Behavioural Activities and Foraging Ecology of Proboscis Monkey in Sarawak, Malaysia (Borneo)

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FINAL REPORT

A juvenile Proboscis Monkey selecting young leaves of *Mesua* sp. (Photo by Bolhan Budeng, 2012)

Abstract

There has been limited information on the foraging behaviour of Proboscis Monkeys particularly feeding ecology of these monkeys. Foraging behaviour of Proboscis Monkeys and the effect of phenology of the food plants between wet and dry seasons, and the influence of food availability on feeding strategy are still not much understood. Observation of behavioural activities and foraging behaviour of Proboscis Monkeys was undertaken in Bako National Park and Kuching Wetland National Park over a period of at least one year. A one-male group was selected from each study site and was followed continuously during the day for three to four days a week. In Bako National Park, the group of 15 which was habituated and easy to identify was selected, as one of its females was having a problem of fur loss and her skin looked very exposed. This observed group was relatively stable. Observations were undertaken on foot in the heath forest. In Kuching Wetland National Park the group of 18 which was found to have one baby with dark brown fur on its body was selected. The group size had always been monitored. The survey was carried out by boat and on foot during high and low tide in the area between Sg. Pergam and Sg. Jebong area. Observation of the two selected focal groups was done continuously during the day for three to four days a week. Each age/gender category from the selected one-male group was followed on different days. Feeding, resting, travelling and "other" activities of each category of animal were systematically sampled and recorded in five-minute intervals every 30 minutes from 6:30 am to 6:30 pm. The group was continuously observed outside the five-minute intervals. The total accumulated field time of 25 months, 310 days, and 2439 hours of direct observation ensured a comprehensive data set was available for analysis. Behavioural activities occurred within different forest strata and crown levels were also observed and analyzed. Feeding behaviour and types of food plants the monkey ate were observed using binocular. Food plants eaten by the monkeys were

indentified on the spot after they left the feeding area. Food plants that could not be identified were marked with ribbon taps, photographed and samples were collected. Samples of food plants were taken to the Forest Botany Section of Forest Department Sarawak and were identified using the collection of Forest Herbarium. Behavioural activities were significantly higher in the upper crown level and upper canopy particularly feeding activity. Feeding was significantly higher during the wet season as opposed to the dry season in Bako National Park. Young leaves were the most preferred food plant parts. Feeding on young leaves was significantly different between wet and dry seasons. There was a positive and moderate correlation between feeding and the production of young leaves with more frequency of feeding associated with higher production of young leaves of mangrove stands in Kuching Wetland National Park. Higher feeding on young leaves during the wet season coincided with higher foliation of mangrove stands during the same season. This explains the availability of food resources in the mangrove habitat influence feeding and diet category of the monkeys.

Introduction

Proboscis Monkeys showed variation in percentage of time spent feeding, resting and travelling in relation to different category of height of trees (Boonratana, 2000). Fluctuations in dietary diversity accessible to Proboscis Monkeys are influenced by seasonal availability of fruit, but they engage more in resting as opposed to feeding and moving when availability of fruit is scarce (Matsuda, Tuuga, & Higashi, 2009a).

Previous studies on feeding ecology of Proboscis Monkeys mainly focused on one habitat type and comparisons between two or more similar habitats in different locations (Matsuda, et al., 2009a; Yeager, 1989). Nevertheless, information on the effect of seasonal change on the activity budgets and a more comprehensive understanding of feeding ecology is still lacking. This is because Proboscis Monkeys' diet in the wild is more varied than has previously been understood and the phenology of some food plants does not follow mass flowering and fruiting of many tropical rain forests. In addition some food plants foliate regularly and are available during all seasons (Hon & Gumal, 2004; Matsuda, et al., 2009a; Yeager, 1989).

Proboscis Monkeys were found to be more varied in their diet (Bennett & Sebastian, 1988; Matsuda, 2008; Matsuda, et al., 2009a; Salter & MacKenzie, 1981), with young leaves forming a significant proportion of this diet (Matsuda, 2008; Yeager, 1989). They also showed variation in terms of amount of food items consumed (Bennett & Sebastian, 1988; Matsuda, 2008) depending on their size, age and gender and daily activities they performed (Bismark, 2010). Most of the food eaten by Proboscis Monkeys is digestible food but bitter, and non-sugary and not sweet fruit (Bennett & Gombek, 1993).

Plant species categorized as food plants for Proboscis Monkeys also varied according to habitat and locations. Although young leaves were the most preferred food, fruits and seeds formed over half of Proboscis Monkeys' diet (Bennett & Sebastian, 1988).

The preferred objectives of this research are:

1.1 To examine whether behavioural activities of Proboscis Monkeys differ in relation to forest strata and crown levels.

1.2 To examine whether wet and dry seasons influence behavioural activities of Proboscis Monkeys.

1.3 To document the preferred food plants and food items of Proboscis Monkeys and seasonal variations in this preference.

1.4 To examine whether seasonal fruiting and flowering changes foraging behaviour.

Method

The field survey was undertaken over a thirteen-month period from May 2011 to May 2012 at Bako National Park (NP), and a twelve-month period from June 2011 to May 2012 at Kuching Wetland National Park (NP), Sarawak, East Malaysia (Borneo). This twelve to thirteen-month study period ensured that seasonal changes under the broad categories of wet and dry seasons could be accounted for over a period of at least one year.

In these two study sites the wet season, which averages 562 mm of rain, occurs from November to February, and the dry season, which averages 157 mm of rain, occurs from May to August. There were months outside the designated wet and dry season periods which were excluded from the analysis of seasonal change and these were September/October and March/April. From May/June 2011 to May 2012, a range of field data was recorded five days each week from Monday to Friday across the two field sites (Bako NP and Kuching Wetland NP) by myself, the principal investigator, and two field assistants (Field Assistant #1 and #2). I trained these two field assistants in data collection techniques and continuously supervised them as we worked at the same time and place. This was to establish the reliability of the data collection to ensure the application of a standardised process and inter-observer reliability. However, most of the data collection I did myself whilst the field assistants assisted with the phenological survey.

For the purpose of this study I selected a one-male group (a group with one male) from each study site and I followed this focal group with one field assistant from June 2011 to May 2012. The use of a focal group for data collection of animal behaviour is well established in primate research as it is considered an efficient, reliable and representative sampling unit (e.g., Milton (1980); Yeager (1991); Boonratana (2000); Chapman et al, (2000); Chapman et al, (2007); Matsuda et al, (2009b)).

In Bako NP, I identified three groups of Proboscis Monkey, each with their respective young off-spring. The difference between these three groups was that they had 18, 15 and 5 individuals respectively, including offspring. I selected the group of 15 which was habituated and easy to identify, as one of its females was having a problem of fur loss and her skin looked very exposed. This observed group was relatively stable. They only joined together with other groups in the mangrove forest over the study period. Observations were undertaken on foot.

In Kuching Wetland NP, I identified two groups of Proboscis Monkey which comprised of 18 and 22 individuals respectively. I selected the group of 18 which was found to have one baby with dark brown fur on its body. The group size had always been monitored. There were two sub-adult females immigrated and a juvenile with a sub-adult female emigrated throughout the study period. But the number of individual within the observed group remained the same at the end of the study period. The survey was carried out by boat and on foot during high and low tide in the area between Sg. Pergam and Sg. Jebong area.

Observation of the two selected focal groups was done continuously during the day for three to four days a week. The remaining days in each week were allocated for phenological work, mapping the feeding and sleeping places, and identifying the food plants in both study sites (Milton, 1980). My field assistant and I followed each age/gender category of focal monkey on different days from the selected one-male group.

Four main behaviours were identified and recorded during the periods of direct observation of the focal group and/or individual. These behaviours were defined as follows and are in accordance with other research undertaken in the field (Matsuda, 2008; Milton, 1980; Salter, MacKenzie, Nightingale, Aken, & Chai, 1985; Soendjoto, 2005; Soerianegara, Sastradipradja, Alikodra, & Bismark, 1994).

a. Feeding
   Feeding is eating and/or drinking something. This also includes the feeding process: plucking or putting something into mouth, chewing and swallowing.
b. Resting
   The monkey is considered resting when it is predominantly in an inactive state but includes defecating, and urinating. Physically there is no feeding and moving from tree to tree, or climbing, or shifting from one sitting place to another sitting place on the same branch of tree, or on the forest floor.
c. Travelling
   Travelling is spatial change in monkey's position including moving from tree to tree, or climbing, or shifting from one sitting place to another sitting place on the same branch of tree, or on the forest floor. This behaviour also includes moving while chewing something in mouth.
d. Other
   Any behaviours that are not falling within the above three defined behaviours, including grooming, copulation, swinging, and social interactions.

Behavioral activities and other related behaviours were systematically sampled (Altmann, 1974) and recorded in five-minute intervals every 30 minutes from 6:30 am to 6:30 pm at each study site. This provided a quantitative data set of number of behavioural events per five-minute-sample period across the twelve-hour period, totalling 22 five-minute-sample periods per day of follow and direct observations. In addition to this events sampling method, the group was continuously observed outside the five-minute intervals such that it was not lost from sight. Outside the five-minute-sample period incidental observations were recorded in a field note book. My field assistant and I chose another focal monkey when the first observed one was lost for more than 30 minutes. The use of a focal animal sampling method within the focus group (Altmann, 1974) was applied for recording behavioural data. The repeated sampling of particularly conspicuous individuals (Chapman, Chapman, & Gillespie, 2002) was avoided by purposely recording data on a focal animal from each age/sex category on different days. The data collected is therefore representative of the mixed membership of the focus groups.

Our daily routine was to arrive at the sleeping place at 6:00 am, which was identified at 6:30 pm or 7:00 pm on the previous census day. I recorded the daily feeding and sleeping locations using Garmin GPSmap 76CSx. The focal group was continuously followed for the whole day till 7:00 pm or until the monkeys set up the next sleeping place. This sequence

was followed until the end of both the twelve and thirteen-month survey periods.

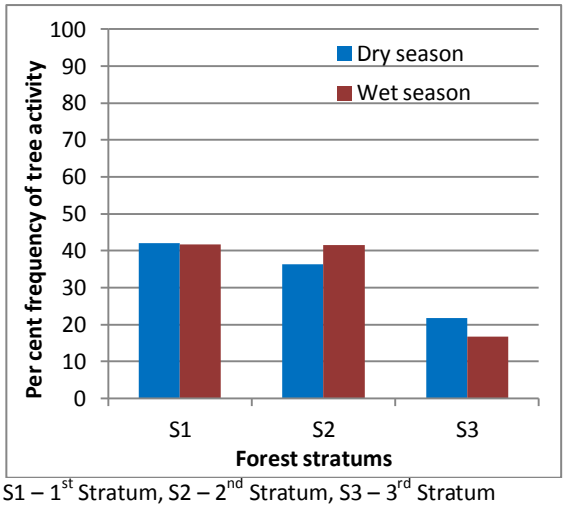
During the day of follow, in addition to recording each behavioural event over the five-minute-sample period, and the intervening 30 minute incidental observation period, all food plants eaten by Proboscis Monkeys were identified on the spot after they left the feeding area. This was undertaken with the assistance of the second field observer. Food plants that could not be identified were marked with ribbon tapes, photographed and samples were collected. A Vivitar Series1 Binocular 7x35WA was used to observe feeding behaviour and types of food plants the monkey ate. In this way the diet of study animals was established.

In Bako NP, I with one field assistant and one casual labourer made five sampling quadrats along Paku Trail-Lintang Trail zones in the heath forest. The size of each sampling quadrat was 20 m x 20 m and located 5 m away from the trail. The distance between each quadrat was not less than 100 m depending on the terrain. All trees ≥ 10 cm D.B.H. were measured and tagged. The total height of trees was calculated using trigonometric principle. These quadrats were visited once a week from June 2011 till May 2012. Flowering and fruiting trees were recorded.

In the mangrove forests in Bako NP, 3 plots comprising of 5 quadrats each were set up in the small pocket of mangrove in parallel with the coastal line. The distance between each plot was not less than 100 m and distance between each quadrat was 50 m. Each quadrat size was 20 m x 20 m. In Kuching Wetland NP, a total of 5 plots comprising of 5 quadrats each of the same size were established, and also parallel with the coastal line. All trees ≥ 10 cm D.B.H. and their height were measured. With the help of a field assistant, phenology of mangrove forests was undertaken every week at both study sites. Young leaves, flowers, flower-buds and fruits were counted in one crown unit and multiplied by the number of crown units in the tree (Kavanagh, 1987).

Results

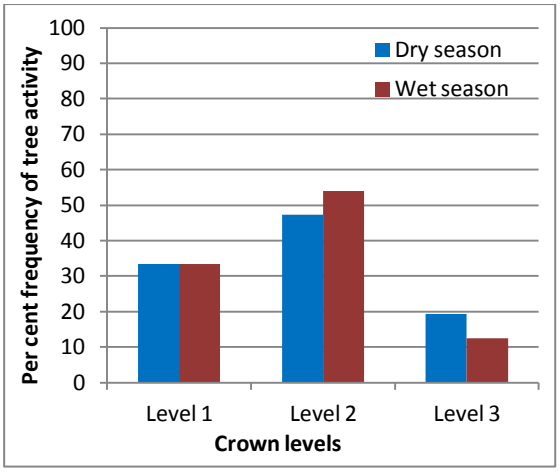
The study group in Bako NP mostly preferred upper canopy (S1) as opposed to other forest stratums, upper canopy activity (Figure 1) also occurred most frequently in both dry (42%) and wet (41.7%) seasons. However, the frequency of tree activity during the wet season in the upper canopy was almost similar to mid canopy (41.5%).



S1 – 1st Stratum, S2 – 2nd Stratum, S3 – 3rd Stratum

Figure 1: Percentage of tree activity according to seasons in Bako NP

In Kuching Wetland NP, seasonal variation in activity in Level 1 was not evident (33% dry and wet season) but there was a preference to use Level 2 in the wet season (54%) and Level 3 during the dry season (19%) (Figure 2).



Level 1 – Top Level Crown, Level 2 – Middle Level Crown, Level 3 – Bottom Level Crown

Figure 2: Percentage of tree activity according to seasons in Kuching Wetland NP

Behavioural Activities

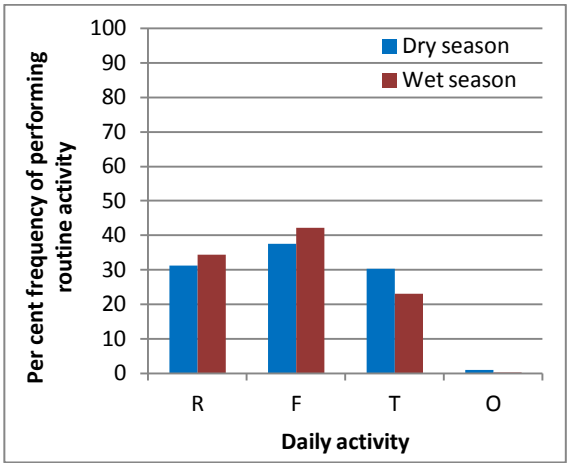
a. Bako National Park

Feeding A significant difference was evident for *feeding* activities performed in the wet and dry season (n = 1398; X^2 = 10.65, d.f. 1, p = 0.001). Figure 3 shows that this study group of Proboscis Monkeys engaged more frequently in *feeding* during the wet season (42%; n = 1800 activity events performed) compared to dry season (37%; n=1700 activity events performed).

Resting The most frequent *resting* activity occurred during wet season (34%) as opposed to dry season (31%). The difference in *resting* activity between these two seasons was significantly different (n = 1149; X^2 = 6.89, d.f. 1, p = 0.009).

Travelling A statistically significant variation was also evident for *travelling* activity between wet and dry seasons (n = 932; X^2 = 10.73, d.f. 1, p = 0.001). The *travelling* activity occurred most frequently during the dry season (30%) as opposed to the wet season (23%).

This study group did not engage in "other" activities during the wet season but they did engage in "other" activities during the dry season (1%).



R – resting, F – feeding, T – travelling, O – Other activities

Figure 3: Seasonal routine behavioural events in Bako NP

b. Kuching Wetland National Park

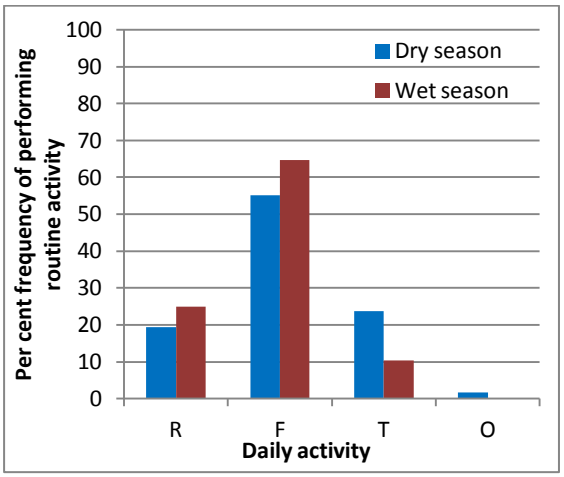
The activity pattern of the study group of Proboscis Monkeys in Kuching Wetland NP during both wet and dry seasons was slightly different to that of Bako NP (Figure 4).

Feeding The Kuching Wetland NP study group was much more active *feeding* during the wet (64%) season (n = 1199 activity events performed in wet season) compared to the dry (55%) season (n = 1300 activity events performed in dry season). However the variation of *feeding* activity between wet and dry seasons was not significantly different (n = 1492; X^2 = 2.25, d.f. 1, p> 0.05).

Resting They engaged more frequently in *resting* during the wet season (25%) compared to the dry season (19%) and this variation was significantly different (n = 553; X^2 = 3.99, d.f. 1, p = 0.04).

Travelling They engaged more frequently in *travelling* during the dry season (24%) compared to the wet season (10%) and this variation was significantly different (n = 25; Z = -2.723, $p < 0.01$).

Furthermore, whilst they did not engage in "other" activities during the wet season they did engage in "other" activities during the dry season (2%).



R – resting, F – feeding, T – travelling, O – Other activities

Figure 4: Seasonal routine behavioural events in Kuching Wetland NP

Food Plant Intake

a. Bako National park

Proboscis Monkeys in this study group did not exclusively utilize a single tree for feeding purposes. Rather a number of trees of the same and varied species were used in their daily forging routine. They were observed eating different consumable food items from 53 species of plants including two vines over the 12-month-study period. In addition to these plant species, they were also found eating White-rot Fungus (*Lentinus* sp.; on one occasion).

Of the Myrtaceae family, at least nine species provided the food sources most commonly eaten. Among these *Syzygium* spp. was most preferred. From family of Clusiaceae, at least six species provided their most frequently sourced food items, *Garcinia* spp. being their most preferred. These food plants were observed to be foliating consistently. In September and October 2011, they were also found eating seeds from *Syzygium* spp. In mangrove forests, this study group of Proboscis Monkeys preferred to eat young leaves of *Sonneratia alba* from the family of Sonneratiaceae.

b. Kuching Wetland National Park

Proboscis Monkeys in this study group were observed eating different food items from 6 species of plant from the families of Avicenniaceae,Meliaceae, Rhizophoraceae, and Sonneratiaceae. They ate most frequently young leaves of *Avicennia alba, Avicennia marina, Rhizophora apiculata, Rhizophora mucronata and Sonneratia alba* for whole study period. The most preferred food plant was *Sonneratia alba,* which foliated consistently over the study period. In January, February, and March, this study group was found eating seeds from the fruits of *Sonneratia alba*. However, they were only found eating young leaves of *Xylocarpus granatum* in July, September, October, December 2011 and May 2012 especially the *adult females* on many occasions ate young leaves of *Xylocarpus granatum* in July and December 2011.

Feeding on Food Items Categories According Seasons

a. Bako National Park

This study group showed variation in *feeding* on food item categories between wet and dry seasons (Figure 5). They engaged more frequently in *feeding* on young leaves (56.5%) during the wet

season as opposed to the dry season (50%). However, they fed more frequently on shoots during the dry season (39.7%) as opposed to the wet season (27.5%). Variation was also evident in frequency of *feeding* on other food items. They engaged more frequently in *feeding* on flower buds (1.6%) and leaf bases (3.8%) during the dry season, and more frequently in *feeding* on flowers (3.2%) and seeds (8.7%) during the wet season. In the dry season, flowers and seeds occupied 1.5 per cent and 3.3 per cent frequency of *feeding* respectively. While the frequency of *feeding* on green fruits was 0.6 per cent during the wet season, there was no record of *feeding* on this food item during the dry season.

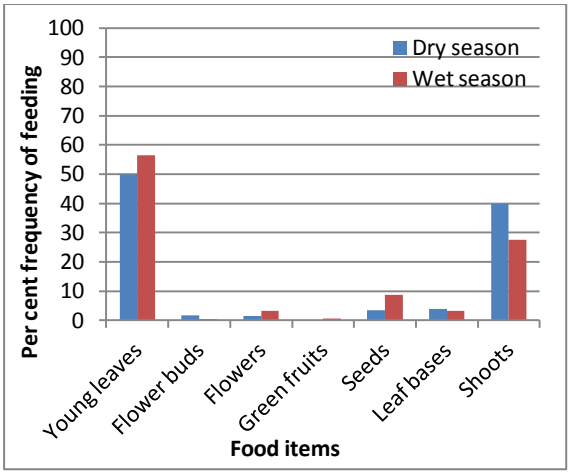


Figure 5: Per cent frequency of feeding on food items according to seasons in Bako NP

b. Kuching Wetland National Park

Variation in frequency of *feeding* according to food categories between wet and dry seasons was also evident in this study group (Figure 6). They engaged more frequently in *feeding* on young leaves during the wet season (66.1%) as opposed to the dry season (65.8%). Frequency of *feeding* on flower buds was the lowest (3.6%) among the food items during the wet season. Frequency of *feeding* on green fruits was 5.1 per cent, whereas a similar frequency of *feeding* on seeds (12.8%) and shoots (12.4%) during the wet season was recorded. They engaged most frequently in *feeding* on shoots during the dry season (32.1%) compared to the wet season (12.4%). Frequency of *feeding* on flower buds and seeds were 1.6 per cent and 0.6 per cent respectively during the dry season. Similar to Bako NP, there was no record of *feeding* on green fruits during the dry season.

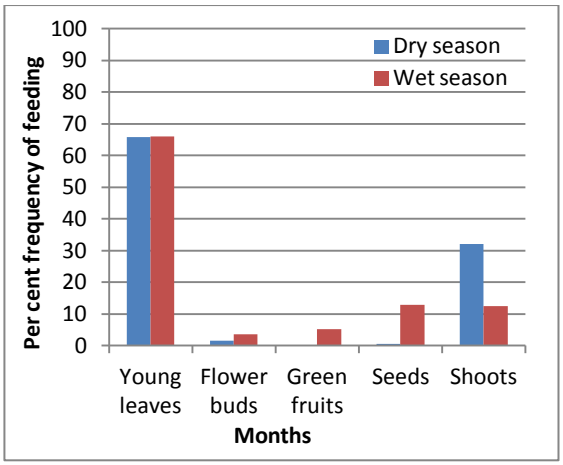


Figure 6: Per cent frequency of feeding on food items according to seasons in Kuching Wetland NP

Relationship between Plant Phenology and Feeding

a. Heath Stands Inside Monitoring Plots in Bako National Park

For heath forest, there was no significant correlation between *feeding* and flowering events (n = 21; *rho* = 0.147, *p* = 0.524) and also no significant correlation between *feeding* and fruiting events in heath forests (n = 25; *rho* = 0.164, *p* = 0.434).

b. Mangrove Stands Inside Monitoring Plots in Bako National Park

There was no significant correlation between *feeding* and the production of young leaves (n = 38; *rho* = 0.047, *p* = 0.778) and also no significant correlation with production of other food items (*feeding* and production of flower buds (n = 25; *rho*= 0.221, *p* = 0.289), *feeding* and production of flowers (n = 16; *rho* = 0.233, *p* = 0.386), *feeding* and production of green fruits (n = 18; *rho* = 0.369, *p*> 0.132).

c. Mangrove Stands Inside Monitoring Plots in Kuching Wetland National Park

There was a positive and moderate correlation between *feeding* and the production of young leaves (n=37; *rho* = 0.387, *p* = 0.018) with more frequency of *feeding* associated with higher production of young leaves of mangrove stands. As young leaves constituted a considerable component of the food intake of this study group of Proboscis Monkeys, increase in the production of young leaves and hence their availability would be followed by an increase in *feeding* on this food item given its preferred food item status. Positive correlation was also evident between frequency of *feeding* and production of flower buds (n=25; *rho* = 0.004, *p* = 0.984). This relationship, however, was not significantly correlated. Negative correlation between frequency of *feeding* and production of green fruits was also not significant correlated (n= 21; *rho* = -0.016, *p* = 0.944).

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Final budget

Item	**Total Cost (£)**	**Amount Provided by PSGB (£)**
Supplies	300	
Accommodation	1,800	
Transport	1,900	
Food	1,500	400.00
Field assistants	1,100	350.00
Field equipments	1,350	
Total	**7,950**	**750.00**

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