THE FORAGING PATTERN OF CAPTIVE *Cynopterus brachyotis* FED WITH *Ficus benjamina* AND BANANA

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*Ficus benjamina* AND BANANA

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This project is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science with Honours (Animal Resource Science and Management Program)

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2005
DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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</tbody>
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The Foraging Pattern of Captive Cynopterus brachyotis Fed with Ficus benjamina and Banana

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ABSTRACT

The purpose of this study was to investigate the foraging pattern of captive Cynopterus brachyotis fed with Ficus benjamina and banana (Musa sp.). Nine adult male C. brachyotis used, were placed inside the bat room and fed with different food: (a) banana only, (b) F. benjamina only and (c) banana + F. benjamina. The amount of food consumption and foraging pattern were tested under dark and bright background. The total amount of each food consumed was recorded. Foraging pattern, which was indicated by the time of first flight, time of first landing, time of first feeding and frequency of bat feeding was also recorded. The time of first flight, time of first landing and time of first feeding were significantly earlier in dark versus bright background. There is less frequency of bat feeding during bright background. For two types of food offered, C. brachyotis have greater preference on banana compared to F. benjamina. However, when F. benjamina or banana was offered alone the bats consume more F. benjamina than banana.

Key words: Foraging pattern, C. brachyotis, banana, F. benjamina, captivity.

ABSTRAK


Kata kunci: Corak pemakanan, C. brachyotis, pisang, F. benjamina, dalam kandang.
1.0 INTRODUCTION

Bats are distinguished from other mammals by their wings and their ability to fly. Eleven genera of fruit bats are currently recognized from Borneo (Payne, 1985). Bats are divided into two suborders, which are Megachiroptera and the Microchiroptera (Findley, 1993). All Megachiroptera belong to the family Pteropodidae and feed exclusively on fruit, flowers and pollen. Morphological features of fruit bats differ depending on type of plant that they feed on. Several small species have elongate snouts and tongues, this is an adaptive features for fruit bat which specialize in nectar and pollen feeding (Findley, 1993).

*Cynopterus brachyotis* belongs to the suborders Megachiroptera, which feeds exclusively on plants, especially on small fruits and nectar. It is found in lowland primary forest to mangroves (Payne, 1985). *C. brachyotis* can be distinguished from other bats through the pale colour of the edge of its ears and their whitish wing bones (Payne, 1985). According to Payne (1985), the teeth of *C. brachyotis* are designed to cut and chop up fruits. It has two pairs of lower incisors for feeding on fruits and it has a strong jaw (Payne, 1985).

Previous study has shown that pteropodid bats have great predilection for *Ficus* spp. including *F. benjamina* (Tan et al., 1999). According to Wilson (1988), banana is a primary diet for bats in captivity. According to Fujita (1988), banana (*Musa* sp.) is considered as ‘bat plant’ production in Tropical forest.

Compared to microbats, fruit bats rely on eyesight and smell to locate their food (Payne, 1985). Although fruit bats can see perfectly well, they cannot distinguish color. However it is important for bats to be able to tell if it is dark enough to venture out of their roost sites for foraging (Richardson, 1985).
The objectives of this study is (i) to determine the foraging pattern and amount of food consumed by *C. brachyotis* fed with *F. benjamina* compared to when fed with known preferred food such as banana (*Musa* sp.), and (ii) to determine the effect of dark versus bright background/environment on foraging pattern and amount of food consumed by the bats.

2.0 LITERATURE REVIEW

2.1 Diet of fruit bats

*Cynopterus brachyotis* occupies a variety of habitats including primary lowland and hill forest, mangrove forest, swamps forest, cultivated areas, orchards, garden and urban areas, and it is well adapted to anthropogenic conditions (Tan *et al.*, 1997) and commonly feed on small fruits and nectar. It is reported, that *C. brachyotis* feed on the fruits of 54 species, the leaves of 14 species and the flower part of four species (Tan *et al.*, 1999; Tan *et al.*, 1998). From the previous study, it was still suggested that *Ficus* spp. are a key component in the diet of fruit bat. *Ficus* spp. has steady production of fruits throughout year (Tan *et al.*, 1997). Among all the fruit available, there is selective fruit chosen by frugivorous bats depending on the hardness, size, composition, nutritional quality and other physical features of the fruit (Kunz, 1982). Feeding experiments have shown that bat only eat ripe fruit (Thomas, 1988). Previous study shows that *Carollia perspicillata*, *C. subrufa*, and *Glossophaga soricina* fed only on ripest fruits as they offered with elaecarpaceae (*Muntingia calabura*) in captivity (Thomas, 1988). This study indicates strong selectivity
on ripeness by fruit bats. Normally, the ripe fruits have a conspicuous color, strong odor, clustered at the end of the branches (Stashko and Dinerstein, 1988). The color and the odor of the fruit will attract the bats. The quality of particular food item depends upon the animal’s requirements, the energy and the nutrient contents of the items, the types and the amounts of non-nutrients that the item contains, and the efficiency with which energy and nutrient can be extracted and allocated to the above functions (Dinerstein and Stashko, 1988). Fruit that are available throughout the year or with a long fruiting season presumably play a major role in maintaining the population of C. brachyotis (Tan et al., 1998). C. brachyotis consumed all or parts of fruits from 38 plant species (Tan et al., 1999).

2.2 Foraging activity of fruit bats

It is suggested, that Cynopterus brachyotis eats several different types of fruit each night (Tan et al., 1999). According to Thomas (1988), bats might eat the fruit on the tree or carry it to the feeding roost when foraging. Sometimes, bats transported fruits to other nearby fruiting trees (different fruit species). After consuming one fruit, a bat would typically remove another fruit and transport it to a feeding or day roost (Tan et al., 1999). Megabats that are large in size carry fruit away from the tree when feeding, but small bat may eat on the same tree (Altringham, 1996). The mass of fruit that the bat carried was significantly correlated with body mass of the bat (Thomas, 1988). August (1981) found that the number of bats captured at Ficus spp. trees in Venezuela is positively correlated with mean fruit size but it shows negative correlation with fruit hardness. Fruits weighing up 20g were usually carried to feeding roosts up to 100m from the source tree (Tan et al., 1999). In the
previous study done by Funakoshi and Zubaid (1997), *C. brachyotis* did not feed in the fruiting trees, but instead dispersed seed to feeding roosts. Some pteropodids fly up to 50km each night to forage for food (Whittaker and Jones, 1994).

*Cynopterus brachyotis* first become active shortly after sunset, when individuals appeared in the vicinity of fruiting trees (Tan et al., 1999). Foraging time is defined as the time that the bats were away from the day-roost, including all foraging bouts over the night (Hamilton and Barclay, 1998). Most bats made one to several flights around fruiting trees before removing a single fruit (Tan et al., 1999). Before the bats start to feed, they will nudge the feed a little bit as a “bite test”. This is done to check the condition of the food and to confirm the location of the food. When the bat confirm that the territory is secure, it will start feeding when they hungry (Abdul Wahab, 2000).

### 2.3 Factor influencing foraging activity

There are many factors that influence foraging activity of bat. The factors are the temperature, ambient light, and humidity. Bats are active during warm temperature and hibernate during cold. Minimum temperature for bats to allow for normal flight and feeding behavior is probably 24°C, and maximum is 33°C. An optimal temperature for most species is probably around the 26°C (Wilson, 1988). An ambient temperature was not a significant influence for emergence time. Juveniles and adults fruit bats increased foraging time with increasing ambient light temperature at emergence. Emergence time is defined as the time in minutes after sunset, when a bat emerged for its first foraging bout (Hamilton and Barclay, 1998).
Moonlight is an environmental factor that inhibits the nocturnal activity pattern of a few species of bats, both under natural and laboratory conditions. The number of bats visiting the food patch was higher during dim period and the peak foraging activity was at 0200h (Marimuthu and Singaravelen, 2002). Bats reduced in number when feeding during bright moonlight in order to avoid nocturnal predators. All these studies show that when there is an increase in the intensity of moonlight, animals reduce the use of open space and restrict their foraging activity to the periods of darkness (Marimuthu and Singaravelen, 2002). Bats possess essentially all rod retinas, and thus appear to lack color vision. It is often been assumed that bats are therefore insensitive to long-wavelength light, and, thus a number of studies of bat behavior have relied upon dim red lights with wavelength greater than 580 nanometers (Barclay and Bell, 1988).

Another factor that affects foraging pattern of fruit bats is humidity. It is important to regard either it is raining or not when the observation on bat activity is conducted. Rain will influence the ambient temperature, and will affect the foraging activity of bats both in field and captivity. Most people recommended humidity in the range of 60-90% for most species of bats (Wilson, 1988). Ecological factors such as food shortage play the major role in the bat’s food choice (Funakoshi et al., 1993).

Research study done by Codd (1997) revealed that roosting was the major part of the activity budget of M. schreibersii. The next most frequently observed behaviors is foraging and grooming which occurred with about the same frequency and the inversely related to levels of roosting. Time budget for bats is different at each level of age and sex. Male bat spent more time crawling and grooming than adult female bats. Bats were less active during the day than at night.
3.0 MATERIALS AND METHODS

3.1 Bats

The bats were caught near Kampung Muara Tuang, Kota Samarahan. Two mist nets were used to capture the sample. These were put up at 6pm and checked at 8pm. The species of bats captured were identified using Payne et al., (1985). The body weight and standard morphological were recorded. Only male adult C. brachyotis were taken for this study and the others were released. The bats were taken to Unimas (Rumah Haiwan) and then release in the ‘bat room’. Nine Short-nose fruit bats Cynopterus brachyotis were used.

Table 1. Measurement of the C. brachyotis used in the study.

<table>
<thead>
<tr>
<th>No.</th>
<th>Weight (g)</th>
<th>Forearm (mm)</th>
<th>Wing length (cm)</th>
<th>Tail length (mm)</th>
<th>Ear length (mm)</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>64.46</td>
<td>38</td>
<td>8.48</td>
<td>15.04</td>
<td>Male</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>64.65</td>
<td>40</td>
<td>9.27</td>
<td>15.99</td>
<td>Male</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>60.39</td>
<td>37</td>
<td>8.14</td>
<td>14.68</td>
<td>Male</td>
</tr>
<tr>
<td>4</td>
<td>37</td>
<td>63.97</td>
<td>41</td>
<td>8.12</td>
<td>15.76</td>
<td>Male</td>
</tr>
<tr>
<td>5</td>
<td>38</td>
<td>64.26</td>
<td>43</td>
<td>8.26</td>
<td>15.50</td>
<td>Male</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>64.68</td>
<td>42</td>
<td>8.91</td>
<td>16.91</td>
<td>Male</td>
</tr>
<tr>
<td>7</td>
<td>36</td>
<td>63.05</td>
<td>43</td>
<td>8.93</td>
<td>16.28</td>
<td>Male</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
<td>62.44</td>
<td>42</td>
<td>8.48</td>
<td>16.23</td>
<td>Male</td>
</tr>
<tr>
<td>9</td>
<td>36</td>
<td>62.84</td>
<td>42</td>
<td>8.07</td>
<td>15.50</td>
<td>Male</td>
</tr>
</tbody>
</table>
3.2 Bat room

The size of the room is 583 cm length X 289 cm width X 267 cm high. The room is decorated with black netting attached on the wall and a tree was placed inside the room. Two basins of water also put in the room to provide water for the bats to drink. The plan of bat room is given in figure 1.

![Figure 1: Plan of bat room.](image)
Figure 2. Banana and *F. benjamina* was hanged on the tree in bat room for dark background.

Figure 3. Banana and *F. benjamina* was hanged on the tree in bat room fitted with white cloth on the wall to create a bright background.
3.3 Experimental Design

The study is based on a 2 X 3 factorial design. Factor A (Food) has three levels: (A1) *Ficus benjamina* only, (A2) banana (*Musa sp.*) only, (A3) *Ficus benjamina + banana* (*Musa sp.*). Factor B (environment/background) has two levels: (B1) dark background and (B2) white background. Each treatment was replicated five times.

The hypotheses are:

Ho1- There is no difference in foraging pattern in dark and bright background.

Ha1- There is difference in foraging pattern in dark and bright background.

Ho2- There is no difference in amount of food (banana versus *F. benjamina*) consumed in dark and bright background.

Ha2- There is difference in amount of food (banana versus *F. benjamina*) consumed in dark and bright background.

3.4 Collection of data

Banana and several branches of *Ficus benjamina* were weighed. *F. benjamina* was weighed after all of the leaves were removed in order to reduce the influences on the loss of weight by evaporation from the leaves on the data of weight recorded. Banana and *F. benjamina*, which have been weighed, were hanged up on the artificial tree inside the bat room. Foraging activity of *Cynopterus brachyotis* was observed from 6pm till 6am. After the time of first feeding was taken, the observation is made every five minutes for foraging activity of bats at night. This activity was recorded as the frequency of bats seen feeding on
the food. The time and the frequency of bats feed on food are recorded. The *F. benjaminia* and banana were weighed again the next morning.

The following data were recorded:

- Time of first flight - Time when first bat leave the roost for the first time.
- Time of first landing on food patch
- Time of first feeding, and after this, the frequency of bats feed in every five minutes.
- Weight of each food consumed (initial weight-final weight).

Light intensity for dark and bright background was measured using light meter model LI-250.

- Dark background
  Five watt of bulb was used for dark background. Light intensity for dark background was 1.6 lx.
- Bright background
  36 watt of Pendarflour lamp was used. Light intensity for bright background is 41.3 lx. A piece of white cloth is attached on the wall nearby food patch.

**3.5 Analysis of data**

Weight of food consumed, time of first flight, time of first landing and time of first feeding of bats were analyzed using MS-Excel (ANOVA, 2 factors with replication).
4.0 RESULTS

4.1 Amount of food consumed by *C. brachyotis*.

Table 2 shows the mean amount of banana and *Ficus benjamina* consumed by *Cynopterus brachyotis* in dark and bright background. From the table, it can be concluded that *C. brachyotis* consumed more when the background is dark.

Table 2. Mean amount of banana and *F. benjamina* consumed by *C. brachyotis* in captivity.

<table>
<thead>
<tr>
<th>Food</th>
<th>Background</th>
<th>Grand mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dark</td>
<td>Bright</td>
</tr>
<tr>
<td>Banana</td>
<td>365.0g</td>
<td>216.0g</td>
</tr>
<tr>
<td><em>F. benjamina</em></td>
<td>507.0g</td>
<td>228.0g</td>
</tr>
<tr>
<td>Banana + <em>F. benjamina</em></td>
<td>233.9g</td>
<td>205.0g</td>
</tr>
<tr>
<td>Grand mean</td>
<td>368.3g</td>
<td>216.3g</td>
</tr>
</tbody>
</table>

From table 3, the main effect of food and background colour is highly significant ($P<0.05$). Food consumption is lower when the background is bright compared to when it is dark (216.33g versus 368.33g per night). *C. brachyotis* eat more when food offered is *F. benjamina* and least when food offered is a combination of *F. benjamina* and banana (367.5g versus 219.0g per night). Each combination of treatments affects the amount of food intake by bats hence the interaction is also significant ($P<0.05$).
Table 3. ANOVA of the amount of banana and F. benjamina consumed in captivity.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>110311.667</td>
<td>2</td>
<td>55155.8333</td>
<td>4.8989</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Background</td>
<td>173280</td>
<td>1</td>
<td>173280</td>
<td>15.3906</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Interaction</td>
<td>78785</td>
<td>2</td>
<td>39392.5</td>
<td>3.4988</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Within</td>
<td>270210</td>
<td>24</td>
<td>11258.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>632586.667</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From figure 4, it is clearly that C. brachyotis consumed more food in dark background. For three levels of treatment given, all of treatment shows that the amount consumed in dark exceeded the mean amount consumed in bright background. Although there is not much difference in amount of food taken when the both types of food offered simultaneously, the bats still consumed more in dark. For this level of treatment, the amount of food consumed is less compared when the bats offered with only one type of food at one time.
4.2 Amount of banana and *F. benjamina* consumed when both fruit were put simultaneously in the same room at same night.

Figure 5 shows amount of banana and *F. benjamina* consumed when both fruit are put in the room simultaneously. There is greater difference in the amount of banana consumed compare with *F. benjamina*. The preferences of *C. brachyotis* for banana obviously can be seen in the figure below, when the fruit are put simultaneously in the room. Banana is consumed more when it is in dark background (218g) while less amount of *F. benjamina* is consumed in dark background (15g).
Figure 5. Mean of banana and *F. benjamina* consumed in captivity (both fruit put simultaneously in the same room).

Table 4 shows ANOVA of the amount of banana and *F. benjamina* consumed when both fruits put simultaneously in the same room and night. It can be concluded that, there is significant difference in the amount of fruits consumed by bats in each treatment given. There is a very small value of P-value, meaning that the bats have a great preference on banana. The amount of banana consumed is very much greater than *F. benjamina*.

There is no significant interaction between the combination of background light intensity and levels of food offered (P>0.05). This indicates that the bats still prefer banana whether the background is dark or bright. Light intensity does not influence the preferences of the bats on the food they feed on.
Table 4. ANOVA of the amount of banana and F. benjamina consumed when put simultaneously in the same room and night.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>F</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>172980</td>
<td>1</td>
<td>172980</td>
<td>95.4701</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Background</td>
<td>980</td>
<td>1</td>
<td>980</td>
<td>0.5408</td>
<td>NS</td>
</tr>
<tr>
<td>Interaction</td>
<td>1445</td>
<td>1</td>
<td>1445</td>
<td>0.7975</td>
<td>NS</td>
</tr>
<tr>
<td>Within</td>
<td>28990</td>
<td>16</td>
<td>1811.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>204395</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NS=Not significant

4.3 Time of first flight of C. brachyotis.

It is observed that, the bats first fly out from roosting place between 6pm till 8pm most of the time. From the data recorded, there were a few times when the bats start going out from their roosting places at 8pm to 10:30pm. This is contrast to our common understanding that bats go out to forage at around 6pm and 8pm, which is the time is just after the sunset.

From table 5, it is clearly that the bats start to fly out earlier from roosting place, when the background is dark compared when the background is bright. The time of first flight was not really affected by the types of food given.