Advantages and disadvantages of different observation methods on a troop of wild olive baboons at a river in Southern Kenya

För- och nackdelar med olika observationsmetoder för en grupp vilda anubisbabianer vid en flod i södra Kenya

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ABSTRACT

Every observation method has its advantages and disadvantages and a well-adopted method gives more reliable results. Factors affecting the choice of the most appropriate methods for recording foraging behaviours include species, group size, environment, seasons and age. The focus for this study was to determine which method is most appropriate for studying the foraging behaviour of a troop of 89 olive baboons (*Papio anubis*) living in a riverine forest by the Southern Ewaso Ng'iro River by Lale'enok Resource Centre in Kenya. To determine this, a literature study was carried out to compare methods from monkeys and apes. I found instantaneous sampling was the most common method with intervals of 5 minutes in most cited studies. The most appropriate method along with instantaneous sampling was found to be focal animal sampling due to group size and behaviours in question. Seasonal changes can affect the water flow of the Southern Ewaso Ng'iro River, increasing it during the rainy season making it tough for the observers to cross. No articles were found on olive baboons living in riverine forests, showing that more research is needed. In other studies the most common length for collecting data was one to two years. The olive baboons at the Southern Ewaso Ng'iro River were habituated and the observers knew them individually, which made instantaneous focal animal sampling easier to use.

INTRODUCTION

Olive baboons (Papio anubis)

Olive baboons (*Papio anubis*) belong to a subgroup of Old World monkeys that are able to temporarily store food in pouches in their cheeks (Martin, 2004). The diet of the olive baboon includes different components such as leaves, seeds, fruit, flowers, grass, roots (Whiten *et al.*, 1992; Redmond, 2008) and sometimes even small animals such as rabbits (Strum, 1983). Overall the olive baboon is qualified as a frugivore and is a very important spreader of seeds from the consumed fruits (Kunz & Linsenmair, 2008).

Barton and Whiten (1994) discovered that energy and nutrition were the most important factors in choice of food and time spent foraging. In their study, olive baboons preferred food with high contents of carbohydrates, indicating a food source high in energy. Furthermore the baboons preferred protein but disliked fibers. A difference they found in food intake between males and females was that female baboons would eat less alkaloid containing plants while being pregnant. Common fig and acacia trees are examples of such plants (Liber Herbarum Minor, 2013).

Other ways to measure differences in foraging behaviour is by studying size and weight of the baboon. However, Eley *et al.,* (1989) dissuade from both of these parameters due to the fact that wild baboons have similar sizes regardless of what they eat, and the skeleton structure can affect their weight.

Southern Ewaso Ng'iro River

Baboons are only found in Africa, where they often live in dry and open areas (Martin, 2004). My study is based on olive baboons with a focal troop living along the Southern Ewaso Ng'iro River close to the Lale'enok Resource Centre, Kenya. Along that river a riverine forest is located with heavy vegetation including trees and bushes, but a few meters away from the river the landscape is dry, semi-arid and contains mostly open soil and the occasional bush. In dry areas riverine forests offer a big and important variety of animals and plants (Stave *et al.,* 2007). The riverine forest contains acacia trees and fig trees, among other plants (Odada *et al.,* 2006). According to S. Sompeta at Lale'enok Resource Centre (personal message, 19 February 2013) acacia and figs are preferred food choices for the local olive baboons.

A study by Odada *et al.* (2006) on the riverine forest by the Southern Ewaso Ng'iro River showed that these habitats are very interesting for many reasons. According to Odada *et al.* (2006) this riverine forest contains very important ecosystems with unique animals and plants. Furthermore they also found that the riverine forest is a big source for food, water and medicine for wildlife as well as for humans and livestock living near it.

A study on the riverine forest of the Tana River in eastern Kenya by Kinnaird (1992) showed that fruits and flowers in the riverine forest were dependent on the river's water level, showing that a dry condition as a result of low water level makes the flowers bloom. Furthermore water level distraction, such as upstream dams, can affect the flowers negatively and therefore also reduce the quantity of fruits in the area. This is relevant as flowers and fruits are very important food sources for olive baboons (Redmond, 2008).

According to S. Sompeta at Lale'enok Resource Centre (personal message, 19 February 2013) the olive baboons will spend more time outside the riverine forest than usual during the rain period, which occurs between March and June. During the rainy season the river can, according to the same source, become wide due to the rain and difficult to cross for the observers, which is an issue. Another issue with a riverine forest, according to the same source, is the poor visibility when the olive baboons are among trees and shrubs.

Different observation methods

The chosen methods used in a study will affect the results; hence a well thought through study is crucial (Ejvegård, 2009). The main observation methods I will focus on during this literature study are continuous sampling and instantaneous sampling. According to Martin and Bateson (2011), instantaneous sampling consists of short intervals where at each

sample point a record is made of the animals' behaviour. They also suggest using instantaneous sampling for measuring the behaviour's proportion. Ejlertsson (2010) suggests instantaneous sampling to calculate the variation size between two behaviours, for instance the variation between females and males.

While using continuous sampling, Martin and Bateson (2011) state that each behaviour is recorded along with the time it started and the time it ended, in a way that the behaviours' frequency, duration and latency can be measured. This is also a good method for analysing different sequences of a complex behaviour. Since continuous sampling requires the observer's total attention during the full observation it can be a very demanding method for the observer; a way to minimise this is to only include a few behaviour categories (Martin & Bateson, 2011).

Another factor that must be decided is how to observe the animals. The most common methods are scan sampling and focal animal sampling. Scan sampling refers to when the entire, or visible parts of, group is scanned by the observer and each animal's behaviour is recorded, this is best to use when the group includes few animals or when the behaviour categories are few (Martin & Bateson, 2011). Focal animal sampling on the other hand means that only one or few animals are studied at a time during the observation, this way more behaviours can be studied (Martin & Bateson, 2011). It is very important that each observation has a different focal animal sequence. Focal animal sampling is generally the best way to study groups (Martin & Bateson, 2011).

Aim of this study

The aim of this study was to establish the advantages and disadvantages of different observation methods used for collecting data on foraging behaviours of the olive baboon in the riverine forest by the Southern Ewaso Ng'iro River region. To test this I focused on the following questions:

- Would continuous sampling or instantaneous sampling be preferred in this study?
- Would scan sampling or focal animal sampling be preferred in this study?
- How will the environment affect the methods for the study?
- For how long should the study last?
- For how long should the baboons be habituated to the observers?

MATERIALS AND METHODS

Animals

The troop in this study contained 89 wild olive baboons, living by the Southern Ewaso Ng'iro River by Lale'enok Resource Centre, Kenya. Out of these 89 olive baboons approximately 45 of them were adults. The troop has been habituated to the field workers for three-five years. When observing, the recorders do not wear red clothing and wear a hat, this to distinguish them from the local Masai people whom olive baboons see as a threat. The other two threats for the baboons were lions and leopards. The troop included a male leader, lactating and non-lactating females, juveniles and low ranked males. I followed the two observers for seven days during their observations to see how they worked, the environment and how the baboons behaved.

I compared two ways of observing baboons in Lale'enok with each other, and evaluated these methods with the help of literature. The two methods were the following:

Old method used near the Southern Ewaso Ng'iro River (scan sampling) for studying foraging behaviour of olive baboons (Papio anubis)

The scan sampling method for studying olive baboons at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre was based on a protocol with instantaneous sampling with intervals of 15 minutes, and a weather sheet. Each day the weather was noted and a female was selected and followed, her ID and rank being noted (known due to earlier observations). Every 15 minutes the group around the female was scanned and the most common behaviour of the group was noted. Recordings were carried out 12 hours per day (six hours in the morning and six hours in the afternoon), five days a week (Monday to Friday). The recording of data was four times per hour, 12 hours a day, five days a week, giving a number of 960 recordings per four weeks. Since the olive baboons are diurnal (Redmond, 2008), they were not studied at night. In the protocol troop, date, observer, date, time, grid (GPS location), activity scan (any behaviour seen at the time), visibility (good, medium or poor) dispersal of the group in North-South and East-West directions showing the length between the furthest individuals of the group by codes, foods and other comments were noted. The list of food species all had number codes and the number was noted in the protocol.

New method used near the Southern Ewaso Ng'iro River (focal animal sampling) for studying foraging behaviour of olive baboons (Papio anubis)

The focal animal sampling method for studying olive baboons at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre is based on two protocols, one with continuous

sampling and one with instantaneous sampling. A weather sheet was also used daily, where date, time, temperature, humidity, sunshine (sunny (<30% cloud cover), sunny/cloudy (30-70% cloud cover), cloudy (>70% cloud cover) or rain) and greenness (the vegetation where the baboons were located, usually “green” by the river, “quite green” or “little green” by the savannah) was noted. For each adult ID, category, date, time of day, age, family and number of infants (infants being less than 6 years of age) were noted. In the continuous focal animal protocol time, habitat (river, gallery forest, savannah, crops, boma or shoats), position (ground, shrub or tree), sitting species (the tree or bush the baboon is sitting, foraging, grooming or standing under), rare behaviours (mainly social behaviours not included in the instantaneous focal animal protocol), recipient (to whom the behaviour is directed to), carrying offspring (number off) and other comments were noted.

When instantaneous sampling was used the focal animal's behaviour was recorded every five minutes. In the instantaneous protocol time, way point (the location of the baboon, every time the baboon walks more than five meters a new way point was noted and its GPS position recorded), habitat (river, gallery forest, savannah, crops, boma or shoats), position (ground, shrub or tree), sitting species (the tree or bush the baboon is sitting, foraging, grooming or standing under), visibility, locomotion, foraging and common social behaviour (standing, lying, walking, running, chasing, being chased, grooming, being groomed, nursing, greeting, submission, disciplining, sound, playing, foraging, drinking or lactating), carrying offspring, plant species, plant part and other comments were noted.

The adult baboons were divided into the categories male, non-lactating female or lactating female. Each day one non-lactating female, one lactating female and one male were selected and studied for 2.5 hours. This order rotated daily. For every new day new adults were selected. The recording was made 12 times per hour, 7.5 hours per day, 16 days per month, giving a total number of 1440 recordings per month and 480 recordings per animal category per month. This resulted in 48 focal animals per month. If the focal animal was lost during the 2.5 hours of recording the observer switched to another adult of the same category. The list of food species all had number codes and the number was noted in the protocol, this was the same list that was used during Old method. Every column in each protocol was filled out according to the template (Appendix 1).

Articles and literature

I have conducted a literature study based on the questions mentioned under “*Aim of this study”* earlier in the text and hence used scientific articles as my main source of information rather than books. Problems could occur when relevant articles cannot be reached due to their cost, though this can also be an issue when using books. I have found articles about different apes and monkeys, including olive baboons. When looking at baboons I have only focused on olive baboons, since these are the main focus in my study.

A few of the articles I have used are rather old, the oldest is from 1977, yet I have decided to use them since my main focus was the methods used in the articles, rather than the actual results. Results can change due to new research, yet the methods used do not necessarily have to change.

To find relevant articles for this study I have used Google Scholar and the words “riverine forest”, “olive baboon”, “baboon foraging behaviour”, “Shirley Strum foraging”, “monkey foraging”, “method foraging behaviour monkey”, “effects of habituation to the observer”, “observer habituation primates”. I have also used the website www.baboonsrus.com to find articles.

I have not been able to use articles exclusively on the riverine forest by the Southern Ewaso Ng'iro River as enough studies have not been carried out at this location, to compensate this I have decided to use articles about other riverine forests in Kenya. Since the main area for this study has been Lale'enok by the Southern Ewaso Ng'iro River some of the local information has been gathered through interviews with two local observers that have been working with the olive baboons in the area, Sisco Sompeta and Joel Njonjo at Lale'enok Resource Centre.

RESULTS

Methods for studies on foraging behaviour of apes and monkeys, excluding olive baboons (Papio anubis)

To study the ecology and the foraging behaviour of proboscis monkeys (*Nasalis larvatus*) a study conducted by Yeager (1989) in a riverine forest in Tanjung Putting National Park in Indonesia. The vegetation was monitored monthly for an update on the availability of different kinds of food. Temperature was noted daily. To collect the data instantaneous scan sampling was used on groups, 12 groups were followed giving a total number of 145 animals. Behaviours were recorded every five minutes, 30 minutes per hour. Food was recorded as plant part and species. In total 1700 hours of observations were completed, resulting in 3739 individual recordings from January to December 1985. The groups were habituated to the observer (Yeager, 1989).

Year 1982 Leighton and Leighton published a study on the amount of *Trichilia* eaten by howler monkeys (*Alouatta palliata*) during one fruit season. The data was collected between August 21st and September 10th, when the *Trichilia* had the highest fruiting activity. Once a day a route of 3.7 km was walked and data was recorded with scan sampling, recording information about location, food species, activity and group size. To measure the amount of fruit in the area eight trees were chosen and during five days fruits and capsules were collected, counted and divided by five to get the amount of fruits fallen each day (Leighton & Leighton, 1982).

In Japan Maruhashi (1980) studied a wild troop of Japanese monkeys' (*Macaca fuscata yakui*) foraging behaviour on plant parts and species. The monkeys were studied from August to December 1976, resulting in a total number of 407 observed hours and 3349 recorded foraging behaviours. The monkeys were living in a forest and habituated to the observer. Scan sampling was used as one-zero sampling with a five minute interval. During the interval all the plant parts and species were noted that the Japanese monkeys consumed. Every 15 minutes the group was scanned and all the activities were recorded (Maruhashi, 1980).

In a study from 1998 Agetsuma and Nakagawa compared foraging behaviour between Japanese monkeys (*Macaca fuscata yakui*) in warm and cold habitats. All groups were habituated to the observers. Both females and males were included in this study, but not females in heat. Some of the food items in this study were fruits, seeds, flowers and leaves; not any specific parts. Two methods were used, depending on the size of the groups. For the smaller groups instantaneous scan sampling was used, with a five minute scan recording of all the individuals every 10 minutes. For each scan the number of foraging monkeys was divided by the total number of seen monkeys, to get the proportion. The smaller groups each included 5 to 19 and 7 to 10 individuals, which were studied between August 1989 and April 1992. The method used on the larger group was continuous focal animal sampling. A new focal animal was picked every day and the recorded behaviours were only used in the study if the observation lasted for more than three hours. The larger group included 20 - 51 individuals and was studied between November 1984 and August 1992 (Agetsuma & Nakagawa, 1998).

A study on silver leaf monkeys (*Trachypithecus auratus sondaicus*) in the Pangandaran Nature Reserve, Indonesia, on their foraging behaviour was made by Kool (1993). The monkeys were divided into two groups with 14 monkeys in each. Instantaneous scan sampling was used, recordings occurred during five consecutive days each month for a total number of 13 months. These 13 months included both low and high rainfall. Each interval was 10 minutes. In total 4359 scan samples were done, giving a total of 32 538 observations (Kool, 1993).

Doran (1997) studied the amount of time 70 habituated chimpanzees (*Pan troglodytes verus*) spent foraging. They were studied for 438 hours during seven months. The chimpanzees lived in an evergreen rain forest inside a national park in West Africa, where two rainy seasons and two dry seasons occur each year. The method used was instantaneous focal animal sampling where one chimpanzee was followed the entire day. The interval was one minute and the first 50 minutes of each hour were noted. Attempts were made to follow males and females equally. Furthermore the distance the focal animal traveled each day was noted (Doran, 1997).

The ideal way to record foraging behaviour in the wild according to Conklin-Brittain *et al.* (2001) is to record the grams of food, divided by time and food type. This was done to investigate how much time apes spend eating a particular food item. An issue is the difficulty of estimating the actual weight of the food. Often, measures of food amount and

foraging time are not combined into the same study, but done separately. During dense vegetation with poor visibility or with poorly habituated apes a lists of the food items is created from faecal analysis and actual observations and includes items such as plant parts and species (Conklin-Brittain *et al.,* 2001).

Nishihara published a study 1995 about how gorillas' (*Gorilla gorilla gorilla*) foraging pattern changed depending on the seasons throughout a year. The study was conducted on an area of 20 km2 inside the NouabaIé-Ndoki Reserve. The study recorded data during 287 days during one year, and the year contained two seasons, dry season and rainy season. Part of the area contained a riverine forest. Gorillas were observed and faeces were collected and analysed (Nishihara, 1995).

A study by MacKinnon was published in 1977 about the differences between gibbons, siamangs and orang-utans and their foraging behaviour and foraging preferences. These apes were studied together on different places such as Borneo, Sumatra and Malaya. Both gibbons and siamangs avoided riverine forests due to competitive macaques wanting the fruit in that area. The observers used the same observation method on all species, on the same place and during the same time. The method they used was instantaneous scan sampling. The animals were habituated to the observers and the observers knew each individual animal and every five minutes the behaviour and location of each animal in the group was noted. The data was collected during 16 months.

Methods for studies on foraging behaviour of olive baboons (Papio anubis)

To investigate the issue between human agriculture and wild olive baboons in Kenya, Strum (1994) studied four wild troops for six months in a high altitude savannah in the Great Rift Valley, Kenya. The body mass of the baboons was investigated, their home range measured, the size of the troops were counted and a behavioural study using continuous scan sampling was performed to see if there was any difference in time spent on foraging depending on what season it was (Strum, 1994).

To study predatory behaviour of olive baboons, one troop was studied for a total of 1200 hours, from December 1972 to January 1974. The olive baboons were located on a high altitude savannah in the Rift Valley in Kenya. Ad libitum sampling was used to study this behaviour (Strum, 1983).

Barton *et al.* (1992) investigated how the environment and food resources affected the group foraging behaviour; instantaneous scan sampling was used. The environment was divided into squares with an area of 0.25km^2 and the square with the most individuals was studied every 15 minutes between 7:00 in the morning and 18:00 in the evening. Food was collected each month at 28 sampling points. The olive baboons in this study were habituated to the observer. This study lasted from January 1986 to January 1987 and the

troop included 100 olive baboons. The location was at the Laikipia Plateau in Kenya where the habitat was dry savannah (Barton *et al.,* 1992).

In 1989 Eley *et al.* published a study based on three troops of wild olive baboons in the dry savannah of Rift Valley, Kenya. The troops included 138 olive baboons that were sedated so blood samples, faecal samples, weight and body condition could be measured. The study also included behavioural observations to study the foraging behaviours of the baboons. The observations were conducted for six months between 1983 and 1984 through instantaneous scan sampling, which was recorded every 30 minutes and included all the individuals and 28 different behaviours. The baboons were captured due to a translocation program (Eley *et al.,* 1989).

Barton and Whiten (1994) used continuous focal animal sampling while recording bite rate, species of food, food part and number of bites between January 1986 and January 1987 on habituated olive baboons. In their study fruits and flowers were counted as a unit of food, whereas grass and leaves were counted in bites. Furthermore the food was also divided into groups of small, medium or large plant sizes (Barton & Whiten, 1994).

Length of the intervals and length of the study

Out of the above mentioned studies in which the methods include an interval such as instantaneous sampling and one-zero sampling one study had one minute intervals (Doran, 1997), four studies had intervals of five minutes (MacKinnon, 1977; Maruhashi, 1980; Yeager, 1989; focal animal sampling study at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre), two studies had intervals of 10 minutes (Kool, 1993; Agetsuma & Nakagawa, 1998), two studies had intervals of 15 minutes (Barton *et al.,* 1992; scan sampling study by the Southern Ewaso Ng'iro River by Lale'enok Resource Centre), and one study had 30 minute intervals (Eley *et al.,* 1989).

In four cases data was collected for less than one year (Maruhashi, 1980; Leighton & Leighton, 1982; Eley *et al.,* 1989; Doran, 1997) where the study by Leighton and Leighton (1982) only meant to investigate one fruit season of *Trichilia* and therefore cannot really be included in those three cases. Seven of the studies were conducted during one to two years, making this time frame the most common length of study (MacKinnon, 1977; Strum, 1983; Yeager, 1989; Barton *et al.,* 1992; Kool, 1993; Barton & Whiten, 1994; Nishihara, 1995). Two studies collected data for more than two years (Strum, 1994; Agetsuma & Nakagawa, 1998).

Methods for studies on riverine forests during dry season and rainy season

All the articles referred to here have occurred during both dry season and rainy season. These seasons have not had any effect on the methods and there were no differences between methods for dry seasons or rainy seasons. According to S. Sompeta at Lale'enok Resource Centre (personal message, 19 February 2013) their baboons are effected by the different seasons in such way that they are more spread out during the dry season, due to the difficulty of finding food.

Kinnaird (1992) collected fruits and flowers all year around from 16 plant species in the riverine forest around the Tana River in Kenya. These plant species are important food for primates. Daily rain and temperature were recorded, along with the amount of plant species found. The area around the riverine forest is semi-arid and therefore the forest is only located close to the Tana River and is dependent of its ground water supply rather than the rain water. Due to this water supply the riverine forest often contains fruits and flowers throughout the year. The high water flow in the river occurs during and after the rainy seasons (Kinnaird, 1992).

To study the distribution and composition of woody vegetation by the Tana River Maingi and Marsh (2006) published a study on how sampling was made by using the transect method. Transects started by the river bank and ran out towards the edge of the forest while each segment was given the sides 25 meters x 25 meters. The riverine forest was 500 meters to 3000 meters wide on each side of the river (Maingi & Marsh, 2006).

Riverine forests at the Turkwel River in north-western Kenya have been studied by Stave *et al.* (2007) during seven botanical excursions from 1998 to 2004. Plants and bushes were collected and registered during these excursions. The rainy seasons occurred in this area during April and November (Stave *et al.,* 2007).

In year 2006 Odada *et al.* published a study concerning the importance of the Southern Ewaso Ng'iro River in southern Kenya. The inhabitants of eight villages were interviewed resulting in 300 interviews about wetland values, uses and attributes. The Southern Ewaso Ng'iro River is very important for its fresh water which is needed by wildlife, humans and their livestock. The rainy seasons occur from April to May and November to December.

Habituation

It can be very difficult to know how much the observer affects the behaviour of the study animal. According to Crofoot *et al.* (2010) the fact that the animals are not showing any aggression does not necessarily mean that the presence of the observer will not affect other behaviours. They tested if the observer had any effect on habituated white-faced capuchins' movement, activity pattern and ranging behaviour, but found there was no statistical difference between when an observer was present or when the capuchins were monitored

with radio telemetry. The monkeys had been habituated for five months. Crofoot *et al.* (2010) suggested habituation is important while studying wild animals in their natural environment. Furthermore habituation works best on group living animals rather than on solitary living animals (Crofoot *et al.*, 2010).

If the primates to be studied have been hunted, this will increase the time needed for habituation (Williamson & Feistner, 2003). Williamson and Feistner (2003) also claim that a general rule among baboons is that since they are opportunists they need relatively little time to habituate since they are often extrovert and are used to changes in their environment. Another rule, according to the same authors, is that baboons that live in open areas need relatively little time to habituate since they can spot the observer more easily than in a forest with limited visibility due to the vegetation. For olive baboons Williamson and Feistner (2003) suggest two to five months of habituation is needed before the study can start.

DISCUSSION

Choosing methods

Finding the best method for each study is very important; according to Ejvegård (2009) different methods can lead to different results. In my opinion, different methods can affect the animals' welfare as well, due to how close the observers must be to be able to observe and what the observers must do. Stress due to observer presence near an unhabituated group of white-faced capuchins resulted in high cortisol levels in the white-faced capuchins and them showing different behaviours than the habituated group showed (Jack *et al.*, 2008). Depending on which behaviours are relevant to the study each method has its advantages and disadvantages. Other factors to consider include the species of animals to study, the environment where they live, the weather changes during the year, do the animals live in groups or are they solitary, genders, ages and if the animals are wild or domesticated.

Old method used near the Southern Ewaso Ng'iro River (scan sampling) for studying foraging behaviour of olive baboons (Papio anubis)

In the Old method, a female was noted and followed and the group around her was scanned and noted, genders were not separated. Martin and Bateson (2011) suggest using instantaneous sampling for measuring the proportion of the behaviour. I therefore think this is a good method to use if you want to study the proportion of foraging behaviour of the total time budget. According to Ejlertsson (2010) instantaneous sampling can be used as a method to answer questions about how common a behaviour is and to calculate the variation between two behaviours or the variation between genders. Considering the fact

that foraging behaviours can be very short depending on what the baboons are eating, behaviours can be missed if the baboons are only scanned every 15 minutes. I suggest that the intervals should be shorter, no more than five minutes, since this would result in more captured foraging behaviours. An issue with short intervals is the higher difficulty of relocating the female in time if she is lost or out of sight. However the observers for this study are used to the olive baboons and therefore short intervals should not be an issue. Another issue with short intervals is if the baboon decides to cross the river; more on how to cross the river can be found under the heading "*Methods for studies on riverine forests during dry season and rainy season*" under Discussion.

Scan sampling is, according to Martin & Bateson (2011), a preferred method when the group includes few animals or when the behaviour categories are few. In this case the troop of wild baboons included 89 individuals, of which approximately 45 of them were adults. I find it hard to believe that all individuals would be visible during the same scan, yet at one time I could spot over 40 individuals at the same time which would make scan sampling very difficult in this case due to the large number of individuals.

There was no definition in the Old method of how close the baboons around the followed female had to be to be a part of the scanned group. The behaviour of the majority of the group was recorded, this means the other behaviours were lost, mainly the rare ones. I feel it is very important with clear definitions while recording data, especially if there are several observers. A lack of definition can resolve in reliability issues with the recorded data (Martin & Bateson, 2011), and I believe it can also complicate future attempts to carry out this study. To test the reliability between observers a between-observer test can be conducted, in which a video recorded clip is shown to each observer and their notes are compared, the more similar the higher the reliability (Martin & Bateson, 2011).

To study the amount of food the olive baboons eat there has to be a good definition for "amount". If "amount" is referring to numbers of items, then this can be answered with the scan sampling method by using short intervals and counting the number of items. If "amount" is referring to weight then this cannot be answered with this method. There are different ways to calculate the weight of food. One suggestion is to record the number of food items and what kind of food items they are and in addition collect and weigh these food items from the area and get a mean value of each item. Of course, food items of the same kind can vary in size and weight, but this procedure would give a rather good estimation of the amount of food the olive baboons eat. According to Eley *et al.* (1989) another way to measure amount is to sedate the baboons and measure body condition and weight. However, I feel this is not possible to accomplish in the wild since it is very important to measure the same individuals to compare differences, which would be very difficult to carry out in the wild. Another issue is the actual sedation which, by experience from working in a zoo environment, is very stressful for the animals due to lack of control of their situation.

New method used near the Southern Ewaso Ng'iro River (focal animal sampling) for studying foraging behaviour of olive baboons (Papio anubis)

In the New method both females and males were noted and followed, which allows the possibility of comparing female data with male data to find similarities or differences between genders. Two protocols were used, one with continuous focal animal sampling and one with instantaneous focal animal sampling. Continuous sampling is preferably used with focal animal sampling and few animal behaviour categories, since it is a very demanding and tiring method (Martin & Bateson, 2011). The observers in this case are very familiar with the animals they are observing and can easily separate them from one another, which is essential since the observers cannot afford to lose the focal animal during the entire observation. Focal animal sampling can also be used with instantaneous sampling, but it is more preferred to use scanning (Martin & Bateson, 2011).

Focal animal sampling is in general the best way to study groups if each observation has a different sequence of focal animals (Martin & Bateson, 2011). This is also the case in my study, which consists of three rotating focal animal sequences to eliminate differences that can depend on the time of day. I therefor consider, in this case, that focal animal sampling would be a better method to use than scan sampling.

Methods for studies on foraging behaviour of apes and monkeys, excluding olive baboons (Papio anubis)

While investigating the studies on monkeys and apes I have found that the variation of the interval length has been very broad, from just one minute (Doran, 1997) up to 10 minutes (Kool, 1993; Agetsuma & Nakagawa, 1998). Comparable to this are the lengths for the Old method (scan sampling) and New method (focal animal sampling) using 15 minute intervals and five minute intervals. Out of the eight articles I read, instantaneous sampling was the chosen method in six of them, for studying apes and monkeys (MacKinnon, 1977; Maruhashi, 1980; Yeager, 1989; Kool, 1993; Doran, 1997; Agetsuma & Nakagawa, 1998).

Doran (1997) used instantaneous focal animal sampling with one minute intervals when studying chimpanzees foraging behaviour. Barton and Whiten (1994), Doran (1997) and New method (focal animal sampling) were the only three primate articles I came across that used focal animal sampling. I assess that the recording of data must have been difficult since focal animal sampling means the animal in question had to be followed at all time, which can be an issue when studying the olive baboons by Southern Ewaso Ng'iro River where you have factors such as the forest vegetation and river crossing to take into consideration. However, the observers in my case are familiar with the olive baboons in the area and know them individually.

Nishihara (1995) collected and analyzed faeces from gorillas to study their diet. I feel a positive side of this method is the gorillas do not need to be habituated since the observers

do not need to observe them all the time. An issue with this method is, according to Nishihara (1995), the analyses mainly showed if the faeces included fruits or other plants depending on how much fiber it contained, not specifically what species of fruits or plants it contained. It does not say anything about the time spent foraging and it is very difficult to measure the amount of food that has been eaten (Nishihara, 1995). This is also a method that will need extra money and time; therefore I feel this is not an ideal method for studying foraging behaviour.

In year 1980 Maruhashi used one-zero scan sampling to study the foraging behaviour of Japanese monkeys. This is the only article I have come across that has used one-zero sampling. According to Martin and Bateson (2011) one-zero sampling cannot measure time, nor can instantaneous sampling, yet is an easy method for measuring proportions of a behaviour, proportions can also be measured with instantaneous sampling.

Agetsuma and Nakagawa (1998) used instantaneous scan sampling while observing groups of Japanese monkeys. For each scan the number of monkeys foraging were divided by the total number of seen monkeys to get the proportion of the foraging behaviour, rather than the actual number of behaviours. I believe this is a very good way to measure how common a behaviour is, although this would only be possible in a smaller group. The troop in my study includes 89 wild baboons which makes this method impossible to use since it includes both counting all the visible baboons and also how many are doing the behaviours being recorded.

Methods for studies on foraging behaviour of olive baboons (Papio anubis)

The social structure of an olive baboon troop consists of the dominant male as the leader, followed by females and juveniles as middle ranked and then low ranked males (Redmond, 2008). A high rank is positively correlated with high food competition (Sapolsky, 1982), which in my opinion can lead to a possibility of better food quality if they can manage the competition. I believe this hierarchy can result in a gender related difference between males and females when it comes to their foraging behaviour.

Two olive baboon studies out of five used instantaneous scan sampling (Eley *et al.*, 1989; Barton *et al.*, 1992) while two studies used continuous sampling (Barton & Whiten, 1994, Strum, 1994) and one study used ad libitum sampling (Strum, 1983). According to Martin and Bateson (2011) ad libitum sampling is often used if the behaviour is rare or important, focusing on recording whatever seems relevant to the studied behaviour.

One thing to keep in mind is that all of these studies were conducted in dry savannah habitats which I believe would be more open and therefore easier to see the olive baboons than in a green riverine forest like the one by the Southern Ewaso Ng'iro River by Lale'enok Resource Centre. Therefore I believe instantaneous scan sampling is a method

that might work in more open habitats but not in my case where the visibility of the olive baboons can be more limited and focal animal sampling would be preferred.

Only 3 out of 13 articles (excluding New method and Old method) referred to in this paper mentioned primates living by a riverine forest, none of them were about baboons. For these three studies the methods used were collecting faeces (Nishihara, 1995) and instantaneous scan sampling (MacKinnon, 1977; Yeager, 1989). I therefore consider this is a habitat that needs to be explored more, especially to investigate its importance for baboons. According to Odada *et al.* (2006) this is an important habitat for humans, their livestock and the wildlife due to its fresh water. Another subject to investigate is how local Masai people and wild olive baboons can use this forest and river together with minimum threat from both sides. According to J. Njonjo at Lale'enok Resource Centre (personal message, 20 February 2013) the local Masai people sometimes hunt olive baboons since the olive baboons can steal goats or sheep from them. I believe a better understanding between olive baboons and local Masai people can benefit both parts since they both need the riverine forest.

Length of the intervals and length of the study

Five minutes was the most common length for intervals in my study (MacKinnon, 1977; Maruhashi, 1980; Yeager, 1989; focal animal sampling study at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre). Three of these studies (MacKinnon, 1977; Maruhashi, 1980; Yeager, 1989) were monkey studies. I think since monkeys are usually smaller and therefore more difficult to observe than larger primates, it is impressive that intervals as short as five minutes have been used, which implies it might be possible to use such short intervals on olive baboons as well. Intervals used on olive baboons have been between five minutes (focal animal sampling study at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre) and 15 minutes (Barton *et al.*, 1992; scan sampling study at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre). I feel if the intervals are too long a lot of behaviours will be lost, while if they are too short the observer must be more alert, also if the intervals are too short there is a risk that the same behaviour could be noted twice. I feel five minute intervals are not too long or too short, which could be a reason for it being commonly used in the studies found.

I found the most common length of a study is one to two years with seven studies (MacKinnon, 1977; Strum, 1983; Yeager, 1989; Barton *et al.*, 1992; Kool, 1993; Barton & Whiten, 1994; Nishihara, 1995) compared to four studies lasting for less than one year (Maruhashi, 1980; Leighton & Leighton, 1982; Eley *et al.*, 1989; Doran, 1997). I consider it important to at least collect data during a whole year to get a good view on the animals' behaviour since a year usually will include different seasons. If data are collected during a shorter time, for instance during a rainy season, the results will only be reliable for that season and not in general. Of course seasons can change from year to year, so the longer the data is collected, the better and more reliable results will be. Only two studies lasted for more than two years (Strum, 1994; Agetsuma & Nakagawa, 1998). However, it is also a

matter of money, the longer the study the more time and money it is going to cost. One way to solve this is to take samples throughout the year without doing it continuously.

Methods for studies on riverine forests during dry season and rainy season

During the rainy season the river becomes wider due to the rain. Crossing by foot can be tough and to walk around the river time consuming. I believe a solution to this can be a crossing made of two thick ropes, one to walk on and one to hold on to. These kinds of crossings are easy to make along the river, they are cheap and they should not affect the environment nor the wildlife. Another suggestion would be ropes tied up in the trees for the observers to swing across the river. Both the two rope crossing and the swinging option have the benefit of not providing easier crossing for threats like lions and leopards. I feel a small bridge can be made over the river to make it easier for the observers to cross during the rainy season. The issue with this is that it also would be easier for other animals to cross the river, such as predators like lions or leopards and this could be a stressful and even dangerous situation for the olive baboons. That is why a bridge should not be built or in a way that it cannot be used by predators. If there is no way to cross the river then maybe there would need to be two observers, one on each side of the river to follow the baboons if they cross over.

According to S. Sompeta at Lale'enok Resource Centre (personal message, 19 February 2013) the rainy season by the Southern Ewaso Ng'iro River occurs anywhere between the middle of March to May or June and November to December which is also supported by Odada *et al.* (2006). The rainy seasons are similar in all of Kenya (Kinnaird, 1992; Odada *et al.*, 2006; Maingi & Marsh, 2006; Stave *et al.*, 2007). After reading the articles for this study I have discovered there is no difference between methods for rainy seasons and methods for dry seasons. A reason for this can be the fact that to collect enough data for a study the data must be collected over a long time and different seasons or it will not be reliable for the foraging behaviour throughout the entire year, it would only be relevant for that particular season. According to S. Sompeta at Lale'enok Resource Centre (personal message, 19 February 2013) the olive baboons by the Southern Ewaso Ng'iro River are more dispersed during the dry season, due to the difficulty of finding food. I think this will not affect the length of the intervals if using instantaneous sampling, only that “walking” or “moving” might become more common.

Habituation

I have found that 7 out of a total of 13 articles (excluding New method and Old method) about primates mentioned habituation to the observer before the data was collected (MacKinnon, 1977; Maruhashi, 1980; Yeager, 1989; Barton *et al.*, 1992; Barton & Whiten, 1994; Doran, 1997; Agetsuma & Nakagawa, 1998). I have found habituation is slightly

more common in ape studies, including baboons, (MacKinnon, 1977; Barton *et al*., 1992; Barton & Whiten, 1994; Doran, 1997), than monkey studies (Maruhashi, 1980; Yeager, 1989; Agetsuma & Nakagawa, 1998). Habituation by neutral exposure to the observers can, according to Jack *et al.* (2008), have an important effect on animals and results when they are studied. Same source studied different groups of white-faced capuchins (C*ebus capucinus)* and found that the habituated group showed different behaviours and lower cortisol levels than the less habituated groups. The less habituated groups showed signs of stress which led to watchfulness, use of alarm calls and keeping a distance to the observer, which I believe might prevent the behaviours the observers wanted to study. After two months the less habituated groups showed similar cortisol levels at the long-term habituated group (Jack *et al*., 2008). I also feel it is important to be near the primates while studying foraging behaviour.

According to Williamson and Feistner (2003), as baboons in general are opportunists, extrovert and used to environmental changes, they often do not need much time for habituation. They also mean that baboons who live in open areas need very little habituation since they can easily spot the observer. However, if the baboons have been hunted they will need more time to habituate than baboons that have not been hunted (Williamson & Feistner, 2003). The surrounding area around the riverine forest by the Southern Ewaso Ng'iro River is an open area, which would indicate a shorter time for habituation, yet the olive baboons there have experienced hunting from the local Masai people which on the other hand would indicate a longer time for habituation. The troop by the Southern Ewaso Ng'iro River has been habituated to the observers for three-five years to prepare the troop, which is a lot considering Williamson and Feistner (2003) suggest two to five months of habituation is needed and Jack *et al.* (2008) suggests two months. I feel habituation can take time and be costly since you would need to pay observers to follow the primates, yet is important while studying their foraging behaviour since unhabituated primates have shown signs of stress and fear which would prevent them from showing foraging behaviour (Jack *et al*., 2008).

Gender and age

In the studies I have read the definition of the primates in question, lacks in details. Primates have only been defined as groups (MacKinnon, 1977; Yeager, 1989; Barton *et al.*, 1992; Barton & Whiten, 1994; Kool, 1993; Agetsuma & Nakagawa, 1998), troops (Maruhashi, 1980; Strum, 1983; Eley *et al.*, 1989; Strum, 1994; Doran, 1997) or in some cases definition is missing, including information such as gender and age (Leighton & Leighton, 1982; Nishihara, 1995). In the cases of mentioned groups, it is not clear if they mean troops or if the observed primates are divided into groups by the observers. I believe they have not focused on differences between age and gender, but rather seen them as a group. A few of the more detailed studies include Agetsuma and Nakagawa (1998) who did not record females in heat and the focal animal sampling study at the Southern Ewaso Ng'iro River by Lale'enok Resource Centre, where notes were made if the female was

lactating or not. I think this is vital information in a study since primates have different needs and behaviours depending on age and gender (especially dominance) and should be mentioned more in studies in the future since this can have an effect on the results. The lack of definition of the primates also makes it very difficult to do similar studies and to compare the data.

CONCLUSION

Instantaneous scan sampling was found the most common method for studying foraging behaviour in monkeys, while for apes instantaneous sampling was just as common as other methods, such as collecting faeces, sedating and measuring the actual body. With the olive baboons in the riverine forest at the Southern Ewaso Ng'iro River the most appropriate method to use would be instantaneous sampling since this method can answer questions about food items, amount of food and might even be able to tell the proportion of time the baboons spend foraging, which are common questions when it comes to studying foraging behaviour.

When comparing scan sampling with focal animal sampling, focal animal sampling was only used in three articles Barton and Whiten (1994), Doran (1997) and New method (focal animal sampling), yet is the preferred method to study groups according to Martin and Bateson (2011). The olive baboons to be studied by the riverine forest at the Southern Ewaso Ng'iro River are all living in a troop of 89 individuals, scanning such large number of individuals would be an issue. Another benefit of using focal animal sampling in this case is that the observers are familiar with the olive baboons and can easily identify and keep track of each individual.

Very few articles were about primates living in riverine forests and none were about baboons. This shows that additional studies need to be conducted in this environment. For instance, further studies can show if baboons in this environment have any different behaviours compared to those living in rainforests or dry savannahs. There was hardly any mentioning of gender or age of the primates in the articles found, even though this might effect their behaviours and needs. The lack of such information also makes it difficult to compare data from similar studies.

The most common length of a study is one to two years. A good result needs at least one year of data due to different seasons. Due to seasonal changes between years, the longer the data is collected, the more reliable the results will be. However, there is always a cost of time and money to be considered.

Habituation is slightly more common among apes than monkeys in the articles found. Habituating the baboons has its advantages since observers can come closer, even though it would cost more time and money before the data can be collected. Habituation can also lead to less stress (Jack et al. 2008), stress which otherwise can prevent them from showing

foraging behaviour. The open areas around the riverine forest indicate a shorter time of habituation is needed, however the hunting by the Masai people would indicate a longer time of habituation is needed (Williamson & Feistner, 2003). Suggestions on time spent habituating primates are two months (Jack et al., 2008) and two to five months (William & Feistner, 2003).

SAMMANFATTNING

Innan data börjar samlas in inför en studie är det många saker att tänka på, protokoll för observationerna ska testas och anpassas, personal ska tränas och ibland ska även djuren i fråga hinna vänja sig vid de som ska observera dem. Det är viktigt att välja rätt protokoll då detta kan påverka hur trovärdigt resultatet blir till slut, hur studien kommer att gå till samt vad man kan använda resultatet till i framtiden. Syftet med denna rapport är att ta reda på för- och nackdelar av metoder för att studera födosöksbeteenden hos 89 anubisbabianer (*Papio anubis*) som lever i skog längs Southern Ewaso Ng'iro floden vid Lale'enok Resource Centre i Kenya. Dessa primater är dagaktiva och föredrar att äta frukt, blad, blommor och frön. Anubisbabianer äter helst mat som är rik på kolhydrater och protein samt undviker mat med höga halter av fiber. Den vanligaste metoden att använda vid observation av babianer och övriga primater, är intervall registrering med scanning med fem minuters registrering, vilket betyder att tiden delas upp i intervaller och alla primaternas beteenden registreras var 5:e minut. En annan metod är kontinuerlig registrering med fokaldjur registrering, då djuren observeras konstant samt att tid och beteende registreras, för att mäta beteendets längd. Kontinuerlig registrering är en mycket krävande metod då observatören måste vara konstant alert, men ett mycket effektivt sätt att registrera beteenden. Ett sätt att underlätta för observatörerna är att endast fokusera på ett fåtal beteenden. Den lämpligaste metoden för anubisbabianerna vid Southern Ewaso Ng'iro floden är enligt mig intervallregistrering med fokaldjur registrering då det är en enklare metod att använda än kontinuerlig registrering, samt att fokaldjur registrering passar bättre för observation av större grupper. Denna grupp anubisbabianer inkluderar 89 individer. Under regnsäsongen ökar Southern Ewaso Ng'iro floden i storlek tack vare allt regnvatten, detta leder till problem då observatörerna inte längre kan korsa floden till fots för att följa anubibabianerna. Olika sätt att lösa detta på är genom användning av rep tillverka antingen enklare broar (ett rep att gå på, ett rep att hålla i) eller genom att svinga sig över till andra sidan. Dessa är alla enkla, säkra, billiga och snabba sätt att ta sig över floden samtidigt som dessa metoder inte gör det lättare för rovdjur som lejon och leoparder att korsa floden vilket annars skulle öka hotet mot anubisbabianerna.Tiden det tar att samla in data tar som vanligast mellan en till två år. Tar studien mindre än ett år riskerar den att undgå skillnaden av de olika säsongerna som förekommer under ett år, vilket kan påverka resultatet. Kanske gäller resultatet endast under regnsäsongen? Det kan även förekomma skillnader från år till år, dock är det viktigt att studien inte blir för lång då detta kostar extra tid och pengar. Forskning visar att primater som är vana vid observatörerna drabbas mindre av stress,

stress som kan leda till att primaterna utför andra beteenden än de födosöksbeteenden som önskas. Andra fördelar med vana primater är att de är lättare att se då observatörerna kan vara nära dem, vilket underlättar för att studera vad de äter, samt att det är lättare att vänja primater som är grupplevande (anubisbabianer) än de som lever solitärt. Trots att det kostar tid och pengar att vänja primater är det i detta fall värt det. Det tar i regel två till fem månader att vänja babianer. Ingen studie kunde hittas om anubisbabianer som lever i skogar längst med floder, så kallade riverine forests, vilket tyder på att mer forskning behövs om denna speciella miljö som både är en viktig vattenkälla för primater samt lokalbefolkningen som bor i närheten.

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Appendix 1

ID	Category	Date	Day time	Age	Family	Number of infants
name	Male	date	Sunrise	years	name	number
	Lactating		Morning			
	Non lactating		Afternoon			
			Evening			

Time	Waypoint	Habitat	Position	Sitting species	Visibility	Dispersal NS	Dispersal EW
6.30		1 River	Ground	Species code	Good	Codes	Codes
6.35		2 Gallery	Shrub	Sky	Fair		
6.40		3 Savanna	Tree		Poor		
...	...	Crops					
		Boma					
		Shoats					

Behaviour	Carry offspring	Plant species	Plant part	Closest adult	Dispersal NS	Dispersal EW
Standing	Yes	Species code	Shoots	Name		
Lying	No	Insects	Fruits			
Walking		Mammals	Seed			
Running		Birds	Flower			
Chasing		Eggs	Leaves			
Being chased		Lizards	Roots			
Grooming		Scorpions				
Being groomed						
Nursing						
Greeting						
Submission						
Disciplining						
Sound						
Playing						
Foraging						
Drinking						
Lactating						

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