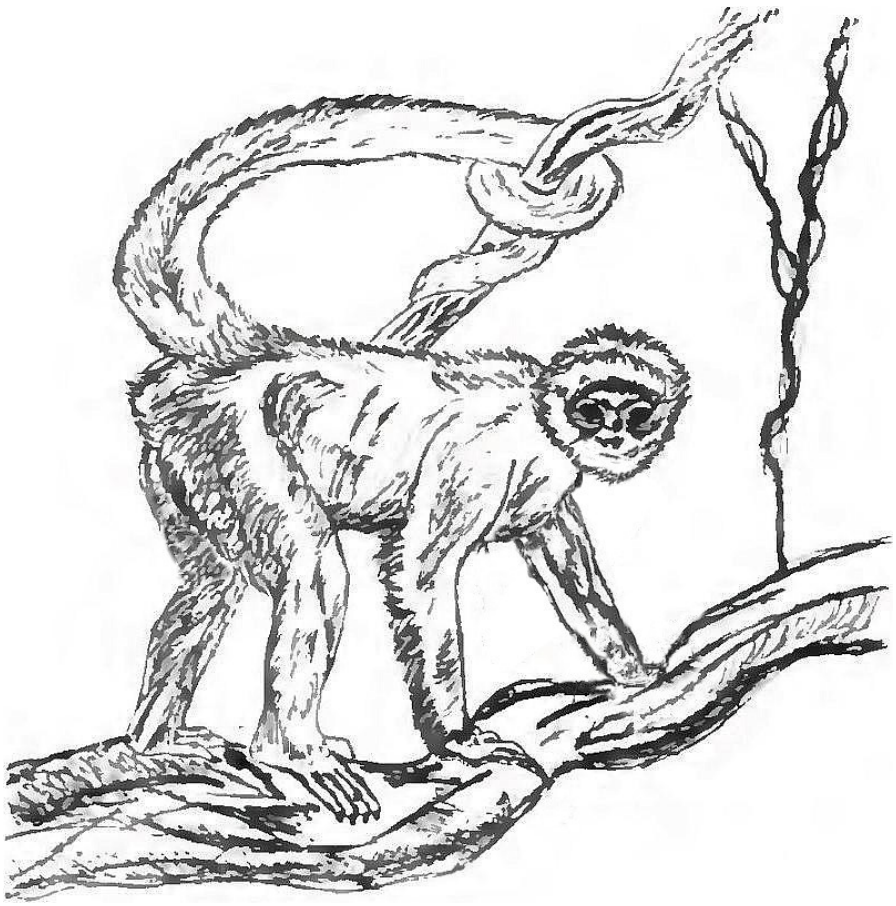
# Enrichment for Colombian black spider monkeys (*Ateles fusciceps rufiventris*) in a zoo

*Berikning för Colombiansk svart spindelapa (Ateles fusciceps rufiventris) i en djurpark*

**Tina Torstensson**



**Sveriges Lantbruksuniversitet** **Skara 2009** **Studentarbete 261**
**Institutionen för husdjurens miljö och hälsa**
**Etologi och Djurskyddsprogrammet**

***Swedish University of Agricultural Sciences*** ***Student report 261***
***Department of Animal Environment and Health***
***Ethology and Animal Welfare programme***

**ISSN 1652-280X**

# Enrichment for Colombian black spider monkeys (*Ateles fusciceps rufiventris*) in a zoo

*Berikning för Colombiansk svart spindelapa (Ateles fusciceps rufiventris) i en djurpark*

**Tina Torstensson**

**Examensarbete, 15 hp, Etologi och Djurskyddsprogrammet**

Handledare: Jenny Loberg,
Institutionen för husdjurens miljö och hälsa, Sveriges Lantbruksuniversitet, Skara

Biträdande handledare: Jennie Westander,
forskningsansvarig, Parken Zoo, Eskilstuna

# INDEX



*On the cover*: Spider monkey. Picture from Eisenberg (1976), modified by Tina Torstensson.

# 1. ABSTRACT

The Colombian black spider monkey (*Ateles fusciceps rufiventris*) is critically endangered. The wild population is still decreasing and today there are no records of the actual population size. Enrichment makes the animals keep their natural behaviours, which makes an eventual reintroduction to nature easier. The purpose of this study was to evaluate three different food enrichments for Colombian black spider monkeys. The purpose was also to try to come up with new ideas for enrichment suitable for the lifestyle and behaviour of spider monkeys. The attractiveness of branch balls, food puzzles for dogs and ice blocks, all filled with treats, was compared in order to determine the best enrichment for the spider monkeys. The food puzzles were used for the longest period of time and during a bigger proportion of time than the ice blocks, followed by the branch balls. But the branch balls made the frequencies of behaviours come the closest to those of wild spider monkeys. The literature study indicates that food enrichment is the most appreciated form of enrichment by spider monkeys. When empty, food enrichments lose their attractiveness. Though, in the end, a mix of different kinds of enrichment is what should be strived for, in order to fulfil all the needs of the spider monkeys, which increases their welfare and chances to later reproduce and survive in the wild.

# 2. SAMMANDRAG

Den Colombianska svarta spindelapan (*Ateles fusciceps rufiventris*) är akut hotad. Den vilda populationen minskar fortfarande i antal, och i dag finns det inga uppgifter om den faktiska populationsstorleken. Berikning gör att djuren behåller sina naturliga beteenden, vilket gör ett eventuellt återinförande till naturen lättare. Syftet med denna studie var att utvärdera tre olika födoberikningar för Colombianska svarta spindelapor. Syftet var också att försöka komma med nya idéer för berikning som är anpassad efter spindelapornas livsstil och beteendemönster. Apornas intresse för grenbollar, hundpussel och isblock, alla fyllda med godsaker, jämfördes för att till slut komma fram till vilken av dessa som var den bästa berikningen för spindelapor. Hundpusslen användes längre och under en större andel tid än isblocken, följda av grenbollarna. Men grenbollarna är den berikning som får frekvenserna av beteendena att mest likna de hos vilda spindelapor. Litteraturstudien som gjordes visar att födoberikning är den mest uppskattade formen av berikning hos spindelapor, men när de tömts tappar spindelaporna intresset för födoberikningarna. I slutändan bör man sträva efter att skapa en mix av olika typer av berikningar för att uppfylla alla spindelapornas behov. Detta ökar deras välfärd och möjligheter att senare föröka sig och överleva i naturen.

*Picture 1*. The spider monkeys in this study. From the left: Diego, Frank, Rodo and Poppin.

# 3. INTRODUCTION

## 3. 1. BACKGROUND

### *Taxonomy*

The Colombian black spider monkey, *Ateles fusciceps rufiventris*, first got it's Latin name by Sclater in 1871 (Rylands et al., 2006; Cuarón et al., 2009). It's one of the New World Monkeys (Grossblatt and Vaupel, 2003). Typical for New World Monkeys is that they are native to Central and South America, whilst the Old World Monkeys are native to Africa and Asia. The spider monkeys belong to the order Primates, the family Atelidae (Cuarón et al., 2009) and the subfamily Atelines. The Atelines include, apart from the *Ateles* (spider monkeys), the *Brachyteles* (muriquis, also known as woolly spider monkeys), *Lagothrix* (woolly monkeys), and *Alouatta* (howler monkeys) (Turnquist et al., 1999). There are seven species of the genus *Ateles*. Apart from *A. fusciceps*, there is also *A. belzebuth, A. chamek, A. geoffroyi, A. hybridus, A. marginatus* and *A. paniscus* (IUCN, 2009). Among others, there have been discussions on whether or not the *Ateles fusciceps* is actually the same species as the *Ateles geoffroyi*. This report will follow Rylands et al.'s (2006) view and consider the Colombian black spider monkey being *Ateles fusciceps rufiventris*.

### *Distribution*

The genus *Ateles* can be found from southern Mexico to southeastern Brazil (Kellogg and Goldman, 1944). They prefer tropical, evergreen or semi-evergreen forests (Kellogg and Goldman, 1944; Cormier, 2003), where they live most of their life in the top canopy layers of the lowland, humid rain forests, below 800 m in elevation. They might occasionally occur at altitudes up to 2500 m (Kellogg and Goldman, 1944). Spider monkeys prefer old-growth forests (Cowlishaw and Dunbar, 2000) and do only to a limited degree tolerate other types of primary forests (Collins and Dubach, 2000). Their special preferences and the past and current exploitation of the rainforest make their lives more concentrated to isolated areas (Defler et al., 2003). The *Ateles fusciceps rufiventris* lives in western Colombia and eastern Panama (Rylands et al. 2006).

### *Food*

Spider monkeys are highly frugivorous (Boere, 2001), with a diet comprising of approximately 90 % fruits (Laska et al., 2007), mainly ripe fruit, which is a preference (Pastor-Nieto, 2001; Dew, 2005; Laska et al., 2007). According to Laska et al. (2007) spider monkeys primarily rely on visual information to evaluate foods that are new to them, but also use olfactory (smelling), gustatory (tasting) and tactile cues. In addition to fruit, they eat seeds, mature and immature leaves, flowers, epiphytes (organisms that grow upon or attach to a living plant), dead wood, buds and insects. Spider monkeys occasionally come down from the trees to lick salt from the ground (Committee on Animal Nutrition, 2001). Dew (2005) recorded spider monkeys feeding from abandoned termite nests on the ground and even eating soil. The soil eating is according to Dew probably a way for the spider monkeys to ingest important Mg, Fe, Ca and P, which they do not get enough of from eating mainly fruit. Typically they forage alone or in small parties, preferably in the middle to upper range of the canopy, 10–20 m from the ground, where they also drink water from wet leaves or water filled tree cavities (Dew, 2005).

By moving between different trees, they disperse the seeds of twice as many tree species as birds do. The spider monkeys generally move within a very close range of their territory,

but also occasionally move longer distances, which help spreading the seeds even more (Boyer et al., 2006). The seeds of their favourite fruits are spread by spitting out the seeds or by defecation, which increases the amount of fruits in these paths. This helps the spider monkeys to maintain their habitat (Di Fiore and Suarez, 2007).

### *Physical appearance*

The common name of the *Ateles fusciceps* species are brown-headed spider monkeys (Committee on Animal Nutrition, 2001; Rylands, 2001) whereas the subspecies *Ateles fusciceps rufiventris* is called Colombian black spider monkey, or Colombian spider monkey (Rylands, 2001). Kellogg and Goldman (1944) described *Ateles geoffroyi rufiventris*, as they called the species, as having a "deep black colour of body and flesh-coloured face" and white hairs on their chin.

The *Ateles* are one of the largest of the New World Monkeys (Smith and Jungers, 1997) and usually weigh between 7 and 9 kg (Schmitt et al., 2005). The female is larger than the male (Crook, 1972). The average for *Ateles fusciceps* seems to be 8,9 kg for males and 9,1 kg for females (Smith and Jungers, 1997).

Spider monkeys are one of few primate species that are lacking thumbs (Kellogg & Goldman, 1944; Laska et al., 2007). Because of this, they are limited in their ability to manipulate small objects with their hands (Laska et al., 2007). They swing and balance very well thanks to the long tail, that is distally naked, which makes it work almost as a third hand (Kellogg & Goldman, 1944; Nowak and Walker, 1999). Their bodies are thin, and arms and legs are long and slender with four functional fingers and five toes (Kellogg & Goldman, 1944). Grand (1972) concluded that the long arms of the *Ateles* are an adaptation for hanging vertically in the trees when feeding, and for performing vertical lifts and drops during movement among the branches. They can even hang from branches by only their tail (Nowak and Walker, 1999).

The tail also plays an active role in suspensory locomotion and the spider monkeys get a significant effect on the maximum pendulum length during a stride, using the tail (Turnquist et al., 1999). When standing or walking on all fours (quadrupedal walk) the *Ateles* support 70 % of their body weight on their hind limbs and 30 % on their forelimbs (Reynolds, 1985).

### *Intelligence*

The Machiavellian Intelligence or Social Brain Hypothesis explains the evolution of increased brain size as mainly driven by living in complex organized social systems (Amici et al., 2008). According to the same authors, the individuals in these systems represent "moving targets" who can adopt multiple strategies to respond to one another. They also claim that splitting and merging in subgroups of variable composition, like the *Ateles* naturally do, so called fission-fusion or FF dynamics (Amici et al., 2008; Matsuda and Izawa, 2008; Wallace, 2008), is a sign of social complexity. This way of living may be associated with an enhancement of cognitive skills (Amici et al., 2008). According to Poole (1998), intelligence is the ability to take in information about the world and then use it in order to adapt to changing situations. Spider monkeys significantly outperformed gorillas, capuchin monkeys and long-tailed macaques when being tested on their various cognitive skills (Amici et al., 2008). Because they are long-lived and also depending on their parents for a long time, they have a great opportunity for learning about spatial characteristics of the environment (Di Fiore and Suarez, 2007). As the spider monkeys move from one fruiting tree to another, they rely on mental maps (Boyer et al., 2006).

### *Colour vision*

Primates in general are considered to be primarily visual animals (Laska et al., 2007). Among spider monkeys the colour vision seems to vary. Blue colours can't be detected by any of the spider monkeys. Green, yellow and red can be detected, but to different extents (Riba-Hernández et al., 2004). Red coloured environments have been shown to be rejected by monkeys (Humphrey, 1971).

### *Behaviour*

All spider monkey subspecies mostly share the same kind of behaviour (Kellogg and Goldman, 1944). They usually live in groups of 3-35 individuals (Committee on Animal Nutrition, 2001). Males tend to stay in their natal unit as they mature, while the females in some cases have been reported to move out and join other groups (Nowak and Walker, 1999). Sometimes the groups can consist of only one male with several females and their offspring (Eisenberg, 1976), but normally there are more than only one male in a group (Chapman, 1990; Valero et al., 2006). Even groups of only males are common (Chapman, 1990; Aureli et al., 2006; Wallace, 2008).

*Ateles* move using a combination of climbing, clambering, quadrupedalism, and suspension. They also use tail-assisted brachiation (Schmitt et al., 2005), in which they swing from tree limb to tree limb using their arms, supporting with their tail.

Spider monkeys spend almost all of their time in the upper canopies and rarely venture down to the ground (van Roosemalen, 1985; Campbell et al., 2005; Dew, 2005) other than to e.g. feed on soil or termite nests as already mentioned (Campbell et al., 2005; Dew, 2005). Other reasons to come down to the ground are for water, but also to socialize and to move through the jungle when there are gaps between the canopies. The risk of predation is higher closer to the ground. This is because of the higher frequency of predators there and because of the spider monkeys' morphology that prevents them from moving as efficiently on the ground as they do in the trees. Where predator communities are dense, the spider monkeys even more rarely come down to the ground (Campbell et al., 2005).

As mentioned before, spider monkeys live in fission-fusion societies (Amici et al., 2008; Matsuda and Izawa, 2008; Wallace, 2008) in which individuals usually split into subgroups (Schaffner and Aureli, 2005). The ripe fruits are distributed in patchy areas in tropical America (Pastor-Nieto, 2001), which benefits splitting up onto small groups (Robbins et al., 1991). This keeps the spider monkeys from fighting over resources. Fusing back into bigger groups again is risky, since aggressions at these moments are more likely to occur than at other times, though the amount of aggression is often reduced by embraces between the monkeys (Aureli and Schaffner, 2007).

New World Monkeys are in general not aggressive towards humans and do not respond aggressively to direct eye contact, but will defend themselves when threatened or scared (Grossblatt and Vaupel, 2003). They reach reproductive maturity around five to six years of age (National Research Council Staff, 1998; Nowak and Walker, 1999) and have been reported to live up to 40 years, and even 48 years in one case, in captivity (Nowak and Walker, 1999).

### *Social life*

Spider monkeys are more likely to embrace and hug than to groom each other (Eisenberg, 1976; Aureli and Schaffner, 2007). Embraces seem to occur almost three times as often as grooming does (Schaffner and Aureli, 2005). Aggression among males in zoos seems to be more common than in nature, though. This might depend on the lacking need of cooperated

defence against rivals and the inability of fission-fusion. Therefore, it would be desirable to house them with opportunities to divide into different groups in different enclosures or rooms as they please (Davis et al., 2009). There are reported cases of aggression with a deadly outcome in wild spider monkeys that are unfamiliar to each other (Valero, 2006).

As two familiar spider monkeys greet each other in a fusion, they usually give each other a sniff on the chest, followed by an embrace (Schaffner and Aureli, 2005). They may also exchange face-greetings and whinny vocalizations at variable distances (Schaffner and Aureli, 2005).

It's natural for the group structure to change frequently (Izawa et al., 1979). Monkeys unfamiliar to each other do not share food, while monkeys familiar to each other do, in so-called co-feeding (Pastor-Nieto, 2001).

### *Threats in the wild*

The *Ateles* is the most threatened genus in South America (Silvius et al., 2004). Known predators of spider monkeys include jaguars, pumas and ocelots, venomous and constricting snakes, crocodilians, raptors, like harpy eagles (Campbell et al., 2005; Matsuda and Izawa, 2008) and crested eagles (Di Fiore and Suarez, 2007) and also humans (Kinzey, 1997; Zaldívar et al. 2004; Campbell et al., 2005). As much as 7 % of the human food consumption in the Peruvian Amazon Region consists of various species of monkeys (Kyle, 1987).

Spider monkeys require large areas for habitation (Kinzey, 1997). Because of their ripe-fruit preference and because of the patchy distribution of the ripe fruits in tropical America (Pastor-Nieto, 2001; Zaldívar et al. 2004) they live in very isolated areas, which makes their populations vulnerable (Sorensen and Fedigan, 2000; Zaldívar et al. 2004).

Mexican law forbids trading with wild primates, but on the black market they are common, since there are no breeding centres for primates in Mexico (Duarte-Quiroga and Estrada, 2003). The infants are attractive as pets (Kinzey, 1997) and are captured after their mothers have been killed (Duarte-Quiroga and Estrada, 2003).

Forest destruction, fragmentation and agricultural practices are other reasons for the degeneration of the *Ateles* (Defler et al., 2003; Silvius et al., 2004; Zaldívar et al., 2004). In intact forests, densities of the species are higher, which means that protection and regeneration of tropical, dry forest is important for the survival of the spider monkeys (Sorensen and Fedigan, 2000). Getting the spider monkey population to regenerate will be a slow process because of their low rate of population growth (Voss et al., 2001; Defler et al., 2003; Silvius et al., 2004; Zaldívar et al. 2004).

Setting up hunting prohibitions or educating people in the importance of protecting the spider monkeys is difficult in the isolated areas where the *Ateles* live (Defler et al., 2003).

The population of *Ateles fusciceps rufiventris* has decreased with 80 % in the past 45 years and is still decreasing. There are no records of the current population size of the Colombian black spider monkey. In 2008 it went from being assessed as "Vulnerable" to "Critically Endangered", in the IUCN Red List of Threatened Species (Cuarón et al., 2009).

### *Enrichment*

Environmental enrichment was first applied in zoos in the beginning of the 1900s (Mellen and Sevenich MacPhee, 2001; Young, 2003). The aim and purpose of environmental enrichment is to bring the behavioural repertoire and level of activity of captive animals as close as possible to that of wild conspecifices (Kreger et al., 1998; Shepherdson, 1998; Celli et al., 2003). There are two types of approaches to enrichment; the naturalistic

approach and behavioural engineering. The first one strives to recreate the wild environment in captivity and the second one adds artificial recreation to the animal's life through toys and objects to interact with and to receive rewards from, e.g. food (Young, 2003; Davey, 2006).

### *Benefits of enrichment*

Environmental enrichment reduces behavioural disorders, like stereotypic behaviours (Boere, 2001; Shyne, 2006), which are repetitive, invariant behaviour patterns with no obvious goal or function (Mason, 1991). Long time exposure to environments without any stimulation can lead to apathy, decreased seeking or exploratory behaviour and slower habituation to novel surroundings (Butler, 1957; Boere, 2001). Since zoos strive to educate the visitors, they must give a correct image of the animals' natural behaviours, which means that e.g. pacing, a common stereotypic behaviour in zoo animals, must be prevented (Young, 2003).

Environmental enrichment is known to improve animal welfare (Poole, 1998; Shepherdson, 1998; Boere, 2001; Mellen and Sevenich MacPhee, 2001; Shyne, 2006). It reduces negative stress that can cause suffering (Carlstead and Shepherdson, 1994; Boere, 2001; Broom and Johnson, 1993; Shyne, 2006) and minimizes the need for clinical interventions and raises the reproduction rates (Boere, 2001). Stress may on the other hand not always be negative to the welfare of the animals (Carlstead and Shepherdson, 1994). Sometimes it has beneficial arousal-inducing effects on reproduction. So by presenting novel enrichments to them, which sometimes can cause minor stress, reproduction may therefore be benefited (Carlstead and Shepherdson, 1994; Lindburg, 1998).

Other benefits of enrichment for primates specifically are increased activity (Wilson, 1982; Perkins, 1992; Young, 2003; Dishman et al., 2009), reduction in injurious behaviour, reduction in aggressive behaviour, increased behavioural diversity, increased space utilisation, increased immune response, including ability to fight disease, enhanced social cognition and other forms of cognition and also increased foraging, exploration and play (Young, 2003).

### *Enrichment in zoos for spider monkeys and other primates*

According to Seidensticker and Forthman (1998) it is a form of environmental deprivation to provide an animal with easy access to food and water in captivity, since they in nature spend a lot of their time foraging. Spider monkeys have a complex and sophisticated central nervous system and therefore they have a high ability to continuously select and respond to novel stimuli in the environment (Butler, 1957; Boere, 2001). This behaviour is very important to spider monkeys, which come from habitats with patchy or seasonally variable resources, where these abilities are of the highest importance for survival (Mench, 1998). Captivity usually doesn't provide with the same high amount of stimulation as the wild environment does, which leads to gradual loss of attention and search capabilities of new stimuli (Boere, 2001). The information gathering needs are therefore some of the most important ones to satisfy for the spider monkeys, in order to maintain welfare (Mench, 1998). Novelty is the key to successful enrichment (Lindburg, 1998; Boere, 2001), but too much novelty could result in stress. Too little novelty, on the other hand, often results in boredom (Lindburg, 1998).

There are many different kinds of food enrichment. Some of them include variation in food presentation, diet composition, treats and hidden food. The food enrichment is the most effective type of enrichment when it comes to reducing aggressive and abnormal

behaviour in captive primates (Honess and Marin, 2006). These enrichments have also proven to be the ones used the most by the monkeys (Bayne et al., 1991; Vick et al., 2000). Food puzzles come in a variety of designs and complexities. They challenge the primates' cognitive and manipulative skills, where they localize and try to get hold of food items through a series of small holes. Some even have mazes in which, in order to be released, food items must be negotiated (Honess and Marin, 2006). By placing several food puzzle devices in the enclosure, aggression and competition among the primates can be prevented (da Rocha e Silva, 2001; Honess and Marin, 2006). Foraging devices seem to be used only when containing food and become boring after they've been emptied.

Another very important type of enrichment is of course social enrichment, by keeping the monkeys in groups (Crockett, 1998). Perches and other devices to promote arboreal behaviour and manipulable objects such as toys are other types of enrichment that have proven to be appreciated by primates (Schaffner and Aureli, 2005; Honess and Marin, 2006). Toys, though, are usually only interesting to animals for a limited period of time, typically less than a day (Young, 2003). To keep the level of interest up, toys should at the end of the day be removed and replaced by new ones the next day and a mixture of enrichment strategies is always best (Young, 2003; Honess and Marin, 2006). Also trees, logs, branches and sticks are recommended (Schaffner and Aureli, 2005; Honess and Marin, 2006). Video and television are both sensory enrichment and it has been shown that different types of music may have different effects on activity levels in primates. But a great enrichment is just space itself, giving the primates a bigger area to explore (Honess and Marin, 2006).

Levels of urinary cortisol, related to stress and anxiety, have in spider monkeys been shown to increase with the number of zoo visitors (Davis et. al. 2005). At the same time, it's important for the monkeys to be able to see the external environment - the outdoors, which reduces stress (Newberry, 1995). Appropriate temperature, humidity and light conditions promote behaviours typical for the species, but a slight variation in these factors might increase well being even more, since the changes alone work as a form of enrichment (Honess and Marin, 2006).

## 3. 2. STUDY OBJECTIVE

### *Purpose of the study*

The purpose of the study was to evaluate different kinds of food enrichments for Colombian black spider monkeys and through behavioural and literature studies come to a conclusion about which ones are the best suitable. The purpose was also to, through the literature study, try to come up with new ideas for other kinds of enrichments adapted to the lifestyle and behaviours of the spider monkeys.

### *Questions*

- Which of the three food enrichments tested in the study occupy most time of the two-hour observation period for the spider monkeys?

- Which of the three food enrichments tested in the study attracts the spider monkeys' attention during the longest period of time, from the introduction of the enrichment?

- What other environmental enrichments could be suitable for Colombian black spider monkeys?

### *Predictions*

- The spider monkeys will probably use the food puzzles the most, since it contains the smallest pieces of treats, compared to the other enrichments, and will therefore take a longer time to empty. The treats will also require a bit more searching before being found than do the pieces of the other enrichments.

- The food puzzles will presumably be attractive to the spider monkeys for the longest period of time, because the small pieces of treats will take a longer time to eat than the pieces of the other enrichments. Their interest for the food puzzles might also last since they will not be able to see all the spaces and pockets of the enrichment at the same time and therefore search it repeatedly in order to fully believe that it is empty.

# 4. MATERIAL AND METHODS

### *Animals and housing*

The study was performed at Parken Zoo in Eskilstuna, Sweden. The animals studied were four male Colombian black spider monkeys (*Ateles fusciceps rufiventris)*, called Diego, Poppin, Rodo and Frank (Tab. 1).

*Table 1*. Name, birth date, origin and arrival date of the Colombian black spider monkeys at Parken Zoo.

| **Name** | **Birth date** | **Origin** | **Arrival date at Parken Zoo** |
|---|---|---|---|
| Diego | 2003-09-24 | A zoo in Germany | 2008-10-11 |
| Poppin | 2004-12-01 | A zoo in England | 2008-11-03 |
| Rodo | 2004-06-30 | A zoo in Denmark | 2008-10-11 |
| Frank | 2003-01-23 | A zoo in France | 2008-11-28 |

The monkeys were housed indoors with access to an outdoor enclosure during summer time. At the time of the study (April 2009) they only had access to three of their four indoor enclosures, all connected to each other by closable tunnels. Room number 1 and 2 were furnished with shelves, trees and ropes positioned at the same location in both rooms. The rooms also had one window each. Room number 3 was not accessible for the monkeys during the study. Room number 4 was bigger than room number 1 and 2. It contained trees with branches sticking out and with ropes hanging between the trees. It also had surfaces located high up to sit on. It was visually exposed to the outdoors and to visitors through windows on one side of the room. The enrichment, when tested, was placed in both room number 1 and 2. Room number 4 was unchanged and always accessible. An ethical application was sent in to the Ethical committee in Linköping and approved before the start of the study.

### *Study design*

Three food enrichments, already familiar to the monkeys, were tested. The main study was preceded by a one week long pilot study where the behaviours of the monkeys were defined in an ethogram and the protocol for the study was formed. The pilot study was also seen as an opportunity to learn to tell the difference between the four individuals. The main study was carried out for three weeks, between April 6 and April 23, 2009. The enrichments were presented to the spider monkeys for one week each. The observation times of the study were 8:00-10:00 (Period 1) and 12:00-14:00 (Period 2), Monday through Thursday. On

Mondays and Wednesdays enrichment was put in at Period 2. On Tuesdays and Thursdays enrichment was put in at Period 1.

The three enrichments tested: Branch balls, food puzzles and ice blocks with fruit.

Week 1: *Branch balls*. Two balls, approximately 50 cm in diameter, built of branches and therefore hollow with possibilities for the monkeys to reach inside with their arms. Before being hung up in the trees, fruit (approximately the equivalent of two apples) was wrapped up in newspaper and put into the balls, so that the monkeys had to fish the paper balls out from the branch balls and open them up in order to get to the fruit.

Week 2: *Food puzzles.* Two "Nina Ottosson Dog Activity Toys". One of them was called "DogTwister", where the monkeys move one disc after the other in different directions on a circular wooden board in order to find sunflower seeds. The other one was called "DogCasino", where the monkeys look for and find sunflower seeds by pulling out flaps in different directions from a rectangular wooden board. A total of 1 dl sunflower seeds were used in the food puzzles for each observation.

Week 3: *Ice blocks with fruit.* Twelve circular blocks of ice (approximately 10 cm in diameter and 3 cm high), filled with pieces of fruit (two apples). These were put on the shelves of the enclosure, six in each room, for the spider monkeys to manipulate until the ice had melted and they could get the fruit out.

During the study, the enrichment was always presented to the monkeys at the same spot of the enclosure, with the same amount of enrichment in both room 1 and 2. For every food puzzle observation, the rooms alternated between having one of the two different food puzzles. Even though only two branch balls and two food puzzles were used, twelve ice blocks were needed in order to hold and cover the pieces of the two apples. Since male spider monkeys don't compete much over food (Aureli et al., 2006), using only two food puzzles and two branch balls was therefore thought to be enough for them, since the enrichments were big enough to be used by several monkeys at the same time. The spider monkeys were already used the enrichment before the study, so I didn't want to change the amount of treats in them, in case that would disturb the monkeys. The enrichment was given along with their regular food, either fruit or pellets, depending on observation period, scattered on all the shelves of the enclosure, except for the shelf of the enrichment.

### *Feeding schedule*

*Morning (Given at Period 1)*: 300g pellets + eventual enrichment treats
*Lunch (Given at Period 2)*: 700g vegetables, 500g fruit + eventual enrichment treats
*Afternoon*: 300g pellets

### *Ethogram*

The ethogram was used to define the behaviours of the spider monkeys during the observation periods of the study. Each behaviour was also put into groups of more general behaviours (Tab. 2).

*Table 2.* Ethogram with defined behaviours of the spider monkeys studied and also to the far left the categories in which the behaviours were grouped to compare the time budgets for the different enrichments.

| **Group** | **Behaviour** | **Definition** |
|---|---|---|
| Inactive | Resting/Sleeping | Sitting or lying down, with closed eyes. |
| | Lying | Supporting a bigger proportion of its body weight on other parts than hands, feet or tail. |
| | Sitting | Sitting upright on its bottom, with or without support from the tail or hands. If eating, when sitting down, the behaviour will be recorded as "eating". If performing other behaviours than eating, when sitting down, the behaviours will be recorded as "sitting". |
| Movement | Walking | Supporting its body weight on both hands and feet, moving one foot in front of the other, and one hand in front of the other, while the body is moving forward. |
| | Walking upright | Supporting its body weight on only its feet, moving one foot in front of the other, while the body is moving forward. |
| | Climbing | Moving its body vertically upwards or downwards, by moving its feet, hands and tail in the same direction. |
| | Brachiation | Moving horizontally above ground by holding on to branches/ropes etc. and moving hands, feet and tail forward in a series of different movements. |
| Social | Wrestling/playing | Touching the other monkey with hands and/or feet and/or mouth in a random order, sometimes even chasing it. |
| | Hugging | Holding its arms around another monkey. |
| | Grooming itself | Scratching, by repeatedly sweeping its fingers across its own body, or grooming the fur of its own body, by plucking in the fur with its fingers. |
| | Grooming friend | Plucking in the fur of another monkey with its fingers. |
| | Aggression | Making aggressive facial expressions towards another monkey, through staring at and exposing its teeth to the other monkey. Alternatively, making aggressive body movements towards another monkey, by quickly leaning against it or running up towards it, in combination with aggressive facial expressions. Alternatively actually fighting another monkey, through biting, pushing, wrestling or hitting it. No reaction from the counterpart needed in any of the behaviours above. |
| | Interaction with visitor/s | Looking at and/or exhibiting aggressive, curious (eyes fixated on the visitors, head and neck might be stretched towards the visitor)or playful behaviours towards humans. |
| Eating/ Enrichment | Manipulating or exploring enrichment | Manipulating the enrichment or investigating it, by either looking at it, smelling it or biting/tasting it. |
| | Eating | Keeping food in its mouth and chewing/swallowing. Only holding food with their hands does not count as eating. |
| Abnormal | Stereotypic behaviour | Repetitive, seemingly pointless behaviour. |
| Other | Hanging | Supporting its body weight using its hands and/or feet and/or tail by holding on to something located above or to the side of its body. |
| | Standing | Supporting its body weight on its feet and hands combined, with or without holding on to something with the tail. |
| | Standing up | Supporting its body weight on only its feet, with or without holding on to something with the tail or hands. |
| | Drinking | Manipulating the nipple of the water bottle with its lips and/or mouth and/or tongue, obtaining water into its mouth and swallowing. |
| | Urinating | Urinating. |
| | Defecating | Defecating. |
| | Other | Behaviours not covered by the other behaviours of the ethogram. |

### *Registrations*

Time budget data can usually be collected by instantaneous time recording (Young, 2003), which I chose to do, in combination with scan sampling. The behaviour of each of the four monkeys was recorded into a protocol every minute of the two-hour observation period, resulting in 120 recordings for each observation period. With time sampling intervals of 1 minute or less, you can get a reliable estimation for your statistics of the time used (Dunbar, 1976); therefore I have chosen to show the results as minutes spent on different behaviours, as well as the percentage of the total observation time spent on different behaviours.

### *Data processing*

All data was put into and compiled in Microsoft Excel®. Certain behaviours, not individually answering the questions of this exam work, were in the results grouped together into bigger categories, such as inactivity, movement, social and eating/enrichment. The data was presented in both minutes and percentage of the observation time and then put into diagrams.

# 5. RESULTS

### *Time spent with enrichment and/or eating*

On average, the spider monkeys spent more time with the food puzzles, than they spent with the ice blocks or with the branch balls (Fig. 1). Each of the three enrichments increased the total foraging and eating time of the spider monkeys, compared to when they didn't have access to food enrichment (Fig. 1).

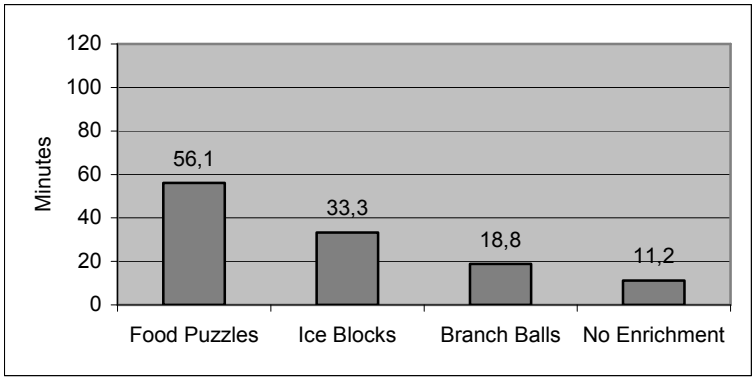



*Figure 1*. The average amount of minutes per monkey and observation period, spent with the enrichment and/or eating, compared to the time spent eating when no enrichment was present.

### *Time spent in the rooms holding the enrichment*

Of the two-hour observation period, the amount of time that the spider monkeys spent in the rooms of the enrichment (room 1 and 2), was the highest when they had access to the food puzzles (Fig. 2). They spent less time in the rooms when they had access to ice blocks, and an even less amount of time with the access to branch balls (Fig. 2). The spider monkeys spent the least amount of time in the rooms usually holding the enrichment when there was no enrichment present (Fig. 2).

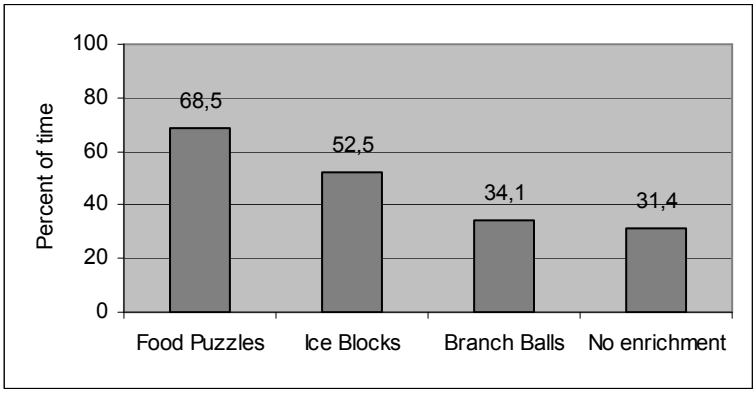



*Figure 2*. The average percent of time per monkey and observation period, spent in the two rooms (room 1 and 2) that were holding one of the three enrichments, compared to the time spent in the two rooms when no enrichment was present.

### *Distribution of behaviours*

The distribution of inactivity, movement, social contact, eating and/or using food enrichment and other behaviours varied between the tested enrichments (Fig. 3).

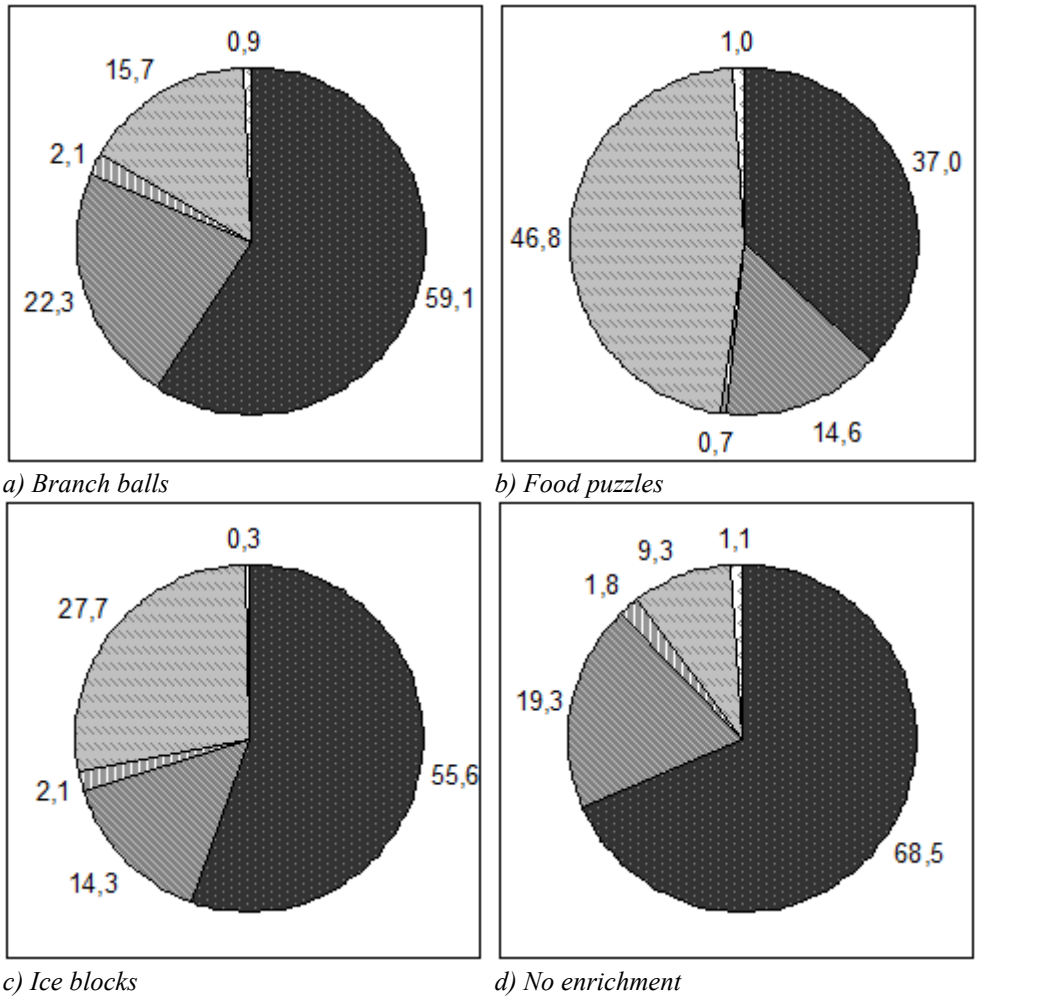
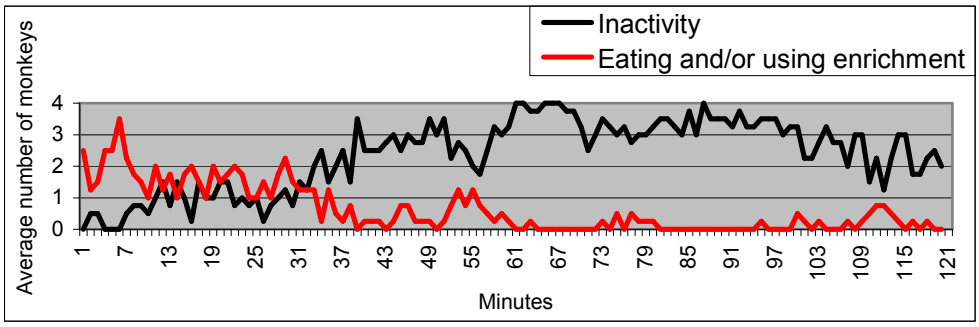


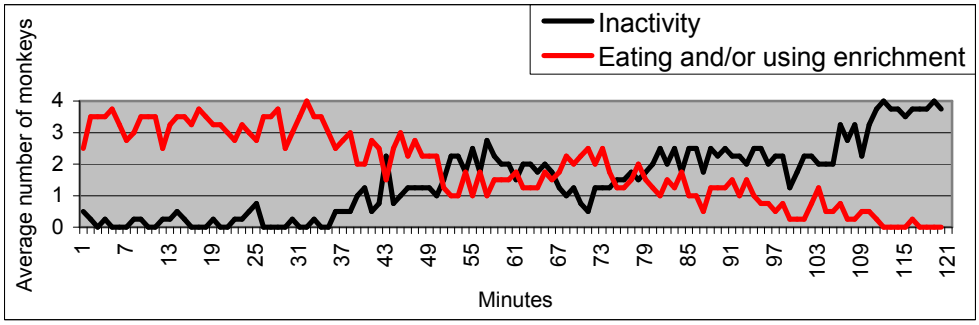

*Figure 3*. The distribution (in percent of time) of behaviours when having access to branch balls (a), food puzzles (b), ice blocks (c) or no enrichment (d).

### *Duration of attractiveness of the enrichment*

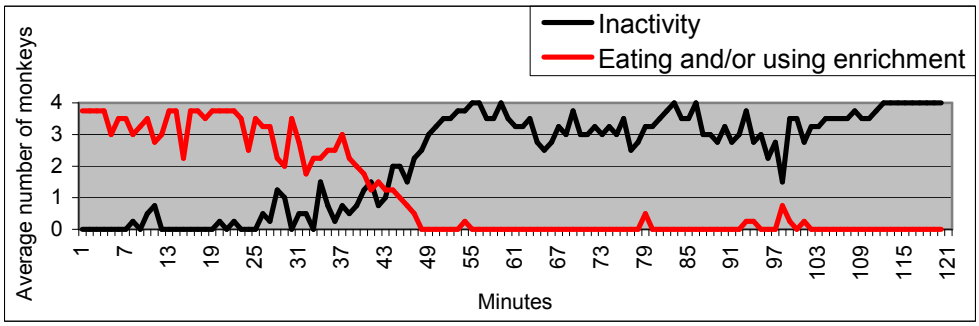
The distribution of eating and/or using the enrichment versus inactivity, over time, varied for each one of the food enrichments (Fig. 4). Inactivity set in the quickest when no food enrichment was present, followed by branch balls and then ice blocks. The food puzzles kept the spider monkeys active for the longest period of time.



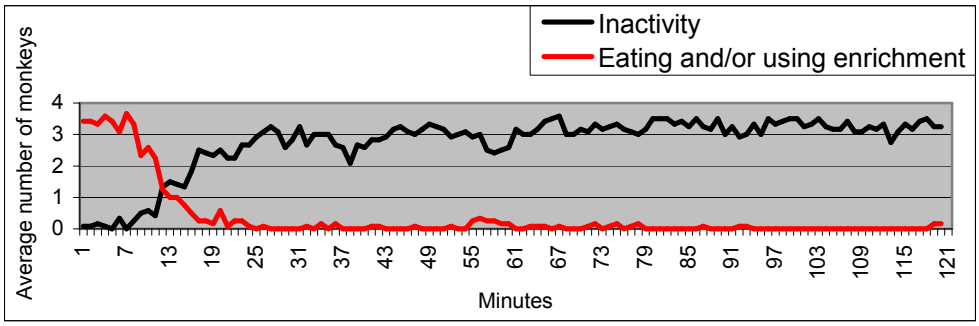

*a) Branch balls*




*b) Food puzzles*




*c) Ice blocks*




*d) No enrichment*

*Figure 4.* The average distribution of inactivity compared to eating and/or using the branch balls (a), eating and/or using the food puzzles (b), eating and/or using the ice blocks (c) and eating with no enrichment being present (d) over the two-hour observation period.

### *Other observations*

The spider monkeys tended to lose interest in the enrichment once the content was gone. At some points during the week of the food puzzles, they spent a lot of time searching the ground for dropped sunflower seeds below the food puzzles, long after they had been emptied. No aggressions or stereotypic behaviours were observed at any moment during the study.

# 6. DISCUSSION

### *The method used*

Testing the enrichments on the monkeys as a group was in this case the only method in which you get a result that is applicable to the monkeys after the study. They were living as a group and were always exposed to the other individuals when given enrichment, which was why they were studied as a group. All *Ateles* are active during daytime (Committee on Animal Nutrition, 2001; Muñoz-Delgado et al., 2004) and start their daily activities about an hour after sunrise and seem to settle down for the night about two hours after sunset. At this point they always return to a sleeping site. There seems to be one peak in their activity around the time before noon and one peak in the afternoon (Chapman, 1989). This was also observed during the pilot study, which was the reason for the chosen observation periods, along with the preference of timing the studies with their normal feeding times. Using scan sampling, recording the behaviour of each individual each minute, was in this case the best way to gather as much data as possible. Since the four monkeys were living as a group, they could only be seen as one unit in the results, since their behaviours might be dependent on the other individuals of the group. This, as well as the fact that no other studies were performed on monkeys on other locations, led to the conclusion that no statistical analyses could be performed on the results.

### *The three enrichments tested*

The spider monkeys spent the least time with the branch balls. This does not say that they paid the least interest in them, since the branch balls were the enrichments that were emptied the quickest, and after the content was gone the spider monkeys paid no attention them. The food puzzles kept them active even though they were not actively manipulating the very puzzles. Some of the sunflower seeds and their empty shells were dropped to the ground as the spider monkeys were manipulating the enrichment, which led to continued foraging on the ground below, even after the food puzzles had been emptied.

There is only a limited amount of time that the ice blocks can be considered being an enrichment, since the ice is melting and eventually will be gone (usually within the first hour for the ice blocks used in this study). On the other hand, it can be seen in the results, and was also observed during the study, that the monkeys seemed to stop manipulating the ice blocks many times and go to rest before all the ice blocks were fully melted.

The purpose of enrichment is, as mentioned before, to make the behavioural repertoire and level of activity of captive animals resemble their wild conspecifices (Kreger et al., 1998; Shepherdson, 1998; Celli et al., 2003). Comparing the time that the spider monkeys in this study spent eating, to the time that spider monkeys in the wild (*Ateles chamek* and *Ateles belzebuth*) spend eating (Tab. 3), the results are clear. Providing captive spider monkeys with enrichment increases their feeding times, and branch balls make the feeding times come the closest to the feeding times of wild spider monkeys (Tab. 3). In the case of

ice blocks and food puzzles, the feeding times are higher than those of wild spider monkeys. Feeding when having no enrichment present is much more similar to that of the wild, compared to when having food puzzles.

Both the study by Klein and Klein (1977) and the one by Wallace (2001), were performed on wild spider monkeys over their whole period of awake time per day, whereas mine was performed on captive spider monkeys only on the two hours following each feeding. In nature, the spider monkeys can choose when to feed, but in this study, they mainly fed directly after they were given food, until most of the food was gone. This might cause the results to differ, and would be more comparable if I, too, would have performed my study on their whole awake period of the day and the spider monkeys would have had access to food the same way wild spider monkeys do.

*Table 3*. Distribution of behaviours (in percent of time) from this study, compared to a study on *Ateles belzebuth* in Colombia, by Klein and Klein (1977) and one on *Ateles chamek* in Bolivia, by Wallace (2001), where the results of subadult (below 80-90 % of the body size of adults) males differed from the results of adult males. "Resting", in this table, is considered the same as "inactive", in this study.

| | Other studies | | | | This study | | | |
|---|---|---|---|---|---|---|---|---|
| | Klein and Klein (1977) | Wallace (2001) adult | Wallace (2001) subadult | **Average** | No enrichment | Branch Balls | Ice blocks | Food puzzles |
| Feeding | 22,2 | 17 | 21 | **20,1** | 9,3 | 15,7 | 27,7 | 46,8 |
| Movement | 14,8 | 26 | 35 | **25,3** | 19,3 | 22,3 | 14,3 | 14,6 |
| Resting | 63 | 53 | 38 | **51,3** | 68,5 | 59,1 | 55,6 | 37,0 |
| Other | No data | 3 | 6 | **4,5** | 2,9 | 3,0 | 2,4 | 1,7 |

The spider monkeys at Parken Zoo were at the time of the study around four to six years old, which made it hard to decide which group (adult or subadult) they should be in, which was why an average of the groups was calculated. Neither of the studies by Klein and Klein (1977) and Wallace (2001) had ethograms, and the behaviours were not defined. Therefore they may be slightly different from the behaviours in this study. Neglecting all these possible differences, the results show that the branch balls bring the feeding times of the spider monkeys the closest to the natural feeding times of wild spider monkeys (Tab. 3). Ice blocks bring the amount of time spent resting the closest to the normal amount of resting time of wild spider monkeys. With branch balls, the amount of other behaviours performed is the closest to that of wild spider monkeys, compared to the other enrichments.

### *Sources of error*

The small group size and the fact that the study was performed only on four males, might affect the results to a large extent. Females probably behave differently, especially on the social aspect, but they could also maybe not be as accepting of other females around the enrichments. Young adult animals and middle-aged females are usually the ones showing the most skills in food puzzles when compared to middle-aged males (Murchison and Nolte, 1992). Maybe middle-aged males would therefore use the enrichments for a longer period of time, since it would take longer for them to empty the enrichments, compared to the males in this study, if they are considered young adults.

Energy-rich plants and sweet taste is preferred among spider monkeys (Laska et al., 2007), and they tend to eat a lot of lipid-rich, fatty fruits, which may constitute of up to 27 % of their fruit intake (Dew, 2005). Maybe this motivates them to spend more time on the food puzzles than on the other enrichments, since the food puzzles contain fatty sunflower seeds, and the other enrichments only contain fruit that they normally also get in their

everyday food. Because of this difference in content of the enrichments, the branch balls and ice blocks might have to be considered as different types of food enrichments than the food puzzles.

Males in general seem to groom each other more often than females or males-females do (Chapman, 1990). Males seemingly compete more over mating than over food (Aureli et al., 2006), and the more females there are, the less competition and aggression there are among the males (Anaya-Huertas and Mondragon-Ceballos, 1998; Valero et al., 2006). Males are also the ones showing the most affection and friendship towards each other (Anaya-Huertas and Mondragon-Ceballos, 1998; Valero et al., 2006; Davis et al., 2009). This is probably because they need to rely on each other for cooperation in defending their territory against other, unfamiliar, groups of spider monkeys (Valero et al., 2006; Wallace, 2008; Davis et al., 2009). All these aspects might be important when interpreting the results, as they might have been different if the study would have been performed on both sexes. The age of the four males in the study might also have affected the results, since they were all around the age of maturity and might not behave like adult individuals. The monkeys had not been at Parken Zoo more than four to five months at the start of the study, and did not know each other before their arrival. They might still have been in the process of getting to know each other as the study started. This might cause them to behave more differently than a group of individuals that have been together for a longer period of time would have done.

Disturbances like building and construction right outside the windows of the enclosure, as well as park visitors, could of course also influence the results. The zoo was only open to visitors for one day of the study, on Thursday of week 1 (branch balls). The amount of visitors at the spider monkey enclosure on this day was still not visibly different from the other days, when the "Zoo School" among others also visited the enclosure. Despite Kellogg and Goldman's (1944) statement that all spider monkeys generally share the same kind of behaviours, the results might not be applicable to all species of spider monkeys.

Maybe the results of this study would have been different if it would have been performed in the outdoor enclosure, where more disturbing stimuli are present.

### *Ideas for enrichment for Colombian black spider monkeys*

The criteria for enrichment at Parken Zoo is that it should look natural, keep the monkeys busy for a long time, be cheap to create or to acquire, easy to prepare and it should also be able to be used in both the indoor and outdoor enclosure. According to Mellen and Sevenich MacPhee (2001), enrichment should give the animal choices within its environment. It should be created after assessing the animal's natural history, individual history and exhibit constraints (Mellen and Sevenich MacPhee, 2001; Meehan and Mench, 2007). Meehan and Mench (2007) state that opportunities to solve problems are good enrichments for spider monkeys. They also note that sensory, physical and cognitive capacities should be taken into account when creating enrichment, since it's not preferred to expose animals to situations in which they are unable to successfully cope.

To use many different kinds of food puzzles might in this case be a good idea, considering how appreciated the food puzzles seem to be by the spider monkeys. Objects that need investigation by the spider monkeys, in order to prove if they are empty or not seem to be manipulated for a longer period of time, which is something that should be strived for. Shyne (2006) concluded that additional furniture and other enrichments do not reduce stereotypic behaviour as much as food puzzles do. The ones by Nina Ottosson, used in this study, already come in a variety of different difficulty levels. Apart from buying these puzzles, they are easy to build yourself and should not cost too much to create, and

the variations and possibilities of food puzzles are endless. Also spreading out sunflower seed on the ground might be a good idea, since the spider monkeys tended to look for them for a long time.

In the wild, spider monkeys eat soil in order to obtain Mg, Fe, Ca and P (Dew, 2005), as mentioned before. It might be complicated to provide soil to them in captivity because of the risk of introducing harmful bacteria. Besides, their pellets, Nutrazu's "Primate Maintenance Biscuit", already contain all of these minerals (Mg, Fe, Ca and P). Their pellets also contain salt, but whether it's enough to cover their need is not known. Perhaps their lickings on the ground in the wild are behaviourally rooted needs and not just nutritional needs. In that case enrichment by providing them salt on the ground should be sought for. At the same time, it's important to prevent the spider monkeys from taking too much salt into their bodies. Before this has been investigated, it will probably be best to rely on the salt content of their pellets.

As long as the food enrichments have any fruit or treats left in them the spider monkeys tend to keep being interested, as also proven in the literature study. In order to make them last for longer, maybe cutting the fruit into smaller pieces and create bigger ice blocks might be an idea. Also giving them whole fruits that have not been cut up could be worth a try, so that they would have to try to open them themselves, since that is how it would be like in the wild. This way, though, it will be harder to give them a varied diet, since you will give them less, but bigger, pieces of fruit. But maybe it at least could be used as enrichment every once in a while. Aggressions are unlikely to increase because of the fewer food items. This is because the monkeys are not unfamiliar to each other, and tolerance in the wild is a much better adaptation than fighting over resources within the group, which is energy consuming and sometimes life threatening in fights and chasings (Anaya-Huertas and Mondragon-Ceballos, 1998).

To satisfy curiosity and their need of novel stimuli in their environment, an element of unpredictability is needed (Poole, 1998). Maybe a basket hanging from the ceiling and providing unpredictability by it's swinging would fulfil this requirement. It would also be something for the monkeys to climb on and sit in. Wild spider monkeys face novel things in nature, too, so why not just put in random objects, just for the monkeys to explore for a while? The previous literature study in this report shows that novel enrichment might cause minor stress, but that all stress is not always negative, since this kind of arousal-inducing stress could actually be beneficial to reproduction (Carlstead and Shepherdson, 1994; Lindburg, 1998).

A spontaneous change in humidity and temperature might also be a good form of enrichment, as well as changing and moving their furniture (shelves and ropes etc.) around every once in a while. Attaching handles to the ceiling for the monkeys to swing from could also be a good idea, especially because of its minimal space utilisation. Also putting small handles on the wall, creating something similar to a climbing wall, would be another way of providing enrichment that do not take up any space of the enclosure, but still increase movement possibilities for the spider monkeys.

Since spider monkeys naturally spend most of their time foraging in the canopies, one idea could be to place food items high up on the branches, in places where they are normally not given food. It's easy to fall into the same behaviour of only placing food items on the shelves of the enclosure, but the harder the pieces will be for the spider monkeys to find, the more foraging behaviours they will have to perform.

It is a widely spread assumption among zoos that artificial enrichment affect zoo visitors' experience negatively, but it has been proven that most of the time this is not the case (McPhee et al., 1998). In captivity, only a naturalistic approach to enrichment might

not be enough, since it's hard to fully recreate the animal's natural wild environment. If artificial enrichment can result in the monkeys performing more of their natural behaviours, even though the enrichment does not look natural, the behaviours themselves will still be educational to the visitors. But natural looking enrichment that bring out these behaviours should, of course, still be the main goal. At Parken Zoo, the goal is to do research and to educate the public about how to give the monkeys a second chance in nature, which is why artificial enrichment visible to the public should be kept at a minimum. But if it gives the spider monkeys recreation and increases their well-being, then why not use artificial enrichment, at least when the zoo is closed to visitors? If not, our ethics might come in the way of the well being of the animals. The animals themselves do not care about how natural something is as long as they are having fun or get their needs fulfilled. This is, of course, in addition to naturalistic enrichment, so that the monkeys will not lose their abilities to (or possibilities to learn how to) survive in the wild.

Another assumption among zoos is that visitor interest decreases when animals become less visible at naturalistic exhibits. It has been proven that this is not always the case and that it is possible to balance the needs of animals and visitors at naturalistic exhibits (Davey, 2006). Therefore, lots of vegetation might be a good form of enrichment, especially since the spider monkeys in the wild prefer dense vegetation (Cowlishaw and Dunbar, 2000). It will give the spider monkeys opportunities to hide, but the visitor interest will still not necessarily decrease because of this.

Another form of enrichment is enrichment through taming (Newberry, 1995). Clicker training is in this case a great opportunity to make the monkeys trust humans more. This, in turn, will make it less stressful to them when being around humans in general. The monkeys of Parken Zoo have already started being clicker trained, and hopefully it will lead to the opportunity of being able to examine the monkeys up close and maybe even give them shots through the bars of the enclosure doors.

Coloured enrichment (red, green and yellow), like different kinds of toys, provides a form of sensory enrichment. One should keep in mind, though, not to provide them with objects too small or difficult for them to handle, because of their lack of thumbs. Music is another form of sensory enrichment, proven to be able to both increase and decrease heart rhythm in animals, depending on what type of music it is (Honess and Marin, 2006). Newberry (1995) discusses whether providing them with music might be too anthropomorphic, but as long as you give the monkeys an opportunity to get away from the music or to turn it off, then why not at least try it and see if it will be appreciated?

It is important for spider monkeys who are to be reintroduced back into nature that they practice on exhibiting natural behaviours in order to finally cope with a wild lifestyle. For monkeys who are not going to be reintroduced in the wild, on the other hand, like the spider monkeys at Parken Zoo, how important is it for them to show all their natural behaviours? If they can get their needs covered by enrichments that are not native to their wild environment, are they not good enrichments? If watching TV or listening to music can satisfy some of their needs, then why not benefit from that? For the education of the zoo visitors it probably is important with only naturalistic enrichment, but how important is it for the quality of the lives of the spider monkeys themselves if they still can get all their needs satisfied in artificial ways? -Ways that are simpler for the carers to provide.

Welfare is important in order for the animals to be able to breed and reproduce in captivity. The fitness of captive animals will probably not be affected by artificial enrichment, since they're not living in their right environment, and because of this it's hard to determine which animal has the highest fitness. So despite giving a monkey artificial enrichment in addition to naturalistic enrichment, its ability to survive in the wild will

probably still not be affected.

Food enrichments are great enrichments, especially since the spider monkeys spend a lot of their time in the wild foraging. But recreating natural behaviours through a good and varying mix of enrichments is probably even better, in order to fulfil all their needs – an idea also supported by Young (2003) and Honess and Marin (2006). Using different kinds of food enrichment has in this study proven to make different behaviours become both closer to and more different from the frequency of those of wild spider monkeys, depending on the enrichment. This is also something supporting the thought that a mix of different enrichments is the best for the welfare of the spider monkeys.

The research and development of enrichment are two very important tasks, because in the end, the things that matter the most are the welfare and future of the spider monkeys.

# 7. CONCLUSION

Food enrichments have been shown to be very appreciated by spider monkeys and increase their foraging behaviour. In this study, the food puzzles were the ones used the biggest proportion of time and were also attractive to the spider monkeys for the longest period of time, compared to ice blocks and branch balls filled with fruit. Different enrichments brought different behaviours closer to the normal frequency of behaviours of wild spider monkeys, which is why a mix of enrichments should be used. Branch balls brought most of the behaviours of the spider monkeys closest to the natural frequencies, which is the purpose of enrichment. Other enrichments that could be used are toys and random objects for the spider monkeys to investigate, furniture, whole fruits, music, TV, handles in the ceiling and on the walls, clicker training, changes in humidity and temperature, novel objects, problem solving, vegetation and unpredictability in the environment, like a basket hanging from the ceiling. A mix of all these enrichments would probably be the most preferred in order to give the spider monkeys a high welfare and chance to survive in the wild, which is the most important thing to strive for.

# ACKNOWLEDGEMENTS

I would like to thank…

…Jenny Loberg, for all the help, support and ideas, which have been invaluable.

…Jennie Westander, for all the help and for letting me do the exam work at Parken Zoo, Eskilstuna.

…Marika and the other staff of the South American section at Parken Zoo, for being very welcoming and for all the help.

…Emma, my sister, for letting me stay at her place in Örebro during the pilot study and the three weeks of data gathering at Parken Zoo.

…Paul Vincent and Lill Torstensson for reading through the whole report, correcting the grammar and spelling.

…Diego, Poppin, Rodo and Frank, for letting me take photos of them and stare at them for a month in total.

# REFERENCES


Amici, F., Aureli, F. and Call, J. 2008. Fission-fusion dynamics, behavioral flexibility, and inhibitory control in primates. *Current Biology*, 18, 1415–1419.

Anaya-Huertas, C. and Mondragon-Ceballos, R. 1998. Social behavior of black-handed spider monkeys *(Ateles geoffroyi)* reared as home pets. *International Journal of Primatology*, 19, (4), 767-784.

Aureli, F. and Schaffner, C.M. 2007. Aggression and conflict management at fusion in spider monkeys. *Biology Letters*, 3(2), 147-149.

Aureli, F., Schaffner, C.M., Verpooten, J., Slater, K. and Ramos-Fernandez, G. 2006. Raiding parties of male spider monkeys: Insights into human warfare? *American Journal of Physical Anthropology*, 131, 486–497.

Bayne, K., Mainzer, S., Dexter, S., Campbell, G., Yamada, F. and Suomi, S. 1991. The reduction of abnormal behaviors in individually housed rhesus monkeys (*Macaca mulatta*) with a foraging/grooming board. *American Journal of Primatology*, 23(1), 23-35.

Boere, V. 2001. Order primates (Primates), behavior and environmental enrichment. In: *Biology, Medicine and Surgery of South American Wild Animals* (Ed. M.E. Fowler) 1st Edition. pp 263-266. Iowa State, University Press. ISBN: 0813828465.

Boubli, J.-P., Di Fiore, A., Stevenson, P., Link, A., Marsh, L. and Morales, A.L. 2008. *Ateles belzebuth*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on 12 May 2009.

Boyer, D., Ramos-Fernández, G., Miramontes, O., Mateos, J.L., Cocho, G., Larralde, H., Ramos, H. and Rojas, F. 2006. Scale-free foraging by primates emerges from their interaction with a complex environment. *Proceedings of the Royal Society B: Biological Sciences,* 273(1595), 1743–1750.

Broom, D.M. and Johnson, K.G. 1993. *Stress and animal welfare*. Illustrated Edition. pp 6. Berlin, Springer. ISBN: 0412395800.

Butler, R.A. 1957. The effect of deprivation of visual incentives on visual exploration motivation in monkeys. *Journal of Comparative and Physiological Psychology*, 50, 177-197.

Campbell, C.J., Aureli, F., Chapman, C.A., Ramoz-Fernández, G., Matthews, K., Russo, S.E., Suarez, S. and Vick, L. 2005. Terrestrial behaviour of *Ateles* spp. *International Journal of Primatology*, 26(5), 1039-1051.

Carlstead, K. and Shepherdson, D. 1994. Effects of environmental enrichment on reproduction. *Zoo Biology*, 13(5), 227-458.

Celli, M.L., Tomonaga, M., Udono, T., Teramoto, M. and Nagano, K. 2003. Tool use task as environmental enrichment for captive chimpanzees. *Applied Animal Behaviour Science*, 81, 171-182.

Chapman, C.A. 1990. Association patterns of spider monkeys: The influence of ecology and sex on social organization. *Behaviour Ecology Sociobiology*, 26, 409–414.

Collins, A.C. and Dubach, J.M. 2000. Phylogenetic relationships of spider monkeys (*Ateles*) based on mitochondrial DNA variation. *International Journal of Primatology*, 21(3), 381-420.

Committee on Animal Nutrition 2001. Feeding ecology, digestive strategies, and implications for feeding programs in captivity. *Nutrient Requirements of Nonhuman Primates.* 2nd Edition, Revised 2003. pp 5-40. In: National Academies Press. ISBN: 9780309069892.

Cormier, L.A. 2003. A brief history of New World Monkeys. *Kinship with Monkeys:*

*The Guajá Foragers of Eastern Amazonia*. pp 37. Columbia, University Press. ISBN: 9780231125246.
Cowlishaw, G. and Dunbar, R. 2000. *Primate Conservation Biology*. London, The University of Chicago Press. ISBN: 0-226-11637-9.
Crockett, C.M. 1998. Psychological well-being of captive nonhuman primates. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J. Shepherdson, J.D Mellen and M. Hutchins) Washington DC, Smithsonian University press. ISBN: 1-56098-397-3.
Crook, J.H. 1972. Sexual selection, dimorphism, and social organization in the primates. Chapter 9. In: *Sexual Selection and the Descent of Man* (Ed. B. Campbell) Chicago, Aldine Publishing Company. ISBN: 0202020053.
Cuarón, A.D., Shedden, A., Rodríguez-Luna, E., de Grammont, P.C. & Link, A. 2008. *Ateles fusciceps*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. Downloaded on 26 May 2009.
da Rocha e Silva, R. 2001. Order primates (Primates), Nutrition. In: *Biology, Medicine and Surgery of South American Wild Animals* (Ed. M.E. Fowler.) 1st Edition. pp 261. Iowa State, University Press. ISBN: 0813828465.
Davey, G. 2006. Relationships between exhibit naturalism, animal visibility and visitor interest in a Chinese zoo. *Applied Animal Behaviour Science*, 96, 93–102.
Davis, N., Schaffner, C.M. and Smith, T.E. 2005. Evidence that zoo visitors influence HPA activity in spider monkes (*Ateles geoffroyii rufiventris*). *Applied Animal Behaviour Science*, 90, 131-141.
Davis, N., Schaffner, C.M. and Wehnelt, S. 2009. Patterns of injury in zoo-housed spider monkeys: A problem with males? *Applied Animal Behaviour Science*, 116, 250-259.
Defler, T.R., Rodriguez-M, J.V. and Hernández-Camacho, J.I. 2003. Conservation priorities for Colombian primates. *Primate Conservation*, 19, 10-18.
Dew, L.D. 2005. Foraging, food choice, and food processing by sympatric ripe-fruit specialists: *Lagothrix lagotricha poeppigii* and *Ateles belzebuth belzebuth*. *International Journal of Primatology*, 26(5), 1107-1135.
Di Fiore, A. and Suarez, S.A. 2007. Route-based travel and shared routes in sympatric spider and woolly monkeys: Cognitive and evolutionary implications. *Animal Cognition*, 10, 317–329.
Dishman, D.L., Thomson, D.M. and Karnovsky, N.J. 2009. Does simple feeding enrichment raise activity levels of captive ring-tailed lemurs (*Lemur catta*)? *Applied Animal Behaviour Science*, 116(1), 88-95.
Duarte-Quiroga, A. and Estrada, A. 2003. Primates as pets in Mexico City: An assessment of the species involved, source of origin, and general aspects of treatment. *American Journal of Primatology*, 61, 53–60.
Dunbar, R.I.M. 1975. Some aspects of research design and their implications in the observational study of behaviour. *Behaviour*, 58, 78-98.
Eisenberg, J.F. 1976. Communication mechanisms and social integration in the black spider monkey, *Ateles Fusciceps Robustus*, and related species. *Smithsonian Contributions to Zoology*. pp 213. Washington, Smithsonian Institution Press.
Grand, T. 1972. A mechanical interpretation of terminal branch feeding. *Journal of Mammalogy*, 5(l), 198-201.
Grossblatt, J. and Vaupel, S. 2003. Background and context for occupational health and safety in the care and use of nonhuman primates. *Occupational Health and Safety in the Care and Use of Nonhuman Primates*. In: National Academies Press. ISBN:

9780309089142.
Honess, P.E. and Marin, C.M. 2006. Enrichment and aggression in primates. *Neuroscience and Biobehavioral Reviews*, 30, 413–436.
Humphrey, N.K. 1971. Colour and brightness preferences in monkeys. *Nature*, 229, 615-617.
IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. Downloaded on 26 May 2009.
Izawa, K., Kimura, K. and Nieto, A.S. 1979. Grouping of the wild spider monkey. *Primates*, 20(4), 503-512.
Jahnson, C.H. and Chapman, C.A. 1999. Resources and primate community structure. In: *Primate Communities* (Eds. J.G. Fleagle, C. Janson and K. Reed) pp 256. Cambridge, University Press. ISBN: 0-511-03504-7.
Kellogg, R. and Goldman, E.A. 1944. Review of the spider monkeys. *Proceedings of the U.S. Museum of National History*, 96, 1-45.
Kinzey, W.G. 1997. Ateles. *New world primates: ecology, evolution, and behavior*. pp 192-199. New York: Aldine Transaction. ISBN: 0202011860.
Klein, L. L. and Klein, D. J. 1977. Feeding behaviour of the Columbian spider monkey. In: *Primate Ecology* (Ed. T.H. Clutton-Brock.) pp 153–180. New York, Academic Press. ISBN: 0121768503.
Kreger, M.D., Hutchins, M. and Fascione, N. 1998. Context, ethics, and environmental enrichments in zoos and aquariums. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington, DC, Smithsonian University press. ISBN: 1-56098-397-3.
Kyle, R. 1987. *A feast in the wild.* Great Britain, KUDU Publishing. ISBN: 0-95-12189-0-5.
Laska, M., Freist, P. and Krause, S. 2007. Which senses play a role in nonhuman primate food selection? A comparison between squirrel monkeys and spider monkeys. *American Journal of Primatology*, 69, 282–294.
Lindburg, D.G. 1998. Enrichment of captive mammals through provisioning. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington DC, Smithsonian University press. ISBN: 1-56098-397-3.
Mason, G.J. 1991. Stereotypies: A critical review. *Animal Behaviour*, 41, 1015-1037.
Matsuda, I. and Izawa, K. 2008. Predation of wild spider monkeys at La Macarena, Colombia. *Primates*, 49(1), 65–68.
McPhee, M.E., Foster, J.S., Sevenich, M. and Saunders, C.D. 1998. Public perceptions of behavioral enrichment: Assumptions gone awry. *Zoo Biology*, 17, 525–534.
Meehan, C.L. and Mench, J.A. 2007. The challenge of challenge: Can problem solving opportunities enhance animal welfare? *Applied Animal Behaviour Science*, 102, 246–261.
Mellen, J. and Sevenich MacPhee, M.S. 2001. Philosophy of environmental enrichment: Past, present, and future. *Zoo Biology*, 20, 211–226.
Mench, J.A. 1998. Environmental enrichment and the importance of exploratory behavior. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington DC, Smithsonian University press. ISBN: 1-56098-397-3.
Muñoz-Delgado, J., Corsi-Cabrera, M., Canales-Espinosa, D., Santillán-Doherty, A.M. and Erkert, H.G. 2004. Astronomical and meteorological parameters and rest-activity rhythm in the spider monkey *Ateles geoffroyi*. *Physiology & Behaviour*, 83, 107-

117.
Murchison, M.A. and Nolte, E.M. 1992. Food puzzle for singly caged primates. *American Journal of Primatology*, 27, 285-292.
National Research Council Staff 1998. *Psychological Well-Being of Nonhuman Primates*. pp 86. In: National Academies Press. ISBN: 9780309052337.
Newberry, R.C. 1995. Environmental enrichment: Increasing the biological relevance of captive environments. *Applied Animal Behaviour Science*, 44, 229-243.
Nowak, R.M. and Walker, E.P. 1999. *Walker's mammals of the world*. 6th Edition, Illustrated. pp 541. London, John Hopkins University Press. ISBN 0801857899.
Pastor-Nieto, R. 2001. Grooming, kinship, and co-feeding in captive spider monkeys (*Ateles geoffroyi*). *Zoo Biology*, 20, 293–303.
Perkins, L.A. 1992. Variables that influence the activity of captive orangutans. *Zoo Biology*, 11, 177-186.
Poole, T.B. 1998. Meeting a mammal's psychological needs. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington, DC, Smithsonian University press. ISBN: 1-56098-397-3.
Ramos-Fernández, G. 2004. Vocal communication in a fission-fusion society: Do spider monkeys stay in touch with close associates? *International Journal of Primatology*, 26(5), 1077-1092.
Reynolds, T.R. 1985. Stresses on the limbs of quadrupedal primates. *American Journal of Physical Anthropology*, 67(4), 351-362.
Riba-Hernández, P., Stoner, K.E. and Osorio, D. 2004. Effect of polymorphic colour vision for fruit detection in the spider monkey *Ateles geoffroyi*, and its implications for the maintenance of polymorphic colour vision in platyrrhine monkeys. *The Journal of Experimental Biology*, 207, 2465-2470.
Robbins, D., Chapman, C.A. and Wrangham, R.W. 1991. Group size and stability: Why do gibbons and spider monkey differ? *Primates*, 32(3), 301-305.
Rylands, A.B. 2001. Order primates (Primates): Biology of the Cebidae. In: *Biology, Medicine and Surgery of South American Wild Animals* (Eds. M.E. Fowler) 1st Edition. pp 256-258. Iowa State, University Press. ISBN: 0813828465.
Rylands, A.B., Groves, C.P., Mittermeier, R.A., Cort´es-Ortiz, L. and Hines, J.H.J. 2006. Taxonomy and distributions of Mesoamerican primates. In: *New Perspectives in the Study of Mesoamerican Primates: Distribution, Ecology, Behavior, and Conservation* (Eds. A. Estrada, P.A. Garber, M.S.M. Pavelkaand and L. Luecke). pp 29-79. New York, Springer. ISBN: 978-0-387-25854-6.
Schaffner, C.M. and Aureli, F. 2005. Embraces and grooming in captive spider monkeys. *International Journal of Primatology*, 26(5), 1093-1106.
Schmitt, D., Rose, M.D., Turnquist, J.E. and Lemelin, P. 2005. Role of the prehensile tail during ateline locomotion: Experimental and osteological evidence. *American Journal of Physical Anthropology*, 126(4), 435-446.
Seidensticker, J. and Forthman, D.L. 1998. Evolution, ecology, and enrichment. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington DC, Smithsonian University press. ISBN: 1-56098-397-3.
Shepherdson, D.J. 1998. Tracing the path of environmental enrichment in zoos. In: *Second nature: Environmental Enrichment for Captive Animals* (Eds. D.J Shepherdson, J.D. Mellen and M. Hutchins) Washington DC, Smithsonian University press. ISBN: 1-56098-397-3.
Shyne, A. 2006. Meta-analytic review of the effects of enrichment on stereotypic behavior

in zoo mammals. *Zoo Biology*, 25, 317–337.
Silvius, K.M., Bodmer, R.E. and Fragoso, J.M.V. 2004. *People in Nature: Wildlife Conservation in South and Central America*. pp 1-479. Columbia, University Press. ISBN: 0-231-12782-0.
Smith, R.J. and Jungers, W.L. 1997. Body mass in comparative primatology. *Journal of Human Evolution*, 32, 523-559.
Sorensen, T.C. and Fedigan, L.M. 2000. Distribution of three monkey species along a gradient of regenerating tropical dry forest. *Biological Conservation*, 92, 227-240.
Turnquist, J.E., Schmitt, D., Rose, M.D. and Cand, J.G.H. 1999. Pendular motion in the brachiation of captive *Lagothrix* and *Ateles*. *American Journal of Primatology*, 48, 263–281.
Valero, A., Schaffner, C.M., Vick, L.G., Aureli, F. and Ramos-Fernandez, G. 2006. Intragroup lethal aggression in wild spider monkeys. *American Journal of Primatology*, 68, 732–737.
van Roosemalen, M.G.M. 1985. Habitat preferences, diet, feeding strategy and social organization of the black spider monkey (*Ateles paniscus paniscus Linnaeus* 1758) in Suriname. *Acta Amizonica*, 15(suppl. ¾), 3-238.
Vick, S-J., Anderson, J.R. and Young, R. 2002. Maracas for macaca? Evaluation of three potential enrichment objects in two species of zoo-housed macaques. *Zoo Biology*, 19, 181–191.
Voss, R.S., Lunde, D.P. and Simmons, N.B. 2001. The mammals of Paracou, French Guiana: A neotopical lowland rainforest fauna, Part 2: Nonvolant species. *Bulletin of the American Museum of Natural History*, 263, 66-69.
Wallace, R.B. 2001. Diurnal activity budgets of black spider monkeys, *Ateles Chamek*, in a southern Amazonian tropical forest. *Neotropical Primates*, 9(3), 101-107. ISSN: 1413-4703.
Wallace, R.B. 2008. Towing the party line: Territoriality, risky boundaries and male group size in spider monkey fission-fusion societies. *American Journal of Primatology*, 70, 271–281.
Wallace, R.B., Mittermeier, R.A., Cornejo, F. and Boubli, J.-P. 2008. *Ateles chamek*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on 12 May 2009.
Wilson, S.F. 1982. Environmental influences on the activity of captive apes. *Zoo Biology*, 1, 201-209.
Young, R.J 2003. *Environmental Enrichment for Captive Animals*. Iowa State, Blackwell Publishing. ISBN: 0-632-06407-2.
Zaldívar, M.E., Rocha, O., Glander, K.E., Aguilar, G., Huertas, A.S., Sánchez, R. and Wong, G. 2004. Distribution, ecology, life history, genetic variation, and risk of extinction of nonhuman primates from Costa Rica. *Revista de Biología Tropical*, 52(3). ISSN: 0034-7744.

Vid **Institutionen för husdjurens miljö och hälsa** finns tre publikationsserier:

*** Avhandlingar:** Här publiceras masters- och licentiatavhandlingar

*** Rapporter:** Här publiceras olika typer av vetenskapliga rapporter från institutionen.

*** Studentarbeten:** Här publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

Vill du veta mer om institutionens publikationer kan du hitta det här:
www.hmh.slu.se

**DISTRIBUTION:**

Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Box 234
532 23 Skara
Tel 0511–67000
**E-post: hmh@slu.se**
**Hemsida: www.hmh.slu.se**

*Swedish University of Agricultural Sciences*
*Faculty of Veterinary Medicine and Animal Science*
*Department of Animal Environment and Health*
*P.O.B. 234*
*SE-532 23 Skara, Sweden*
*Phone: +46 (0)511 67000*
***E-mail: hmh@slu.se***
***Homepage: www.hmh.slu.se***