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The time budget of a wild population of yellow-tailed woolly
monkey (*Oreonax flavicauda*)

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Degree project in biology, Master of science (2 years), 2011

Examensarbete i biologi 30 hp till masterexamen, 2011

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TABLE OF CONTENTS

Abstract	3
Introduction	4
Methods	5
<i>Study area</i>	5
Results	6
Discussion	9
Acknowledgements	11
References	11

ABSTRACT

The yellow-tailed woolly monkey *Oreonax flavicauda* is critically endangered and endemic to a small part of the Peruvian Andes. It is one of the least studied primate species and therefore further knowledge about the species is crucial for the conservation work.

The groups I studied have a daily time budget of 41.9% moving, 30.0% feeding, 18.8% resting and 9.3% other activities. Their time budget is similar to other species of the same subfamily. However, *O. flavicauda* move more and rest less and this could be caused by the fragmented habitat of the studied population which makes it necessary to move more to ensure optimal foraging. Females spend more time feeding than other categories and this is probably because of the additional cost of pregnancy and lactating.

As many other primate species, *O. flavicauda* have feeding peaks in the morning and afternoon, and a midday resting peak.

Similar to other woolly monkey's fruit is the main food source (56%) The rest of the diet consists of 36% insects, 6.5% leaves and 0.6% flowers. This mainly frugivorous diet is probably another reason for the high moving scores since frugivory is positively correlated to travel time and home range size.

INTRODUCTION

The knowledge of the proportion of time that individuals spend on different activities during a day is important for the understanding of the ecology and life-cycle of a species. Time budgets indicate how individuals in a species interact with its environment and they show the investment in time that is necessary for activities that are important for the species survival and reproduction (Defler 1995). The variation in time budgets between primate species has been shown to fit certain physical traits and environmental conditions; for example the proportion of the time spent foraging is positively correlated to body weight and negatively correlated to the proportion of foliage in the diet (Clutton-Brock & Harvey in Harrison 1985).

Primate species that inhabits increasingly isolated, fragmented and marginal forests face a number of ecological restrictions: restricted home range, low tree density, low food availability and increased hunting pressure. These limitations affect the diet, mortality rate, reproduction rate and survival of the population (Wallace 2005).

How primate groups distribute their time can give clues about the species ability to survive under such restrictions and about their ecological limits of their tolerance. Time budgets are influenced by group size, habitat quality (Dunbar 1992) and proximity to human settlements (Singh & Vinathe 1990).

Since primates appear to balance their time budget to suit environmental conditions (Harrison 1985) they can be used to compare different populations of the same species inhabiting different habitats.

The yellow-tailed woolly monkey (*Oreonax flavicauda*) is endemic to a small area of the Peruvian Andes and one of the world's 25 most endangered primates (Cornejo et al. 2009). It is listed as Critically Endangered on the IUCN Red List of Threatened Species (Cornejo et al. 2008) and was once thought to be extinct. Since its rediscovery in 1974 (Mittermeier 1975) there has been a major reduction in available habitats, resulting in a population decline (Cornejo et al. 2008). It is one of the least studied primates in the world and this lack of basic knowledge makes the conservation work difficult (Shanee & Shanee 2010).

The species was previously placed in the genus *Lagothrix* but is since 2001 considered to be monotypic, that is, the only member of the genus *Oreonax* (Grooves 2001 in Cornejo 2008).

Until the 1950's the species was protected because of the inaccessibility of its habitat. In the 1980's however, the Lima-Tarapoto highway was constructed throughout its range. The road brought settlers from the Peruvian coast (DeLuycker 2007), resulting in an increased deforestation and fragmentation (Shanee & Buckingham 2009). The rapid deforestation occurring in its habitat has, in many areas forced the species into isolated forest fragments (Shanee *et al.* 2007). A recent GIS-survey shows that 50% of the species original habitat is lost and that only 6302 km² of potential habitat is still available. About 70% of this potential habitat is not protected, showing that it is possible to expand the existing protected area network to protect the species (Shanee & Buckingham 2009).

Hunting is also a major threat to the species (Leo Luna 1980). The human population in the area do not generally consume primate meat but the species is hunted opportunistic for pet-

trade. Interviews with the local population show that 8 % of them target primates while hunting (Shanee et al. 2007). Leo Luna (1987) estimated that around 600 individuals were killed by opportunistic hunting during a 10-years period and Shanee et al. (2007) believe that the numbers are similar today.

The total population of the species was estimated to 250 individuals in the wild in 1999 by Nowak (1999). This is probably an underestimate but the number is not likely to be much higher and most likely decreasing (Shanee et al. 2007). The species have long inter-birth intervals and probably low reproductive rates and population densities. These traits make it vulnerable to anthropogenic pressures (Leo Luna 1987).

In this study I analyzed the time budget and dietary composition of different age and sex classes of several groups of wild Yellow-tailed woolly monkeys.

METHODS

Study site

The survey was conducted in the department of Amazonas, north-eastern Peru, in a region where the species is relatively abundant. The two study areas, locally known as *Peroles* and *El Toro* consist of disturbed primary forest and regeneration secondary forest scattered with grazing land. Peroles (S 05 39 46, W 77 54 32) is about 700 hectares and El Toro is about the same size and 7 km further north. These areas lie between 1800 and 2400 meters above sea level (Shanee & Shanee 2010). They are characterised by montain cloud forest, high ridges and deep valleys. The canopy height is 15-25 meters although some trees reach up to 35 meters. Rainfall is heavy all year and varies between 15 and 120 mm per month. The driest period is August to December. The forest in this region is disappearing rapidly because of commercial logging, mining and land clearance for livestock production and coffee cultivation. The area is located between two reserves, forming a natural corridor between these reserves. The NGOs Neotropical Primate Conservation (NPC) and Asociación Ecosistemas Andinas (ECOAN) are currently working on turning the area into a community based reserve. The population density in Peroles was estimated to 18 individuals/ km² in 2009 (Shanee & Shanee 2010).

Data was collected between April and June on 6 occasions, 5 days each, using focal animal sampling technique. When locating a group, one individual was randomly chosen and its activity recorded every second minute. Each individual was followed for one hour if possible, before another individual was chosen. However, on those occasions when the focal animal was lost for more than 10 min, the observation was ended and another group member was selected as the focal animal. The following activities were recorded on standardized data sheets: Rest (all immobile positions that does not include interactions with another individual), Feed (eating, handling or searching for food), move (all mobile activities such as jumping, swinging and walking), play, vocalize, aggressive (moving and vocalizing, shaking branches or throwing objects), grooming self, grooming other, sexual activity and human watch.

If the individual's activity was feeding, data on the diet type (fruit, insect, flower, leave) was collected. Distance to nearest individual and height above ground was also estimated every fourth minute.

Individuals were separated by age and sex and categorised as adult male, adult female, female with infant, juvenile, female juvenile and male juvenile. Adult males were easily recognized by their long genital tuft and their larger size. Females were recognized by their prominent clitoris. Male juveniles do not have genital tuft but female juveniles do have a visible clitoris. "Female with infant" was used when the infant was carried by the mother. If the infant moved independently it was scored as a juvenile. Moreover, "whole group" was used when the group was moving altogether from one place to another so that one individual could not be followed. When this occurred the time the whole group moved was estimated by multiplying the time it took for the observers to walk the distance with a number between 0.3 and 0.6. The reason being that it takes much longer for a human to move a distance than it does for the monkeys because of the rugged terrain and dense vegetation. Depending on how heavy the terrain was, a higher or lower number was chosen. If the observers for example, followed the monkeys uphill in dense bamboo forest for ten minutes, the lowest numbers (0.3) was chosen and multiplied with ten to estimate the time the group of monkey moved.

When located, the group was followed from dawn, ~6 am until dusk, ~6 pm (if possible). At dawn the monkeys sleeping position was marked on a GPS to facilitate locating them the next morning.

Data was inserted in SPSS (Statistical program for the social science) and most analyzes were carried out using this program. To test if the data was independent or not 20% and 10% of the data was randomly chosen to produce a time budget. Since the result was the nearly the same as when all data was used the conclusion was made that the whole data set most probably consisted of independent observations and therefore all data could be used in the analysis.

Since “human watch” is not a natural activity it was excluded before calculating the time budget. The categories male juvenile and female juvenile were put in one group together with juvenile since there were few scores in these categories.

RESULTS

A total of 1408 individual activity records, or 42 hours of observation was collected by J.S and another observer. The yellow-tailed woolly monkey spend 41.9% of the day moving, 30.0% feeding, 18.8% resting, 5.0% vocalizing, 1.9% playing, 0.9% grooming other, 0.7% on aggressive displays, 0.5% grooming self and 0.2% on sexual behaviour (figure 1).

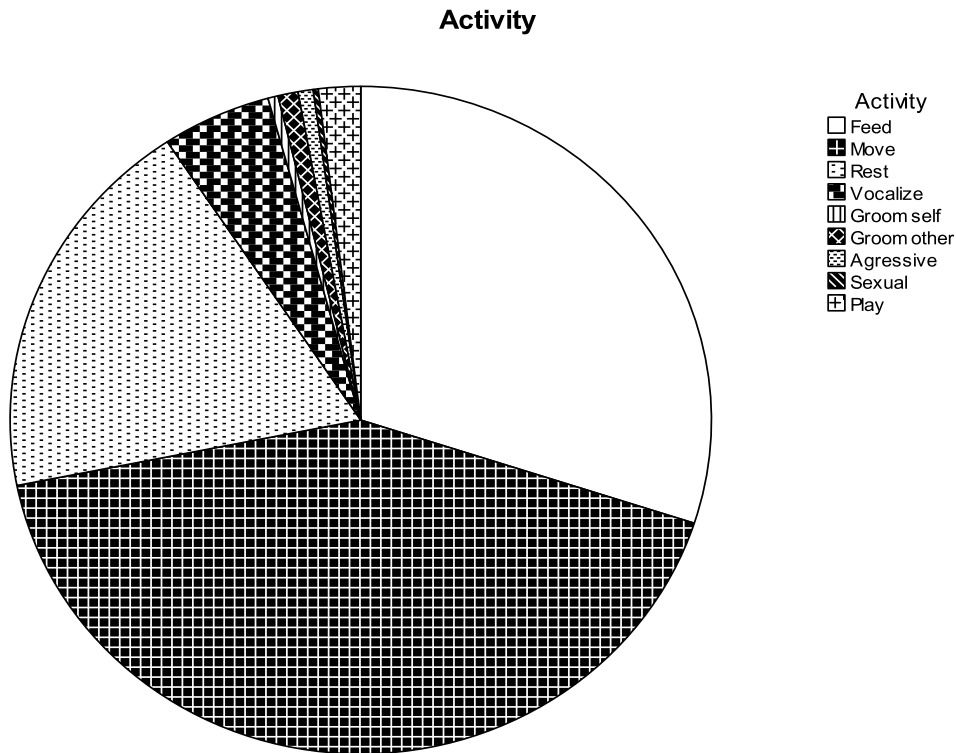


Figure 1. Time budget of *Oreonax flavicauda*

As seen in table 1, females and females with infants feed more than the other categories ($X^2=5.04$, $df=1$, $p=0.025$). Females with infants also vocalize more ($X^2=52.118$, $df=1$, $p<0.0001$) Juveniles move ($X^2=9.238$, $df=1$, $p=0.0024$) and play ($X^2=81.00$, $df=1$, $p<0.0001$) more. Juveniles and females with infants rest less ($X^2=37.17$, $df=1$, $p<0.0001$). Human watch was not included in the time budget but a comparison showed that juveniles do this more ($X^2=38.44$, $df=1$, $p<0.0001$). Males spend more time on aggressive behaviour ($X^2=4.50$, $df=1$, $p=0.0339$).

Table 1. Comparison of time budgets in different age-sex classes (Human watch removed).

		Adult female					
		Adult male	Adult female	+ infant	Juvenile	Total	
Activity	Feed	Count:	104	133	67	83	387
		%	29,2%	40,8%	38,5%	35,5%	30,0%
	Move	Count:	100	90	54	96	540
		%	28,1%	27,6%	31,0%	41,0%	41,9%
	Rest	Count:	108	90	22	23	243
		%	30,3%	27,6%	12,6%	9,8%	18,8%
	Vocalize	Count:	27	4	31	3	65
		%	7,6%	1,2%	17,8%	1,3%	5,0%
	Groom self	Count:	4	0	0	2	6
%		1,1%	0%	0%	,9%	,5%	
Groom other	Count:	6	6	0	0	12	
	%	1,7%	1,8%	0%	,0%	,9%	
Agressive behaviour	Count:	6	2	0	1	9	
	%	1,7%	,6%	,0%	,4%	,7%	
Sexual activity	Count:	0	0	0	3	3	
	%	0%	0%	0%	1,3%	,2%	
Play	Count:	1	1	0	23	25	
	%	0,3%	0,3%	0%	9,8%	1,9%	
Total	Count:	356	326	174	234	1290	
	%	100,0%	100,0%	100,0%	100,0%	100,0%	

All categories spend less time moving ($X^2=7.82$, $df=1$, $p=0.0052$ and more time resting ($X^2=37.63$, $df=1$, $p<0.0001$) when raining than in sunny or cloudy weather. Juveniles and females with infant spend more time at short distance (0-5m) to closest other individual than the other categories ($X^2=10.04$, $df=1$, $p=0.0015$).

O. flavicauda spends 49.4 % of its time in canopy up to 20 meters and 50.4% in canopy higher than 20 meters. Juveniles spend more time in the lower canopy (≤ 20 meters) than other categories ($X^2=17.44$, $p<0.0001$) and adult males spend more time in the higher (>40 meters) canopy ($X^2=7.88$, $df=1$, $p=0.0050$).

As seen in Table 2, fruits compromise the majority of the feeding record (56%). The rest of the diet consisted of 36% insects, 6.5% leaves and 0.6% flowers. Juveniles spend more time feeding on insects than other categories ($X^2=11.81$, $df=1$, $p=0.0006$).

Table 2. Dietary composition of the different age-sex classes.

			focal animal				Total
			Adult male	Adult female	Adult female with infant	juvenile	
Feed	Fruit	Count	37	38	15	6	96
		%	61,7%	54,3%	88,2%	26,1%	56,5%
	Leaves	Count	6	2	0	3	11
		%	10,0%	2,9%	0%	13,0%	6,5%
Flowers	Count	0	1	0	0	1	
	%	,0%	1,4%	0%	,0%	0,6%	
Insects	Count	17	29	2	14	62	
	%	28,3%	41,4%	11,8%	60,9%	36,5%	
Total	Count	60	70	17	23	170	
	%	100,0%	100,0%	100,0%	100,0%	100,0%	

As figure 2 describes all categories spend more time feeding in the morning; 6.00-8.59 and in the afternoon; 15.00-18.00 ($X^2= 19.21$, $df=1$, $p<0.0001$). During these hours less time was spent resting ($X^2=24.62$, $df=1$, $p<0.0001$).

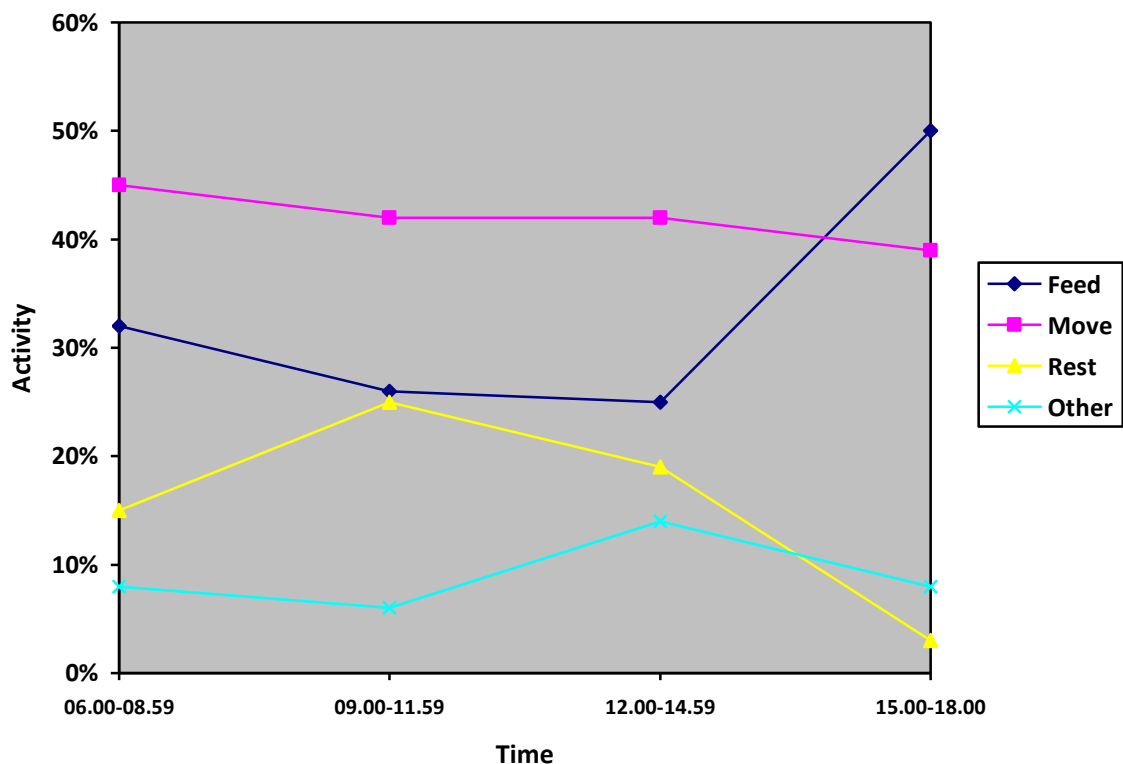


Figure 2. Activity patterns during the day.

Different groups could not always be distinguished from each other but it was estimated that 5-8 groups was encountered. The group size was estimated to 13-18 individuals except for one group that consisted of only 4 individuals (pers obs.)

Other primate species that was observed in the area during the study was White-fronted Capuchin *Cebus albifrons* and Andean night monkey *Autos miconax*.

DISCUSSION

The time budget of *O. flavicauda* is similar to other species of the same subfamily (Table 3). However, this species spend more time moving and less time resting than the others. The reason could be the fragmented habitat that this population inhabits, making it necessary to move more to ensure optimal foraging. Other studies have found this relationship when comparing groups of the same species in disturbed and undisturbed habitats (Menon & Poirer 1996).

Table 3. Time budgets for several species of the subfamily Atelinae

Species	Move	Feed	Rest	Other
<i>Oreonax flavicauda</i> (this study)	41.9%	30.0%	18.8%	9.3%
<i>Lagothrix lasotricha</i> (Defler 1995)	38.8%	25.5%	29.9%	5.5%
<i>Lagothrix lagotricha poeppigii</i> (Fiore & Rodman 2001)	34.4%	36.2%	23.2%	6.1%
<i>Ateles chamek</i> (Wallace 1995)	29.7%	18.9%	45.5%	5.9%

Similar to other woolly monkeys, the major food source is fruit although the percentage for other species is reported to be higher. For example the percentage of fruit in the diet of three woolly monkey subspecies subspecies, *Lagothrix lagotricha cana*, *L. l. poeppigii*, and *L. l. lugens*, was 77%, 73.6% and 60% respectively (Defler & Defler 1996). However, one must remember that the numbers in this study are based on a three months survey and might diverge from the annual diet proportions due to variation in resource abundance during the year. The frugivorous diet of the species probably forces them to travel a lot, hence the high scores on moving. It also indicates that they have large home range since frugivory is positively correlated to travel time and home range size (Milton & May 1976).

Juveniles spend more time feeding on insects. This relationship was also found in *Macaca Silenus* (Kumar 1987 in Umapathy & Kumar 2000), the reason being unclear. Juveniles could be expected to feed more since they are growing and in addition move and play more. The reason that they do not feed more is probably that at least some of them still suckle. Females with and without infants however, feed more. This is probably because of the additional cost of pregnancy and lactating since they do not move more.

The feeding peaks in the morning and afternoon, and the midday resting peak (Figure 2) are typical and reported for many other primates e.g. *Trachypithecus leucocephalus*. (Huang et al 2002) *Macaca silenus* (Umapathy & Kumar 2000) These peaks could be an adaptation to temperature changes during the day but it could also be a way of maximizing food intake, assuming that feeding time is limited by digestion time (Harrison 1984).

Juveniles have higher scores on playing and moving. These higher scores are attained by lower resting scores. This difference was also found in the common woolly monkey *Lagothrix Lagothrix* (Defler 1995). Juveniles also spend more time at a closer distance to nearest

individual. This is most likely related to their high playing scores and that they still depend on their mothers. The fact that juveniles spend more time in the lower canopy could be related to their high scores on human watching. Even if all human watch scores were removed before calculating the time budget it could be a general curiosity towards human that kept them lower even when they were not human watching.

When the first studies of the species were made in the 1980s Leo Luna reported group size to range between five and 18 individuals (Leo Luna 1982). In a recent survey by DeLuycker (2007) they found larger groups ranging from 17 to 20 and as high as 30 individuals. In 2009 group sizes of 3 to 19 individuals (average 8.9) was reported (Shanee & Shanee 2010). I estimated the group sizes to be between 12 and 18 individuals, except for one group that consisted of only four individuals. These recently observed larger groups could be a sign of a lack of available habitat leading to less dispersal.

Females with infants vocalize more than the all other categories together. I noticed that these vocalizations were mostly high-pitched alarm calls that seemed to be elicited by startling events such as loud noises or the sight of a raptor. This is problematic since females with infants usually are the main target for poachers as the infants are wanted for the pet trade. The fact that they vocalize more and that this seems to occur in intimidating situations probably makes them an easier target for poachers. This might seem like an unadaptive and costly behavior but it probably functions as a predator deterrence call for natural predators (Zuberbühler 1999). These alarm calls are also often observed when a group spots humans and if the humans keep approaching aggressive behaviors such as branch shaking are displayed.

ACKNOWLEDGEMENTS

I would like to thank the devoted founders of Neotropical Primate Conservation (NPC) Sam Shanee and Noga Shanee, and my supervisor at University of Uppsala Mats Björklund. I also thank my co-field worker Linda Romero and all the local guides of La Esperanza for their support and hard work in the field.

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