) she started shaking branches. When he did not react she became very agitated and rushed out of the tree. She made 'kiss' vocalizations and continued shaking branches but did not enter the tree again. She moved away a bit further but kept on vocalizing and looking around for another 15 minutes.

9.2 *Reactions to and Encounters with Humans*

Several orangutans (Charlie, Uce, Bento, Grimeh) which were 'ranging', or spending time in the area near our base camp came to the house soon after we had moved in. The technicians from the project had been feeding a few individuals there before we arrived and when that was stopped two orangutans (Bento and Grimeh) became quite annoyed and tried to raid the house and one of them (Grimeh) became aggressive towards humans.

Several newly released orangutans, when hearing human voices, would immediately move towards them and this was also observed with some orangutans from the first release group.

Two orangutans (Grimeh and Willie) repeatedly left the forest and went to the village near the forest entrance (± 3 km. from our base camp). They were taken back to the forest several times but they knew the way to the village and sometimes left the forest again after a day. One orangutan (Grimeh) who persistently kept leaving the forest was taken back to the Wanariset station to be released in the Meratus area.

At the release of group 4 one orangutan (Ding-Dong) became aggressive towards several people which were present at the release and he was taken back to the station.

As mentioned earlier one orangutan (Otong) was found twice near a plywood factory (± 25 km. from the forest) and was taken back to the station. In addition, another orangutan (Bawdi), was found near a village in a concession area neighbouring the forest.

Another orangutan (Romanis) was bitten by a dog when he was venturing near some houses at the edge of the forest and was taken back to the station, treated and re-released.

Sometimes the orangutans from the first two release groups would show annoyance for a brief period to observers who were following them, making 'kiss' vocalizations and shaking branches. However they usually did not react at all if only one observer was following them.

9.3 *Discussion*

The reintroduced orangutans seemed to be quite tolerant and indifferent to other species of mammals when encountering them in the forest. Their reactions to humans were different and even some orangutans from the first release group were curious when human voices were heard in the forest. They still had not lost their attraction to humans and showed very little fear. As the distance to the nearest village was only a couple of kilometres a number of orangutans occasionally left the forest to venture near or in to the village.

CHAPTER 10: FOOD COMPETITION AND EFFECT ON THE FOREST

10.1 *Food Competition*

The Sungai Wain Nature Reserve is home to several other species of birds and mammals (see Appendix 3 for a listing of observed mammals and birds in the Sungai Wain area) which have some degree of dietary overlap with the orangutan. Unfortunately no assessment was made of densities of other sympatric primate species already occurring in the forest but pig-tailed macaques (*Macaca nemestrina*), gibbons (*Hylobates muelleri*), red leaf monkeys (*Presbytis rubicunda*) and long-tailed macaques (*Macaca fascicularis*) were often observed in the core study area near the release sites. In the swamp area near the forest entrance proboscis monkeys (*Nasalis larvatus*) were also observed.

Rijksen (1978) presents a list of potential food competitors, other than the sympatric primates, of the orangutans in Ketambe. Of these, several species of hornbills (Bucerotidae), fruit bats (Chiroptera), sun bears (*Helarctos malayanus*), binturongs (*Arctitis binturong*), several civet species and squirrels were also observed in the Sungai Wain area.

All these species might compete in some degree for food with the reintroduced orangutans and vice versa. Although just a few instances of inter-species contacts were observed during this study at food sources (see Chapter 9) this does not exclude the fact that in the longer term there might be some effects on both sides.

During the dry period the reintroduced orangutans were observed feeding on several plant species on which no other animals were seen feeding (e.g. the palm *Borassodendron borneensis* and several rattan species).

10.2 *Effects on the Forest*

Orangutans can influence their habitat in several ways: they can have quite a destructive effect on the vegetation by their feeding and locomotor habits (Galdikas 1982; Rijksen 1978) but they are also dispersers of the seeds of several plant species (Galdikas 1982). Rijksen (1978) reports that rehabilitant orangutans often broke branches and saplings, and bit through or detached lianas in playful displays or during social play and 'gymnastics'. He states that such behaviour was rarely seen among wild adolescents and subadults. He also mentions that the destructive influence was especially noticeable in the surroundings of the rehabilitation station due to the high density of apes there. This was also the case near the release sites in the Sungai Wain forest.

Since orangutans have not been living in the Sungai Wain area for an unspecified period of time the release of 60 apes could have quite an effect on the vegetation and hence on the community at large and it would be interesting to further study their effect on the forest.

Caldecott and Kavanagh (1983) mention that if conspecifics are absent from the 'receiving' area, the reintroduction of the new species runs the risk of creating ecological disruption. The newly arrived species might out compete and eliminate a competitor which might have effects for the community as a whole.

Further information regarding the effect of reintroduced orangutans on vegetation and other species may therefore be an important part of longer term monitoring.

CHAPTER 11 : GENERAL DISCUSSION and CONCLUDING REMARKS

11.1 *General Discussion*

In the preceding chapters I have described several aspects of the behaviour and ecology of reintroduced orangutans which could be of importance and relevance to their adaptation to forest life.

I have made a comparison between the different release groups of orangutans in order to see if there were differences which could be attributed to the amount of time spent in the forest. This approach was aimed at gaining an understanding of how long it takes to develop certain adaptive skills and traits.

The behaviour and ecology of the different groups of reintroduced orangutans was also compared to that observed for wild orangutans from several field studies. The groups which have spent the longest time in the forest were expected to show more similarities to wild (juvenile/ adolescent) orangutan behaviour than more recent release groups.

It is not possible to say exactly how many orangutans have survived the reintroduction as not more than 26 out of the 60 orangutans were observed/ sighted during this study. Individual characteristics probably play an important part in the development of the adaptation process as some animals have been captured from the wild at a later stage in life than others and probably conditions during captivity will also have influenced the animals. But because the results are based on observations (follow days) of 17 individuals, a preliminary overview can be drawn of the development of the adaptation process.

The activity budgets found for the first three release groups (time spent in forest ranging from 9 months to 2.5 years) were similar to those found for two female juvenile/ adolescent wild orangutans (Galdikas 1988). The newly released groups (time spent in forest ranging from two weeks to 5 months) displayed a different activity pattern, spending more time resting and less time feeding than the other groups. None of the groups of reintroduced orangutans showed a corresponding diurnal pattern of activities as described for wild orangutans with two distinct feeding peaks (in the morning and afternoon), a clear midday rest period and an increase in movement in the afternoon (MacKinnon 1974; Rijksen 1978; Rodman 1979). It is not clear whether wild independent juvenile/ adolescents display a similar diurnal pattern as described for adult animals.

Several orangutans from the first three release groups showed differences in their activity budgets between the dry and the wet period which corresponds to the reaction to seasonal variation in fruit availability, as shown by wild orangutans (Galdikas 1978, 1988;

MacKinnon 1974; Mitani 1989; Rodman 1977). Two animals showed a decrease in feeding time and an increase in travel time during the wet period when more fruit was available, which has also been observed for wild orangutans (Galdikas 1979; Mitani 1989; Rodman 1977).

The feeding ecology of the first two release groups (group 1: 2.5 years in the forest, group 2: 2 years) is quite similar to that observed for wild orangutans. They displayed quite an opportunistic diet feeding heavily on flowers, young leaves and fruit when they became available but during the dry period, when fruit was scarce, they concentrated on permanent food items like bark, leaves, rattan and palm pith. During the wet period they spent most of their time feeding on fruit, supplemented with small amounts of permanent food sources. Orangutans from the third release group (9 months to 1 year in the forest) showed quite a similar pattern but during the wet period when fruit was available they still spent a considerable amount of time feeding on permanent food sources when compared to group 1 and 2.

The newly released animals (group 4: 1 to 5 months in the forest, group 5: 1 month) spent most of their time feeding on termites and leaves during the dry period. When fruit became available they also started feeding on those items but they showed a much more equal division of time spent feeding among the different food categories during the wet period when compared to the other groups. The group which was released during the wet period seemed to gain a much wider dietary composition in a shorter time span than the group which was released during the dry period. This could also have been due to inter individual differences or to the fact that the group which was released during the wet period came immediately in contact with more experienced orangutans from older release groups as their release site was situated close to the release sites of the first three groups. Or more food items were available in the wet season allowing them to develop a more varied diet.

Supplementary food for the newly released animals should be brought to the release site on specific hours of the day in order to avoid animals waiting near the site for several hours. When a release takes place during lean food periods, supplementary feeding should be done on a regular basis and in sufficient amounts so that animals will remain in a healthy state while becoming familiar with the new surroundings.

When comparing the time spent feeding on fruit during the dry period of this study with that found for wild orangutans during periods of fruiting lows, the figure found here seems to be quite low. It could be that the reintroduced orangutans have more difficulty locating fruit trees when they are scarce due to the lack of detailed topographical knowledge or it might be that there hardly was any fruit during the dry period but no phenological data was gathered to support this.

Newly released animals spent almost half of their time on the forest floor and only 25% of their time in the middle and high canopy. Individuals from group 3 already spent considerably less time on the forest floor than newly released animals but still most of their time was spent in the low storey (0-10 m.). The orangutans from the first two release groups spent most of their time in the middle canopy (11-25 m.) and hardly any time on the forest floor. The groups that have been the longest in the forest shows some similarities to the height use described for wild adolescent orangutans by Sugardjito (1986). During the wet period, when fruit was more abundant, the orangutans from the first two release groups spent more time in the high canopy (>> 26 m.) than during the dry period when they spent more time in the low storey (0-10 m.).

Nesting behaviour corresponded reasonably to that observed for wild orangutans although the reintroduced orangutans were quite often seen to reuse an old nest or sleep on top of tree ferns. Of the newly released animals most individuals seemed to be able to construct a nest but one animal was observed to spent the night on the forest floor. Taking this into account and the fact that the newly released animals spent a large amount of their time on the forest floor, the orangutans seem to be most susceptible to predation by bearded pigs or clouded leopards during the first period after release. It was not observed that the orangutans were specifically selecting for a nest site, usually they built a nest in or very near the last tree where they had been feeding.

The importance of sociality for juvenile/ adolescent wild orangutans was stressed by several researchers. Sugardjito (1986) suggests that the development of social skills would be an important aspect of grouping in adolescents and that grouping allows observational learning of adaptive solutions to ecological problems. Rijksen (1978) mentions that during this relatively social phase the adolescents and subadults seem to establish dominance relationships.

The groups of reintroduced orangutans seemed to disperse soon after release although some animals remained together. The orangutans from different release groups mixed freely in the forest and new bonds between individuals from different release groups were established. The orangutans that had spent more time in the forest were very tolerant of the newly released individuals and associations were often observed. This created opportunities for the new animals to gain more knowledge about the distribution of food patches, which food items could be eaten, and some other survival skills. Food sharing and begging was a common activity during associations and two individuals were once observed to share the same nest. The different release groups spent on average the same amount of time in association with other orangutans. The only difference observed was that the females from the first two release groups were only seen in prolonged association

during the period of higher fruit availability, whereas individuals (male and female) from other groups (more recently released) were also seen associating during lean food periods.

The largest subadult male from the first release group seemed to be the most dominant individual, reconfirming his position by initiating play wrestling session with all other orangutans he encountered. He was also observed consorting and mating with a female from the third release group.

Grouping did not seem to have much effect on the activity patterns of several orangutans, except for one female who spent more time resting when she was alone. This could be because all the reintroduced orangutans were small juveniles/ adolescents, who will be less affected by food competition than adult animals.

Newly released animals would usually linger around the release site for a few weeks after which most of them disappeared. The amount of time the orangutans remain near a release site is highly dependent on how frequently and in what amounts supplementary food is brought to the site. Some newly released animals slowly increased their range around a release site while others started wandering over large areas soon after release. The ranges of a few orangutans from the first three release groups, which were most observed, were plotted. Two females seemed to range in small ($\pm$ 0.75 km^2) areas which overlapped each other. The largest subadult male from the first group ranged over a much larger area (at least 2.5 km^2) encompassing the ranges of several females. From the first release group five animals were seen in the area near their release site 2.5 years after release. As group 1 was the first to be released it could have been that several animals had established their ranges in that area but for most individuals of the other release groups it is difficult to speculate about their ranging patterns. The distance between the different release sites could be an important factor in the establishment of individual ranges and overcrowding in a certain area should be avoided.

Only a few inter species encounters were observed but the orangutans seemed to show little reaction to ground walking mammals and when encountering other primate species they also continued with what they were doing. Only once was it observed that an orangutan left the tree where she was feeding when an adult male pig-tailed macaque approached her.

The reactions towards humans were quite different, and often when orangutans from the last three release groups heard human voices, they immediately approached. Even orangutans from the first release group were curious when humans were in the forest, and although they were more timid they still did not seem to be afraid of humans. The distance from the release sites to the nearest village was only $\pm$ 5 km. and several orangutans left the

forest occasionally to enter the village. Ideally a release site should be situated further away from human settlements in order to keep such contacts to a minimum.

11.2 *Concluding Remarks And Recommendations*

When examining several aspects of the ecology of the different groups of reintroduced orangutans it seems that there are differences between the groups in activity patterns, feeding ecology and the usage of heights which could be related to the differences in the amounts of time spent in the forest. Groups which have spent 2-2.5 years in the forest show a very similar activity and feeding pattern as described for wild orangutans. They also spent very little time on the forest floor and several individuals had established a home range. The group that had spent approximately one year in the forest showed a similar activity pattern as the longer established groups and also their feeding pattern was similar but they still spent a considerable amount of time on the forest floor. Most of the changes in activity pattern and feeding ecology seem to take place within the first year after release.

It could be argued that the reintroduction of orangutans, using the new method developed for this end, is possible.

Still a few recommendations are suggested in order to further improve the implementation of the program and the survival chances of the orangutans:

- During the first period after release, when the orangutans are most vulnerable, supplementary food should be brought to the feeding site at regular times and in sufficient amounts so that the animals can gradually adapt to their new surroundings.

- When a group is being released there should preferably be a small number of people present, in order to reduce stress and to avoid that animals immediately flee into the forest.

- A group should preferably be released during periods of high food (fruit) availability as the animals develop a wider dietary composition in a shorter period of time, and they are more stimulated to search for food in the trees.

- The distance between different release sites could be an important factor in the establishment of home ranges and crowding in a certain area should be avoided.

- The distance between a release site and human settlements should ideally be more than 5 km. as some orangutans do not loose their attachment to humans easily.

- All people around the forest where the reintroduction takes place and surrounding forests should be well informed about the project and what to do when they encounter an orangutan.

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APPENDIX 1:

List of all Reintroduced Orangutans

Name:	Male/ Female	From:	Time at Wanariset	Appr. Age at Release	Release Date	Contact w.Humans	Back at WR	Sighted during Study
Charlie	M	Taiwan	6 mths	6 -	23-May-92	N	N	Y *
Made	M	Taiwan	6 mths	5+	23-May-92	N	N	N
Otong	F	Taiwan	6 mths	5 -	23-May-92	Y	Y/RR	Y *
Buddah	M	Taiwan	6 mths	4+	23-May-92	Dead	x	x
Romanis	M	Taiwan	6 mths	4+	23-May-92	N	Y	N
Imelda	F	Taiwan	6 mths	4 -	23-May-92	N	N	Y
Aming	M	Kaltim	6 mths	5+	23-May-92	N	N	Y
Uce	F	Kaltim	15 mths	4+	23-May-92	N	N	Y *
Dodoy	M	Kaltim	15 mths	4+	23-May-92	Y	Y/RR	Back at WR
Leni	F	Kalsel	2 wks	3+	23-May-92	N	N	N
Nova	F	Kaltim	6 mths	4+	23-May-92	N	N	N
Sri	F	Kaltim	3 wks	3+	23-May-92	N	N	Y *
Erik	M	Kaltim	6 mths	4 -	23-May-92	N	N	N
Mary	F	Kaltim	6 mths	5 -	23-May-92	N	N	N
Group 1: Total 14								
Manis	F	Kaltim	14 mths	4+	1-Feb-93	N	N	N
Longnah	M	Kaltim	26 mths	3+	1-Feb-93	N	N	N
Hero	M	Kaltim	10 mths	4+	1-Feb-93	N	N	N
Inem	F	Kaltim	10 mths	4+	1-Feb-93	N	N	N
Rico	M	Kaltim	8 mths	4 -	1-Feb-93	N	N	N
Veta	F	Kaltim	7 mths	4 -	1-Feb-93	N	Y/RR	Y
Willie	M	Kalsel	5 mths	4+	1-Feb-93	Y	N	Y
Tuti	F	Kaltim	4 mths	3+	1-Feb-93	N	N	Y *
Kiani	F	Kaltim	5 mths	3+	1-Feb-93	N	N	N
Semi	F	Kaltim	9 mths	3 -	1-Feb-93	N	N	N
Bento	M	Kaltim	11 mths	4 -	1-Feb-93	N	Y/RR	Y *
Beben	M	Kaltim	16 mths	5+	1-Feb-93	N	Y/RR	Y *
Grimeh	M	Taiwan	16 mths	4+	1-Feb-93	Y	Y/RR	Back at WR
Group 2: Total 13								
Alto	M	Kaltim	25 mths	4+	1-Feb-94	N	N	N
Unyil	F	Kalsel	15 mths	14+	1-Feb-94	N	N	N
Lulu	F	Java	6 mths	4 -	1-Feb-94	N	N	Y
Dede	M	Java	6 mths	4+	1-Feb-94	N	N	Y
Arlette	F	Kaltim	17 mths	4+	1-Feb-94	N	N	N
Enggong	M	Kaltim	6 mths	3 -	1-Feb-94	N	N	Y *
Garong	M	Kaltim	27 mths	4+	1-Feb-94	N	N	N
Joe	M	Kaltim	10 mths	4 -	1-Feb-94	N	N	N
Agustin	F	Kaltim	27 mths	4+	1-Feb-94	N	N	N
Boy	M	Kaltim	26 mths	4+	1-Feb-94	N	N	N
Saryem	F	Kaltim	6 mths	4 -	1-Feb-94	N	N	Y *
Group 3: Total 11								

Name:	Male/ Female	From:	Time at Wanariset	Appr Age at Release	Release Date	Contact w.Humans	Back at WR	Sighted during Study
Bona	M	Kaltim	23 mths	4+	3-Sept-94	N	Y/RR	Y *
Smits	M	Kaltim	22 mths	4+	3-Sept-94	N	N	Y *
Nemo	F	Kaltim	33 mths	4+	3-Sept-94	N	N	N
Tini	F	Kalbar	7 mths	4+	3-Sept-94	N	N	N
Hello	F	Taiwan	7 mths	5+	3-Sept-94	N	N	N
Haishan	F	Taiwan	7 mths	4+	3-Sept-94	N	N	N
Bright	M	Taiwan	7 mths	5+	12-Sept-94	N	N	N
Paulie	F	Taiwan	7 mths	4+	12-Sept-94	N	N	N
Juliet	F	Taiwan	7 mths	4+	3-Sept-94	N	N	N
Shawban	M	Taiwan	7 mths	5+	12-Sept-94	N	N	Y *
Bawdi	M	Taiwan	7 mths	4+	12-Sept-94	Y	Y/RR	Y *
Ding-Dong	M	Taiwan	7 mths	6+	12-Sept-94	N	Y	Back at WR
Coco	F	Taiwan	7 mths	5+	12-Sept-94	N	N	N
Group 4: Total 13								
Ramon	M	Kaltim	7 mths	3+	3-Dec-94			
Semoi	M	Kaltim	38 mths	4+	3-Dec-94			
Clint	M	Kaltim	19 mths	4 -	3-Dec-94			
Boneng	F	Kalbar	10 mths	6 -	3-Dec-94			
Nita	F	Kaltim	5 mths	3+	3-Dec-94			
Atong	M	Kaltim	37 mths	4 -	3-Dec-94			
Ludah	M	Kalbar	10 mths	5 -	3-Dec-94			
Paul	M	Kaltim	30 mths	5 -	3-Dec-94			
Dai-Dai	F	Taiwan	10 mths	6+	3-Dec-94			
Group 5: Total 9								
TOTAL 60		RR= Released again after being taken back to Wanariset Y*= Observations made on Orangutan (Y= sighted, but no observations)						

Kaltim = Kalimantan Timur (East Kalimantan), Kalsel = Kalimantan Selatan (South Kalimantan), Kalbar = Kalimantan Barat (West Kalimantan), Taiwan = Repatriated from Taiwan, Java = Repatriated from Java.

APPENDIX 2:

List Of Identified Plant Families And Species Eaten By Reintroduced Orangutans

Family	Parts Eaten	Other Studies
Anacardiaceae		
Mangifera sp.	Fruit	G (5 sp.)
Ancistrocladaceae		
Ancistrocladus tectorius	Fruit	
Annonaceae		
Fissistigma manubriatum	Fruit	
Polyalthia sumatrana	Fruit	M
Polyalthia sp.	Fruit	M (4 sp.), G (2 sp.)
Uvaria sp.	Fruit	G (1 sp.)
Xylopia sp.	Fruit	M (1 sp.), G (2 sp.)
Araceae		
Aglaonema sp.	Inner core	
Asclepidiaceae		
Dischidia sp. A	Leaves	M (1 sp.), G (3 sp.)
Dischidia sp. B	Leaves	
Dischidia sp. C	Leaves	
Dischidia sp. D	Chew leaves	
Dischidia sp. E	Chew leaves	
Hoya sp.	Chew leaves/ stem	G (1 sp.)
Bombacaceae		
Durio kutejensis	Fruit	
Durio oxleyanus	Fruit	G
Neesia synandra	Seeds	
Burseraceae		
Canarium sp.	Fruit	M (2 sp.), G (1 sp.)
Dacryodes rugosa	Fruit	G (same genus other species)
Combretaceae		
Combretum sp.	Seeds	M (1 sp.)

Dilleniaceae		
Dillenia sp. A	Flowers, Fruit	M (2 sp.), G (2 sp.)
Dillenia sp. B	Inner core	
Dillenia sp. C	Fruit	
Tetracera sp.	Fruit	
Dipterocarpaceae		
Dipterocarpus cornutus	Flowers, Fruit	M (same genus, 3 other sp.)
Dipterocarpus tempehes	Fruit	
Shorea laevis	Fruit	
Ebenaceae		
Diospyros sp. A	Fruit	M (2 sp.) G (6 sp.)
Diospyros sp. B	Fruit	
Euphorbiaceae		
Aporusa dioica	Fruit	
Aporusa nitida	Fruit	
Baccaurea sp. A	Fruit	M (1 sp.), G (6 sp.)
Baccaurea sp. B	Fruit	
Baccaurea sp. C	Fruit	
Chaetocarpus castanocarpus	Fruit	G
Cleistanthus sp.	Fruit	
Drypetes sp.	Fruit	M (1 sp.), G (1 sp.)
Macaranga conifera	Fruit	
Macaranga hypoleuca	Fruit	
Fagaceae		
Castanopsis motleyana	Fruit	M, G (same genus, other sp.)
Castanopsis oviformis	Fruit	
Flacourtiaceae		
Hydnocarpus polypetala	Fruit	M (same genus, other species)
Flagellariaceae		
Flagellaria sp.	Inner core	
Gnetaceae		
Gnetum sp.	Fruit	M (3 sp.), G (2 sp.)
Gramineae		* M (other genera)
Scrotochloa urceolata	Inner core	

Guttiferae		
Garcinia manggostana	Fruit	M (4 sp), G (7 sp.)
Garcinia parvifolia A	Fruit	G
Garcinia parvifolia B	Fruit	
Garcinia sp.	Young leaves	
Lauraceae		* M/ G (other genera/ sp.)
Litsea sp.	Fruit	
Lecythidaceae		
Barringtonia sp.	Fruit	M (1 sp.)
Leguminosae		
Archidendron sp.	Seeds	
Dialium indum var. bursa	Fruit	M (2 sp.), G (3 sp.)
Fordia splendissima	Flowers, Fruit	M (1 sp.)
Parkia timoriana	Flowers, Inner core	G (1 sp.)
Sindora sp. A	Seeds	M (1 sp.), G (2 sp.)
Sindora sp. B	Seeds	
Spatholobus sp.	Seeds	G (1 sp.)
Magnoliaceae		* M/ G (other genera/ sp)
Magnolia borneensis	Fruit	
Melastomataceae		
Pternandra sp.	Fruit	G (1 sp.)
Meliaceae		
Aglaia sp.	Fruit	M (2 sp.), G (2 sp.)
Moraceae		
Artocarpus anisophyllus	Flowers, Fruit	M (4 sp.), G
Artocarpus integer	Fruit, Young leaves, Bark	G (7 sp.)
Artocarpus lancaefolius	Young leaves, Inner core	
Artocarpus sp.	Fruit	
Ficus benjamini	Leaves	M (7 sp.), G (7 sp.)
Ficus deltoidea	Leaves	G
Ficus lowii	Fruit,Leaves	
Ficus sp. A	Fruit	
Ficus sp. B	Fruit	
Ficus sp. C	Fruit	
Ficus sp. D	Fruit	
Myristicaceae		
Knema sp.	Fruit	M (1 sp.), G (2 sp.)

Myrsinaceae		
Ardisia sp.	Fruit	G (1 sp.)
Myrtaceae		
Eugenia sp.	Fruit	M (2 sp.), G (8 sp.)
Orchidaceae		* M/ G
Sp. A	Roots/ Bulb	
Sp. B	Leaves	
Palmae		
Borassodendron borneensis	Inner pith leafstem	
Korthalsia sp.	Leaves	
Licula spinosa	Base young leaves	
Rotan sp. A	Inner core, Leaves	M (1 sp.), G (6 sp.)
Rotan sp. B	Inner core, Leaves, Fruit	
Pandanaceae		
Pandanus sp. A	Leaf base	
Pandanus sp. B	Leaf base	
Passifloraceae		
Adenia sp.	Fruit	
Polygalaceae		
Xantophyllum griffithii	Fruit	G (3 sp.)
Xantophyllum obscurum	Fruit	
Xantophyllum sp.	Flowers	
Polypodiaceae		
Asplenium nidus L.	Leaves	
Rubiaceae		* G (other genera/ sp.)
Mussaenda sp.	Flowers, Leaves	
Porterandia anisophylla	Fruit	
Sapindaceae		* M/ G (other genera/ sp.)
Dimocarpus longan	Fruit	
Sapotaceae		* M/ G (other genera/ sp.)
Madhuca sp.	Flowers, Fruit, Bark	
Pouteria sp.	Fruit	

Simaroubaceae		
Eurycoma longifolia	Fruit	
Irvingia malayana	Fruit	G
Stercullariaceae		
Sterculia sp. A	Seeds	G (1 sp.)
Sterculia sp. B	Seeds	
Thymelaeceae		* G (other genera/ sp.)
Aquilaria malaccensis	Fruit	
Tilliaceae		
Microcos sp.	Leaves	G (2 sp.)
Ulmaceae		
Gironniera nervosa	Fruit, Young leaves	G

M= MacKinnon (1974)- Segama (Sabah), G= Galdikas (1988).
* M/ G = same family (no corresponding genus/ species).
M/ G = same genus, other species (or not further identified).
underlined = same species in either MacKinnon's list or Galdikas' list.

APPENDIX 3:

Birds Observed in the Sungai Wain Area (May 1994- November 1994)

Family	Species	English name
Accipitridae	*Aviceda jerdoni*	Jerdon's Baza
	Haliastur indus	Brahminy Kite
Falconidae	*Microhierax fringillarius*	Black-Thighed Falconet
Phasianidae	*Rollulus rouloul*	Crested Partridge
	Argusianus argus	Great Argus
	Lophura erythrophthalma	Crestless Fireback
Columbinae	*Ducula aenea*	Green Imperial-Pigeon
Psittacidae	*Loriculus galgulus*	Blue-Crowned Hanging Parrot (Malay Lorikeet)
Cuculidae	*Cuculus micropterus*	Indian Cuckoo (call identification)
	Phaenicophaeus sumatranus	Chestnut-Bellied Malkoha
	Phaenicophaeus curvirostris microrhinus	Chestnut-Breasted Malkoha
	Centropus sinensis	Greater Coucal
Strigidae	*Strix leptogrammica*	Brown Wood Owl
Apodidae	*Hirundapus giganteus*	Brown-Backed Needletail
Trogonidae	*Harpactes diardii*	Diard's Trogon
	Harpactes duvaucelii	Scarlet-Rumped Trogon
Alcedinidae	*Pelargopsis capensis*	Stork-Billed Kingfisher
	Alcedo meninting	Blue-Eared Kingfisher

Meropidae	*Merops viridis*	Blue-Throated Bee-Eater
Bucerotidae	*Aceros undulatus*	Wreathed Hornbill
	Aceros corrugatus	Wrinkled Hornbill
	Annorhinus galeritus	Bushy-Crested Hornbill
	Anthracoceros malayanus	Black Hornbill
	Buceros rhinoceros	Rhinoceros Hornbill
	Anthracoceros albirostris	Pied Hornbill
	Buceros vigil	Helmeted Hornbill (call identification)
Picidae	*Picus puniceus*	Crimson-Winged Woodpecker
	Mulleripicus pulverulentus	Great Slaty Woodpecker
	Dryocopus javensis	Great Black Woodpecker
	Sasia abnormis	Rufous Piculet
	Picumnus innominatus	Speckled Piculet
	Meiglyptes tristis	Buff-Rumped Woodpecker
	Meiglyptes tukki	Buff-Necked Woodpecker
	Picoides moluccensis	Brown-Capped (Sunda) Woodpecker
Eurilaimidae	*Eurylaimus javanicus*	Banded Broadbill
	Corydon sumatranus	Dusky Broadbill
Pittidae	*Pitta granatina*	Garnet Pitta
Hirundinidae	*Hirundo tahitica*	Pacific Swallow
Campephagidae	*Hemipus hirundinaceus*	Black-Winged Flycatcher Shrike
	Pericrocotus igneus	Fiery Minivet
Chloropseidae	*Cloropsis cyanopogon*	Lesser Green Leafbird
Pycnonotidae	*Pycnonotus atriceps*	Black-Headed Bulbul
	Alophoixus phaeocephalus	Yellow-Bellied Bulbul

Dicruridae	*Dicrurus aeneus*	Bronzed Drongo
	Dicrurus paradiseus	Greater Racket-Tailed Drongo
	Dicrurus hottentottus	Spangled Drongo
Oriolidae	*Oriolus xanthornus*	Black-Hooded Oriole
	Irena puella	Asian Fairy Bluebird
Corvidae	*Pityriasis gymnocephala*	Bornean Bristlehead
Timaliidae	*Pellorneum capistratum*	Black-Capped Babbler
	Stachyris erythroptera	Chestnut-Winged Babbler
Turdidae	*Trichixos pyrrhophygus*	Rufous-Tailed Shama
	Copsychus malabaricus	White-Rumped Shama
	Enicurus leschenaulti	White-Crowned Forktail
Muscicapidae	*Hypothymis azurea*	Black-Naped Monarch
	Rhipidura perlata	Spotted Fantail
	Terpsiphone paradisi	Asian Paradise Flycatcher
	Philentoma pyrhopterum	Rufous-Winged Philentoma
Sturnidae	*Gracula religiosa*	Hill Myna
Nectariniidae	*Aethopyga siparaja*	Crimson Sunbird
	Arachnothera longirostra	Little Spiderhunter
	Arachnothera robusta	Long-Billed Spiderhunter

Sources of Reference:

* MacKinnon, J. and Phillips, K. (1993). A Field Guide to the Birds of Borneo, Sumatra, Java and Bali, The Greater Sunda Islands. Oxford University Press.

Mammals Encountered in the Sungai Wain Area
(May 1994- November 1994)

Family	Species	English name
Erinaceidae	*Echinosorex gymnurus*	Moonrat
Tupaiidae	*Tupaia minor*	Lesser Treeshrew
Cynocephalidae	*Cynocephalus variegatus*	Colugo/ Flying Lemur
Pteropodidae	*Pteropus vampyrus*	Large Flying Fox
Lorisidae	*Nycetebus coucang*	Slow Loris
Cercopithecidae	*Presbytis rubicunda*	Red Leaf Monkey
	Nasalis larvatus	Proboscis Monkey
	Macaca fascicularis	Long-Tailed Macaque
	Macaca nemestrina	Pig-Tailed Macaque
Hylobatidae	*Hylobates muelleri*	Bornean Gibbon
Manidae	*Manis javanica*	Pangolin/ Scaly Anteater
Sciuridae	*Ratufa affinis*	Giant Squirrel
	Calloscurius prevostii sanggaus	Prevost's Squirrel
	Sundasciurus lowii	Low's Squirrel
	Exilisciurus exilis	Plain Pygmy Squirrel
	Nannosciurus melanotis	Black-Eared Pygmy Squirrel
Muridae	*Leopoldamys sabanus*	Long-Tailed Giant Rat
Hystricidae	*Hystrix brachyura*	Common Porcupine
Ursidae	*Helarctos malayanus*	Sun Bear

Viverridae	*Arctictis binturong*	Binturong/ Bearcat
	Hemigalus derbyanus	Banded Palm Civet
	Herpestes semitorquatus	Collared Mongoose
Felidae	*Felis bengalensis*	Leopard Cat
Suidae	*Sus barbatus*	Bearded Pig
Tragulidae	*Tragulus javanicus*	Lesser Mouse-Deer
	Tragulus napu	Greater Mouse-Deer
	Muntiacus muntjac	Bornean Red Muntjac/ Common Barking Deer

Sources of Reference:

* Payne, J., Francis, C.M., and Phillipps, K. (1985). A Field Guide to the Mammals of Borneo. The Sabah Society, Kuala Lumpur.

* Yasuma, S.(1994). An Invitation to the Mammals of East Kalimantan. Pusrehut Jica, Samarinda.