DENSITY, DIET AND HABITAT PREFERENCE OF THE TWO-TOED SLOTH *Choloepus hoffmanni* IN AN ANDEAN FOREST OF COLOMBIA

Final Report

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INTRODUCTION

Rapid forest destruction, illegal wildlife trade and indiscriminate hunting have been determinant causes of wildlife population decline. Like many other mammals, sloths are vulnerable to the conditions above. Sloths are often used for pet trade and confiscated from illegal owners by environmental authorities (Polanco-Ochoa 1998, 2001). They are listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); although they are not endangered yet, they could be so in the future unless their trade becomes regulated (Hemley 1994 in Polanco-Ochoa 1998). In addition, the two-toed sloth (*Choloepus hoffmanni*) is listed under the Deficient Data (DD) category, because available information is inadequate to determine if it is endangered or not (IUCN 2002). According to the Colombian Red List of the Alexander von Humboldt Institute sloths are under the low risk/near threatened (LRca) category (Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 1998). But studies on their population ecology and status in neotropical forests are scarce, to confirm the level of extinction risk.

Sloths belong to the Order Phyllophaga (Alberico *et al*. 2000) and range from east Honduras, and north Nicaragua, to Perú and Brazil. It's one of the three species of sloths in Colombia and the only inhabiting the high mountain forests of the Andes from 0 to 3200 m of altitude (Alberico *et al*. 2000). These exclusively neotropical animals are characterized by their slow movements and some anatomical and physiological adaptations that allow them to survive in the high tree tops. Few studies (Sunquist and Montgomery 1973, Montgomery and Sunquist 1975, 1978, Polanco-Ochoa 1998, Taube *et al*. 1999, 2001) have provided information on this and other sloths' species ecology, distribution, habitat use and importance in lowland forests.

Two-toed sloths (*Choloepus hoffmanni*) are nocturnal, quiet, slow animals living in the canopy of neotropical forests. They are supposed to visit the ground only once in a week to defecate and urinate (Meritt 1985). Contrary to three-toed sloths, two-toed sloths have a very low activity during the day, hiding between branches and lianas. Its behavior makes it difficult to study and using direct methods can produce biased results, but the low defecation rate turns into an obstacle for indirect methods. Two-toed sloths are mainly herbivores, probably complementing its diet with fruits and flowers. Until date, there was no information about the ecology of the species in mountain ecosystems.The Andean forests of Colombia support the highest human population density and agricultural activities (Cavelier et al. 2001), which have reduced the sloth's potential habitat. The study area corresponds to a private reserve near Bogota, a suitable site to develop biological survey, conservation and management programs. The aim of this research was to gain information on the ecology of the species as a needed background for further conservation and management programs at the reserve.

OBJECTIVES

1. To estimate abundance and density of *Choloepus hoffmanni* in an Andean forest.
2. To determine the distribution pattern of *C. hoffmanni* in an Andean forest.
3. To determine the habitat preferences of sloths at the study area.
4. To identify the principal components of the *C. hoffmanni* diet in an ecosystem found in the mountain forest of the Andes.
5. To determine if *C. hoffmanni* works as seed dispersal agent for plant species.

RESEARCH DEVELOPMENT

Field site

Figure 1. A normal cloudy day at El Macanal.

Fieldwork took place from November 2002 to October 2003 at "El Macanal" farm (04º39' N; 74º20' W), Bojaca, Colombia. A mountain cloud forest covered most of the area (134.4 ha) from a total of 173.2 ha (Fig. 1). The non-forested area corresponded to pastures occasionally used for ranching and shrubby vegetation. Altitude ranged from 2100 to 2900 m and average annual temperature is 13 ºC.

Three forest patches with different levels of disruption resulting in differences in composition and structure were identified. The patch Macanal-Bocachica (MB) is the largest forest area covering 71.2 ha. The form of this patch resulted in a relatively large border affecting its composition and structure.

The patch CC corresponded to the smallest one and the most frequently used by cattle and people. And the third patch San Benito-Encanto (SBE) was separated from the other two by the main road between Bogota and La Mesa. It is a mature forest area dominated by oak trees.

Each objective was carried out by one of the researchers in the team. Density through direct sampling, abundance, and distribution pattern were estimated by Carmona (2003), density through indirect sampling, habitat characterization and preference analysis by Alvarez (2004), and diet analysis, a microhistological reference collection and germination tests by Sánchez (2004).

Density estimation through direct sampling

100 m long transects were located through a modification of the method used by Ruette *et al*. (2003). The number of transects per site was proportional to its area. Eight transects randomly selected were daily sampled at each forest patch and direct observations were performed for about 30 min. in each transect. Data were collected twice in a month for six days a week for three months. Once an animal was spotted, geographic coordinates of its location were obtained with a GPS and three distances were recorded distance from the observer to the animal, perpendicular distance from the transect to the animal, and the angle formed by these two distances (Eberhardt 1978; Mandujano 1994). Several times, when a sloth was no more than five meters above ground, a field assistant climbed the tree and attempted to mark the animal with paint on its back (Polanco-Ochoa 1998), for posterior individual identification. Nevertheless, sloths ran away once the climber moved the tree. Consequently, individual identification of sloths among sampling periods was not possible, and density estimates and spatial distribution patterns had to be obtained for each sampling period to avoid overestimation of these parameters (Caughley 1977; Eberhardt 1978; Tellería 1986; Buckland *et al*. 1993; Mandujano 1994; Wilson *et al*. 1996; Brower *et al*. 1998; Thompson *et al*. 1998). A density estimate from the line transects data was obtained by King's method, using Ecological Quantitative Analysis software (Brower et al. 1998). In order to determine differences in density estimations among the three sites, a Kruskal-Wallis non-parametric test and the a posteriori Box and Whisker graph were applied.

Density estimation through indirect sampling

To estimate the number of pellet groups on the study area, 28 plots of 10 X 10 m were randomly stratified located. An initial cleaning of the ground was carried out removing dead leaves and pellet groups of any animal in the plot. Every two weeks for five and a half months, plots were visited, sloth's pellet groups were counted, and dead leaves were removed again. We planned to use 2 more plots but security problems at the area didn't allow us to continue visiting them after the first cleaning.

Sloth's density (individuals/ha) was estimated for each forest patch and the whole forested area using the number of pellet groups counted in the plots (Telleria 1986, Skalski 1994, Thompson *et al.* 1998). A Kruskal Wallis non-parametric test was used to compare the estimated values for each fragment. One of the problems related to this technique is the lack of information of defection rates for sloths in mountain forest. Thus, fallowing Meritt (1985), 5.5 was used as the mean defecation rate of *C. hoffmanni*.

Distribution pattern

The same data obtained for the estimation of abundance and density through transect counts was used to determine the spatial distribution of *C. hoffmanni*. Spatial distribution of the population was estimated using the ratio variance/sample mean, where $\sigma 2/\mu = 1.0$ when distribution is random (Brower et al. 1998).

Habitat description

Figure 2. Clímaco-Corraleja forest.

Vegetation: The three patches were described based on arboreal vegetation (dbh>10 cm). The same plots used to count pellet groups were used for the vegetation survey (Fig. 2). Evaluated variables included composition (relative abundance of species), density, height, dbh, and basal area of trees (Matteucci & Colma 1982). A principal coordinate analysis was carried out to determine the separation between habitat types and a stepwise regression analysis was made to detect the most important variables for the use of a habitat type by sloths.

Trees: Supposing that the nearest tree (DAP>10 cm) to faeces in sampling plots or out of them were used by sloths, variables already identified as relevant for the selection of trees by sloths (Montogmery & Sunquist 1978, Polanco-Ochoa 1998) were evaluated for each tree. Trees where sloths were observed were characterized, too. The variables included species, dbh, height, vines and epiphytes covertures, crown exposition to sun and crown depth. A principal coordinate analysis was applied to separate trees used by sloths and a stepwise regression analysis was made for detecting relevant variables of the trees.

The habitat preferences of *C. hoffmanni* were analyzed at two levels, as well as the habitat characterization. At the vegetation level, a preference analysis following Neu *et al.* (1974) was applied, dividing sloth's registration at the study area into pellet observations and individual observations. At the tree level, the technique proposed by Les Marcum and Loftsgaarden (1980) was used.

Diet composition

Faeces analyses were used to determine two-toed sloth's diet composition. Faeces were searched throughout the area using the plots, transects and ways at the field site. Faeces were collected, labeled and stored in hermetic plastic bags, and frozen stored in field. A reference plant collection of species considered possible part of the diet of sloths was made from trees with evidence of use by a sloth. Plant samples were taxonomically identified and through a microhistological technique and the varnish mantle technique the patterns for later cuticles fragments identification were obtained. A modification of the microhistological technique for extraction of leaves cuticles from faeces described by Osbarh (1999) was used. Percoll was replaced by sacarose to separate cuticles from mesophyll and the number of lecture fields was increased to improve the probability of detecting species consumed in low amounts. Plant samples were fixed on slides with Entellan and a photographic register of the most representative structures slides was produced.

The samples of fecal material collected were prepared on slides in the same way. Identification was based on epidermal tissue characteristics. 50 microscope fields per slide were examined in each slide under a compound microscope. Relative frequency of occurrence of food items was recorded, and as an index of volume the percent coverage of a species on a slide was estimated (De Blase, 2001). To compare these two measurements, an importance value index was adapted (I.V.I) (Rangel *et.al.* 1997).

Seed dispersal tests

The efficiency of two-toed sloth as seed-dispersal agent by endozoocory was assessed by making germination tests as follow. A portion of eight faeces samples was sow at 5 cm with the following treatments: (T1) Sterile soil + faeces of two-toed sloth, (T2) Native soil + faeces of two-toed sloth, and (T3) Only native soil, or control treatment. The test was maintained under greenhouse conditions. Growing plants were collected after 180 days of constant watering because most of the seeds that pass through the intestinal tract, germinate two or three months after consumption and defecation (Downer, 1999).

SLOTH'S DENSITY

A total of 19 sloth sightings were obtained at the three sites of the El Macanal farm during the six sampling periods. Average sloth density at El Macanal farm was 0.3 individuals/ha ± 0.2 (Table 1). The site with the highest sloth density was SBE with an average of 0.7 individuals/ha ± 0.8, followed by BCM with 0.3 individuals/ha ± 0.1 and CC with 0.1 individuals/ha ± 0.2. Density differences were found among the three areas (H=7.46, n=18, p=0.02). According to the *a posteriori* Box-Whisker graph, density estimation at SBE is different from the estimations at BCM and CC. Total abundance estimated for El Macanal 42 sloths, with the highest site estimation found at SBE with 23 sloths, followed by BCM with 17 sloths at and by CC with 2 sloths.

Table 1. Density obtained by King´s method in each zone at El Macanal.

Sampling	BCM	CC	SBE
1	0,4	0,0	0,2
2	0,3	0,0	1,1
3	0,2	0,4	2,1
4	0,3	0,0	0,0
5	0,2	0,0	0,5
6	0,2	0,0	0,4
Average	0,3	0,1	0,7
Standard deviation	0,1	0,2	0,8

As a result of indirect sampling, 13 pellet groups (Fig. 3) were counted, most of them in the SBE fragment. Table 2 presents density values obtained for the three patches and the whole forested area. Differences were not statistically significant (H=0.687, α=0.05). But sloth's density was higher in SBE than in any other fragment.

Tabla 2. *C. hoffmanni* density derived from the pellet counts at El Macanal.

Estimation	Forest patch			Total forested area
	SBE	**CC**	**MB**	
Density (sloths/ha)	3.63	1.06	0.64	1.49
Density variance	5.48	0.45	0.11	6.04
Confidence intervals (95%)	$-2.1<D<9.4$	$-1.2<D<2.8$	$-0.1<D<1.4$	$-3.3<D<6.3$

One of the problems associated with direct observation is animal detection (Tellería 1986), which could be linked to weather conditions such as fog and rain. Constant foggy conditions at the study area (6/8 monthly) caused low visibility and became one of the main problems affecting sampling. In addition, April and May coincided with the rainy season, making it more difficult to observe sloths. Individuals observed during the same sampling period were different individuals, according to their separate locations at the study area.

The pellet count technique can be efficient for these highly undetectable animals. Although the number of pellets found inside the plots was low, the density estimation obtained was supported especially by the number of pellets found outside the sampling plots and complemented by the sightings. The defecation rate may have been different as proposed by Meritt (1985) due to variation in important factors (e.g. environmental variables, stress and food availability), and as a result estimations may be biased (Tellería 1986). An estimation of *C. hoffmanni* defecation rate at the study area is still needed so that these results can be confirmed or reevaluated. The data distribution for this sampling technique which resulted in wide confidence intervals is quite common for mammals and feaces (Telleria 1986). Nevertheless a higher number of sampling plots could be helpful to reduce them.

Figure 3. Pellet of *C. hoffmanni* at El Macanal.

Density estimations obtained by both sampling methods at the study area are the first estimations for *C. hoffmanni* populations in a mountain forest. The direct method could slightly fail as it had to assume that the probability of sloth detection right above transects was 100%, difficult to accept for such a cryptic animal as *C. hoffmanni* in a cloudy forest. On the other hand, the indirect method had to assume that the defecation rate of *C. hoffmanni* in the study area was the same as the one reported for the species in a lowland forest. In that context, it's probable that direct sampling resulted in a density underestimation meanwhile the indirect sampling overestimated density.

Using both techniques at the same time did give us information about differences in density between forest patches, and about habitat use and preference. Both methods resulted in a higher sloth density in SBE and much lower values for the other two sites. These differences could be due to differences in tree composition among sites, especially in the abundance of frequently used species such as *Quercus humbodtii* and least used ones such as *Miconia tonduzii* as explain below. Another factor that could be affecting sloth density in the patches is the presence of a barrier generated by the Bogotá-La Mesa road, that separates SBE site from the other two sites, as well as the eucalypt trees located along this road. Internal fragmentation is one of the main impacts on wildlife Goosem (1997). On the other hand, human presence, degree of intervention in each of the three sites, and presence of pastoral activities might affect sloth density.

DISTRIBUTION OF SLOTHS

Departure from a random distribution pattern was not significant for sampling periods 1, 2, 3, and 6. For sampling period 5, departure from a random distribution pattern was significant, according to the *t* test (d.f. 47; $\alpha = 0.05$); indicating a clumped distribution.

Random distribution of sloths (*C. hoffmanni*) at the study area is seldom found in a natural environment. Ecological characteristics of sloths, such as their solitary behavior and no tendency to either avoid each other or clump to each other (Beebe 1926; Montgomery and Sunquist 1975; Taube *et al*. 2001) are factors that could favor random distribution. The presence of *Brunellia sibundoya* and *Quercus humboldtii*, frequently used trees and highly abundant at the three forest sites, make it possible for sloths to use them anywhere in the forested sites. Likewise, the absence of large predators such as jaguars (Izor 1985; Polanco-Ochoa 1998; Galetti and de Carvalho 2000) means that there is not direct predation pressure on the sloths without affecting their distribution at the three sites of the forest.

Random distribution had not been reported for sloths in other studies. Polanco-Ochoa (1998) reported a clumped distribution for the species *Bradypus variegatus* at the Aviarios del Caribe reserve, in Costa Rica. Taube *et al.* (1999) found a uniform distribution along the Sinnamary River, in French Guyana for both *Bradypus tridactylus* and *Choloepus didactylus*. These differences could be related to the used methods.

SLOTH'S HABITAT

The three forest fragments differed in the number of tree species and the dominant species in each one of them. In MB the arboreal cover was higher than in any of the fragments, meanwhile the basal area and trees density presented the highest values in SBE (Table 3). The three fragments are different according to the statistical analysis, and the most significantly different variable was tree cover (Lambda de Wilks=0.491, p<0.10). None of the variables evaluated for each patch seemed to explain the differences in *C. hoffmanni* density between them.

Table 3. Summary of the arboreal vegetation features of the forests used by *C. hoffmanni* at the El Macanal farm, Bojacá, Cundinamarca, Colombia.

Variable	**SBE**	**CC**	**MB**
Number of tree species	17	13	20
Dominant species	*Quercus humboldtii* *Hedyosmum goudotianum*	*Quercus humboldtii* *Brunellia sibundoya* *Hedyosmum goudotianum*	*Miconia tonduzii* *Brunellia sibundoya*
Height (m)*	11.1 ± 1.97	11.3 ± 2.78	11.8 ± 3.96
DBH (cm)*	25.8 ± 6.19	22.5 ± 10.00	26.3 ± 15.37
Total cover (%)	92	62	83
Trees density (trees/ha)*	557.1 ± 243.97	383.3 ± 147.20	480.0 ± 217.78
Basal area (cm^2/m^2)	40.8	24.2	28.8

The trees near to faeces were different from the trees were sloths were observed (Lambda de Wilks=0.620, p<0.000). On the other hand, the trees used by *C. hoffmanni* in each forest patch were similar (Lambda de Wilks=0.829, p<0.328), which would support the idea that sloths would select trees independently from the patch. None of the measured variables in each tree seemed to explain the differences in the frequency of use of each one of them by *C. hoffmanni*.

According to pellet data, sloths don't prefer SBE or CC, e.g. they used each of these patches according to its availability. But sloths avoided MB or used this area less frequent than they're supposed to according to its availability. According to sightings, there were no preferences or avoidances detected (X^2=4.010, α=0.05). Nevertheless the number of observation of individuals was half the number of pellet found, which gives more force to the first result obtained and the tree preference analysis.

C. hoffmanni presented no preference for any tree species but it avoided *Miconia tonduzii* (0.105< p_{id} - p_{iu} <0.371), a common species in secondary growing areas of the patches, and a dominant one in MB. The lower density values reported for MB can be explained by this result. *M. tonduzii* is a small tree (≈ 8 m high) with narrow canopy that tends to form large patches in the forest, mostly in transitional areas between forest and grasslands. These features don't offer a safe place for sloths to sleep or move through the canopy. Besides, *M. tonduzii* is too small to give sloths the chance of finding a place to hide and expose to sun. Although MB is the largest patch its shape enlarges the border area and allows *M. tonduzii* to grow successfully, reducing the size of sloth's potential habitat and population size due to avoidance of this specie by sloths. The fragmentation process at the study area, and the sloth density estimated, support the idea that changes in the vegetation composition and structure may affect *C. hoffmanni* populations. Although sloths are considered to be easily adapted organisms to secondary vegetation (Chiarello 1999, Lopes & Ferrari 2000), it's possible that successional stages and border vegetation highly reduce potential habitat areas for them as in this case.

The differences in the characteristics of trees near to sloth's pellet groups and trees were sloths were sighted lead us to think that it is necessary to use direct and indirect sampling methods to get a more complete characterization of the habitat requirements of *C. hoffmanni*. Both small trees and large trees are important for *C. hoffmanni*, so it can have a place to rest in the daytime and a way to reach the floor to defecate. Small trees have to be close to large ones so sloths can go up and down. In lowland tropical forests, this connection between canopy and floor might be accomplished thanks to the presence of large woody lianas (Montgomery & Sunquist 1978). A tree used by sloths may provide one or more of several functions protection, connection between trees, food, access to sunlight and shadow to regulate body temperature, or access to the forest floor (Montgomery & Sunquist 1978). Frequently used trees could satisfy more than one these requirements, which could be the case for *Quercus humboldtii* and *Brunellia sibundoya* at the study area. These results show the importance of analyzing the whole stratification of a forest in order to have a better understanding of the habitat of sloths and their requirements.

The use of similar trees in the three sites evidences a process of habitat selection given at different scales (Morrison *et al*. 1998), where selection at the smaller scale (in this case the tree) can influence selection on a larger scale (in this case the forest patch), depending on the resource offered at the tree scale. The relative frequency of trees used by *C. hoffmanni* affects use and selection of an area and as a result sloth density.

SLOTH'S DIET

A reference collection of slides was obtained. For this collection leaves from collected plants samples belonging to 25 families and 29 species were identified. The description of epidermic features of leaves was made fallowing Strasburger et al. (1990), Lindorf et al. (1991), Gómez et al. (1997), and Judd (1999).

Sloth's diet was determined from 43 fecal samples analysis. 90.7% of the fragments were identified with the reference collection slides, corresponding to 17 species. This indicates that *C. hoffmanni* is a generalist (Margalef, 1986) with a broad range of consumed species. *Q. humboldtii, B.sidundoya* y *Cordia cylindrostachya*, were present in more then 50% of faeces samples. Other species in less than 10 % of faeces samples (Fig. 4).

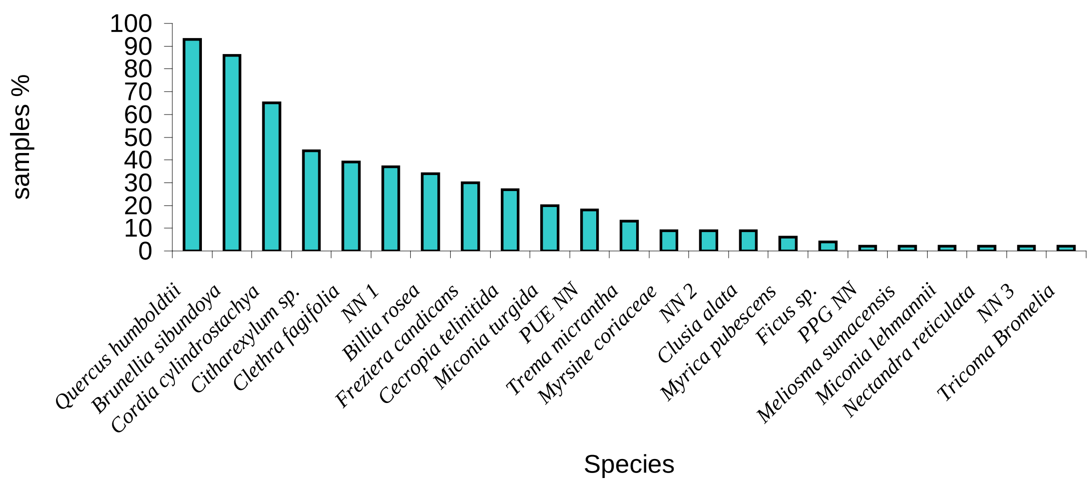

Figure 4. Species identified in 43 fecal samples of *Choloepus hoffmanni* at El Macanal.

The highest percentage in relative frequency and relative coverage was found for *B.sidundoya. C. cylindrostachya, Q. humboldtii, Citharexylum sp., Clethra fagifolia* were the most important species, representating 50.45 % of the diet of the two-toed sloth in Andean forest according to importance value index.

These results correspond to the first description of the diet of *Choloepus hoffmanni* in an Andean forest. to compare and contrast the results little information exists, and corresponds to captivity studies (Beebe, 1926, Goffart, 1971) where the diet nature was replaced by fruits (banana, apple, and grape) and vegetables (lettuce and carrot).

The epidermal features doesn't seem to affect food choose by sloths because it was possible to find glabrous, pubescens and glaucous leaves consumed by *C. hoffmanni*. This offers an explanation to the several species consumption by sloths. Epidermal fragments found in faeces samples are evidence of the low digestibility of the tree species consumed.

The evidence that *Cecropia sp.* is eaten by *C. hoffmannii* coincides with analysis of stomach contents from three toed-sloth *Bradypus variegatus,* in a study that applied a histological technique, too (Montgomery & Sunquist, 1975), as well as through Beebe (1961), Polanco (1998), and Falla (2000) obsrvations. In this research, the relative frecuency and coverage show low consumption (5.5 %) by *C. hoffmanni*, sloths were never observed in it, although it was reported as a used tree by Alvarez (2004).

Ficus sp. consumption by sloths was suggested by other authors in other researches (Krieg, 1961, Goffart, 1971, Montgomery & Sunquist, 1982 y Falla, 2000) on *B. variegatus*. Evidence of *Clusia sp.* consumption was reported by Goffart, (1971) for *Bradypus sp.* Similar use of these tree species by *Bradypus* and *Choloepus* shows that competition is probably an important factor affecting populations if both species exist in the same area. Evidence of Bromeliaceae consumption may be related to water supplies.

The random distribution of *C. hoffmanni* in the area (Carmona, 2003) indicates a broad availability of food resourses. According to Alvarez (2004), sloth used 28 tree species, but mainly *B. sibundoya* and *Q. humboldtii* with 21 y 18 % respectively. This two species have a broad distribution in andean forests (Pacheco & Pinzón, 1997; Orozco, 2002), and a high availability in El Macanal Macanal (Álvarez, 2004), too. This information indicates a relation between availability and food consumption that confirms the generalist and opportunist diet of sloths.

SEED DISPERSAL BY SLOTHS?

11 seedlings were obtained for treatments 2 and 3 (Table 4). All the seedlings corresponded to herbaceous plants, and the similarity between them in the two treatments indicate seeds came from the soil and not from faeces.

Table 4. Result of germination tests faeces of *Choloepus hoffmanni* at El Macanal.

Samples	Treatment1	Treatment 2	Treatment 3
1	0	*Phytolacca bogotensis*	*Phytolacca bogotensis*
	0	*Rubus urticifolia*	0
2	0	0	0
3	0	*Palicourea sp.*	*Smilax tomentosa*
4	0	0	Asteraceae
5	0	0	*Palicourea sp.*
6	0	0	Urticaceae
7	0	*Phytolacca bogotensis*	*Rubus urticifolia*
8	0	*Solanum nigrum*	0

Goffard (1971) and Montgomery & Sunqiuist (1982), reported the fruit consumption by sloths, but it was not possible to test it through the germination tests made in this research. Maybe consumed seeds lost germination efficiency after passing sloth's intestine. The germinated seeds in the T2 corresponded to species that appear in first successional stages in open places.

FURTHER RESEARCH RECOMMENDATIONS

- Further studies at El Macanal during the dry season in order to compare results and to have a more complete study of the two-toed sloth ecology.
- Variable width line transect method is recommendable for wildlife evaluation and should be used for future sloth studies increasing the sampling effort to obtain enough sightings.
- To estimate *C. hoffmanni* defecation rate at the study area in order to confirm or reevaluate the estimated sloth density.
- For field studies of *C. hoffmanni*, it is recommended to use every possible animal sign to obtain a good characterization of its habitat.
- To include some other habitat variables for characterization of *C. hoffmanni* habitat, especially variables related to the forest canopy.
- To evaluate the border effect on sloth density together with the use of fragments by sloths, in order to determine the effect of fragmentation on sloth population.
- To eliminate areas covered by pig fern (*Pteridium aquilinum*) at El Macanal which significantly reduce the extension of potential habitat for sloths.
- To connect the patches CC and MB by reforestation programs with native species to ensure a larger continuous habitat for *C. hoffmanni*.
- To monitor *C. hoffmanni* for a long period by radio-tracking at the El Macanal to obtain complementary information about sloth's activity and ecology.
- To inform and increase sensibilization of local people about the importance of this reserve and the conservation of sloths and their habitat.

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C. hoffmanni in a *Brunellia sibundaya* tree at El Macanal.

EXPENDITURE AND BUDGET

Item	Budget			Expenditure		
	Amount	Unitary cost (£)	Cost (£)	Amount	Unitary cost (£)	Cost (£)
Materials & Equipment						
AA Batteries	40	0.43	17	36	0.4	14.4
Woody Boxes	100	0.23	23	100	0.3	30
Disketts + CDs	40	0.28	11	40	0.3	12
Field Notebooks	6	2.8	17	5	2.8	14
Flagging Tapes	10	1.4	14	2	1.4	2.8
Masking Tape	5	0.57	2.8	0	0	0
Paper Press	1	5.7	5.7	1	5.7	5.7
Photocopies	2500	0.03	75	5000	0.03	150
Photographic Films	25	1.7	42.5	101	1.7	180.2
Film Development	25	3.4	85	101	3.4	343.4
Hermetic Bags	70	0.09	6.4	100	0.2	20
Plastic Bags	400	0.09	36	0	0	0
Rope (Km)	0	0	0	5	7.1	35.5
Paint Brush	0	0	0	1	0.5	0.5
Metal pole	0	0	0	1	5	5
Compass	0	0	0	1	7.5	7.5
Decameter	0	0	0	1	4.3	4.3
Markers	5	8.5	42.5	5	0.5	2.5
Ink Cartridge	7	11	77	7		
Black Ink				5	8.2	41
Color Ink				2	14.3	28.6
Printing Paper Blocks	7	6	42	5	2.2	11
Publication	3	42.5	127.5	11	4.9	53.9
Parchment Paper Roll	1	0.6	0.6	1	0.6	0.6
Aluminous*/ Paper	3	2.6	7.8	0	0	0
Vinipell	3	1.3	3.9	0	0	0
Alcohol (L)	60	0.5	30	0	0	0
Ammoniac (ml)	500	0.03	15	500	0.1	50
Basic Fuchsine (ml)	500	0.02	10	500	0.1	50
Cromic Acid (ml)	500	0.02	10	500	0.1	50
Distilled Water (L)	30	1.2	36	30	1.2	36
Entellan (ml)	1000	21.4	21.4	200	0.3	60
Hypochlorite (L)	1	5.3	5.3	1	5.3	5.3
Lugol (ml)	500	0.03	15	500	0.1	50
Metylene Blue (ml)	500	0.02	10	500	0.1	50
Nitric Acid (ml)	500	0.02	10	500	0.1	50
Percoll (ml)	2000	0.02	40	200	0.8	160
Phosphate Buffer (ml)	500	0.05	25	500	0.1	50
Sacarose (Kg)	0	0	0	1	3.2	3.2
Filter Paper (box)	5	3	15	5	3	18
Microscope Slides (box)	5	4.3	21.5	5	4.3	21.5
Mortar	1	11	11	1	11	11
Petri Cases	100	0.34	34	0	0	0
Test Tubes	30	1.4	42	30	1.4	42
Vials	50	0.3	15	0	0	0
Newbauer Chamber	1	32	32	0	0	0
Field Expenses						
Food (days)	120	15 daily	1800	120	10	1200

Item	Budget			Expenditure		
	Amount	Unitary cost (£)	Cost (£)	Amount	Unitary cost (£)	Cost (£)
Materials & Equipment						
Personal Care	---	---	115	---	---	0
Bus transport	15	14	210	25	2.1	52.5
Car transport	0	0	0	50	4.3	215
Plants Drying			85	0	0	0
Services						
Climatic data	0	0	0	1	7	7
Information Processing	---	---	115	---	---	81.7
Unexpected Expenses	---	---	115	---	---	112.3
TOTAL			**3439.9**			**3341.6**

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