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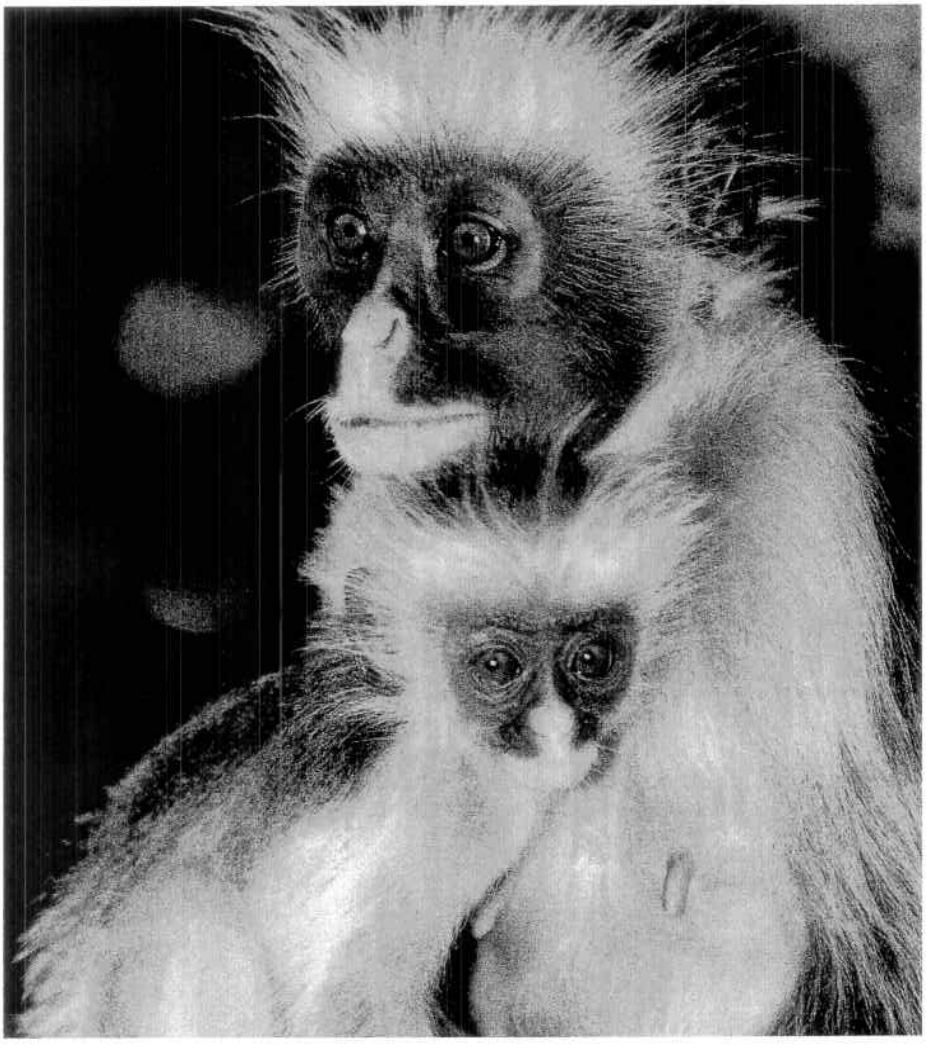

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Front cover. Zanzibar red colobus *(Procolobus kirkii)* adult female and infant (approximately 1 month old). Taken at Jozani, Zanzibar, June 1996. Photo by Thomas T. Struhsaker.

A Word from the Chairman

This is the 18th issue of *Primate Conservation*, and our 18th year producing this journal. It brings us up-to-date for the first time in nearly a decade. Now that Anthony Rylands has taken over status as Chief Editor of this publication, we are confident that it will now come out more regularly. Ideally we would like to have it appear in December of each year, depending of course on the availability of sufficient material. This issue has a nice balance of articles from different regions, lacking only Madagascar among the major areas with wild primate populations, and covers a wide variety of topics, from discussions of the status of all primates in Guatemala, China, and Cameroon, to ecological studies and reviews of species' status, to a theoretical paper on range size distribution. We hope to maintain this balance in the future, and make a special plea to those involved in the conservation of primates and their habitats in Madagascar to contribute articles for the next issue in 1999.

As always, we would appreciate your input as to how the publication might be improved and the extent to which you find it of value. At various moments over the past few years we have considered phasing it out because we now have four regional newsletters that serve many of the communication and network functions for which *Primate Conservation* was originally created. However, we have decided to continue it at least to the new millennium, and to reassess its contribution at that time. Any thoughts you might have, one way or the other, would be most welcome.

As always, we are most interested in receiving contributions from you and especially from Primate Specialist Group members who have not yet published in our journal. Instructions for contributors are given on the last page.

Russell A. Mittermeier
Chair, IUCN/SSC Primate Specialist Group

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Baseline Range Size Distributions in Primates

Clara B. Jones

Community Conservation Consultants, Gays Mills, Wisconsin, and
Livingstone College, Department of Psychology, Salisbury, North Carolina, USA

Studies of anatomy, physiology, phylogeny, and social behavior have dominated the field of primatology, but relatively little attention has been paid to biogeographic processes. This paper examines relationships between several characteristics of species and range-size distributions. Recent work on mammals and other taxa suggest that "many features of the structure of local species assemblages can only be understood with reference to regional scale phenomena" (Gaston 1996, p.197). Implications of species-range-size distributions for the conservation of primates in Africa, Asia, and Latin America, are discussed.

Primates are well suited for the present analysis since, compared to rodents and some other mammalian groups, their species identities, ranges, population structures, and behaviors have been relatively well documented. The data base for this report is extracted from Wolfheim's (1983, Table 190) review of 151 primate species distributions, population characteristics, and conservation status, although data were not available for all species on all variables.

Wolfheim (1983) mapped species-ranges on a continental scale. Sampling error, however, must be considered in evaluating the present study. Errors are expected to arise from several sources. In particular, methods for estimating the species-range-size distributions of primates are not standardized, yielding "substantial" variability from estimate to estimate. Further, species with small ranges may have these ranges underestimated. Error may also arise from "temporal considerations", whereby the spatial occurrence of a species in time may vary and may be difficult to estimate. Gaston (1996) discussed these potential sources of error and points out that "assuming constant sampling effort at different resolutions, at higher resolutions, greater and greater areas will become apparent in which the species does not actually occur"(p. 199). Since primate taxonomy and the determination of species ranges are in continuous flux (e.g., Van Roosmalen and Van Roosmalen 1997), the present analysis is presented as a baseline against which future information can be compared.

Figure 1 presents the proportion of primate species occupying a variety of geographic range sizes (GRS). As reported for other taxa, GRS is skewed to the right (see Rapoport 1982; Gaston 1994) and appears to be log skewed to the left (Fig. 2), as in Neotropical birds (Gaston 1996). This pattern is poorly understood but probably reflects underlying processes of phylogeny and ecology that are similar across space and time.

For the African continent, mean ($\pm$ S.D.) GRS is 1460.86 $\pm$ 2357.37 (x 1000 km^2; n = 65); for Asia, 935.35 $\pm$ 1344.95 (n = 42); and, for Latin America, 1915.24 $\pm$ 2398.28 (n = 41). Mean geographic range size in Asia is significantly smaller and mean GRS in Latin America is significantly larger than one would expect by chance alone (χ^2 = 334.64, P<.001, df = 2). Mean GRS for Africa is about the same as the mean GRS for the sample as a whole (N = 148). Continental differences have been identified in other mammalian taxa (Smith *et al.* 1994). Because of these significant differences for primates, further analyses will be presented by continent.

Across continents, GRS's are significantly and positively correlated with the number of subspecies or races. Thus, for Africa, r = 0.58; P< .01, Y'= 0.001x +1.61 (N = 64); for Asia, r = 0.36, P< .02, Y'= 0.001x +2.89 (N = 40) and, for Latin America, r = 0.65, P<.01, Y'= 0.001x +1.25 (N = 40). Identical slope (+0.001) across continents implies some commonality within the order, possibly the "role" of primate species within ecosystems. In particular, this finding is consistent with "niche-breakage models" whereby resources are subdivided across species in a lawful manner (Lawton 1993; Gaston 1996).

Local abundance (as measured by log mean population density; Wolfheim 1983) is correlated significantly with GRS only on the continent of Asia (N = 20; r = 0.69, P<.01; Fig. 3). This relationship is common across animal taxa and may result from ecological similarities (especially niche-breadth) permitting species to enlarge their GRS (see Lawton 1993; Gaston 1996). This observation suggests dynamic similarities between population-level and species-level phenomena (Brown 1986). Home range size is not correlated with GRS on any continent, suggesting that geographic range size and local abundance exhibit significant independent variance.

Most GRS's are relatively small (Fig. 1). This observation is related to the finding that GRS and "extinction proneness" are negatively correlated (Gaston 1994, 1996), a result having important consequences for conservation (Jones 1997).

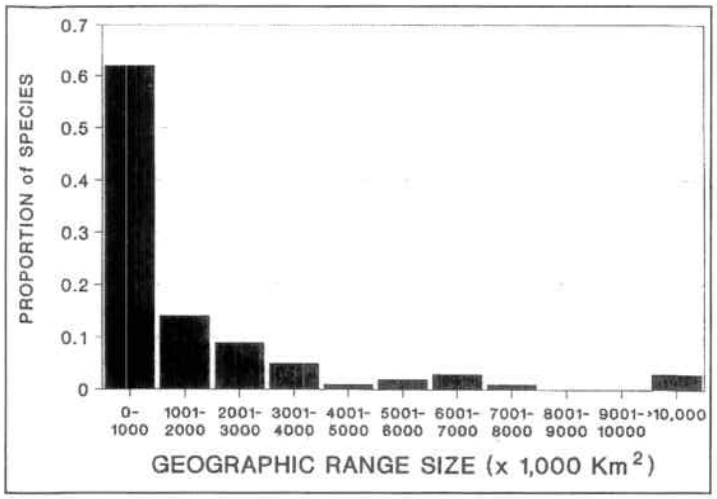

Figure 1. Species-range-size distributions in primates. Proportion of primate species as a function of geographic range size.

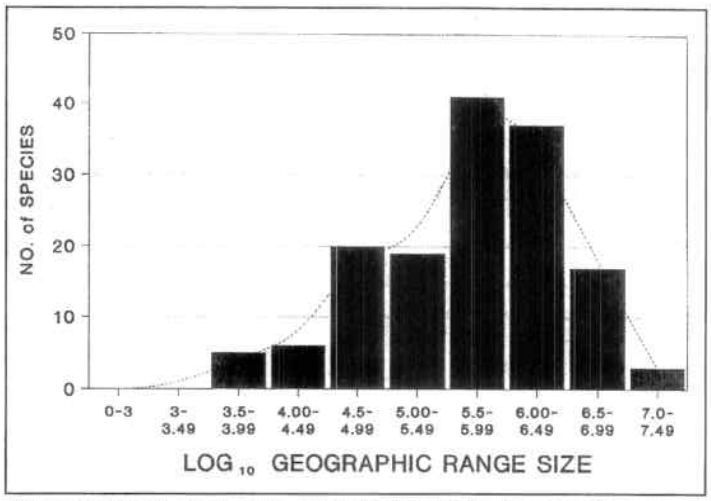

Figure 2. Primate species-range-size distribution for $\log_{10}$-transformed geographic range sizes.

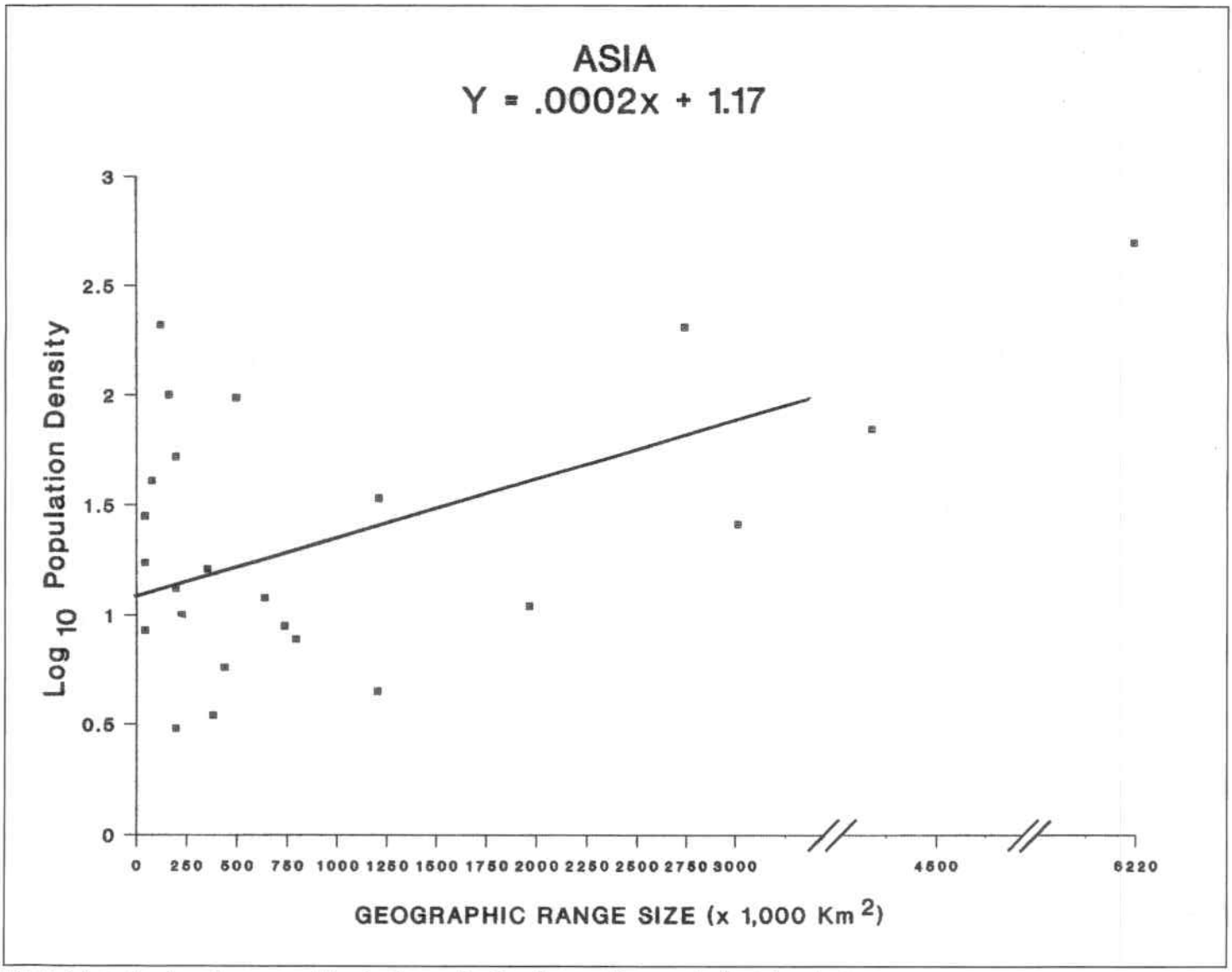

Figure 3. Log_{10}-transformed mean population density as a function of geographic range size for Asian primates.

Acknowledgments

I am very grateful to Dr. Sydney Anderson for critically reading a previous draft and to A. Kaplan for constructive discussion.

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Author's Address:
Clara B. Jones, Community Conservation Consultants, RD 1, Box 96, Gays Mills, Wisconsin 54631, USA.
Address for correspondence: Livingstone College, Department of Psychology, 701 West Monroe Street, Salisbury, North Carolina 28144, USA.

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Ecological Response of Spider Monkeys to Temporal Variation in Fruit Abundance: The Importance of Flooded Forest as a Keystone Habitat

Jorge A. Ahumada, Pablo R. Stevenson and Marcela J. Quiñones

Departamento de Ciencias Biológicas, Universidad de Los Andes, Santafé de Bogotá, Colombia

Introduction

As in many other tropical habitats, neotropical rain forests north and south of the equator are characterized by temporal variation in fruit abundance on an annual basis (Terborgh 1983; Van Schaik *et al.* 1993). Additional variability in fruit abundance is imposed by habitat heterogeneity in fruit production within a given forest (Terborgh 1983; Stevenson *et al.* 1994). In Neotropical rain forests, there are differences in the patterns of fruit production between *terra firme* and flooded forests. In general, *terra firme* forests are much more variable in fruit abundance and show strong peaks of production during the end of the dry season and beginning of the rainy season (Foster 1990; Terborgh 1983; Stevenson *et al.* in press). Due to their lower diversity and floristic composition, flooded forests have consistently lower fruit production throughout the year. However, these forest types show episodic outbreaks of fruit, mainly due to the aseasonal phenology of *Ficus* trees, which are common in these habitats.

As a result of this, vertebrates that consume significant amounts of fruit are faced not only with temporal but also spatial variability in fruit production on small, local scales (1-3 km^2). As such, it is critical to study both temporal and spatial patterns of annual fruit production to identify habitats that are important for frugivorous animals, especially when fruit production is low. On a local scale, and specifically in the Amazon region, these forest types would act as keystone habitats, critical for the maintenance and survival of frugivorous animals during periods of fruit scarcity.

In this study, temporal and spatial variation in fruit production were monitored during one year in a lowland Neotropical rain forest, and the effects of this variation were examined regarding the habitat use, feeding behavior and activity budget of spider monkeys (*Ateles belzebuth*). Spider monkeys are mainly frugivorous; around 80% of the diet is composed of ripe fruit (Klein 1972; Van Roosmalen 1985; McFarland 1986; Chapman 1988). This makes them an ideal species to identify habitats within the larger matrix of rain forest which are critical for the survival of frugivorous animals in periods of low fruit production.

Study Site

This study was part of a larger project on the ecological strategies of four primate species in a Neotropical rain forest at Tinigua National Park, Colombia, between March 1990 and April 1991. Tinigua is located west of La Macarena mountains near the center of Colombia. The base camp is found on the west bank of Río Duda, Departamento del Meta at 2°40' north, 74°10' west and 350 m above sea level. The region is characterized by a high seasonality in rainfall, with a dry period from December to March and a rainy period through the rest of the year (> 100 mm per month). The average rainfall and temperature from 20-year records are 2400 mm and 25°C (Instituto Colombiano de Hidrología, Meteorología y Adecuación de Tierras, HIMAT). There are three main forest types within the area, clearly discernible from the floristic and structural point of view: mature forest, open-degraded forest and flooded forest (Hirabuki 1990). Mature forest is located away from floodplains and is basically a *terra firme* habitat with high diversity, relatively open understorey, a canopy 20-25 m in height, and emergents of up to 30 m in height. Open-degraded forest patches are found within a matrix of mature forest on erosion fronts, small valleys and streams. The stature of this habitat is lower than the mature forest surrounding it, and is characterized by a thick understorey of vines, lianas and bamboo. Flooded forest is found on floodplains created by the meandric dynamics of the river. The canopy is fairly discontinuous and dominated by *Ficus* spp., *Inga* spp. and *Cecropia* spp. The understorey is variable in thickness and dominated mostly by "Platanillos" (*Heliconia* spp.).

The most common of these forest types in the study area is mature forest (53%), followed by open degraded (34%) and flooded (11%). The remaining 2% was composed of secondary human-disturbed forest and riparian forest (Stevenson *et al.* 1994).

There are six more primate species other than spider monkeys in the study area: woolly monkeys (*Lagothrix lagotricha*), tufted capuchins (*Cebus apella*), red howlers (*Alouatta seniculus*), squirrel monkeys (*Saimiri sciureus macrodon*), tití monkeys (*Callicebus cupreus*) and night monkeys (*Aotus vociferans*).

The Study Group

Observations of spider monkeys were concentrated on a single group which had its home range west of the study camp. At the time of the study, the group consisted of 4 adult males, 7 adult females, 3 juvenile females, 2 juvenile males and 5 infants. It had been studied previously in 1987 and 1988, and the individuals and the group's home range were well known (Ahumada 1989, 1990). Animals were located by searching through an extensive trail system in the site. Sometimes the group was sampled continuously for two-three days by following the animals to their sleeping sites and picking them up the next morning.

Observations

Data on feeding behavior, habitat use, activity and social interactions with other species were collected systematically from March 1990 to March 1991. A combination of instantaneous and focal animal sampling was evenly distributed across all hours of the day and for all age/sex classes, comprising 48 h of observation per month. Whenever the focal animal was feeding on fruit or vegetative parts of plants, the number of minutes spent feeding, the plant species, and whether the fruit was mature or immature were recorded.

A vegetation map was constructed by superimposing a 50 x 50 m grid over a trail map of the study area. Each cell was assigned a particular forest type (mature, open-degraded or flooded) based on intensive surveys of the area. The focal animal's location and the cell it was occupying was recorded every 30 min. Trails marked every 50 m were used to determine the exact location of the focal animal on a map. To have a tri-dimensional projection of the way spider monkeys used their habitat, the spatially referenced data for each month (use of each map cell) were entered into a geostatistical analysis program (SURFER) and gridded using the inverse distance method. This smoothing procedure generates isoclines of habitat use which are useful to visualize how spider monkeys "see" their habitat each month. It is stressed here that this procedure was used as a visualization aid only and does not imply a particular explicit spatial model of how spider monkeys use their habitat.

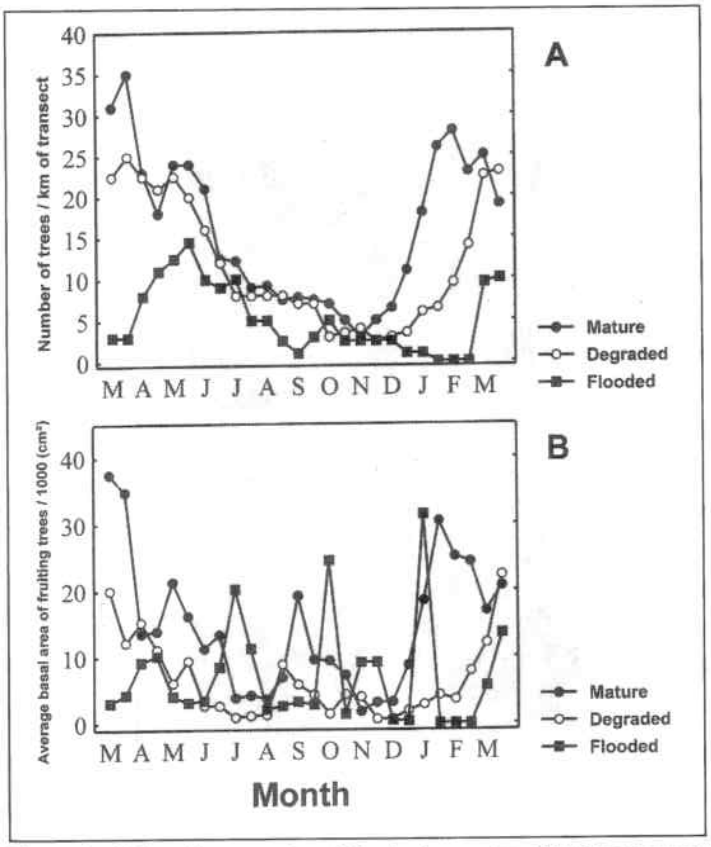

Figure 1. a) Biweekly temporal variation in the number of fruiting trees per km of transect for three different forest types. **b)** Biweekly average basal area of fruiting trees (as an indicator of patch size) divided by 1000 for three different forest types.

Variation in fruit abundance during the year of study were estimated using two different methods: fruit traps and phenological transects. A total of 300 fruit traps (800 cm^2 each) were distributed with equal density in the three forest types in proportion to the area covered by each (150 in mature, 100 in open degraded and 50 in flooded). The contents of the traps were collected twice a month, separating fruits and seeds from leaves, stems, flowers and animal material. Samples were dried in an oven for 6 h at about 80°C and weighed in an electronic balance. Fruit abundance was calculated biweekly and separately for each forest type in kilograms of dry fruit per hectare per day.

Phenological transects, 2 m wide, were also carried out twice a month, along trails where the traps were located. Fruit abundance was quantified in two ways: number of fruiting trees which projected their crown above the transect and basal area of each fruiting tree. Basal area has been shown to be correlated with fruit production for some species (Leighton and Leighton 1982). When using basal area, biweekly fruit production was calculated *a posteriori* as the sum of the fractions of the basal areas of all trees fruiting according to a triangular fruit production pattern for each tree. By following such procedure, overestimation of fruit production by very big trees with very long fruiting periods was avoided. For more details and a full justification of this procedure see Stevenson *et al.* (1994).

The number of fruiting trees was found to be a good indicator of fruit production (Stevenson *et al.* in press). This measure was highly correlated with the number of traps with fruit ($r = 0.90$, $p<0.001$) and with fruit production, as measured by the dry weight of fruit fall in traps ($r = 0.62$, $p<0.001$). Henceforth, the number of fruiting trees per km of transect will be used as the measure of fruit abundance in this paper (see Stevenson *et al.* in press).

Results

Seasonality in Fruiting

As in many other lowland Neotropical sites, fruit production varied seasonally at Tinigua. During the dry season (January-April), the number of fruiting trees per km of transect oscillated between 40 and 60. During the rainy season, this number declined throughout to 8-9 trees until the end of the rainy season (November). As the rains subsided the number of fruiting trees increased again (Fig. 1a).

This pattern was similar in all forest types (Fig. 1a). However the size of fruiting trees was larger in flooded forest than in other forest types, especially at the period of lowest fruit abundance, as measured by their basal area (Fig. 1b). The flooded forest, there-

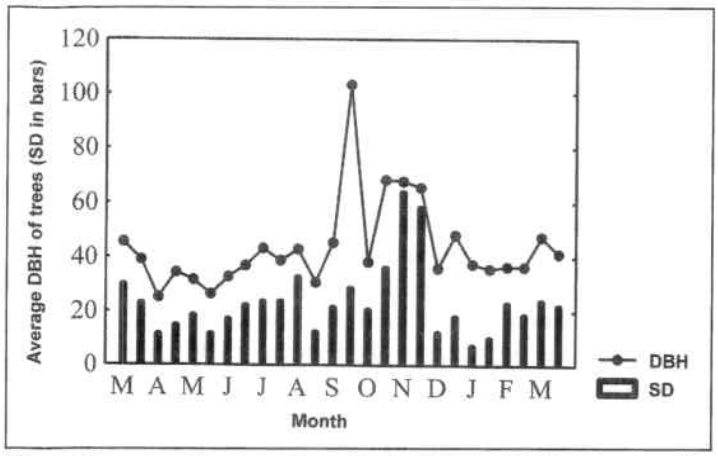

Figure 2. Average diameter at breast height (DBH) of fruiting trees used by spider monkeys in biweekly periods (points connected by thick line). Bars represent the standard deviation of DBH for each biweekly period.

fore, was offering larger fruiting trees (more fruit) than other forest types at the period of lowest fruit abundance. Spider monkeys fed on larger trees during this period as well (Fig. 2).

Seasonality in Habitat Use

Spider monkeys varied seasonally in their use of different forest types (Fig. 3b). They spent most of their time in *terra firme* forest, but during periods of low fruit abundance increased their time spent in flooded forest. A comparison of the habitat use in two months of contrasting fruit abundance (March-high, September-low) shows this shift clearly (Fig. 4). The use of open-degraded forest and human-disturbed secondary forest was low throughout the year (Fig. 3b).

Seasonality in Diet

These shifts in habitat use during the period of lowest fruit abundance were clearly associated with fruit feeding (Fig. 3a). Although spider monkeys spent around 80% of their time feeding on fruit on an annual basis, this proportion varied from 86 to 35 % in different months of the year. Young leaves were also an important portion of their diet, especially during periods of low fruit abundance (August through November, Fig. 3a). During this period, however, there were some peaks in fruit-feeding clearly associated with the use of flooded forest, especially in September (Fig. 3). A large *Ficus* tree provided most of the fruit during this period (Fig. 2). This same tree accounted for around 10% of the annual diet of spider monkeys, ranking as the fifth staple in the diet of the species for this particular year (Table 1). Three more species of *Ficus*, represented by a few individuals, were among the 20 top species eaten by spider monkeys in that year (*ibid*).

Table 1. List of the 20 most consumed fruit species in the diet of spider monkeys during one year of observation. Note: The 5th in the list is a single *Ficus* tree which was located in the flooded forest.

Family	Genus-species	# of minutes feeding	# of trees visited
Arecaceae	*Oenocarpus bataua*	494	114
Lechytidaceae	*Gustavia hexapetala*	405	62
Myristicaceae	*Virola flexuosa*	360	20
Sapotaceae	*Sarcaulus brasiliensis*	323	35
Moraceae	*Ficus andicola*	315	1
Arecaceae	*Oenocarpus mapura*	268	12
Moraceae	*Ficus americana*	263	2
Moraceae	*Pouroma bicolor*	184	26
Burseraceae	*Protium crenatum*	161	20
Anacardiaceae	*Spondias mombin*	157	25
Moraceae	*Cecropia sciadophylla*	155	26
Burseraceae	*Protium glabrescens*	142	26
Moraceae	*Ficus nymphaefolia*	138	1
Moraceae	*Cousapoa orthoneura*	137	7
Moraceae	*Ficus yoponensis*	130	1
Burseraceae	*Trattinnickia rhoifolia*	120	7
Meliaceae	*Trichilia tuberculata*	118	16
Arecaceae	*Astrocaryum chambira*	109	10
Moraceae	*Brosimum alicastrum*	106	8
Moraceae	*Pseudolmedia laevis (1)*	92	24

Discussion

These data show that spider monkeys maintain a high proportion of fruits in their diet, shifting their habitat use into the forest type that offers more fruit for them at any given time. During most of the year, it is the mature forest that contains the highest number of fruiting trees per unit area, and it is there that spider monkeys spend most of their time. However, during periods of general fruit scarcity, the flooded forest offers bigger fruiting trees, notably *Ficus* spp., which usually bear large crops.

If flooded forest is an alternative habitat for spider monkeys during periods of low fruit abundance, this would imply that in its absence spider monkeys would need a larger area of mature forest to survive, and therefore their density would be lower. However, too much flooded forest in the home range of a spider monkey group would also reduce the density of the monkeys, because there is less fruit available in flooded forest than in mature forest. This line of argument suggests that density is probably a non-linear function of the proportion of non-flooded forest in home range of a group. At low proportions of flooded forest the density of spider monkeys should be low, peak at intermediate propor-

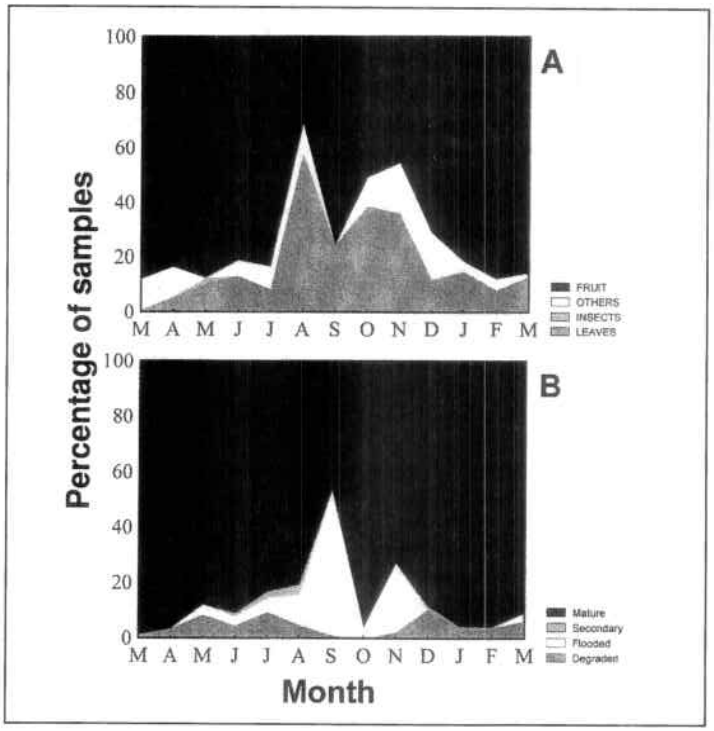

Figure 3. a). Monthly variation in the percent of instantaneous samples spent by spider monkeys feeding on different food items. **b).** Monthly variation in the percent of instantaneous samples spent by spider monkeys in different habitat types.

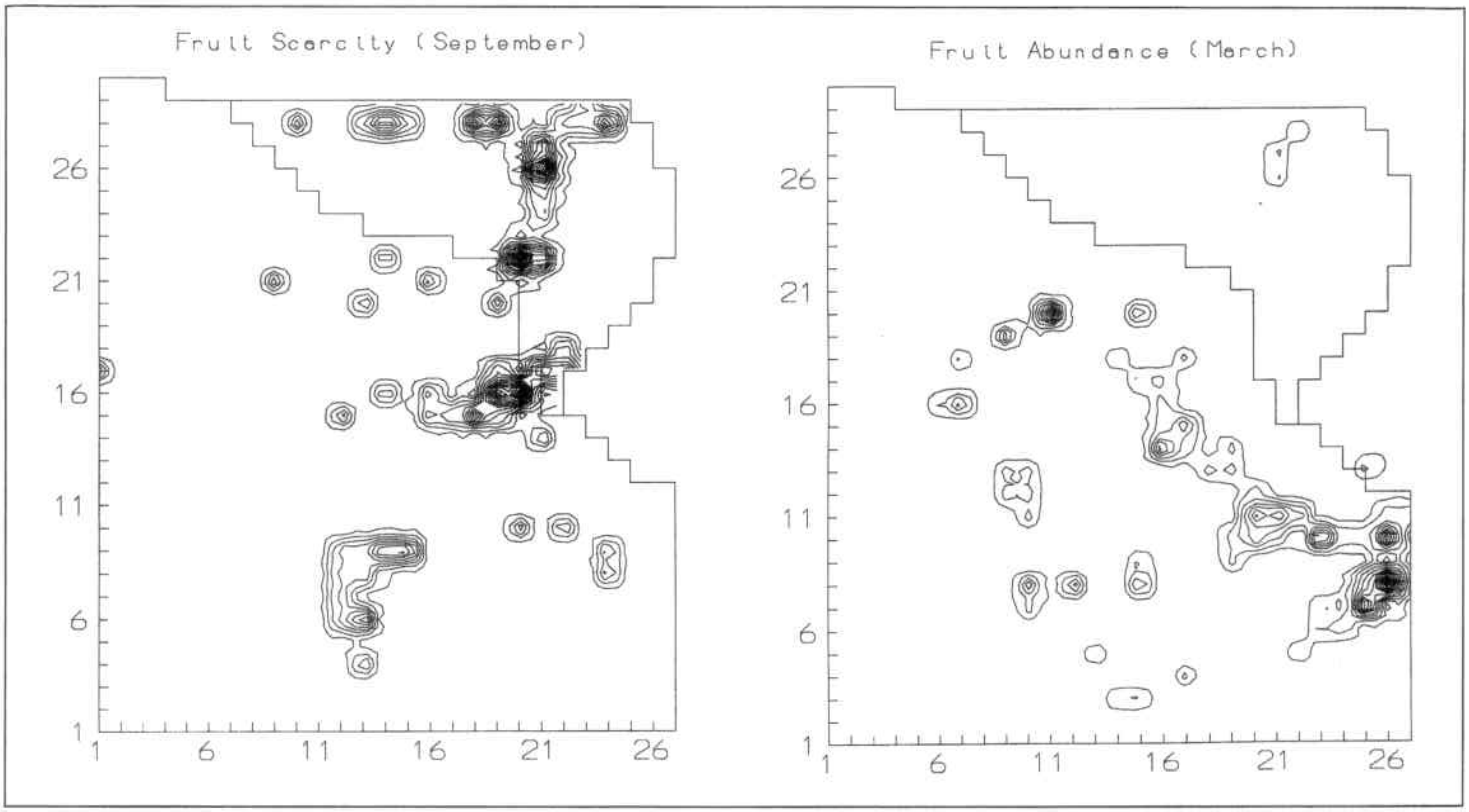

Figure 4. Isoclines comparing the habitat use of spider monkeys in two months of contrasting fruit abundance. Left: a month of fruit scarcity (September 1990); Right: a month of fruit abundance (March 1991). The line dividing each plot is the boundary between flooded forest (upper right section) and a combination of mature and open, degraded forests (lower left section).

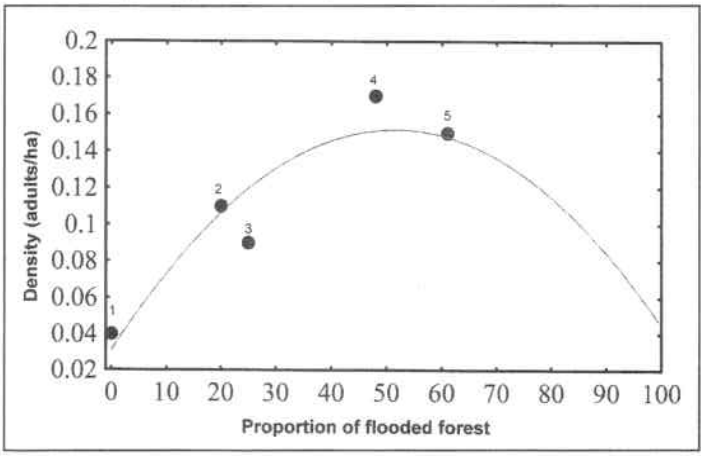

Fig. 5: Relationship between the density of spider monkeys (number of independent adults per ha) and the percentage of flooded forest in their home range. Each numbered point corresponds to a different group; 1. *Ateles paniscus* in Suriname (Van Roosmalen 1985), 2. *Ateles belzebuth* in Tinigua National Park, Colombia (this study), 3. *Ateles belzebuth* in the Guayabero river (Klein 1972), 4. *Ateles chamek* in Manu National Park, Peru, East group (McFarland 1986) and 5. *Ateles chamek* in Manu National Park, Peru, Lake group (McFarland 1986). The home ranges of points 4 and 5 were located on sectors of the study area which differed in the amount of flooded forest available. The parabola drawn is the hypothesized relationship between these two variables.

tions of flooded forest, and again decrease at very high proportions of this forest type.

A comparison of the density of adult spider monkeys in different sites in the Amazon basin living in habitats with different amounts of flooded forest partially supports these predictions (Fig. 5). Although there is not much data available for the right-hand side of the curve, the density of spider monkeys peaked at about 48% of flooded forest, and a further 10% increase in flooded forest cover reduced the density by 11% (Fig. 5). Point #3 in this graph does not fit the model very well. This point, however, comes from a study done with *A. belzebuth* in Colombia by Klein between 1969 and 1970 (Klein 1972). He estimated the proportion of flooded forest in his study site rather roughly as between one third and one fourth of the total forest cover, and there is probably some error in this estimation.

In general, the data suggest that the flooded forest offers an alternative habitat for spider monkeys during periods of low fruit abundance, increasing their density on a very local scale probably through the presence of large aseasonally fruiting *Ficus* trees in these forests. Although more data are still needed, this simple model suggests that spider monkey density is highest when roughly half of their home range is covered with flooded forest. Conservation priorities should be given to these riverine habitats in meandering rivers because their mixture with mature forest reduces the area requirements of these primates and sustains a larger number of individuals per unit area.

Acknowledgments

We thank Olga and José Stevenson, Cecilia Fernández, Hernando Quiñones, Agnes de Ahumada and Jorge J. Ahumada for their support. We are also grateful to Hernando Mestre and the Japan-Colombia Cooperative Study of Primates for their help. The study was funded by El Banco de la República through La Fundación para la Promoción de la Investigación y la Tecnología and by Fondo FEN para la Protección del Medio Ambiente "José Celestino Mutis".

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Authors' Addresses:

Jorge A. Ahumada, Departamento de Biología, Universidad Javeriana, Cra 7a # 40-62, Santafé de Bogotá, Colombia.

Pablo R. Stevenson, Department of Anthropology, State University of New York, Stony Brook, NY 11794, USA.

Marcela J. Quiñones, Department Water Resources, Wageningen Agricultural University, Wageningen, The Netherlands.

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Primates of the Tropical Forest of the Pacific Coast of Peru: The Tumbes Reserved Zone

Filomeno Encarnación[1] and A. Gaylon Cook[2]

[1]Estación Experimental del Trópico, Centro de Investigación (C.I.),
Instituto Veterinário de Investigaciones Tropicales y de Altura (IVITA)
Universidad Nacional Mayor de San Marcos, Iquitos, Peru
[2]Bioconservation Research, Provo, Utah, USA

Introduction

There are 32 species of primates in the tropical forests of Peru (Encarnación *et al.* 1993; Aquino and Encarnación 1994). Thirty-one of these occur in the Amazon region, comprising 59% (756,856.6 km²) of the country, with ecoregions of upland forest and lowland forest, and the life zones of humid and very humid forest, and rain forest between the altitudes of 105-3,000 m above sea level. Only two species have been recorded in the ecoregion of the tropical forest of the Pacific coast, including the life zones of dry and very dry forest, located in the north-western coast in the Department of Tumbes: *Alouatta palliata* and *Cebus* cf. *albifrons* (see Saavedra and Velarde 1980; Pulido and Yockteng 1986). This area corresponds to the National Forest of Tumbes, part of the Tumbes Reserved Zone, which itself is part of the Peruvian North-West Biosphere Reserve, along with the Cerros de Amotape National Park, the El Angolo Hunting Reserve, and the Mangroves of Tumbes National Sanctuary.

The Tumbes Reserved Zone

The Tumbes Reserved Zone is the largest protected area for the dry forests of the Pacific coast, covering 75,102 ha, between 03° 28' and 04° 00'S and 80° 08' and 80° 29'W. The National Forest is limited in the north by the Quebrada de la Angostura and Quebrada Faical; in the east by the Río Zarumilla and the Quebradas Balsamal, Cotrina, and Trapazola; and in the south and west by the Río Tumbes. The region is hilly, with altitudes ranging from 150 to 885 m. above sea level (Pulido and Yockteng 1986). Annual precipitation varies from 700 to 2000 mm, with 85% of the rainfall between December and April (Anonymous 1988), creating seasonal changes in the creeks, from fast-flowing and turbid to sluggish and clear, flowing into the Ríos Zarumilla and Tumbes. The relief is low along the river and stream valleys and high on the moderately steep hills, escarpments and terraces. The soil is easily eroded along footpaths, especially during dry periods and through run-off in the "winter". Perennial, woody and seasonal, herbaceous vegetation make up seven distinct formations of trees, lianas and epiphytes, deciduous and semi-deciduous plants (Cook and Encarnación 1995), which define eight life zones within the most humid ecosystems of the Tropical Dry Forest (Pulido and Yockteng 1986).

The Study Area

Intensive studies on the mammals and birds were carried out from June to October 1994 within a radius of 5 km from the Estación Biológica de Pro Naturaleza (FPCN) on the Quebrada Faical (03°49'19"S, 80°15'24"W, and 1.5 km south-east of the Estación El Caucho of the National Police, see Fig. 1). The study area included valleys and hills between the Quebrada de la Angostura and the Quebradas Faical, Ciruelo, Mango, Las Pavas and de La Vaca, and including riparian forest, tall primary forest, primary hillside forest, and subhumid montane forest (Cook and Encarnación 1995). Additional observations were made in subhumid forest in the higher hills, and to the south-east as far as the guard posts of Campoverde, Figueroa, Condor Flores, and Bocana Murciélago (Cook and Encarnación, 1995). Indicator tree species are deciduous. They include "seibo" *Eriotheca discolor*, "pasayo" *E. ruizii*, "pretino" *Cavanillesia platanifolia*, and "polo polo" *Cochlospermum vitifolium*. July to September marks the end of the "spring", with annual herbaceous and forb species in flower, and bushes and trees in fruit. "Autumn" is from September to October, with the herbaceous species dying off, and the woody species losing their leaves, creating a deep, dense leaf litter on the forest floor. *Cochlospermum vitifolium* produces yellow flowers, and "fernán Sánchez" *Triplaris cumingiana* yellowish white flowers, from June through August. *Cavanillesia platanifolia* produces abundant whitish flowers, and "porotillo" *Erythrina velutina* bright red flowers from the beginning of September, at the same time as *Eriotheca discolor* produces its exploding anemochoric capsules, and the reddish pink to yellowish white seeds of *Triplaris cumingiana* are maturing (Table 1).

Figure 1. The Northwestern Peru Biosphere Reserve, including: 1. The Reserved Zone of Tumbes; 2. Cerros de Amotape National Park; 3. El Angolo Hunting Reserve; and 4. Mangroves of Tumbes National Sanctuary. Map by Stephen D. Nash.

The Primates

Populations of three species of primates have been recorded in the Tumbes forests: *Alouatta palliata* (see Grimwood 1969; Saavedra and Velarde 1980; Pulido 1981, 1991; Pulido and Yockteng 1986; Saavedra and Green 1987; Emmons and Feer 1990; Vásquez *et al.* 1992), *Cebus* cf. *albifrons* (see Saavedra and Velarde 1980), and *Saimiri* cf. *sciureus* (this study). Other mammals recorded during the study are listed in Table 2.

Alouatta palliata

A group of *Alouatta palliata*, the "mono coto de Tumbes", comprised of more than 20 individuals including adults and juveniles, was seen on various occasions along the Quebrada de la Vaca where it meets the path to El Naranjal. Another group of 10 was contacted by the Quebrada El Ciruelo, near the Biological Station and eating immature papaya fruits in September. A single individual was seen between El Caucho and the Quebrada El Faical, and a group was heard roaring to the south of El Caucho. A further two groups were heard roaring in July 1994, one to the south of Campoverde and another in the vicinity of Figueroa, on the south side of the Cerro Lindachara. The monkeys were quite tame, and in July the groups had infants, becoming independent by September-October. They were found to occupy mainly riparian forest.

Cebus cf. *albifrons*

Two groups of the "machin blanco", *Cebus* cf. *albifrons*, were seen. One on the Inca path above the Biological Station was seen on a number of occasions between July and October. The group

Table 1. Trees and bushes in the diet of the primates of the Tumbes National Forest. Records from July to October 1994. (Nomenclature follows Brako and Zarucchi 1993).

Species	Fruit	Part	Period	Primate	VF
Muntingia calabura	berry	mesocarp	J-O	Ss	BR/BPC
Cavanillesia platanifolia	capsule	flowers	S-O	Ap	BAP
Eriotheca ruizi	capsule	flowers	S-O	Ap	BAP
Ochroma pyramidale	capsule	flowers	S-O	Ap	BR/BPC
Carica papaya	berry	fruit (i)	J-O	Ap	BR
Annona muricata	apocarp	mesocarp	S-O	Ap	BR/MR
Psidium guajava	berry	mesocarp	J-O	Ca	BR
Psidium rostratum	berry	mesocarp	J-O	Ca	BPC
Phytolacca weberbaueri	drupe	flowers	J-O	Ap	MR
Ficus aripuanensis	syconium	entire fruit (m)	A-S	Ap	MR
Ficus eximia	syconium	entire fruit (m)	A-S	Ap	MR
Ficus guianensis	syconium	entire fruit (m)	A-S	Ap	MR
Maquira sp.	apocarp	entire fruit (m)	J-S	Ap,Ca	MR/BPC
Maclura tinctoria	apocarp	entire fruit (m)	J-A	Ap,Ca,Sa	BPC/BAP
Coccoloba ruiziana	drupe	mesocarp	J-S	Ss	BPC
Coccoloba sp.	drupe	mesocarp	J-S	Ss	BPC
Neea spruceana	drupe	mesocarp	J-S	Ss	BPC
Pisonia macracanthocarpa	drupe	flowers	S-O	Ap	BPC
Guazuma ulmifolia	drupe	mesocarp	J-S	Ca,Ss	BPC
Celtis iguanea	drupe	mesocarp	J-O	Ap,Ca,Ss	MR/BPC
Celtis pubescens	drupe	mesocarp	J-O	Ap	BPC
Inga edulis	lomentum	aril	J-S	Ap,Ca	MR/BPC
Inga feurillei	lomentum	aril	J-S	Ap	MR/BR
Inga sp. (5 leaflets)	lomentum	aril	J-S	Ap,Ca	BPC
Erythrina velutina	legume	flowers	S-O	Ap	BPC
Centrolobium achroxylon	samaroid	seeds (i)	J	Ca	BPC
Myroxylon peruiferum	samaroid	seeds (i)	J	Ca	BPC
Chrysophyllum lucentifolium	drupe	mesocarp	A-S	Ap,Ca	BR/BPC
Sapotaceae (tree)	drupe	mesocarp	A-S	Ap	BPC
Cochlospermum vitifolium	capsule	flowers	J-A	Ap	BPC/BAP
Terminalia valverdae	samara	seeds (i)	A-S	Ap,Ca	BPC/BAP
Tabebuia chrysantha	capsule	flowers	S-O	Ap	BPC/BAP
Vitex cf. *gigantea*	drupe?	mesocarp?	J(+)	Ap	MR/BPC
Cordia eriostigma	drupe	mesocarp	J-A	Ap	BAP/BPC
Sapindus saponaria	capsule	seeds (i)	J-A	Ap,Ca	BR/MR/BPC
Simira williamsii	drupe	mesocarp	J	Ap	BPC
Alseis peruviana	drupe	mesocarp	J	Ap	BPC/BAP
Brugmansia candida	berry	flowers	J-A	Ap	MR
Solanaceae (tree)	berry	flowers	S-O	Ap	BPC

Part: the part eaten; (i): immature, (m): mature, (+): last fruits.
Period: J - July; A - August; S - September; O - October
VF: Vegetation formation. MR - Riparian forest; BR - River edge; BPC - Hillside primary forest; BAP - Tall primary forest.
Primate: Ap - *Alouatta palliata*; Ca - *Cebus albifrons*; Ss - *Saimiri sciureus*.

included nine adults and a juvenile. Another group was seen in October 1994 in the hills of the Cerro Shamán, above the Quebrada El Ciruelo. A guard also told us that a group was sometimes seen crossing the path from Campoverde to Figueroa, indicating a third group.

Saimiri cf. *sciureus*

Two group of the "fraile" or "mono castilla" were observed. One was on the Inca path and seen associating with *Cebus* on three occasions between July and September, and including juveniles. Another, with 122 individuals counted, was seen between Campoverde and Figueroa in July 1994, with two dependent infants. A guide, Sr. Alberto Feijoo, informed us of the presence of a third group in the region of El Cafetal.

Some Primate Foods

We identified 39 species of trees and bushes, fruiting between January and May, and flowering between August and December, the fruits (mesocarps and arils) of which were eaten by mammals; the procyonids and mustelids and particularly the primates (Table 2). *Alouatta palliata* and *Cebus* also eat the immature seeds of *Terminalia valverdae*, as do the parakeets, *Brotogeris pyrrhopterus*, and parrots, *Aratinga erythrogenys*. *Saimiri* eats the fruits of *Coccoloba* in evident competition with some bird species. In the gallery forest, *Alouatta palliata* was seen eating immature fruits of *Ficus aripuanensis*, *Maquira* sp., *Carica papaya*, Sapotaceae and others.

Birth Season

The sightings of young of 4-6 weeks of age in all three primates in July, with juveniles being present between September and October, indicate that the birth season at Tumbes is between January and April. This birth season may well apply also to other mammals, and coincides with the time of the greatest availability of fruits.

Cebus and *Saimiri* in the Tumbes Reserved Zone

Grimwood (1969) suggested the occurrence of *C. albifrons* in the Tumbes Reserved Zone following the reference of Hershkovitz (1949) for coastal Ecuador just to the north, as well as reports and descriptions of a capuchin monkey by local people. Hershkovitz's (1949) affirmation was followed by Emmons and Feer (1990), Nowak (1991) and Groves (1993). Emmons and Feer (1990) refer to it as occurring in isolated areas along the Pacific coast of Ecuador, and their distribution map would seem to indicate sympatry with *C. capucinus* along the Colombia-Ecuador border on the western slopes of the Andes, as was also indicated by Hershkovitz (1949, p.379). Hershkovitz (1949) stated that there was no evidence for the occurrence of *C. capucinus* along the coast, however, and gave the capuchin monkey there as *C. a. aequatorialis* Allen 1914 (type locality: Province of Manaví, western Ecuador, near sea level). Hershkovitz (1949, p.378) described its range as "Northwestern Ecuador; coast and western slopes of the Cordillera Occidental to not more than 2,000 meters above sea level". He noted that *C. a. aequatorialis* is apparently isolated from other members of the species, although the possibility remains that its distribution may extend north to meet *C. a. hypoleucus* along the Pacific coast of Colombia. He made no reference to its occurrence further south in northernmost Peru, but the presence of a race of white-fronted capuchin (not necessarily *aequatorialis*) in the Tumbes forests was confirmed by Saavedra and Velarde (1980), who observed a group of 3-5 individuals, as well as in this study (see below).

In August, 1986, Encarnación (unpublished data) examined two dried skins in the Centro de Datos para la Conservación of the Universidad Nacional Agraria La Molina, Lima from the Tumbes National Forest. One of them was a squirrel monkey, *Saimiri* cf. *sciureus*, and the other a white-fronted capuchin, *Cebus* cf. *albifrons*. This is the first record that we know of a squirrel monkey from the western slopes of the Andes and the Pacific coast of South America (see Hershkovitz, 1984, pp.158-159 and Figs. 2 and 3 and p.187, Fig. 19). The only other squirrel monkey from the Pacific coast is *Saimiri oerstedi*, with two forms - *oerstedi* and *citrinellus*, in Costa Rica and Panama, and Hershkovitz (1969, 1972, 1984, pp.160-161) argued at length that they had been introduced, probably from Ecuador and/or Peru in the distant past, with the well-defined gothic-type facial pattern indicating that they were derived from *S. sciureus macrodon*, being close, for example, to the forms from Caquetá (Colombia) and Yurac Yacy, San Martín (Peru). The introduction of *Saimiri* to Central America was, following the reasoning of Hershkovitz (1984), Pre-Colombian, and due to emigration of Indians from Peru and Ecuador along the Pacific coast, documented to have been occurring at least as long ago as 3000 BC. In this case, the interesting question arises as to the origin of the *Saimiri* in Tumbes, which may have come from the westernmost populations in Amazonian Peru and Ecuador, between 2°07'-5°06'S and 78°15'-78°25'W, and may have been the link with the Central American squirrel monkeys. The same situation may also apply to Central American *Ateles*, *Alouatta* and *Cebus* (Hershkovitz, 1984).

Neither the Tumbes *Cebus* nor the squirrel monkey were included in the primate listing for Peru drawn up by Rylands *et al.* (1995). Supposing that the *Saimiri* is a distinct taxon, and including this form of *Cebus,* the number of Peruvian primates would increase to 53 (16 callitrichids and 37 cebids), a number superseded only by Brazil.

Table 2. Mammals of the Tumbes National Forest. Records from July to October, 1994 (Nomenclature follows Wilson and Reeder 1993).

Species	Register				Habitat[5]	Niche[6]
	Visual[1]	R/H[2]	VO[3]	Inf.[4]		
Marmosops noctivagus	(2)	-	-	-	N/AT	If,Fr
Dasypus novemcinctus	(5)	-	-	-	ND/T	It
Tamandua tetradactyla	(1)	-	-	-	DN/AT	Iv
Tamandua mexicana	(3)	-	-	-	DN/AT	Iv
Alouatta palliata	3 (16?,10,1)	-	3	3	D/A	Fr,Fo
Cebus albifrons	2 (10,87)	-	-	1	D/A	Fr,If
Saimiri sciureus	2 (+12,+15)	-	1	1	D/A	Fr,If
Pecari tajacu	3 (+16,107,+50)	2	-	(2m)	D/T	Fr,Fo,Om*
Mazama americana	(6) (4m)	(4)	-	(1m)	DN/T	Fo,Fr
Odocoileus virginianus	(1)	-	-	-	DN/T	Fo,Fr
Pseudalopex sechurae	(1)	-	-	-	ND/T	Ca
Eira barbara	4 (3,1,1,1)	-	-	-	D/TA	Ca,Om*
Nasua nasua	4 (127,2,17,4)	-	-	-	D/TA	It, Ca, Om*
Procyon cancrivorus	1 (3)	2	-	-	ND/TA	Iv**
Leopardus pardalis	(3)	-	-	-	ND/T	Ca
Leopardus wiedii	(3)	-	-	-	ND/T	Ca
Puma concolor	-	(1)	-	-	DN/T	Ca
Tremarctos ornatus	-	(1)	-	-	DN/T	Ca
Sciurus stramineus	+7(2,3,2,1,3,1,3)	-	-	-	D/A	Se

[1]Number of groups observed and (in parentheses) the number of individuals; 'm' indicates dead animals (hunting or natural causes).
[2]R. tracks, H: signs from fruits and trunks
[3]VO. Vocalization
[4]Inf: Reports from local villagers, guards and others.
[5]N: Nocturnal, D: Diurnal, A: Arboricolous, T: Terrestrial
[6]Fr. fruit — Fo: hojas, follaje
Ii: insects/invertebrates in foliage — It: terrestrial insects/invertebrates
Om*: omnivorous — Iv**: river crabs and molluscs
Se: seeds — Ca: carnivorous

The Wildlife of Tumbes and Future Research

The species listed in Table 2 were recorded either visually or by vocalizations (n = 17), by tracks in the humid soils of the quebradas (n = 1) and claw marks in the bark of tree trunks (n = 1). Also listed are species which were reported through interviews with ranch hands, guards, hunters and local villagers.

The rich fauna at Tumbes is reflected in the presence of a healthy diversity in mammalian carnivores (Table 2), raptors and vultures. Raptors include *Buteogallus urubitinga* "gavilán negro grande", *Buteo magnirostris* "gavilán alirrojizo", *Accipiter bicolor*, *Leucopternis occidentalis* "gavilán dorsigris", and *Spizaetus ornatus* "águila penachuda", among others. Vultures include *Coragyps atratus* "gallinazo", and *Sarcorhampus papa* "buitre real".

Our study in Tumbes was specifically aimed at carrying out an intensive survey for *Alouatta palliata*, following that of Vásquez *et al.* (1992) in 1980, which resulted in discovery of *Cebus cf. albifrons* by Saavedra and Velarde (1980). Considering the geographic isolation and ecological conditions of the area (Brack 1986), the high pressure on the mammals, especially the primates (Vásquez *et al.* 1992), and the larger birds, resulting from subsistence hunting and from capture for pets (Grimwood 1969; Saavedra and Green 1987, Pulido and Yockteng 1986, 1991), there is an urgent need for more research on the populations and the distributions of the wildlife of the region (Cook and Encarnación 1995). Further study (most especially genetic research) is also required to examine the hypothesis of Hershkovitz (1969, 1972, 1984) regarding the origins of the populations of *Cebus* cf. *albifrons* and *Saimiri sciureus*. Specifically, future studies need to examine: 1) The status of the natural habitats and populations of *Alouatta palliata*; 2) the systematic status and geographic distributions of *Cebus* cf. *albifrons* and *Saimiri sciureus*; and 3) the origins of the Andean *Alouatta*, the Andean and Amazonian *Cebus albifrons*, and the Amazonian *Saimiri*.

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Authors' Addresses:

Filomeno Encarnación, Estación Experimental del Trópico Centro de Investigación (C.I.), Instituto Veterinário de Investigaciones Tropicales y de Altura (IVITA), Universidad Nacional Mayor de San Marcos, Apartado Postal 575, Iquitos, Loreto, Peru.

A. Gaylon Cook, Bioconservation Research, 3306 North Canyon Road, Provo, Utah 84604-4548,USA.

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Some Observations on the Ecology of *Cacajao calvus ucayalii* in the Peruvian Amazon

Rolando Aquino

Centro de Investigación, Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, Iquitos, Peru

Introduction

The geographic range of *Cacajao calvus ucayalii* is restricted to the right banks of the Ríos Ucayali and Amazonas (Hershkovitz 1987; Aquino 1988). Like other primates of medium to large size, it suffers from hunting pressure. Weighing less than 4 kg, the red uakari is hunted for subsistence, while the larger game species are commercialized, being sold in regional markets. It is one of the least known of the Neotropical primates in terms of its ecology, behavior and population dynamics. Information available to date has come from chance encounters and observations during field studies concentrated on other species (Bartecki and Heymann 1987; Aquino 1988; Heymann 1989, 1990; Puertas and Bodmer 1993; Heymann and Aquino 1994).

Motivated by the lack of information, a number of expeditions were carried out from June 1993 to August 1994 in an attempt to contact this species and establish a site for an ecological study.

Study Areas

The study of *C. calvus ucayalii* was carried out at the Quebrada Blanco, an affluent of the Río Tahuayo, south-east of Iquitos (4°23'S, 72°55'W), more precisely in an area delimited by the Quebradas Tunchío, Palmichal, and Tangarana. Additional observations were made in the basin of the Río Yavarí, to the east of Iquitos, between Agua Negra and Carolina (4°30'S, 71°43'W) (Fig. 1).

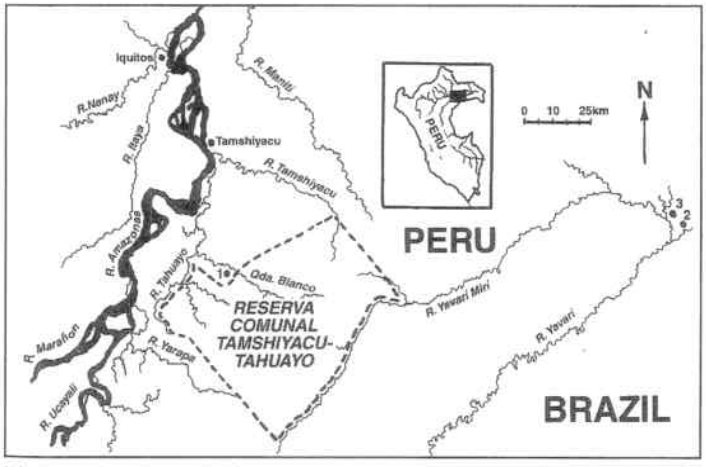

Figure 1. Study areas 1. Quebrada Blanco. Río Tahuayo, 2. Agua Negra, Río Yavarí, 3. Carolina Rio Yavarí-Mirí. Map by Stephen D. Nash.

Following the terminology of Encarnación (1985, 1993), the primary forest in these areas corresponds to high forest and swamp forest. Canopy heights range from 20 to 35 m, with some emergents taller than 40 m. Both areas have numerous paths opened up by hunters, and also used for collecting honey and fruits. Hunting is common and includes all primates of medium to large size, including uakaris.

Methods

The first steps involved the establishment of a path system, involving parallel and perpendicular transects, covering more than 70 km, and each ranging from 2 to 8.8 km. Along with the already existing hunter trails, this provided a total trail system of about 110 km of paths. The transects and trails were walked at a speed of 2 km/h, with pauses lasting two to three minutes to listen and look for monkeys (vocalizations, falling fruits, etc.). Important information was also obtained by searching for fallen fruits, especially immature fruits, and this on occasion led us to the uakari groups. Vocalizations were also an important means of detection, including those of woolly monkeys, *Lagothrix lagotricha*, which were often found in association with the uakaris. The location of all groups sighted was noted in order to obtain estimates of home range size.

When contacted, the uakari groups were followed for as long as possible. Their activities, and the vegetation types they were in, were recorded every 10 minutes. Contact time varied from 35 minutes to 8 hours, although on two occasions they were followed from sleeping tree to sleeping tree, once in July (active for 12.2 hours) and once in February (active for 12.4 hours). The classification of the vegetation types used by the uakaris followed Encarnación (1985, 1993). Special attention was paid to the time that the uakaris spent in association with other primates. All fruits

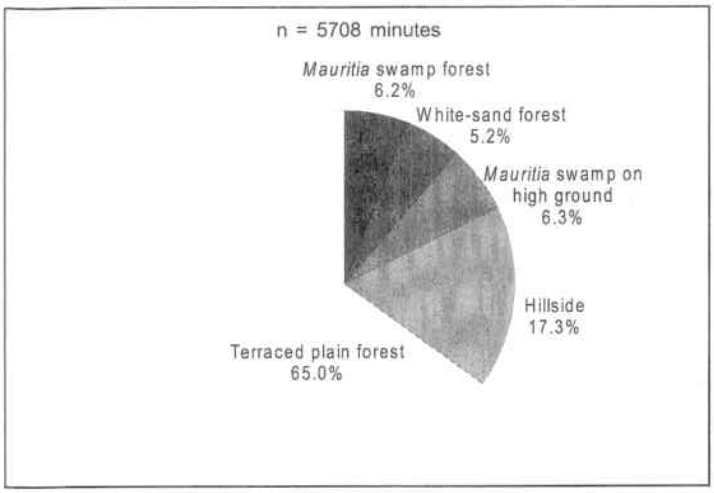

Figure 2. Proportion of time spent by *C. calvus ucayalii* in different vegetation types.

eaten by them were collected for identification, and their remains were examined to determine the part(s) eaten.

Results and Discussion

Use of Different Vegetation Types

During 95.1 hours of observation, *C. c. ucayalii* was seen to enter four distinct vegetation types in the high forest and one in the swamp forest (Fig. 2). At the Quebrada Blanco, they were found only in high forest, where, during a total contact time of 86 hours they spent most of their time in forest on terraced plains. This was due to the fact that this heterogeneous forest, with trees in some cases taller than 30 m, was the most widespread of the high forest types. There, predominant plant associations included *Parahancornia* sp., *Pouteria* spp., *Eschweilera* sp., and *Jessenia* sp.; all with fruits preferred by the uakaris.

The majority of the contacts in the basin of the Río Yavarí occurred in swamp forest. During the majority of the nine hours of observation they remained in the *Mauritia* palm swamp, spending relatively little time in the forest on the terraced plains and hillside forest. Their preference for this forest type was seasonal and related to the availability of food. From March to July they spent most of their time in the swamp forest due to the higher production of fruits, especially of *Mauritia flexuosa*, which according to my records as well as those of R. Bodmer (pers. comm.), is a principal food for uakaris and other primates at this time. During the rest of the year they spent more time in the high forest of the Quebrada Blanco, where fruits are generally abundant throughout the year, but especially during June-August.

The data suggest that the high forest, with its varied forest types and plant communities, is the optimal habitat for the uakaris. This is in agreement with observations reported by Bartecki and Heymann (1987), Aquino (1988) and Heymann (1990), but in contrast to Fontaine (1979) who reported that they are restricted in their habitat to black-water flooded and swamp forests, and to Ayres (1986b, 1986b) who recorded *C. c. calvus* using exclusively white-water flooded forest (*várzea*) on the Rio Japurá in Brazil.

Table 1. Contacts with groups of *Cacajao calvus ucayalii* in the Quebrada Blanco and Río Yavarí study sites.

Date	Site	Estimated Group Size
1993		
July	Tunchío, Qda. Blanco	40-60
July	Cuchara, Qda. Blanco	48-52
July	Cuchara, Qda. Blanco	48-52
July	Cuchara, Qda. Blanco	70-75
July	Cuchara, Qda. Blanco	60-70
August	Palmichal, Qda.Blanco	60-70
August	Palmichal, Qda.Blanco	60-65
August	Palmichal, Qda.Blanco	60-65
1994		
February	Palmichal, Qda.Blanco	35-40
February	Cuchara, Qda. Blanco	37-35
February	Palmichal, Qda.Blanco	100-120
March	Cuchara, Qda. Blanco	30-35
March	Cuchara, Qda. Blanco	37-45
March	Cuchara, Qda. Blanco	8 (exact count)
March	Cuchara, Qda. Blanco	25-30
June	Tunchío, Qda. Blanco	12 (exact count)
June	Tunchío, Qda. Blanco	40-50
June	Palmichal, Qda.Blanco	60-60
June	Agua Negra, Río Yavarí	30-35
June	Agua Negra, Río Yavarí	25-35
June	Agua Negra, Río Yavarí	45-50
June	Carolina, Rio Yavarí-Mirí	50-60

Group Size

The following is based on 22 contacts from July 1993 to August 1994. Of these, 18 were at the Quebrada Blanco, and four in the Río Yavarí basin (Table 1). The majority of contacts in the Quebrada Blanco site, covering about 10,000 ha, were believed to be of one or perhaps two groups. The only exception was a very large group of about 120 individuals seen in February 1994, which resulted from two or even three groups traveling together. Similar "combined" groups have been seen on the Río Orosa (about 200 individuals, Aquino 1988), and more recently, in March 1995, at the Quebrada Corrientes, a right bank affluent of the Quebrada Blanco (approximately 150-170 individuals).

Besides these large groupings, group size for each contact usually varied from 30 to 50 individuals, although some contacts registered 52-75 individuals. On two occasions the uakaris were found traveling in subgroups of 7 and 12 individuals, respectively. The smallest of the subgroups was composed of three adult males and four juveniles (sex not identified). Adults (at least three males) and subadults made up the group of 12. For the larger groups, the numbers were estimated from repeat counts.

Group sizes reported here are in agreement with those observed by Bartecki and Heymann (1987), Aquino (1988), Heymann (1990) and R. Bodmer (pers. comm.). Similar group sizes have also been reported for *C. c. calvus* by Ayres (1986b) and Ayres and Johns (1987). These group sizes, and their fission into subgroups, would appear to be typical of the species, depending on such factors as: group size and composition; home range size; food availability; the availability of sleeping sites and resting trees; and their tendency to associate with other primate species.

All groups were composed of adults of both sexes, subadults, juveniles of 1.5 to 2 years, and independent (less than a year old) and dependent infants carried by their mothers (sometimes dorsally, sometimes ventrally). Unfortunately it was not possible to record group composition with sufficient precision to calculate the ratio of adults to juveniles, although the impression gained was that immature forms were more numerous.

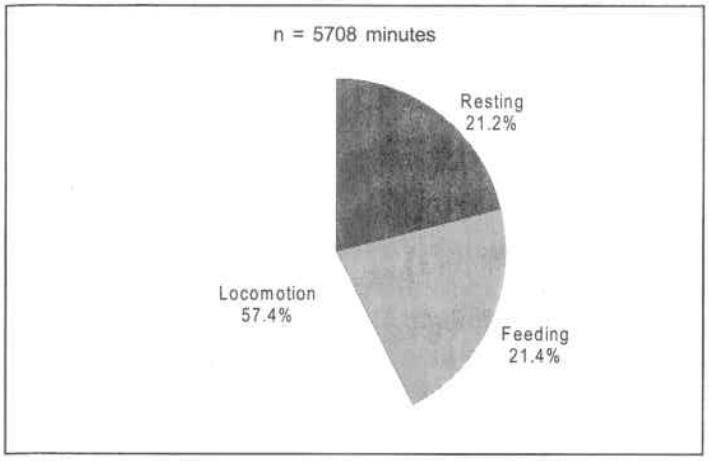

Figure 3. Proportion of time spent by *C. calvus ucayalii* in different activities.

Activity Patterns

The preliminary analysis shows that *C. c. ucayalii* spends most of its time moving about (Fig. 3), related to the dispersed nature of its food resources. The high forests are characterized by a high diversity of plant species, with constant if low production of fruits throughout the year, and the uakaris, especially considering their large group sizes, need to travel long distances in order to obtain sufficient food. While following these monkeys it was possible to distinguish three types of travel: 1) slow travel, generally in areas where fruit availability was high, with travel interspersed with brief resting bouts; 2) normal travel, when moving between food trees in areas otherwise scarce or lacking in fruits; and 3) rapid travel, observed in two situations; when they saw the observers or predators, and in the late afternoon when moving to their sleeping sites.

Feeding bouts (time spent feeding from the moment they went into the feeding tree(s) to when they left) varied from three to 35 minutes. Bout duration was dependent on the availability and abundance of food at the site as well as group size. They generally spent longer feeding in such trees as *Pouteria* spp., *Eschweilera* spp. and *Mauritia flexuosa*, all characterized by the simultaneous production of large numbers of fruits.

Time spent resting varied from five to 2.2 hours. In the majority of cases they rested in the canopy of three or more trees at heights above 20 m. Adults usually rested in silence on their own, with the body relaxed along a branch in a ventro-cubital position with the limbs suspended. Occasionally they would groom, with the initiative being taken by the females. During resting bouts, independent infants would often play chasing games, sometimes descending to as low as 5 m above the forest floor, or they would just move about, investigating objects and sometimes hanging by their hind feet. On occasion, resting would be interrupted by loud alarm calls, and the uakaris would rapidly descend to the lower strata of the forest, evidently responding to the appearance of an aerial predator (eagle or hawk).

Sleeping Trees

On four occasions it proved possible to follow uakari groups to their sleeping trees. On two days in February and March they retired at 1821 hours and 1823 hours, respectively. On two days in July and August they retired a little earlier, 1800 hours and 1803 hours, respectively. The first movements and the accompanying vocalizations before leaving their sleeping sites in the morning occur at 0536 hours in February and 0540 hours in July, in each case the first animal leaving the sleeping site at 0544 hours and 0547 hours, respectively. These findings are similar to those reported by Ayres (1986b) for *C. c. calvus*, who recorded that seasonal differences in the activity period were no more than 20 minutes. The number of trees used at each sleeping site varied according to the size of the group, from three by a group of 48 individuals to eight by a group of 75. The trees used were approximately 20 m to 150 m distant from each other. The heights of the trees varied from 17 m to 32 m. Some of the trees used were also important sources of fruits; (*Pouteria* sp. and *Eschweilera* sp.).

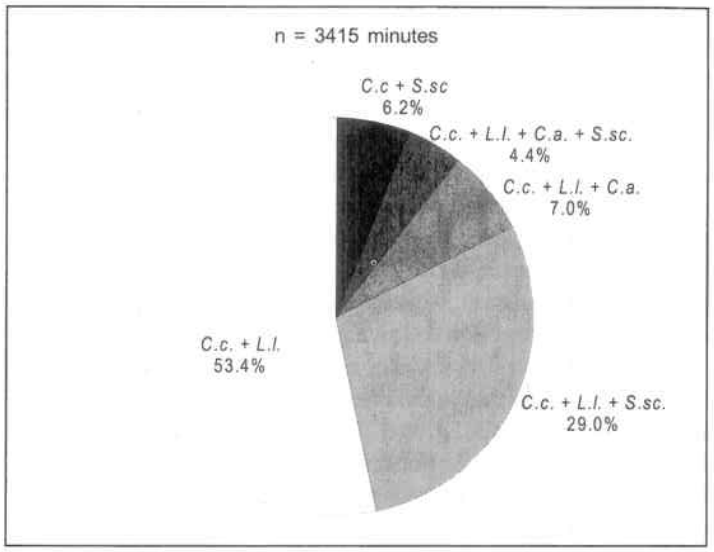

Figure 4. Frequency of associations between *C. calvus ucayalii* and other primate species. C. c. = *C. calvus ucayalii*, L. l. = *Lagothrix lagotricha*, C. a. = *Cebus* albifrons, S. Sc. = *Saimiri sciureus*.

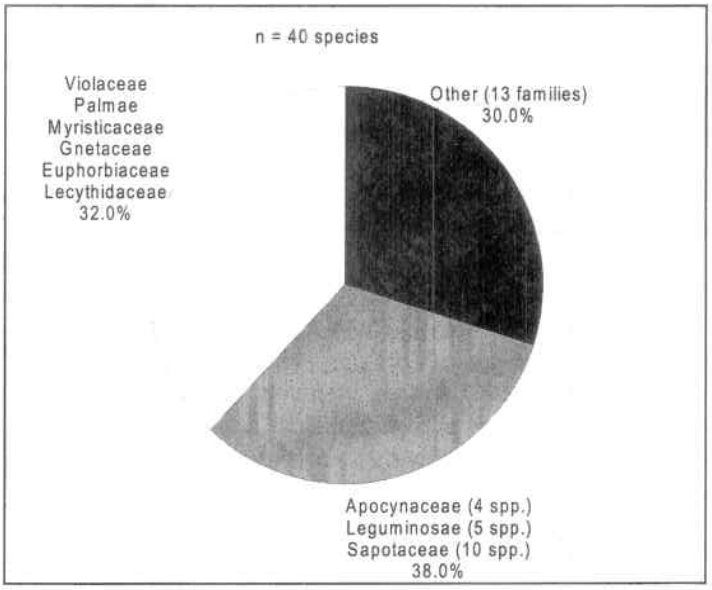

Figure 5. Principal plant families in the diet of *C. calvus ucayalii*.

Interspecific Associations

Thirteen other primate species occur in the two study areas (Puertas and Bodmer 1993). Of these, the woolly monkey *Lagothrix lagotricha*, the white-fronted capuchin *Cebus albifrons*, and the squirrel monkey *Saimiri sciureus*, were seen to associate

with *C. c. ucayalii*. In nine of 22 encounters, the uakaris were in mixed groups with one, two, or all of these species. They spent more time in association with *Lagothrix* than the other two species, and least time with *Saimiri* (Fig. 4). While traveling, uakari groups were also seen in proximity to the moustached tamarin *Saguinus mystax*, saddle-back tamarins *S. fuscicollis*, titi monkeys *Callicebus cupreus* and *C. caligatus*, sakis *Pithecia monachus*, and tufted capuchins *Cebus apella*. When an encounter between these species was imminent, the tamarins and the titis moved into the lower layers of the forest, whereas the other species simply moved off in a different direction following a brief mingling.

A mixed group of four spider monkeys *Ateles chamek* and *C. c. ucayalii* was recorded just once during a mammal census along the Quebrada Lopunillo, in the Tamshiyacu-Tahuayo Communal Reserve in May 1995. Unfortunately, observation of this mixed group was terminated after only a few minutes when a hunter shot one of the spider monkeys (an adult female), and the two groups fled in different directions.

On two occasions it was possible to witness the formation of mixed groups, once with *Lagothrix* and once with *Saimiri*. In both cases, the groups approached each other quite fast and then continued on together, although changes in the direction of travel, sometimes through 180°, always seemed to be led by some of the adult *Cacajao*. Not necessarily at the front of the group, the adults would vocalize, often some distance away, resulting in the change of direction. Direction changes of this sort sometimes caused the two species to separate, which otherwise occurred when they sought their sleeping trees in the late afternoon.

Plant Species in the Diet

Samples of fruits (immature and mature) of about 50 species of more than 20 families eaten by the uakaris have been collected since the study began. Among the most important families in terms of the number of species included in the uakaris' diet are Sapotoceae, Leguminosae and Apocynaceae, together representing 38.0% of the total (Fig. 5). The species most frequently eaten and which have extended fruiting periods were *Schistostemon* spp., *Mauritia flexuosa*, *Eschweilera* sp., *Irianthera* spp. and *Pouteria* spp. On occasion the uakaris were seen to eat the yemas and tender leaves of epiphytes, especially of the families Cyclanthaceae and Bromeliaceae. They were also observed nibbling at the flowers of vines, although it was not possible to see if they were ingesting them.

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Author's Address:
Rolando Aquino, Centro de Investigación, Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, Apartado 575, Iquitos, Peru.

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Notes on The Distribution and Conservation Status of Spider and Howler Monkeys in The State of Quintana Roo, Mexico

Alvaro del Campo Parra Lara[1] and Jeffrey P. Jorgenson[2]

[1]*Centro de Investigaciones de Quintana Roo, Chetumal, Quintana Roo, Mexico*
[2]*Department of Wildlife and Range Sciences and Program for Studies in Tropical Conservation, University of Florida, Gainesville, Florida, USA*

Introduction

Watts *et al.* (1986) investigated the conservation status of spider monkeys, *Ateles geoffroyi yucatanensis*, and black howler monkeys, *Alouatta pigra*, in the Yucatan Peninsula during 1984-1985. They determined that for the State of Quintana Roo, primate populations were absent, threatened, reduced, or with an undetermined status in 8 of the 14 sites visited. Primate populations were stable or increasing at only three sites. This paper expands and complements existing information for these species in the state of Quintana Roo, Mexico, and includes 24 new distribution localities. It also analyzes the factors affecting local primate populations in these areas and their habitat.

Study Area

The state of Quintana Roo is situated on a plain of marine origin and covers an area of approximately 50,843 km² (Cabrera Cano *et al.* 1982). The region is quite flat, with local topographic variations of less 10 m, except in the western portion of the state where the elevation is about 300 m. It is characterized by the absence of surface water and the presence of red-colored redzina soils. Originally the vegetation types of the state were as follows: tall, semi-evergreen forest (30%; TSEF; *Selva Alta Subperennifolia* in Spanish); medium, semi-evergreen forest (42%; MSEF; *Selva Mediana Subperennifolia*); medium, semi-deciduous forest (24%; MSDF; *Selva Mediana Subcaducifolia*); low, deciduous forest (2%; LDF; *Selva Baja Caducifolia*); and mangrove (2%; *Manglar*) (México, Secretaría de Programación y Presupuesto 1980). Today, however, the forested area has been greatly reduced due to logging and agricultural activities, especially along the eastern coast.

Methods

The project was undertaken in three phases. First, the potential habitat of the two species was determined by taking into consideration their ecological requirements, current vegetation types (see Cabrera Cano *et al.* 1982), and land uses (México, Secretaría de Programación y Presupuesto 1980). In the second phase, the local distribution of the two species was determined through interviews with reliable informants (biologists and field personnel of regional organizations working with agriculture and livestock grazing). Finally, this information was confirmed by visits to the areas, direct observations of the primates, and personal interviews with local residents. If primates were observed or heard in the forest, the observation was categorized as Verified (V). If it was not possible to verify the presence of primates in the area, but local residents confirmed their occurrence, the observation was categorized as Reported (R).

Field work was conducted during July-October 1987. During 25 days of field surveys, 36 sites were visited in which it was possible to observe or record the presence of spider or howler monkeys. Other sites were visited at which the local residents could, or would, not confirm the presence of primates. Since we were unable to differentiate between a resident who did not know about the occurrence of primates and one who did not wish to provide information about them, we chose not to include information about the absence of primates in these cases. The study period roughly corresponded to the rainy season and time of year when the local Maya Indians cultivated their crops.

For each direct observation of primates, we recorded group size, composition, and group response to the presence of humans. At all of the sites visited we recorded vegetation type, habitat condition (protected status), and conservation threats to primates and their habitat. We also obtained information about hunting and the local pet trade. Local officials were interviewed about government programs for the management of wildlife in Quintana Roo in order to determine policies and plans specifically for primates.

Results

The occurrence of primates was verified or reported at 36 localities in Quintana Roo (Fig. 1). These sites ranged throughout the state. Spider monkeys were confirmed at 11 sites and reported by local residents at another 19, for a total of 30 localities of the possible 36 (Table 1). For the 30 sites, 13 corresponded to

Table 1. Distribution, habitat, and conservation threats to spider and howler monkeys in the State of Quintana Roo, Mexico (1987).

No.	Site Name or locality	Vegetation type[1]	Primate species[2]		Protected status[3]	Comments
	Northern Zone (Municipalities of Lázaro, Cárdenas, Isla Mujeres, Benito Juárez)					Subject to logging. Livestock grazing, and tourism development.
1	Boca Iglesias	MSEF		AL-V	Unprotected	
2	Road between San Isidro-Quintana	MSDF	AT-R	AL-R	Unprotected	Both species are easily located on property owned by Ambrosio Chan.
3	Cenote Notzonot	MSDF	AT-V	AL-V	Unprotected	Monkeys not alarmed by the presence of humans.
4	Boundary between Ejido Kaltunikin and Leona Vicario	MSDF	AT-R	AL-R	Unprotected	Conservation threats to forest due to logging.
5	Water pump and purification plant	MSEF	AT-V	AL-V	Protected	Protection of pumps and facilities, not of the monkeys or the adjacent forest.
6	Northern boundary of Ejido Valladolid and Nueva Esperanza	MSDF	AT-R	AL-R	Protected	Logging and hunting threaten the conservation status of the monkeys.
7	Laguna Madera	MSEF	AT-V		Unprotected	
8	Punta Negra	MSDF	AT-V		Protected	
9	Southwest portion of Ejido San Juan de Dios	MSDF	AT-V	AL-V	Unprotected	Howler monkeys heard from various locations.
10	Camp Ydaldocortez	MSDF	AT-R		Unprotected	
11	Botanical Garden (CIQRO)	MSEF	AT-V		Protected	Ineffective legal protection.
12	Road to Vallarta (Km 1, near Rancho Paraiso)	MSEF		AL-R	Unprotected	Conservation threats due to sport hunting.
13	Rancho Victoria (Km 11 on road to Vallarta)	MSEF	AT-V		Unprotected	Contains the largest population of spider monkeys observed in the state.
	Central Zone (Municipalities of Felipe Carrillo Puerto and José María Morelos)					Numerous small settlements of Maya Indians scattered throughout the zone.
14	Rancho Culiacán	MSEF		AL-V	Unprotected	
15	Rancho Los dos Compadres	LDF	AT-R		Unprotected	Rapid expansion of livestock grazing.
16	Cobá	MSEF	AT-R		Protected	
17	Chunyaxche	MSEF	AT-V	AL-V	Protected	
18	Extreme northeastern portion of Ejido San Antonio	MSEF	AT-R		Unprotected	Numerous groups of spider monkeys reported.
19	La Isla and Cenote Dominic, Ejido X-Hazil y Anexos	MSEF		AL-R	Unprotected	Logging and hunting of howler monkeys reported.
20	Sian Ka'an Biosphere Reserve	MSDF	AT-R	AL-R	Protected	
21	About 2 km east of Rancho Las Palmas (Km 95)	MSEF		AL-V	Unprotected	
22	Camp Negrete, east of Andres Quintana Roo	MSEF		AL-R	Unprotected	No hunting or conservation threats to habitat.
	Southern Zone (Municipality of Othón P. Blanco)					Zone subjected to extensive development for agriculture and livestock grazing.
23	Boundary between Ejido Rio Verde and Miguel Alemán	TSEF		AL-R	Unprotected	High rates of deforestation due to agricultural development.
24	Southern boundary of Ejido Melchor Ocampo	TSEF	AT-R		Unprotected	
25	Ejido Los Lirios	TSEF	AT-R	AL-R	Unprotected	
26	Boundary between Ejido Reforma and Bacalar	TSEF	AT-R	AL-R	Unprotected	
27	Bacalar Wildlife Sanctuary	TSEF	AT-V		Protected	Included approximately 30 pet monkeys that had been legally seized; numerous other species of birds and mammals.
28	Boundary between Ejido X-Pujil and 20 de Noviembre	TSEF	AT-R		Unprotected	
29	El Paraiso, Ejido Dos Aguadas	TSEF	AT-R	AL-R	Unprotected	
30	Los Cenotes, Rancho Estero Franco	TSEF		AL-V	Unprotected	Howler monkeys were very cautious in the presence of humans; eight individuals observed.
31	1 km to east of La Unión	TSEF		AL-V	Unprotected	Five howler monkeys observed.
32	La Lucha, Ejido Nueva Guadalajara	TSEF	AT-R	AL-R	Unprotected	Hunting and extensive logging reported.
33	Ejido Tres Garantias	TSEF	AT-V	AL-V	Unprotected	Eight pet spider monkeys reported (juveniles).
34	Ejido Tomás Garrido	TSEF	AT-R	AL-V	Unprotected	
35	Ejido Ojo de Agua	TSEF	AT-R	AL-V	Unprotected	Howler monkeys near La Pionera site.
36	Dos Lagunas	TSEF	AT-R	AL-R	Unprotected	

[1] Vegetation type: LDF = low, deciduous forest; MSDF = medium, semi-deciduous forest; MSEF = medium, semi-evergreen forest; TSEF = tall, semi-evergreen forest.

[2] Primate species present: AT = *Ateles geoffroyi yucatanensis*; AL = *Alouatta pigra*; R = reported; V = verified.

[3] Site protected status: protected in the sense that the area has been legally designated as a controlled area with restrictions on the extraction of timber and non-timber forest products.

forest categorized as TSEF, nine to MSDF, seven to MSEF, and one to SDF. Howler monkeys were confirmed at 10 sites and reported by local residents at another 15, for a total of 25 localities (Table 1). For the 25 sites, 11 corresponded to forest categorized as TSEF, nine to MSEF, and five to MSDF. The occurrence of both species was noted at 16 sites (Table 1). Howler monkeys alone occurred at six sites (five categorized as MSEF). Spider monkeys occurred alone at 11 sites.

Of the 12 sites with primates in Quintana Roo visited by Watts *et al.* (1986), nine were visited during the present study. In two it was possible to verify the occurrence of primates (sites 13 and 33, Fig, 1; equivalent to sites 2 and 14 of Watts *et al.* 1986) where they had not been observed previously by biologists. At site 14 (equivalent to site 4 of Watts *et al.* 1986), we verified the presence of howler monkeys where they had only been reported previously.

The largest population of spider monkeys in the state was observed at site 13 (Rancho Victoria). On 23 July 1987, a total of 50 individuals were observed, and 35 individuals were observed on three subsequent occasions (28 August, 16-17 September 1987). Adult females with young were observed in July and August. The four sightings occurred during 1700-1830 h, while the monkeys moved en mass through the forest canopy. An interesting aspect

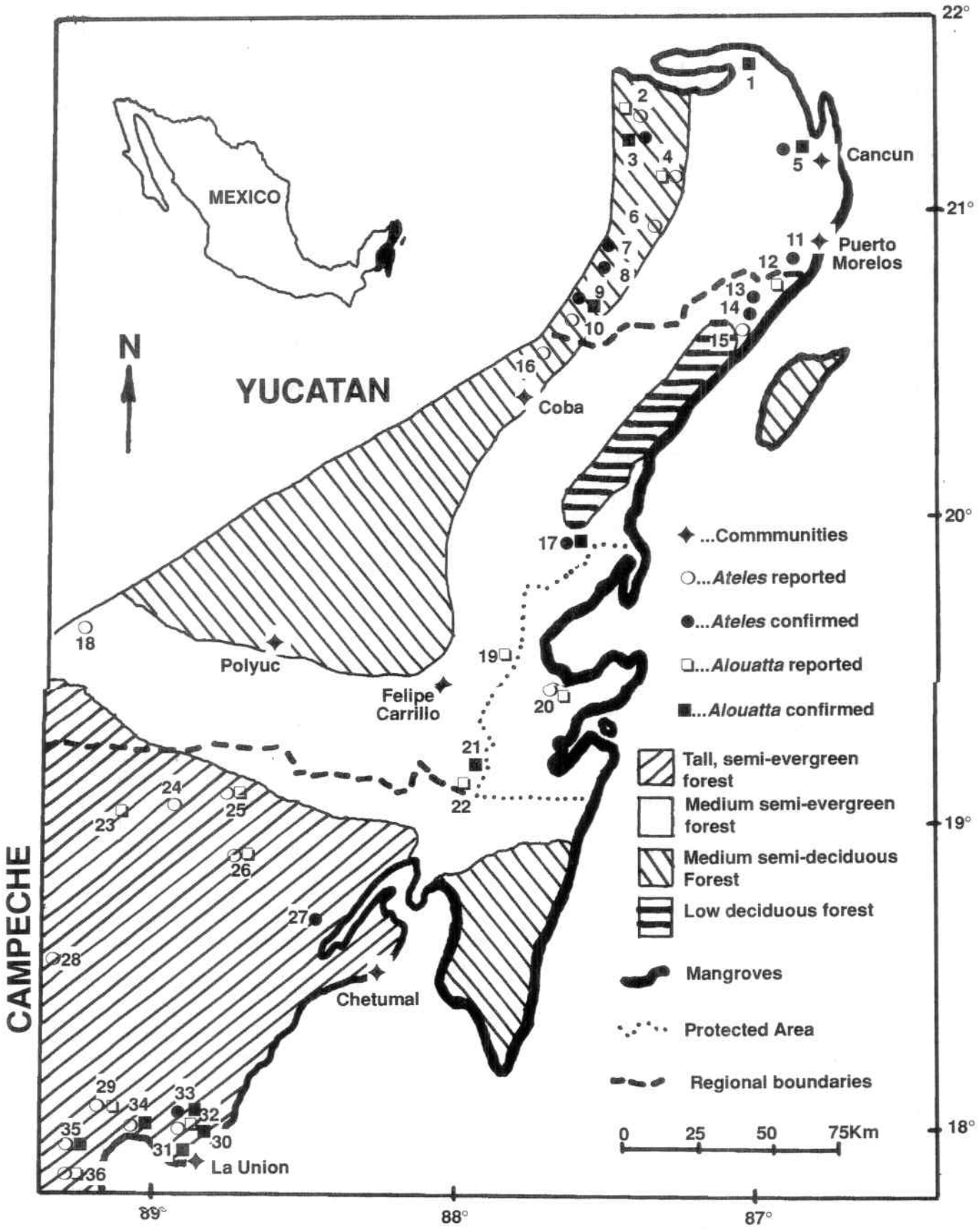

Figure 1. Distribution of spider monkeys (*Ateles geoffroyi yucatanensis*) and howler monkeys (*Alouatta pigra*) in the state of Quintana Roo, Mexico, during 1987. The numbers correspond to the localities listed in Table 1. *reportado* = reported; *verificado* = verified; *selva alta subperen.* = tall, semi-evergreen forest; *s. mediana subperen.* = medium, semi-evergreen forest; *s. baja caducifolia* = low deciduous forest; *manglar* = mangrove; *área protegida* = protected area; *límites regionales* = regional boundaries. Map by Stephen D. Nash.

of these sightings was that the spider monkey groups did not exhibit alarm when they were sighted by humans.

Throughout the state, the condition of the forest was often poor. In the north, logging and livestock grazing presented serious conservation threats to the primates (sites 2, 3, 4, 6, 7, 8, 9, and 16; Fig. 1; Table 1). Along the northeastern coast, many areas were being cleared to develop tourist areas (sites 5, 14, and 15). In the central part of the state, deforestation as a consequence of traditional agriculture as practiced by the Maya residents, was common. The Maya also hunt primates and other wildlife in the forest, but the harvest had reportedly declined substantially over the past 20-30 years (Margar Tuz, Rancho Las Palmas, pers. comm.).

Few areas in Quintana Roo were protected for conservation purposes. Of the 36 sites where primates occurred, only seven were protected in one way or another: Water pump and purification plant (site 5), Cobá (6), Punta Larga (8), Botanical Garden (11), Sian Ka'an Biosphere Reserve (20), and Bacalar Wildlife Sanctuary (27). The conservation value of these areas for primates, however, was limited due to their small size, their unclear legal status, or inconsistent enforcement activities by wildlife and forest rangers. At the Water pump and purification plant (site 5), for example, the main interest of the guards was to protect the pumps and other facilities, while the surrounding forest and associated wildlife were ignored. The Bacalar Wildlife Sanctuary is small (1,064 ha; J.F. Quinto Adrián, Secretaría de Desarrollo Urbano y Ecología, Chetumal, pers. comm.) and subject to hunting or logging incursions by adjacent communities. While the Sian Ka'an Biosphere Reserve is much larger, more than 500,000 ha, it included little forest of value to primates (see López 1983).

Primates throughout the state are subject to hunting, logging of their habitats, and capture for sale in the local pet trade. Hunting was reported specifically at nine sites, but occurred elsewhere as well (Table 1). Logging was reported at 16 sites. While capture for the pet trade was not widely noted, it can be especially damaging because the adult female is usually killed in order to obtain the young (Julio Poot Ake, pers. comm.). Numerous people reported a substantial increase in the pet trade since the mid 1970s due to tourism and increased vehicular traffic along the Cancún-Chetumal highway.

Discussion

Based on the observations made during this study, we conclude that the distribution of the howler monkey is limited primarily to tall, semi-evergreen forest in the southern part of the state. Howlers in the tall forest are frequently located in areas with *ramonales* (tracts with ramon trees, *Brosimum alicastrum*, Moraceae). Howlers are also found, however, in the medium, semi-deciduous forest in the north and the medium, semi-evergreen forest near the Sian Ka'an Biosphere Reserve.

The distribution of the spider monkey in Quintana Roo is more extensive than is that of the howler monkey. With the exception of mangroves and low deciduous forest, spider monkeys are found in all vegetation types. They also frequently occur in areas with extensive human activities. Leopold (1972) noted that spider monkeys were more tolerant of human activities than were howler monkeys (for example, logging and shifting cultivation).

Primate populations in the state are subject to several conservation threats. Most of these are a result of human activities, for example, hunting, logging, and the expansion of shifting cultivation and livestock grazing into formerly forested areas. These threats are increasing as a consequence of human immigration into the area (18% per year; César and Arnaíz 1983), uncontrolled colonization into forested areas (César and Arnaíz 1984), official government support promoting livestock grazing (Codwell 1987), and an increased number of areas being converted for the commercial production of fruits and vegetables (México, Gobierno del Estado de Quintana Roo, 1987).

Hunting is an especially severe conservation threat. With respect to the spider monkey, this activity is focussed on juveniles, with an average sale price in Chetumal of US$15 per individual. For the howler monkey, however, hunting is focused on adults for human consumption, especially in areas inhabited by immigrants from the states of Tabasco and Veracruz (México, Gobierno del Estado de Quintana Roo 1981). This problem persists despite the Federal Hunting Law (*Ley Federal de Caza*) that prohibits the possession or taking of primates and punishes such activities with fines of up to US$2,800 per monkey (J.F. Quinto Adrián pers. comm.). The harvest of primates continues despite strict enforcement and frequent environmental education campaigns by the Secretaría de Desarrollo Urbano y Ecología (SEDUE). An indication of the severity of this activity is the high frequency with which spider monkeys are encountered throughout the state as family pets. Another indication of the problem is the high frequency with which SEDUE enforcement personnel seize these animals; about 25 individuals annually; Quinto Adrián pers. comm.). These results suggest that enforcement and education programs are having little effect.

In response to the large number of confiscated primates, SEDUE created the Bacalar Wildlife Sanctuary, near the city of San Felipe de Bacalar. A major goal of the Bacalar Wildlife Sanctuary is to rehabilitate former pets and reintroduce them into the wild. There is a continuous replacement of released monkeys by newly-confiscated specimens, however, and the population hovers at about 30 individuals. This problem will only become more severe as many specimens cannot be reintroduced into the wild due to physical or psychological problems related to their stay in captivity.

Based on the previous observations, we recommend that studies be undertaken to develop an ecological reserve in the tall, semi-evergreen forest in the southern part of Quintana Roo. This type of forest, in 1979 estimated at 200,000 ha for the entire state, contains the largest populations of primates detected during this study (Mexico, Secretaría de Programación y Presupuesto, 1980). The tall, semi-evergreen forest is also prime habitat for other threatened or endangered species, such as the jaguar (*Panthera onca*), tapir (*Tapirus bairdii*), white-lipped peccary (*Tayassu pecari*), and toucan (*Ramphastos sulfuratus*; Chávez León 1983; Navarro L. *et al.* 1990). This wildlife reserve could be developed in cooperation with the various communities in the region that have created forest reserves. At Ejido Nueva Guadalajara, for example, residents have established the "La Lucha" Forestry Reserve (6,000 ha).

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Authors' Addresses:

Alvaro del Campo Parra Lara, Centro de Investigaciones de Quintana Roo, Chetumal, Quintana Roo, Mexico, *Current address:* Corporación Universitaria Autónoma de Occidente, División de Ciencias Básicas, Centro de Investigaciones, Apartado Aéreo 2790, Cali, Valle del Cauca, Colombia.

Jeffrey P. Jorgenson, Department of Wildlife and Range Sciences, Program for Studies in Tropical Conservation, University of Florida, Gainesville, FL 32611-0301, USA. *Current address:* Departamento de Biología, Facultad de Ciencias, Pontificia Universidad Javeriana, Apartado Aéreo 56487, Santa Fé de Bogotá, DC, Colombia.

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Distribution and Status of the Primates of Guatemala

Gilberto Silva-López[1], Johanna Motta-Gill[2] and Alonso I. Sánchez-Hernández[1]

[1]*Programa Bioconservación, Instituto de Investigaciones Biológicas, Universidad Veracruzana, Veracruz, Mexico*
[2]*Instituto Tecnico de Capacitación y Productividad, Departamento Pecuario, Guatemala, Guatemala*

Introduction

A survey of the status of the primates of Guatemala was established as a high priority as long ago as 1981, in the Global Strategy for Primate Conservation (Mittermeier and Konstant 1981). Previous studies on some of Guatemala's primates have focused on social (Cant 1978), ecological (for example, Coelho *et al.* 1976), and behavioral aspects (for example, Bolin 1981; Fedigan and Baxter 1984). Other key papers, by Konstant *et al.* (1985) and Horwich and Johnson (1986), provided valuable general information on the distributions of *Ateles geoffroyi vellerosus, A. g. yucatanensis, Alouatta pigra*, and *A. palliata*. However, more specific data, on these and the other two monkeys (*A. g. pan* and *Cebus capucinus*) which are believed to occur in Guatemala, are lacking. In fact, besides Curdts (1993), no attempt had been made to conduct more detailed surveys on the distribution and status in the country's primates. Besides this, very little was known of the factors threatening the primates' natural habitats, such as agriculture, cattle-ranching and forest fragmentation.

In early 1994, supported by NYZS The Wildlife Conservation Society, our team initiated a broad survey of the primates of Guatemala. The aim of the project was to obtain data on the distributions of the primates and their relative abundance, along with a preliminary (direct and indirect) assessment of the types and status of their habitats. Information on land-use practices threatening the natural areas in which primates occur was also obtained.

Methods

The survey involved: (1) intensive broad surveys in the field, including: (a) forest censuses of up to 25 km, (b) surveys by boat, and (c) surveys by car on the perimeter and along secondary roads of the areas under study; (2) interviews with locals, including: (a) guides, (b) peasants and their families, (c) tourist guides, and (d) owners of restaurants and other tourist facilities; (3) visits to governmental and non-governmental organizations. In the last case, our visits to these organizations included the search for bibliography and documentary information, as well as interviews. The documents reviewed included such as human population censuses and maps. Interviews were oriented toward three main issues: (1) the organization's current activities and plans, (2) research and/or environmental education involving primates and other wildlife, and (3) collaboration and links with other institutions.

Guatemala

Guatemala, with its 108,889 km², is one of the largest countries in Central America. More than half of Guatemala's territory is mountainous, which contributes to the country's enormous range of environments, and the occurrence of a remarkable biodiversity (Lara 1993).

The country's growing economy is largely based on agriculture and natural resources. According to FUNDESA (1992), Guatemala's Foundation for Development, for example, of the top 25 export products in the period 1990-1991, 11 were agricultural in origin. In addition to agriculture, hunting, forestry and fishing produced revenues representing almost 26% of the Gross National Product (GNP). This figure surpassed the period's GNP figures for commerce (24.5%), manufacture (15.2%), and other economic activities.

Tourism rivals agricultural activities as the main source of revenue. According to the Guatemalan Institute of Tourism (INGUAT 1992, in FUNDESA 1992), income from tourism in the period 1987-1991 was second only to coffee, with sugar, bananas, meat, cardamom, and cotton close behind. Tourism is closely dependent on the country's natural resources, which include beautiful lakes (for example, Atitlán and Izabal), magnificent natural landscapes (for example, Sierra de las Minas and El Petén region), and fantastic archeological sites surrounded by tropical forests, such as that at Tikal, and perhaps the most notable, that of the Ruta Maya (Garred 1989).

Guatemala's demographic growth rate is the second highest in Central America. According to the population projection made by the National Institute of Statistics (INE 1991), the total population of Guatemala in 1994 was estimated at 10,322,011 inhabitants, a figure that will increase to more than 12.2 million by the year 2000 (FUNDESA 1992). In terms of the country's population density, the figures will increase from 94.79 inhabitants/km² to 112.24 in-

habitants/km² in the same period. Approximately one fifth of Guatemala´s population lives in the Department of Guatemala.

Guatemala's population is predominantly rural. Approximately two-thirds of Guatemala's citizens live in the country. Only the departments of Guatemala and Sacatepéquez have a larger urban than rural population. In the remaining 20 departments, the rural population is significantly larger ($p>0.05$) than that in the cities.

Biodiversity and Forest Cover

The tropical forests still remaining in Guatemala are considered a critical habitat for endemic and threatened species. Most of these forests are located in the Department of El Petén and in part of the central plateau. The forests of the highlands (Sierra de los Cuchumatanes, Sierra del Merendón, Cerro San Gil, Sierra de las Minas, and Sierra de Santa Cruz) are important centers of endemism for both plants and animals.

Guatemala is one of Mesoamerica's most important nations in terms of its biological diversity. Its wildlife, for example, is the most diverse of Central America (around 1,500 species), including a number of endemic vertebrates, and is second only to Costa Rica in that category. According to Lara (1993), figures include: 270 freshwater fish species (27 endemic), 112 amphibian species (40 endemic), 214 reptile species (15 endemic), 675 bird species (five endemic and 134 migratory species), and 184 mammal species (four endemic). Guatemala´s flora is also very important as the source of many domesticated foods and fibers, including wild varieties of such as maize, tomatoes, red beans, cotton, papaya, and cocoa. In addition, together with Costa Rica, Guatemala´s broad leaf forests are the most diverse in Central America, including 17 coniferous species, 450 broad leaf tree species, and 527 orchid species (Lara 1993).

Unfortunately, the number of threatened species is also significant. It has been estimated, for example, that 133 wildlife species are endangered, and 12 broadleaf forest plant species are listed in the CITES appendices, including such as *Abies guatemalensis, Cattleya skinneri*, and *Swietenia humilis*. On many fronts, Guatemala is not achieving a harmonious balance between conservation and development and, if present factors threatening the country's biological richness and natural resources continue operating, the costs of economic growth will be very high. A different approach to the problem can be derived from the examination of the nation's forest cover.

According to Ponciano (1979), forests covered 28,796 km² or 27.1% of the area of the country in the period 1974-1976. In his study, in which wetlands and semi-arid zones were excluded, Ponciano included approximately 2,800 km² of cultivated areas, most of which were coffee plantations with shade-trees. Excluding these areas, the actual figure is reduced to 25,996 km², or 24.44% of the country. Ponciano's data also show that percentage of forest cover in each department varies from 5.46% (in Jutiapa) to 46.40% (in Alta Verapaz), with a mean of 21.96%. Thirteen departments have a percent of forest cover larger than the mean, but the figure is significantly larger ($p>0.05$) in only two cases (Sololá and Alta Verapaz). Surprisingly, in the period under consideration, forests covered only 22.7% of El Petén, the largest department in the country, and one of the most important forest areas of the Mundo Maya. On the other hand, they covered 45.24% of Sololá, one of Guatemala's smaller departments. In order to examine further forest cover and its potential relationships to other characteristics of the departments, we applied the Spearman rank correlation coefficient with a number of other developmental parameters. The tests showed there is insufficient evidence to conclude that the percentage of forest cover is positively correlated with any of the following: area, population density, rural population, and urban population ($r_s < r_{22,0.05}$). In other words, the available data suggest that the extent and distribution of the forests still remaining in Guatemala are not related to the size of the departments in which they are found nor are they influenced evidently by any of the population parameters examined.

Today, less than 45,000 km² of forest cover remains in Guatemala, about 40% of the original extent (Houseal 1988; see also Nations 1988). The country's population is expanding at an annual rate of 3.1%, while the deforestation rate exceeds 90,000 hectares per year. As a result, and as noted by Houseal (1988), natural ecosystems are being degraded, important habitats are being lost, and numerous species are faced with extinction. It seems clear that Guatemala needs firm and decisive action to ensure the sustained management of its natural resources and biodiversity, which constitute the basis of the nation's economic growth.

The Database

Encounters with monkeys were classified according to four types of sources. **Source Type 1** includes our encounters with primates in the field. **Source Type 2** includes information from the available literature, either published or in the form of field reports. **Source Type 3** includes verbal information from professional observers, such as local scientists, institution staff with experience in the field, and field researchers of NGOs and "guarda recursos" (wildlife guards)". **Source Type 4** includes verbal information recorded in interviews with guides, peasants, and local inhabitants and their families.

Information from these source types was recorded in a database. The complete list of sources is provided separately (Appendix). For each record, the respective row in the database includes information on the: **Genus** (*Alouatta* or *Ateles*), **Species** (*palliata, pigra* or *geoffroyi*), **Department** (e.g., Huehuetenango), **Municipio** (e.g., Barillas), **Locality** or site (e.g., Barillas), **Distance** from a reference point, **Dir** or direction from a reference point, **Reference point** (e.g., a city, a park), **Lat D** or latitude in degrees, **Lat M** or latitude in minutes, **Long D** or longitude in degrees, **Lat M** or longitude in minutes, **Altitude**, **Vegetation** (e.g., TF = tropical rainforest, STWF = subtropical wet forest), **Type of source**, **Source** number, and **Year** of the source.

Due to the width of the data columns (occupying two pages for every row of a record), we also include a reference number (**Ref. No.**). In some cases, we found that two or more sources were referring to the same species and site or **locality**. In such cases, we included all the available information in separate rows. In most cases, data on the **site** were complemented with information obtained from the *Mapa Hipsométrico de la República de Guatemala* (IGM 1989), and from the maps of La Libertad (IGM 1959), Puerto Barrios (IGM 1963), Río Polochic (IGM 1966), and Tikal (IGM 1977), all of which were prepared by Guatemala's Military Geographical Institute (IGM). Altitudinal records were

based on the maps.

A total of 106 reference numbers are included in the database. They belong to 39 different sources (see Appendix), with data ranging from the years 1976 to 1994. The database will become larger as the research on the distribution and status of Guatemala's primates progresses. However, we consider it to be a good starting point for some general guidelines for the conservation of the country's primates.

Records and Comments

Alouatta palliata

Howling monkeys, *Alouatta palliata*, were recorded on 21 occasions (reference numbers 1-21). We were not able to observe this species in the wild, however descriptions regarding the species' pelage color, external characters, vocalizations, group size, habitat, and dietary habits tend to confirm its presence in the registered sites. From the total, 12 records belong to source type (ST)-2, 7 to ST-3, and 2 to ST-4. The species was recorded in five regions, including three records from Region III (Departments of Huehuetenango and San Marcos), three records from Region IV (Department of Baja Verapaz), one record from Region V (Department of El Petén), 10 records from Region VI (Department of Izabal), and four records from Region VII (Departments of Zacapa and El Progreso). Figure 1 shows the sites indicated in our records. In this figure, we also indicate a preliminary delimitation of the species' range in the country according to the distribution and extent of available habitats and vegetation types, altitude, and from records in the available literature.

An examination of altitudinal records suggest that the species may be found between 10 and 2,700 m above sea level (Fig. 2). We know of no studies indicating the presence of this species at altitudes above 1,200 m (see Silva-López *et al.* 1988; Neville *et al.* 1988), and *A. seniculus* would appear to be the only howler species inhabiting high altitudes (see the review by Neville *et al.* 1988.). However, as we observed during the field research, high elevations are, in most cases, accompanied by considerable variation in terrain. Dells, gorges, and ravines are a common feature of the landscape in mountainous areas. Climate and vegetation may vary considerably even over short distances in such places, and may favor the occurrence of a suitable habitat for the monkeys. Further research will confirm the monkeys' presence in these high altitude sites.

Figure 1. Records on *Alouatta palliata* (see data on the reference number in database). Dashed lines: preliminary delimitation of the species' distribution in Guatemala.

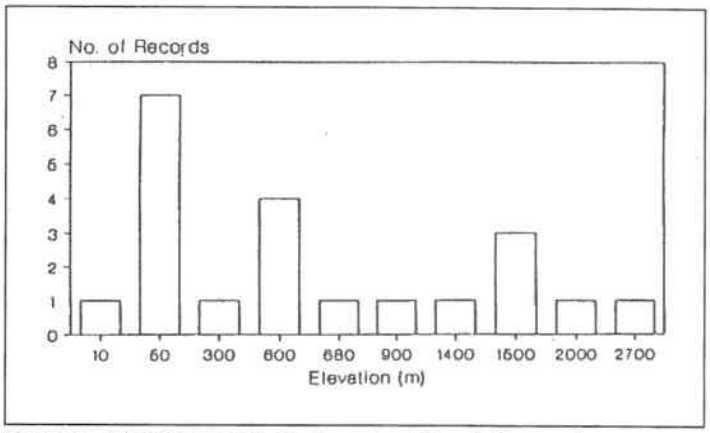

Figure 2. Altitudinal records on *Alouatta palliata* in Guatemala.

Vegetation records suggest the species can be found in two main, broadly described, vegetation types: the tropical evergreen rain forest (TF) and the subtropical wet forest (STWF). In general, due to Guatemala's mountainous relief, most natural areas include a mixture of species from Nearctic and Neotropical origin. It is not unusual, for example, to observe *Pinus caribbea, Pinus oocarpa* or *Quercus* spp. alongside *Ficus* spp. and *Terminalia amazonia*. *Brosimum alicastrum* and *Spondias mombin*, two of the howlers' preferred food items, were common in many localities.

According to our records, *Alouatta palliata* occurs in five protected areas of Guatemala: the Biotopo Cerro Cahuí, the Biotopo Chocón Machacas, the Biotopo Mario Dary Rivera, the Sierra de las Minas Biosphere Reserve, and the Río Dulce National Park, as well as one proposed protected area (Cerro San Gil). It might also be present in the Biotopo San Miguel la Palotada. However, monkeys are facing serious threats in some of these areas.

In the areas surrounding, and in some cases within, these protected areas, monkeys are hunted for meat. The presence of an active pulp processing factory in the vicinity of the Mario Dary Rivera is also causing serious deforestation. Furthermore, agricultural practices in the areas surrounding reserves are causing severe fragmentation of the forests, which threaten to isolate them completely.

In the locality of Finca Trinidad, in the westernmost portion of Sierra de las Minas Biosphere Reserve, a three-year old sawmill is also causing the destruction of a large area of forest, although measures are now being taken to stop the sawmill activities. In the locality of Vista Hermosa, also in the Sierra, the human population is expanding at an alarming rate and is becoming a serious threat to the preservation of the howlers' habitat. The Sierra de las Minas Reserve is, however, the largest in Guatemala and includes other localities, such as the Volcán del Mono, in which the habitat is still well preserved.

In the sites located along the Río Dulce National Park, i.e., the Turicentro Marimonte, and the Río Bonito, agricultural practices are also acting as powerful fragmenting forces. However, the recent proposal of ecotourism projects might reverse the economic situation for the local communities, which in turn may help to protect the forests still remaining. If not properly monitored, however, tourist activities along the river margins may become another important source of threat to the habitat.

Alouatta palliata also occurs in several non-protected areas of Guatemala and its situation in such areas may be summarized as follows: (1) little is known of the monkey's status at Barillas (at northeast of Huehuetenango), but our records indicate that they are hunted as a source of meat by the guerrillas; (2) the recent arrival of colonizers at Crique Grande and Finca La India (in the Motagua Valley), probably from the heavily deforested Río Negro area (another locality in which *palliata* has been recorded), indicates a source of potential threats to the habitat and to the monkeys; the protection of the area may be very important in terms of watershed preservation.

This summary of observations and records, which is presented in detail in the report by Silva-López *et al.* (1995), suggests that the main threats to *Alouatta palliata* are hunting, habitat fragmentation, and deforestation. The habitats and the populations of this species have been severely fragmented, occupying an area no larger than 10,000 km². However, although we believe the status of the species might be considered as 'Vulnerable', the available data provides insufficient evidence to assign the species to any of the IUCN threatened categories (IUCN 1994). The main value of this report on *Alouatta palliata*, however, is that it provides an indirect assessment on the species distribution and population status.

Alouatta pigra

The Guatemalan black howling monkey, was recorded 50 times

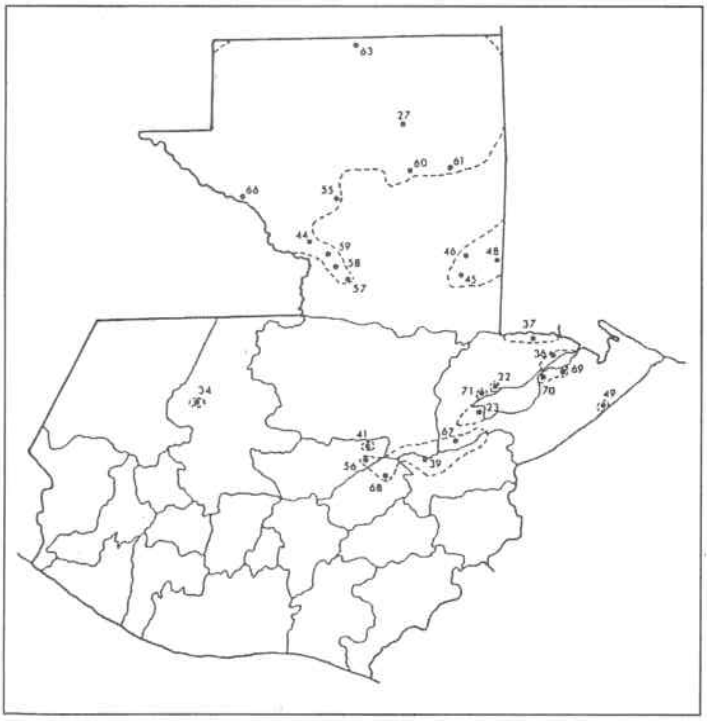

Figure 3. Records on *Alouatta pigra* (see data on the reference number in database). Dashed lines: preliminary delimitation of the species' distribution in Guatemala.

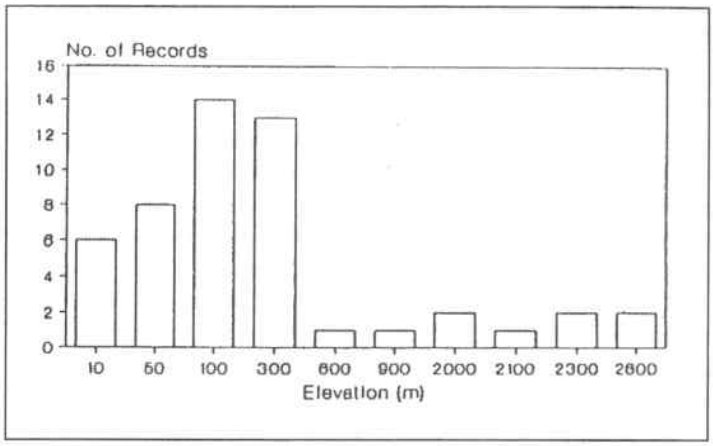

Figure 4. Altitudinal records on *Alouatta pigra* in Guatemala.

(reference numbers 22-71), with nine records from the ST-1, 18 from ST-2, 20 from ST-3, and three from ST-4. The species was recorded in five regions, including five records from Region IV (Departments of El Quiché, Baja Verapaz and Alta Verapaz), 26 records from Region V (Department of El Petén), 17 records from Region VI (Department of Izabal), and two records from Region VII (Departments of Zacapa and El Progreso). Records of *A. pigra* are indicated in Figure 3, which also shows our proposal for the species' distribution in the country.

An examination of the altitude records suggests that *A. pigra* may be found between 10 and 2,800 m, but prefer elevations at or below 300 m (Fig. 4). In fact, only nine of our 50 records indicate the presence of *A. pigra* at altitudes above 300 m. Horwich and Johnson's (1986) paper on the geographical distribution of *A. pigra* states that "All sites and probable sites of *A. pigra* were noted to be under 1,300 ft in altitude (approximately 397 m)..." which reflects well our findings. Most records on Guatemalan black howlers above 300 m were obtained from Curdts (1993). The species' preferred habitats are the high evergreen rain forest and the subtropical wet forest. We made detailed observations of the species at three localities: Bocas del Polochic and El Boquerón, both located on Lake Izabal, and at the National Park of Tikal.

Our records indicate that *A. pigra* is present in seven protected areas: Aguateca and Dos Pilas (two archaeological sites), the Biotopo Chocón Machacas, the Biotopo Mario Dary Rivera, the Sierra de las Minas Biosphere Reserve, the Maya Biosphere Reserve, and the Río Dulce National Park. They might also be present at the Biotopo San Miguel La Palotada. As in the case of *A. palliata*, the black howlers and their habitat are facing serious threats in the vicinities of these protected areas. We have already commented on the threats at the Biotopo Mario Dary Rivera, at the Finca Trinidad (in the Sierra de las Minas), and at the Río Dulce National Park.

In Aguateca and Dos Pilas, the lack of vigilance along with agricultural activities around the perimeter of the archeological sites constitute the main threats to the habitat of the monkeys.

Agricultural activities are rapidly fragmenting the habitat at Campamento Río Zarco (in the Sierra de las Minas' buffer zone) and around the Biotopo Chocón Machacas, which has also been damaged by forest fires and hunting.

It is possible that the Volcán del Mono, in Sierra de las Minas, and El Mirador, in the Maya Biosphere Reserve, are among the best preserved localities.

It seems clear that the future of the black howler and its habitat in these protected areas may depend on the establishment of long-term measures to ensure the protection (and/or restoration) of the natural areas surrounding the reserves. Such measures may depend on regional, socio-economic studies, which would contribute to create a balance between economic development and the conservation of biological diversity. Likewise, more systematic and intensified environmental education programs must be set up, focused particularly on local communities.

In unprotected areas, localities such as Bocas del Polochic, Cerro Caral, Dolores, Machaquilá, and Manos Unidas, are experiencing the negative impact of forest fragmentation due to intense agricultural activity. In some cases, such as in Bocas del Polochic and the south of El Petén, the numerous rivers can be used to promote importance of the areas for watershed protection. In some others, the development of low-impact tourist projects (such as the one promoted by Pro-Petén and Conservation International in the Cooperativa Betheel, west of El Petén), may represent the most promising alternative.

Our records suggest that *A. pigra* is one of Guatemala´s more widely distributed primate species. The available data on its distribution and status suggest that its status may be considered as Low Risk, according to IUCN (1994). However, its situation in both protected and non-protected areas emphasizes the need to conduct more detailed surveys on the extent of the habitat available for the monkeys.

Ateles geoffroyi

Spider monkeys were recorded 34 times (reference numbers 73 to 106), with 10 records from ST-1, seven from ST-2, 12 from ST-3, and five from ST-4. The species was recorded in three regions, including 26 records from Region V (Department of El Petén), five from Region VI (Department of Izabal), and three from Region VII (Department of Zacapa). Figure 5 shows the localities, and our proposal regarding the species' distribution in the country.

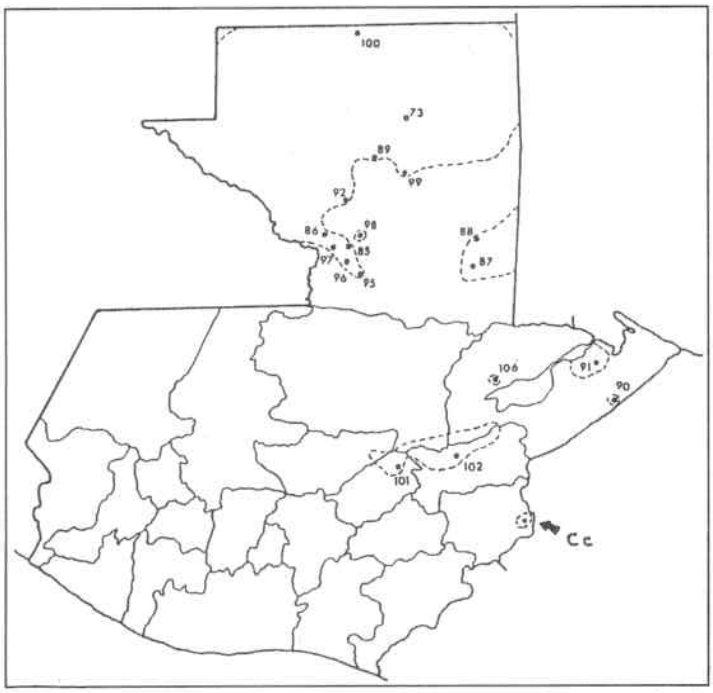

Figure 5. Records on *Ateles geoffroyi* (see data on the reference number in database). Dashed lines: preliminary delimitation of the species´ distribution in Guatemala. Cc: probable site of ocurrence of *Cebus capucinus* in Guatemala.

The records indicate that the species can be found at altitudes between 100 and 2,000 m, but it seems to be most abundant between 100 and 300 m (Fig. 6). Van Roosmalen and Klein (1988), Konstant *et al.* (1985), and Eisenberg (1989), among others, do not provide details on the altitudinal range of the species. Bernstein *et al.* (1976) studied *Ateles geoffroyi* in Colombia at altitudes of between 100 to 400 m, and Silva-López (in press; Silva-López *et al.* 1988) has indicated that it has been recorded at altitudes of between 50 and 1440 m in Mexico.

In Guatemala, the spider monkeys inhabit the high evergreen rain forest of El Petén and Izabal. In Zacapa, where the species was recorded above 1,800 m, the tropical rain forest habitat of the spiders formed part of a complex mosaic of vegetation associations, including coniferous forest and pine forest. We observed the spider monkeys at the National Park of Tikal and made several observations on their habitat at other localities (Silva-López *et al.* in prep).

Our records indicate that *Ateles geoffroyi* occurs in six protected areas including the Biotopo Cerro Cahuí, the archeological site of Ceibal, The Maya Biosphere Reserve, the National Park of Tikal, the Biotopo San Miguel La Palotada, and the Sierra de las Minas Biosphere Reserve. It might also occur in the proposed protected area of Cerro San Gil. The habitat of the monkey is well preserved at El Mirador (in the Maya Reserve), Tikal, the Volcán del Mono and the Finca Alejandría (in the Sierra), and the Cerro San Gil. However, agricultural activities and the extraction of forest products threaten the integrity of the Biotopo Cerro Cahuí, and at Ceibal the monkeys are hunted for meat, or captured for the pet trade.

Outside the protected areas, agricultural activities are fragmenting forests at Cerro Caral (on the Guatemala-Honduras border) and to the south of El Petén. Hunting, on the other hand, is the main threat to spider monkeys at Petexbatún, also to the south of El Petén. Keeping in mind the need to make a direct assessment of spider monkey populations in these sites, and taking into account that the species can be found in several protected areas, we consider that *Ateles geoffroyi* should be considered as a Vulnerable species in Guatemala, according to the criteria provided IUCN/SSC (1994).

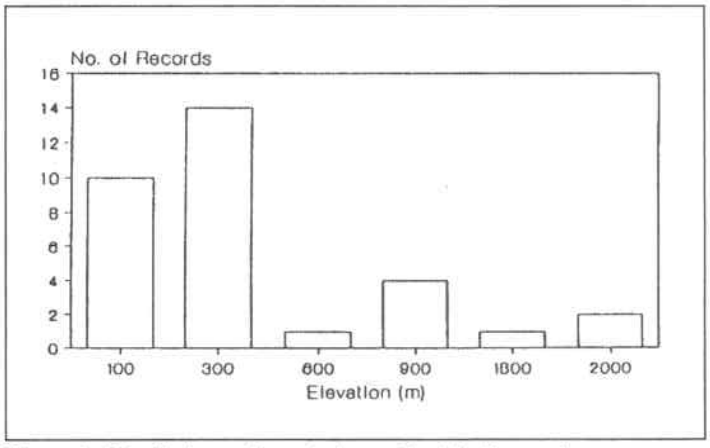

Figure 6. Altitudinal records on *Ateles geoffroyi* in Guatemala.

Cebus capucinus

Our survey provided insufficient information to confirm that *Cebus capucinus* occurs in Guatemala, and we were unable to obtain any firm data on its distribution.

According to Freese and Oppenheimer (1981), the species "...occurs in Central America, ranging from at least as far north as Belize (Hollister 1914) to extreme northern Colombia." It has been studied in Costa Rica (e.g., Fedigan *et al.* 1985; Fishkind and Sussman 1987; Lippold 1989; Chapman *et al.* 1989) and Panama (e.g., Oppenheimer 1968; Baldwin and Baldwin 1972, 1976; Milton and Mittermeier 1977).

It is still not known if *Cebus capucinus* occurs in Belize. Dahl (1984) reported that "A good account of *Cebus* was also obtained north of Chiquebul, but these monkeys have yet to be reported in either the Chiquebul or Bladen areas." The probable presence of *C. capucinus* in Belize was again discussed by Hubrecht (1986), who attempted to verify the report of McCarthy (1982). Hubrecht (1986) noted that "No confirmed sighting [of *C. capucinus*] was made" and, after referring to one venturer's probable sighting, he ended up by stating that "...the fact that only one individual was seen does cast doubt on the observation." Dahl (1987) also stated that "Despite numerous informants' enthusiastic reports of 'white-faced monkeys', there was no evidence of *Cebus capucinus limitaneus*, and careful cross-examinations indicated their sightings were clearly suspect." Likewise, concerning the report by McCarthy (1982), he wrote that "...his claim could not be sustained despite surveys in [the Chiquebul and Bladen areas]."

The situation is quite similar in Guatemala. In the classic text of Napier and Napier, *A Handbook of Living Primates* (1967), *Cebus capucinus* was indicated as the "...most northerly species [of the *Cebus* group]...found in Honduras, Lat. 16° N ...". However, the parallel referred to does not pass through Honduras, crossing instead Guatemala, to the south of El Petén. While in Guatemala, several of our informants told us of the probable presence of capuchins in several localities, but none of them had actually seen the monkeys. Jack Bucklin from the non-governmental organization FUNDAECO, for example, told us he is sure capuchins occur in the Sierra del Espíritu Santo, in the Guatemala-Honduras border, but that he had never actually contacted the species in the area (Fig. 5). We saw them among the primates displayed at La Aurora Zoo, in Guatemala City. However, Lorena Calvo, the former director of the zoo, told us the origin of these animals was unknown.

From our point of view, the available evidence from Belize and Guatemala, plus the lack of studies at El Salvador, Honduras, and Nicaragua, cast doubts on the species' geographical range north of Costa Rica considered until now. Under any circumstances, *Cebus capucinus* is one of the species in need of extensive field work in Central America.

Communities and ecosystems

Guatemala still has remarkably large areas covered by tropical and subtropical forests (Silva-López *et al.*, in prep.). Of special importance are the tropical communities and ecosystems of the Sierra de las Minas Biosphere Reserve, the Mundo Maya Biosphere Reserve, the Biotopo Chocón Machacas, the Biotopo San Miguel La Palotada, the forest of Cerro San Gil and Montañas del Mico, the forest located between the Quebrada Creek and the Sarstùn River's delta, and the wetlands of Bocas del Polochic and the Motagua Valley.

In most of the localities outside these areas, the tropical communities have been severely disturbed due to the impact of human activities - agriculture, cattle-raising, and forest exploitation. From our perspective, action in these localities must include detailed agro-ecological and socio-economic diagnoses at the regional level, which will help to contextualize what is happening in the fragmented forest areas still remaining (additional suggestions by Silva-López *et al.* [1993] are also applicable to this situation).

Recommended Conservation Action

General Recommendations

As in the *Action Plan for African Primate Conservation* (Oates 1986), two different kinds of action are needed if effective conservation measures are to be achieved in Guatemala: (1) More specific surveys are needed in many of the localities included in our report, where the status of primates and their habitat is still unclear. Surveys must produce recommendations for further conservation action at the micro-region level: (2) The establishment of new protected areas and the effective vigilance and management of existing protected areas deserve the highest priority. Action of this sort must include a strong component on the reserves' significance for regional development, as well as intensive and long-term, environmental education campaigns. These two kinds of action can be complemented by: (3) Studies at a national/regional level, supported by the available technology (for example, remote sensing and information retrieval systems), aimed to produce databases which may help studies and conservation-oriented activities in the field.

Identification of Projects Needed for the Conservation of Biological Diversity

1. Estimation of forest cover in Guatemala using remote sensing techniques (after Ponciano 1979).
2. Estimation of deforestation rates and causes of forest fragmentation at: (a) Sierra del Espíritu Santo, (b) Sierra del Merendón, (c) Sierra de Santa Cruz, and (d) south of El Petén.
3. Reforestation with useful, fast-growing, native tree species at: (a) Sierras del Espíritu Santo, El Merendón, and Santa Cruz, and (b) Río Negro and the Motagua Valley.
4. Development of productive alternatives to diversify current agricultural practices at: (a) areas surrounding the reserves, biotopos, and archeological sites, (b) the Motagua Valley, (c) the south of El Petén, (d) the Sierras of Espíritu Santo, Santa Cruz, and El Merendón. (The experience obtained by FUNDAECO's forestry technicians working in the peasant communities of Cerro San Gil can be very useful to define approaches to develop these kind of alternatives).
5. Assessment of the impact of subsistence hunting at: (a) Cerro San Gil and Montañas del Mico, (b) Sierra de las Minas, (c) the Río Sarstùn-Quebrada Creek area, (d) the tropical forest of the north of Huehuetenango and San Marcos, and (e) the south of El Petén.

6. Inventory and exploitation rates of tree species used as sources of wood and firewood at: (a) Río Dulce National Park, (b) Cerro San Gil and Montañas del Mico, (c) Volcán Tajumulco, and (d) Volcán Tacaná.
7. Systematic evaluation of the impact of tourist activities at Río Dulce National Park, and the promotion of low-impact tourist programs (Pro-Petén's low impact tourist project at Cooperativa Bethel can be used as a source of ideas to develop this type of programs at other sites).
8. Watershed protection feasibility studies at: (a) Bocas del Polochic, (b) the Motagua Valley, and (c) the area of Río La Pasión.

Primate Surveys

Priority regions and specific localities recommended for detailed surveys on primate populations and their habitat are listed below. We do not include localities belonging to protected areas, nor localities in which surveys involving primates are currently being conducted, in either a direct (such as in Bocas del Polochic) or indirect way (for example field reports from El Petén by Julio Morales).

Region III: Western Highlands - Barillas, Volcán Tajumulco and Volcán Tacaná.

Region IV: Northern Highlands - Aldea Juil, Aldea Chelemhá, Chilascó, Vista Hermosa.

Region V: El Petén - Aldea El Zapote and Ixlú, El Mirador and San Antonio, La Libertad.

Region VI: Izabal - El Boquerón and Sierra de Santa Cruz, Cerro Caral and Sierra del Merendón, Río Negro, Crique Grande, and Finca La India, Río Sarstún.

Region VII: Eastern Plains - Sierra del Espíritu Santo.

In addition to these projects, it is necessary to emphasize the need to continue studies on the taxonomic status of Guatemala's spider monkeys. The intended genetic study on the spiders by JMG and our field observations on the color patterns of *Ateles geoffroyi* in three countries (Silva-López *et al.* 1996) suggests this research is eminently important.

Concluding remarks

Most of Guatemala's research institutions and NGO's are already involved in different conservation-oriented projects. Their experience, many of which are condensed in this report, can and must be used to promote collaborative conservation efforts , such as the environmental education campaign carried out by Defensores de la Naturaleza and FUNDAECO at Puerto Barrios, Department of Izabal. However, the need to train local researchers, students, and administrators interested in primate conservation must be recognized as a priority goal in Guatemala. Our original proposal identified this need, although local and logistic problems have made it impossible as yet to conduct our intended course on "Basic Techniques for the Study of Primates and Primate Habitat". We strongly recommend the development of courses of this sort, as well as the enrollment of local people in graduate programs from the Universidad de San Carlos de Guatemala and foreign universities, both of which deserve the highest attention and support.

Our experience suggests that, when management plans for a proposed reserve have been properly presented, the Honorable Congress of the Republic of Guatemala has provided the necessary endorsement for them (see, for example, Defensores de la Naturaleza, 1990). In doing so, the Congress is not only helping to conserve the country's remarkable biological diversity, but, as Lara (1993) has pointed out, is also contributing to the well-being of the millions of Guatemalan citizens that directly or indirectly depend on natural resources and Guatemala's rich biodiversity. However, conservation initiatives must take into account the fact that, although the establishment, proper management and protection of reserves are among the best means to preserve and maintain biological diversity, there are other ways in which the Congress can support and stimulate conservation action. Justification of the need to provide fiscal incentives to private landowners to stop the clearing of the forest for extensive cattle-raising, the need to regulate strictly the activities of sawmills and the use of pesticides, and the promotion of productive reforestation programs (involving local communities) with native tree species are but a few of the conservation measures for which the support and endorsement of the Congress are required.

Support from NYZS The Wildlife Conservation Society has given us the chance to contribute to the goals of the World Conservation Union (IUCN 1994), by conducting direct and indirect assessments of three primate species and their habitat in several geographic regions of Guatemala in which they are known to occur. Most assuredly, the primates also occur in other regions and localities in the country. We believe that our database will be of immediate use to orient research and conservation initiatives involving primates and their habitat in this Central American country.

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Authors' Addresses:

Gilberto Silva-López, Programa Bioconservación, Instituto de Investigaciones Biológicas, Universidad Veracruzana, Apartado Postal 294, Xalapa, Veracruz 91000, México.

Johanna Motta-Gill, Instituto Tecnico de Capacitación y Productividad, Departamento Pecuario, Calle Mateo Flores 7-51, Zona 5, Guatemala, Guatemala.

Alonso I. Sánchez-Hernández, Programa Bioconservación, Instituto de Investigaciones Biológicas, Universidad Veracruzana, Apartado Postal 294, Xalapa, Veracruz 91000, México.

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Appendix

The Primates of Guatemala - Database

Source Type 1 (1 source)
1. Field observations

Source Type 2 (11 sources)
2. Bolin (1981), 3. Brown (1993), 4. Cabrera (1994), 5. Cant (1978), 6. Coelho *et al.* (1976), 7. Curdts (1993), 8. Horwich (1983), 9. Horwich and Johnson (1986), 10. Morales (1994), 11. Pérez (1987), 12. Villar (1994)

Source Type 3 (21 sources)
13. José Gilberto Barrera Fuentes, Forestry Technician, Centro de Estudios Universitarios Nor-Occidente, Universidad de San Carlos de Guatemala. Huehuetenango, Huehuetenango, Guatemala.
14. Santiago Billy, Advisor, Conservation International. Flores, Petén, Guatemala.
15. Jack Bucklin, Researcher, FUNDAECO. El Estor, Izabal, Guatemala.
16. Dr. Lorena Calvo, Researcher-in-charge, WPTI-Guatemala. Guatemala City
17. Meregildo Casiano, Inhabitant of Aldea Las Brisas, Resource keeper and collaborator of FUNDAECO for the establishment of Cerro San Gil´s Reserve. Izabal, Guatemala.
18. Biologist José Antonio Castillo, Researcher, Pro-Petén. Flores, Petén, Guatemala.
19. Licenciado Marco Vinicio Cerezo Blandón, Director General, FUNDAECO, Guatemala City.
20. Miss. Teresita Chinchilla, Coordinator for Enviromental Education, CARE. Flores, Petén, Guatemala.
21. Biologist Enrique Coronado, Researcher, CECON, Universidad de San Carlos de Guatemala. Guatemala City.
22. Sergio Dionisio, Forestry Technician, Defensores de la Naturaleza. Guatemala City.
23. Carlos Estrada, Forestry Technician, Centro de Estudios Universitarios Nor-Occidente, Universidad de San Carlos de Guatemala. Huehuetenango, Huehuetenango, Guatemala.
24. Tim Harper, Peace Corps. Chilascó, Baja Verapaz, Guatemala.
25. Dr. Daniel Irwin, Researcher, Pro-Petén. Flores, Petén, Guatemala.
26. José C. Méndez Montenegro, Resource keepers´ Supervisor, Sierra de las Minas Biosphere Reserve, Defensores de la Naturaleza. Finca Trinidad, El Progreso, Guatemala.
27. Renato Morales, Forestry Technician, Centro de Estudios Universitarios Nor-Occidente, Universidad de San Carlos de Guatemala. Huehuetenango, Huehuetenango, Guatemala.
28. Dr. Oscar Murga, Director, ARCAS. Flores, Petén, Guatemala.
29. For. Ing. Oscar Nuñez, Director, Sierra de la Minas Biosphere Reserve, Defensores de la Naturaleza. Guatemala City.
30. Luis Oliveros, Resource keeper, National Park of Tikal. Tikal, Petén, Guatemala.
31. Biologist Sergio Pérez, Researcher, CECON, Universidad de San Carlos de Guatemala. Guatemala City.
32. José Ricardo Pérez Méndez, Resource keeper, Sierra de las Minas Biosphere Reserve, Defensores de la Naturaleza. Finca Trinidad, El Progreso, Guatemala.
33. Scott Wilbur, Researcher, The Nature Conservancy. Flores, El Petén, Guatemala

Source Type 4 (6 sources).
34. Jorge Mario Cordón Marroquín, Inhabitant of San Lorenzo, Zacapa, Guatemala.
35. Alejandro Dubua, Inhabitant of San Felipe, Izabal, Guatemala.
36. Rosendo Ponce, Inhabitant of El Estor, Izabal, Guatemala.
37. Teodoro Ponce, Inhabitant of El Estor, Izabal, Guatemala.
38. Isaias Ramos, Inhabitant of El Estor, Izabal, Guatemala.
39. Hugo Ramos, Inhabitant of El Estor, Izabal, Guatemala.

Localities - The Primates of Guatemala - Database

Alouatta palliata

1. San Felipe, Reserva Marimonte, municipality of Puerto Barrios, Department of Izabal, 0.5 km N, 15°40'N, 89°00'W, altitude 50 m, tropical forest. Source type 2, Source 3, 1993.
2. Río Dulce National Park, Reserva Marimonte, municipality of Livingston, Department of Izabal, altitude 50 m, tropical wet forest. Source type 2, Source 3, 1993.
3. Puerto Barrios, Finca La Inca, municipality of Puerto Barrios, Department of Izabal, 25 km E, 15°42'N, 88°20'W, altitude 50 m, tropical forest. Source type 2, Source 7, 1993.
4. Río Dulce National Park, Crique Grande, municipality of Puerto Barrios, Department of Izabal, altitude 50 m, tropical forest. Source type 2, Source 7, 1993.
5. Park area, Río Dulce, municipality of Puerto Barrios, Department of Izabal, altitude 50 m, tropical forest. Source type 2, Source 7, 1993.
6. Border with Honduras, Sierra del Merendon, municipality of Puerto Barrios, Department of Izabal, altitude 680 m, tropical forest, Source type 2, Source 7, 1993.
7. Border with Honduras, Sierra del Espiritu Santo, municipality of Puerto Barrios, Department of Chiquimila, altitude 1400 m, subtropical wet forest, Source type 2, Source 7, 1993.
8. Puerto Barrios, Río Negro, municipality of Puerto Barrios, Department of Izabal, 25 km S, 15°30'N, 88°40'W, altitude 50 m, tropical forest. Source type 2, Source 7, 1993.
9. Livingston, Biotopo Chocon Machacas, municipality of Livingston, Department of Izabal, 20 km W, 15°50'N, 88°50'W, altitude 50 m, tropical forest. Source type 2, Source 11, 1987.
10. La Reforma, Biotopo Cerro Cahui, municipality of Flores, Department of Peten, 10 km W, 17°00'N, 89°13'W, altitude 300 m, tropical forest. Source type 2, Source 11, 1987.
11. San Pedro Carcha, Biotopo Mario Dary Rivera, municipality of San Pedro Carcha, Department of Baja Verapaz, 15 km E, 15°30'N, 90°10'W, altitude 600 m, tropical forest. Source type 2, Source 11, 1987.
12. San Pedro Carcha, Biotopo Mario Dary Rivera, municipality of San Pedro Carcha, Department of Baja Verapaz, 15 km E, 15°30'N, 90°10'W, altitude 600 m, tropical forest. Source type 2, Source 12, 1994.
13. Aldea Las Brisas, Cerro San Gil, municipality of Puerto Barrios, Department of Izabal, 9 km N, 15°40'N, 89°45'W, altitude 900 m, tropical forest. Source type 3, Source 17, 1994.
14. Chilasco, Vista Hermosa, municipality of Purulha, Department of Baja

Verapaz, 20 km NE, 15°20'N, 90°00'W, altitude 600 m, tropical forest. Source type 3, Source 22, 1994.

15. San Lorenzo, San Lorenzo, municipality of Río Hondo, Department of Zacapa, 15 km NE, 15°10'N, 89°40'W, altitude 1500 m, subtropical wet forest. Source type 3, Source 22, 1994.
16. Tajumulco, Volcán Tajumulco, municipality of Tajumulco, Department of San Marcos, 5 km SE, 15°05'N, 91°45'W, altitude 1500 m, tropical forest. Source type 3, Source 29, 1994.
17. Sibinal, Volcán Tacana, municipality of Sibinal, Department of San Marcos, 12 km W, 15°10'N, 92°10'W, altitude 1500 m, tropical forest. Source type 3, Source 29, 1994.
18. Sta. Eulalia, Barillas, municipality of Sta. Eulalia, Department of Huehuetenango, 17 km E, 15°50'N, 91°20'W, altitude 600 m, tropical forest. Source type 3, Source 13, 23, 2, 1994.
19. Finca Trinidad, Finca Trinidad, municipality of San Agustin Acasaguatlan, Department of El Progresso, 5 km N, 15°05'N, 89°57'W, altitude 2700 m, subtropical wet forest. Source type 3, Source 26, 32, 1994.
20. Volcán del Mono, Volcán del Mono, municipality of Río Hondo, Department of Zacapa, 6 km N, 15°07'N, 89°40'W, altitude 2000 m, subtropical wet forest. Source type 4, Source 34, 1994.
21. San Felipe, Río Bonito, municipality of Puerto Barrios, Department of Izabal, 20 km NE, 15°44'N, 89°50'W, altitude 10 m, tropical forest. Source type 4, Source 35, 1994.

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22. El Estor, El Boquerón, municipality of El Estor, Department of Izabal, 10 km NE, 15°35'N, 89°20'W, altitude 50 m, subtropical wet forest. Source type 1, Source 1, 1994.
23. Ensenada Cayo Padre, Bocas del Polochic, municipality of El Estor, Department of Izabal, 1 km SE, 15°27'N, 89°22'W, altitude 10 m, subtropical wet forest. Source type 1, Source 1, 1994.
24. Ensenada Cayo Padre, Bocas del Polochic, municipality of El Estor, Department of Izabal, 1 km SW, 15°27'N, 89°22'W, altitude 10 m, subtropical wet forest. Source type 1, Source 1, 1994.
25. Bocas de Bujajal, Bocas del Polochic, municipality of El Estor, Department of Izabal, 1 km W, 15°27'N, 89°23'W, altitude 10 m, subtropical wet forest. Source type 1, Source 1, 1994.
26. Bocas de Bujajal, Bocas del Polochic, municipality of El Estor, Department of Izabal, 0.5 km S, 15°28'N, 89°23'W, altitude 10 m, subtropical wet forest. Source type 1, Source 1, 1994.
27. Zona Hotelera, Tikal, municipality of Flores, Department of Peten, 1.5 km SW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source1, 1994.
28. Zona Hotelera, Tikal, municipality of Flores, Department of Peten, 1.5 km SW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source1, 1994.
29. Zona Hotelera, Tikal, municipality of Flores, Department of Peten, 2 km NW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source1, 1994.
30. El Estor, El Boquerón, municipality of El Estor, Department of Izabal, 6 km NE, 15°35'N, 89°20'W, altitude 50 m, subtropical wet forest. Source type 1, Source 1, 1994.
31. Park area, Tikal, municipality of Flores, Department of Peten, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 2, 1981.
32. Park area, Tikal, municipality of Flores, Department of Peten, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 6, 1975.
33. El Estor, Bocas del Polochic, municipality of El Estor, Department of Izabal, 10 km SW, 15°20'N, 89°25'W, altitude 50 m, subtropical wet forest. Source type 2, Source 7, 1994.
34. Nebaj, Aldea Juil, municipality of Nebaj, Department of El Quiche, 15 km NE, 15°32'N, 91°050'W, altitude 2600 m, montane tropical forest. Source type 2, Source 7, 1993.
35. Park area, Tikal, municipality of Flores, Department of Peten, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 7, 1993.
36. El Golfete, Biotopo Chocón Machacas, municipality of Livingston, Department of Izabal, N, altitude 100 m, tropical forest. Source type 2, Source 7, 1993.
37. Border with Belize, Río Sarstun, municipality of Livingston, Department of Izabal, altitude 50 m, tropical wet forest. Source type 2, Source 7, 1993.
38. Lake Izabal, Bocas del Polochic, municipality of El Eastor, Department of Izabal, W, altitude 50 m, sutropical wet forest. Source type 2, Source 7, 1993.
39. Zacapa, Cerro Raxón, municipality of Río Hondo, Department of Zacapa, 35 km NW, 15°10'N, 89°40'W, altitude 2600 m, subtropical wet forest. Source type 2, Source 7, 1993.
40. Cobán, Aldea Chelemha , municipality of Cobán, Department of Alta Verapaz, 25 km SE, altitude 2300 m, montane, low, subtropical pluvial forest. Source type 2, Source 7, 1993.
41. Purulha, Biotopo Mario Dary Rivera, municipality of Purulha, Baja Verapaz, S, altitude 2100 m, tropical montane wet forest. Source type 2, Source 7, 1993.
42. Park area, Tikal, municipality of Flores, Department of Peten, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 8, 1983.
43. Border with Belize, Río Sarstun, municipality of Livingston, Department of Izabal, altitude 50 m, tropical wet forest. Source type 2, Source 9, 1986.
44. Sayaxche, Manos Unidos, municipality of Sayaxche, Department of Peten, 10 km W, 16°15'N, 90°15'W, altitude 100 m, tropical forest. Source type 2, Source 10, 1994.
45. Poptún, Machaquila, municipality of Poptún, Department of Peten, 7.5 km N, 16°27'N, 89°27'W, altitude 100 m, tropical forest. Source type 2, Source 10, 1994.
46. Dolores, municipality of Dolores, Department of Peten, 16°31'N, 89°27'W, altitude 100 m, broadleaf forest. Source type 2, Source 10, 1994.
47. Santa Amelia Xutilha, Department of Peten, altitude 300 m, broadleaf forest. Source type 2, Source 10, 1994.
48. Border with Belize, Montañas Mayas, municipality of Poptún, Department of Peten, E, altitude 600 m, tropical forest. Source type 2, Source 10, 1994.
49. Morales, Cerro Caral, municipality of Morales, Department of Izabal, 30 km E, 15°29'N, 88°31'W, altitude 900 m, tropical forest. Source type 3, Source 14, 1994.
50. Coban, Aldea Chelemha, municipality of Coban, Department of Alta Verapaz, 25km SW, altitude 2300 m, montane, low, subtropical, pluvial forest. Source type 3, Source 16, 1994.
51. Dolores, El Chal, municipality of Dolores, Department of Peten, 30 km SW, 16°40'N, 89°40'W, altitude 300 m, tropical forest. Source type 3, Source 20, 1994.
52. El Miguelón, municipality of Dolores, Department of Peten, altitude 300 m, tropical forest. Source type 3, Source 20, 1994.
53. Cooperative La Palma, municipality of La Libertad, Department of Peten, altitude 100 m, tropical forest. Source type 3, Source 20, 1994.
54. San Diego, municipality of La Libertad, Department of Peten, altitude 100 m, tropical forest. Source type 3, Source 20, 1994.
55. La Libertad, municipality of La Libertad, Department of Peten, 16°48'N, 90°05'W, altitude 100 m, tropical forest. Source type 3, Source 20, 1994.
56. Chilasco, Chilasco, municipality of San Jeronimo, Department of Baja Verapaz, 15 km W, 15°10'N, 90°05'W, altitude 2000 m, subtropical wet forest. Source type 3, Source 24, 1994.
57. Sayaxche, Santa Amelia, municipality of Sayaxche, Department of Peten, 35 km SE, 16°20'N, 90°05'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
58. Sayaxche, Aguateca, municipality of Sayaxche, Department of Peten, 15 km S, 16°25'N, 90°12'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
59. Sayaxche, Dos Pilas, municipality of Sayaxche, Department of Peten, 10 km SW, 16°28'N, 90°20'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
60. Flores, Ixlu, municipality of Flores, Department of Peten, 20 km E, 16°57'N, 89°45'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
61. Flores, Aldea El Zapote, municipality of Flores, Department of Peten, 30 km E, 16°55'N, 89°34'W, altitude 300 m, tropical forest. Source type 3, Source 28, 1994.
62. Park area, San Antonio, municipality of Flores, Department of Peten, altitude 100 m, tropical forest. Source type 3, Source 30, 1994.
63. Tikal, El Mirador, municipality of Flores, Department of Peten, 65 km NW, 17°45'N, 89°55'W, altitude 300 m, tropical forest. Source type 3, Source 30, 1994.
64. Park area, Tikal, municipality of Flores, Department of Peten, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 3, Source 33, 1994.
65. El Estor, Bocas del Polochic, municipality of El Estor, Department of Izabal, 10 km SW, 15°27'N, 89°22'W, altitude 10 m, tropical forest.

Source type 3, Source 15, 19, 1994.

66. Sayaxche, Cooperativa Bethel, municipality of Sayaxche, Department of Peten, 85 km NW, 16°50'N, 90°50'W, altitude 100 m, tropical forest. Source type 3, Source 18, 25, 1994.
67. Campamento Río Zarco, Campamento Rio Zarco, municipality of Panzos, Department of Izabal, 15°20'N, 89°35'W, altitude 100 m, tropical forest. Source type 3, Source 21, 31, 1994.
68. Finca Trinidad, Finca Trinidade, municipality of San Agustin Acasaguatlan, Department of El Progreso, 5 km N, 17°05'N, 89°57'W, altitude 2000 m, subtropical wet forest. Source type 3, Source 26, 32, 1994.
69. San Felipe, Río Frio, municipality of Puerto Barrios, Department of Izabal, 15 km NE, 15°43'N, 89°54'W, altitude 10 m, tropical forest. Source type 4, Source 35, 1994.
70. San Felipe, Río Dulce, municipality of Puerto Barrios, Department of Izabal, 5 km E, 15°40'N, 89°00'W, altitude 50 m, subtropical wet forest. Source type 4, Source 36, 1994.
71. El Estor, Pista de aterrizaje, municipality of El Estor, Department of Izabal, 5 km W, 15°35'N, 89°25'W, altitude 50 m, subtropical wet forest. Source type 4, Source 37, 38, 3, 1994.

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72. Flores, Biotopo San Miguel La Palotada, municipality of Flores, Department of Peten, 50 km N, 17°20'N, 90°03'W, altitude 100 m, tropical forest. Source type 3, Source 30, 1994.

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73. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
74. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1.5 km SW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
75. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1.5 km SW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
76. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1 km NW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
77. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1.2 km NW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
78. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1.5 km NW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
79. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1.3 km NW, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
80. Hotel zone, Tikal, municipality of Flores, Department of Peten, 0.5 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
81. Hotel zone, Tikal, municipality of Flores, Department of Peten, 0.5 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
82. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 1, Source 1, 1994.
83. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 5, 1978.
84. Hotel zone, Tikal, municipality of Flores, Department of Peten, 1 km W, 17°13'N, 89°38'W, altitude 300 m, tropical forest. Source type 2, Source 6, 1976.
85. Sayaxche, Petexbatun, municipality of Sayaxche, Department of Peten, 7.5 km S, 16°28'N, 90°15'W, altitude 100 m, tropical forest. Source type 2, Source 10, 1994.
86. Sayaxche, Manos Unidos, municipality of Sayaxche, Department of Peten, 10 km W, 16°15'N, 90°15'W, altitude 100 m, tropical forest. Source type 2, Source 10, 1994.
87. Poptun, Machaquila, municipality of Poptun, Department of Peten, 7.5 km N, 16°27'N, 89°27'W, altitude 100 m, tropical forest. Source type 2, Source 10, 1994.
88. Dolores, municipality of Dolores, Department of Peten, 16°31'N, 89°27'W, altitude 100 m, broadleaf forest. Source type 2, Source 10, 1994.
89. La Reforma, Biotopo Cerro Cahui, municipality of Flores, Department of Peten, 10 km W, 17°00'N, 89°13'W, altitude 300 m, tropical forest. Source type 2, Source 12, 1994.
90. Morales, Caral, municipality of Morales, Department of Izabal, 30 km E, 15°29'N, 88°31'W, altitude 900 m, tropical forest. Source type 3, Source 14, 1994.
91. Aldea Las Brisas, Cerro San Gil, municipality of Puerto Barrios, Department of Izabal, 9 km N, 15°40'N, 89°45'W, altitude 900 m, tropical forest. Source type 3, Source 17, 1994.
92. La Libertad, municipality of La Libertad, Department of Peten, 16°48'N, 90°05'W, altitude 100 m, tropical forest. Source type 3, Source 20, 1994.
93. Cooperativa La Palma, municipality of La Libertad, Department of Peten, tropical forest. Source type 3, Source 20, 1994.
94. San Diego, municipality of La Libertad, Department of Peten, tropical forest. Source type 3, Source 20, 1994.
95. Sayaxche, Santa Amelia, municipality of Sayaxche, Department of Peten, 35 km SE, 16°20'N, 90°05'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
96. Sayaxche, Aguateca, municipality of Sayaxche, Department of Peten, 15 km S, 16°25'N, 90°12'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
97. Sayaxche, Dos Pilas, municipality of Sayaxche, Department of Peten, 10 km SW, 16°28'N, 90°20'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
98. Sayaxche,Ceibal, municipality of Sayaxche, Department of Peten, 15 km E, 16°32'N, 90°02'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
99. Flores, Ixlu, municipality of Flores, Department of Peten, 20 km E, 16°57'N, 89°45'W, altitude 100 m, tropical forest. Source type 3, Source 28, 1994.
100. Tikal, El Mirador, municipality of Flores, Department of Peten, 65 km NW, 17°45'N, 89°55'W, altitude 300 m, tropical forest. Source type 3, Source 30, 1994.
101. Finca Trindad, Finca Trindad, municipality of San Agustin Acasaguatlan, Department of El Progreso, 5 km N, 17°05'N, 89°57'W, altitude 2000 m, subtropical wetforest. Source type 3, Source 26, 32, 1994.
102. Finca Alejandria, Finca Alejandria, municipality of Río Hondo, Department of Zacapa, 3 km N, 15°08'N, 89°37'W, altitude 2000 m, subtropical wet forest. Source type 4, Source 34, 1994.
103. Santa Clara, Santa Clara, municipality of Río Hondo, Department of Zacapa, 3 km NW, 15°07'N, 89°50'W, altitude 1800 m, subtropical wet forest. Source type 4, Source 34, 1994.
104. Santo Tomas, Cerro San Gil, municipality of Puerto Barrios, Department of Izabal, 15 km W, 15°40'N, 89°45'W, altitude 900 m, tropical forest. Source type 4, Source 35, 1994.
105. Santo Tomas, Cerro San Gil, municipality of Puerto Barrios, Department of Izabal, 15 km W, 15°40'N, 89°45'W, altitude 900 m, tropical forest. Source type 4, Source 36, 1994.
106. El Estor, Sierra de Santa Cruz, municipality of El Estor, Department of Izabal, N, altitude 600 m, tropical forest. Source type 4, Source 37, 1994.

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Dietary Choices in *Cebus olivaceus*: A Comparison of Data from Hato Piñero and Hato Masaguaral, Venezuela

Lynne E. Miller

Department of Anthropology, University of California at San Diego, La Jolla, California, USA

Introduction

This paper has several objectives. First and foremost, it provides a comparison of data from two sites where the wedge-capped capuchin (*Cebus olivaceus*) has been the subject of long-term investigation. Hato Masaguaral is located in the Venezuelan *llanos*, approximately 40 km south-southwest of the city of Calabozo. The capuchins of Hato Masaguaral have been studied since the 1970s by John Robinson and his colleagues, covering many aspects of foraging ecology and social behavior (see, for example, Fragaszy 1990; O'Brien 1991; Robinson 1981, 1984, 1986, 1988a, 1988b; de Ruiter 1986; Srikosamatara 1987; Valderrama *et al.* 1990). More recently, studies of capuchins have been conducted at Hato Piñero, which lies approximately 60 km northwest of Hato Masaguaral (Miller 1991, 1992, 1996, 1997, 1998 and Miller in review, a and b). The two sites are superficially similar, with a typical *llanos* habitat of semideciduous, dry tropical forest. However, this study seeks to compare the vegetational composition of the two sites to assess possible disparities in the tree species present and their abundance.

This study also explores differences in the diets of the two monkey populations. Several previous investigations have demonstrated dietary disparities among populations of the same species (Brown and Zunino 1990; Chapman and Fedigan 1990; Clutton-Brock 1977; Hladik 1977; McGrew 1983; Nishida *et al.* 1983; Richard 1977; Struhsaker and Leland 1979; Waser 1977). In some cases, diet is the result of local resource availability or abundance (Brown and Zunino 1990). However, this explanation is often inadequate, for plants present at two sites may be used at only one (Hladik 1977; Nishida *et al.* 1983; McGrew 1983; Richard 1977). In this case, food choices are sometimes viewed as learned or "cultural" behaviors (McGrew 1983; McGrew and Tutin 1978). Another possible explanation involves differences in "food profitability" (Chapman and Fedigan 1990). A given plant species might be available to two different groups of monkeys, but if one group also has access to something of higher quality, then it might eschew the shared, lower quality plant species. The investigation presented here compares the diets of the two capuchin populations in question and endeavors to explain observed disparities.

This research also addresses the influence of resource dispersion on group size. The spatial pattern of important plant species may have a profound impact on the social structure of monkey populations. Smaller food patches force animals into greater proximity, which tends to promote higher levels of feeding competition and, eventually, more aggression. Where food patches are typically too small to accommodate an entire group, some group members must either wait to feed or go elsewhere to forage. If this pattern arises frequently, it may encourage groups to fission. On the other hand, larger food patches should engender less feeding competition and thus may allow for larger groups. Patch size has been shown to affect foraging party size both within and across various primate species. (For intraspecies comparisons see Leighton and Leighton 1982; Phillips 1995; Symington 1988. For interspecies comparisons see Chapman 1990; Janson 1986; Terborgh 1983.) This study considers how the dispersion of important plant foods may influence group size for the two capuchin populations.

Finally, this paper introduces the reader to Hato Piñero, a privately-owned nature reserve in the *llanos* of Venezuela. Hato Piñero has supported numerous primatological investigations over the past decade and, thanks to its well-equipped biological station, hosts an increasing number of ecological studies every year. It is hoped that providing additional information about this site will encourage other scientists to consider setting up research programs there.

The Study Site

Hato Piñero is a functioning cattle ranch in the *llanos* of Venezuela. The vegetation of the *llanos* is a mosaic of open grassland and semideciduous dry tropical forest (Schürholz and Demarchi unpublished; Troth Ovrebo 1979). There is pronounced seasonality, which is correlated with fluctuations in resource abundance (Robinson 1986; Miller 1996). In the wet season, from May through October, the average monthly rainfall is approximately 190 mm (Fig. 1). The trees are densely foliated and much of the land floods, in some areas by as much as two meters. Due to frequent cloud cover, the mean temperature during the wet season is lower than during the dry season, and temperature fluctuations

are less extreme (Fig. 2). During the dry season, from November through April, the *llanos* receive little rain (Fig. 1). Vast expanses of water are reduced to small ponds and many species of trees lose their leaves. The average daytime temperature is higher and temperature fluctuation is greater than during the wet season (Fig. 2).

Hato Piñero is owned by Sr. Antonio Julio Branger and the Branger family. It covers some 80,000 ha lying between latitudes 8°40' and 9°00' north and longitudes 68°00' and 68°18' west, approximately 120 km south-southeast of the city of San Carlos. Its elevation is roughly 150 meters above sea level. Unlike most of the Venezuelan *llanos*, Hato Piñero has striking topographic relief, being bordered on the north by the massif of El Baul, a Precambrian range of low hills (Schürholz and Demarchi unpublished).

Sr. Branger maintains Hato Piñero as a wildlife refuge, and has done so for nearly 50 years. The grasslands are kept clear for grazing, but existing forest is maintained intact, free from cutting or burning. No hunting is permitted, and efforts are made to preserve the *llanos* ecosystem. As a result, species diversity and population densities are high, and the primates are quickly habituated.

In 1992, the Fundación Branger, the nonprofit organization which operates Hato Piñero, constructed a large and comfortable biological station. It provides accommodation for up to 26 scientists, along with a complete kitchen, dining room, library, conference room and herbarium, replete with samples of *llanos* vegetation (collected, prepared and identified by Drs. Leandro Aristiguieta and Francisco Delascio). Each living space (designed to accommodate 2 to 4 people) has its own bathroom with running water. There is also electricity 24 hours a day. The biological station is fully staffed, thus allowing scientists full-time dedication to their research. Hato Piñero is eager to welcome additional scientists, and can be reached via their web site at <www.branger.com>.

The site of my ongoing primatological investigations at Hato Piñero is a 270 ha plot of semideciduous forest surrounded by thousands of hectares of contiguous forest. There are approximately 45 km of trails laid out in 125 x 125 m sections. The ranch's main road roughly bisects the study site. Traffic is infrequent, however, and the monkeys appear undisturbed by the occasional passing car. In fact, they are often seen crossing the road, usually leaping from trees on one side to trees on the other, but occasionally running across on the ground, providing researchers with an excellent opportunity to census groups.

The forest, characteristic of those found in the *llanos*, is composed of low-growing, deciduous trees. The canopy reaches some 20 to 25 m in height. The drier portions of the forest are composed primarily of *Pterocarpus acapulcensis, Caesalpinia coriaria* and *Astronium graveolens*. The more consistently flooded areas of the study site are dominated by *Hecastostemon completus*. Palm trees (*Copernicia tectorum*) are also common. Fig trees (*Ficus* spp.) are relatively rare compared to nearby Hato Masaguaral (Robinson 1986). The understorey is thick and brushy in some areas but more open in others. There are various species of vines and climbers and many large patches of terrestrial bromeliads, primarily *Bromelia pinquin*.

There is a high diversity of mammals, birds, reptiles, and insects at the study site. Potential monkey predators include jaguar (*Panthera onca*), puma (*Puma concolor*), ocelot (*Leopardus pardalis*), tayra (*Eira barbara*), and boa constrictor (*Boa constrictor*). Large aerial predators are few, but the monkeys do alarm call at passing raptors (pers. obs.), such as the great black hawk (*Buteogallus urubitinga*), long-winged harrier (*Circus buffoni*) and black-and-white owl (*Ciccaba nigrolineata*). Other forest mammals include white-tailed deer (*Odocoileus virginianus*), giant anteater (*Myrmecophaga tridactyla*), tamandua (*Tamandua tetradactyla*), and peccaries (*Tayassu pecary* and *T. tajacu*). The only other nonhuman primate species is the red howler monkey (*Alouatta seniculus*), which has been studied by Dr. Theresa Pope

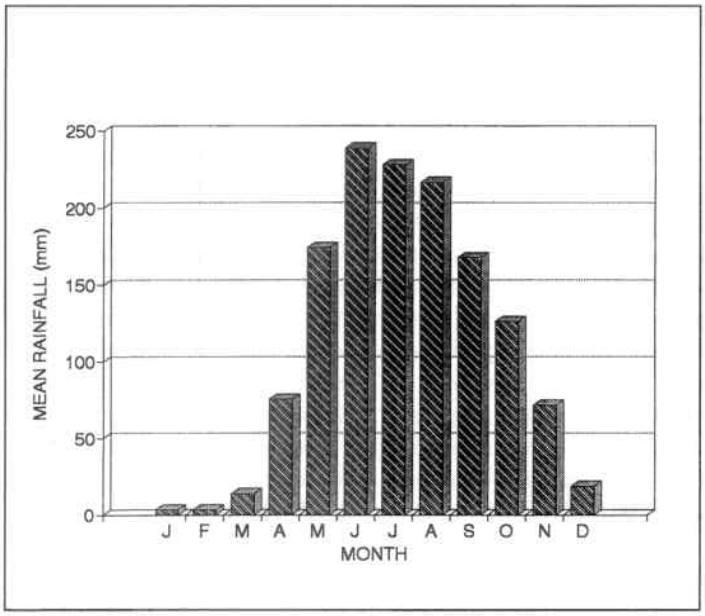

Figure 1. Mean monthly rainfall (mm); data compiled from 1970 through 1995.

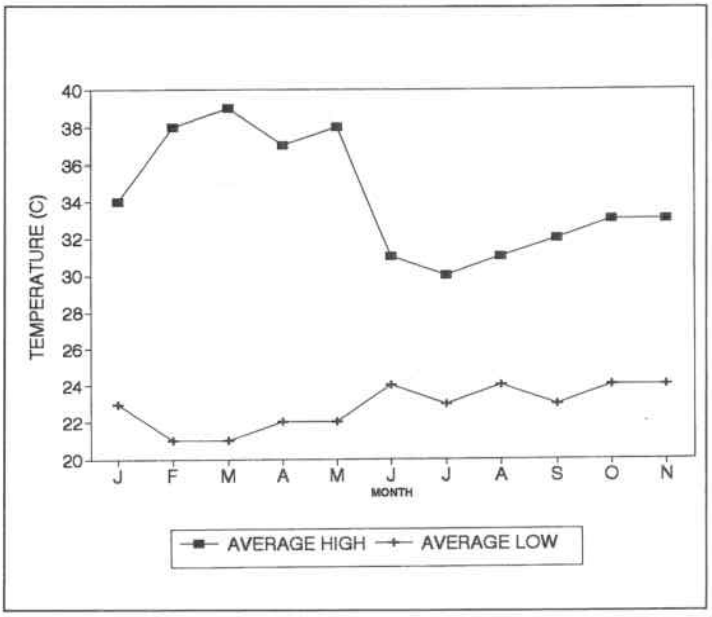

Figure 2. Mean monthly temperatures (°C); data compiled from May, 1990 to June, 1991, excluding December.

(see Pope 1998). There are many forest birds, including woodpeckers (Family: Picidae), woodcreepers (Family: Dendrocolaptidae), manakins (Family: Pipridae), jacamars (Family: Galbulidae), antbirds (Family: Formicariidae), hummingbirds (Family: Trochilidae), and ground doves (Family: Columbidae), as well as scarlet macaw (*Ara macao*), rufous-vented chachalaca (*Ortalis ruficauda*), yellow-knobbed curassow (*Crax daubentoni*), and hoatzin (*Opisthocomus hoatzin*).

A Comparison of Hato Piñero and Hato Masaguaral

The population of *Cebus olivaceus* at Hato Piñero has been the subject of intensive investigation since 1987 (R. S. O. Harding pers. comm.; see also Miller 1991, 1992, 1996, 1997, 1998 and Miller, in review a and b). However, this species is better known from the long-term studies of John Robinson and his colleagues, working at Hato Masaguaral (Fragaszy 1990; O'Brien 1991; Robinson 1981, 1984, 1986, 1988a, 1988b; de Ruiter 1986; Srikosamatara 1987; Valderrama *et al.* 1990). Hato Masaguaral lies approximately 60 km southeast of Hato Piñero (Fig. 3). Although the two sites are quite close to each other, preliminary analysis indicates that there are significant ecological differences between them, for example, in the composition of the vegetation, which may, in turn, have considerable impact on the diet and social structure of the two populations (e.g., Miller 1991).

Table 1. Comparison of the relative densities of four species in the diet of *Cebus olivaceus* at Hato Piñero (HP) and Hato Masaguaral (HM).

Species	Relative Densities[1] (#/ha)		HP/HM[2]
	Hato Piñero	Hato Masaguaral	
Chlorophora tinctoria	7.77	1.81	4.29
Ficus spp.[3]	1.62	36.94	0.04
Coccoloba caracasana	41.23	13.33	3.09
Copernicia tectorum	15.62	152.08	0.10

[1] Relative densities were calculated by dividing total tree number of each species found in sample plots by the total area of sample plots (Robinson 1986; L. E. Miller unpubl. data).

[2] HP/HM provides an index for the disparity between the two sites with, for example, Hato Piñero having 4.29 times as much *Chlorophora* as does Hato Masaguaral.

[3] For simplicity, two and possibly three species of *Ficus* were combined.

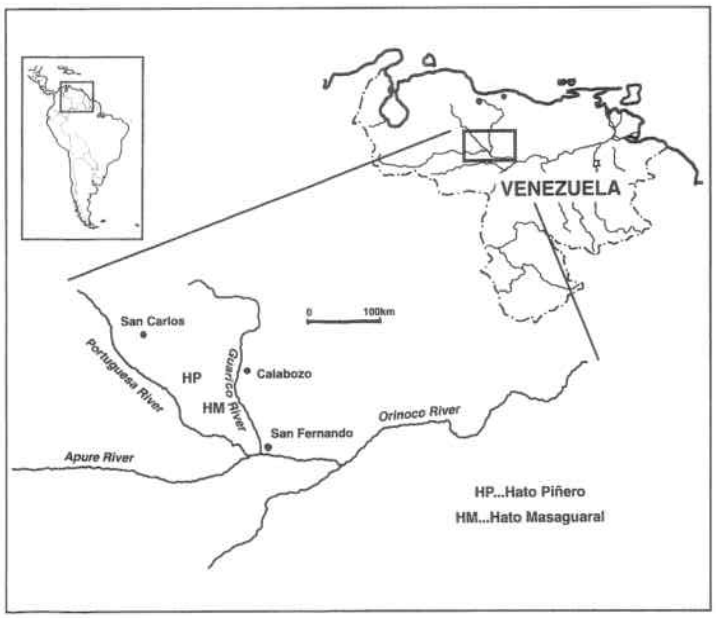

Figure 3. Map showing the approximate locations of Hato Piñero (HP) and Hato Masaguaral (HM). Map drawn by Stephen D. Nash.

Vegetation - Methods

In order to assess the composition of the vegetation at the Hato Piñero study site, my research assistants and I walked each north-south transect and noted the identification and location of each tree over 3 m height, lying within 2.5 m of either side of the transect. This resulted in long, narrow "sample plots" which totaled an area of approximately 13 ha. Plant species were identified by common name by a local *baquiano* (naturalist), upon inspection of the fruits or the entire tree. One example of each tree was tagged with its common name. Later, the trees were inspected by Dr. Leandro Aristiguieta, one of Venezuela's foremost botanists, and common names were matched with their Latin counterparts. In this way, botanical names were determined for all but one tree species, and for approximately half of the non-tree vegetation (e.g., orchids, bromeliads and lianas). These data provided an assessment of the relative frequency and distribution of each tree species throughout the site.

Results

The composition of the vegetation at Hato Piñero was compared with similar data for Hato Masaguaral (Robinson 1986). Space limitations preclude providing complete species lists for each site, but a brief comparison may indicate the magnitude of the disparity. Of a total of 116 tree species, only 34 (29%) are shared between the two sites. The remaining 82 (71%) occur only in one site or the other (32 in Hato Piñero, 50 in Hato Masaguaral). Furthermore, for the species that are shared, there are dramatic differences in relative densities. Table 1 provides comparisons of the relative densities of four of these species, as an example (for greater detail on species abundance, see Robinson 1986 and Miller 1992). These disparities in vegetational composition must affect the diets of the two capuchin populations.

Exploitation of Plant Foods - Methods

During my first field season, from April, 1989 to June, 1991, I observed two focal study troops, one of approximately 36 animals, and the other of approximately 16. The details of troop composition and the data collection protocol are provided elsewhere (Miller 1996). In brief, each adult female in each study group (for each day of observation), was observed continuously for 30 seconds every ½ hour. Records included identification of each food item ingested by the subject. Those 30-second samples interrupted by the disappearance of a subject were discarded. Data were collected from dawn till dusk in all months from June 1990 to June 1991, totaling 485 hours of observation, 265 with the large group and 220 with the smaller group (Miller 1996).

Results

A total of 3841 30-second samples were accumulated. Of these, 1312 recorded the subject feeding; 673 (51%) represent feeding on plant foods. Table 2 lists the plant species used by the

Table 2. Plant species exploited by capuchins, *Cebus olivaceus*, at Hato Piñero (HP) and Hato Masaguaral (HM).

Family and Species	Common Name	Presence	HP[1]	HM[2]
Amaryllidaceae				
Hymenocallis venezuelensis	unknown	HM		0.05 (2)
Anacardiazeae				
Spondias mombin	jobo	both		0.14 (6)
Annonaceae				
Annona jahnii	manirito	both	moderate	3.33 (140)
Annona sp.	manirito del agua	HP	0.14 (1)	
Asclepiadaceae				
Marsdenia undulata	orosun	both	1.19 (8)	0.50 (21)
Matelea maritima	unknown	HP	0.59 (4)	
Bignonaceae				
Macfadyena uncata	unknown	HM		0.02(1)
Boracinaeae				
Cordia collococca	caujaro rojo	both	moderate	4.45 (187)
Cordia polycephala	unknown	HM		0.07 (3)
Bromeliaceae				
Bromelia crysantha	chigue chigue	both	frequent	0.26(11)
Bromelia pinquin	maya	HP	12.48 (84)	
Bromelia plumieri	unknown	HM		0.10 (4)
Cactaceae				
Hylocereus polyrhizus	unknown	HM		0.21 (9)
Capparaceae				
Capparis coccolobifolia	rabo pelado	HM		0.57 (24)
Capparis odoratissima	olivo	both		0.02 (1)
Cochlospermaceae				
Cochlosperum vitifolium	bototo	both		1.26 (53)
Cecropiaceae				
Cecropia peltata	yagrumo	both	0.14 (1)	0.17 (7)
Combretaceae				
Combretum fruticosum	melero	both	11.29 (76)	0.10 (4)
Connaraceae				
Connarus venezuelanus	conchagruesa	HM		0.10 (4)
Cucurbitaceae				
Luffa operculata	unknown	HM		0.02 (1)
Melothria trilobata	unknown	HM		0.81 (34)
Cyperaceae				
Scleria setuloso-ciliata	unknown	HM		0.43 (18)
Dilleniaceae				
Tetracera volubilis	unknown	HM		0.21 (5)
Ebenaceae				
Diospyros ierensis	cacaito	HM		1.55 (65)
Euphorbiaceae				
Dalechampia scandens	unknown	HM		0.02 (1)
Margaritaria nobilis	zarcillo	HM		0.14 (6)
unknown	cardon	HP	0.45 (3)	
Fabaceae				
Albizia guachapele	masaguaro	both		0.07 (3)
Centrosema pubescens	unknown	HM		0.12 (5)
Copaifera officinalis	aceite	HM		0.76 (32)
Entada polystachya	unknown	HM		0.05 (2)
Hymenaea courbaril	algorrobo	HM		0.02 (1)
Machaerium moritzianum	unknown	HM		0.29 (12)
Flacourtiaceae				
Hecastostemon completus	barote	both		0.12 (5)
Hecastostemon guazumaifolius	lagunero	HP	0.45 (3)	
Graminae				
Laciasis anomala	unknown	HM		0.17 (7)
Olyra sp.	carricillo	HP	1.49 (10)	
Leguminosae				
Cassia grandis	cañafistolo burrero	HP	rare	
Pithecellobium daulense	veramacho	HM		0.24 (10)
Pithecellobium guaricense	ororе	HM		0.05 (2)
Pithecellobium saman	saman	both		0.07 (3)
Pithecellobium tortum	cuji blanco	both	2.08 (14)	
Loranthaceae				
Phoradendron sp.	unknown	HM		0.14 (6)
Malpighaceae				
Malpighia emarginata	cerezo	HM		0.05 (2)

Cont.

Table 2. Cont.

Family and Species	Common Name	Presence	HP[1]	HM[2]
Malvaceae				
Wissadula periplocifolia	unknown	HM		0.19 (8)
Meliaceae				
Trichilia trifolia	coloraito	both		0.02 (1)
Moraceae				
Chlorophora tinctoria	mora	both	12.28 (123)	0.26 (11)
Ficus pertusa	matapalo	both		19.83 (833)
Ficus trigonata	higuerote	HM	3.71 (25)	4.74 (199)
Ficus sp.	matapalo	HM		2.10 (88)
Trophis americana	charo/ramon	HP	rare	
Ochinaeceae				
Ouratea guildingii	casco de burro	HM		0.02 (1)
Orchidaceae				
Oncidium carthaginense	unknown	HM		0.05 (2)
Oncidium cebolleta	rabo de iguana	both	7.28 (49)	1.36 (57)
Palmae				
Copernicia tectorum	palma llanera	both	0.14 (1)	14.43 (606)
Passifloraceae				
Passiflora serrulata	unknown	HM		0.38 (16)
Polygonaceae				
Coccoloba caracasana	uvera	both	27.49 (185)	1.48 (62)
Rhamnaceae				
Zizyphus saeri	limoncillo	both	0.74 (5)	
Rosaceae				
Licania apetala	mamoncillo	HM		0.02 (1)
Rubiaceae				
Chomelia spinosa	espinito	both	2.67 (18)	0.02 (1)
Genipa americana	caruto	both	1.34 (9)	6.21 (261)
Guettarda divaricata	punteral	HM		1.29 (54)
Psychotria anceps	agallon	HM		1.81 (76)
Randia hebecarpa	cachito	HM		6.07 (255)
Randia venezuelensis	diente de perro	both		0.19 (8)
Rutaceae				
Zanthoxylum culantrillo	bosu	both		2.55 (107)
Sapindaceae				
Allophyllus cobbe	pata de danta	HM		0.10 (4)
Melicocca bijuga	mamon	HP	moderate	
Paullinia cururu	unknown	HM		2.07 (87)
Sterculiaceae				
Guazuma tomentosa	guacimo blanco	both	0.59 (4)	12.10 (508)
Sterculia apetala	camoruco	both	5.65 (38)	0.57 (24)
Verbenaceae				
Vitex capitata	unknown	HM		0.17 (7)
Vitex compressa	guarataro aceituno	HM		0.17 (7)
Vitex orinocensis	guarataro pardillo	HM		3.07 (129)
Vitaceae				
Cissus alata	unknown	HM		0.12 (5)
Cissus sicyoides	unknown	HM		0.50 (21)
Not identified				
vine	patilla de monte	HP	0.59 (4)	
vine	unknown	HP	0.45 (3)	
vine	zarcillo	HP	rare	
unidentified			0.74 (5)	1.17 (49)
Total			100 (673)	100 (4200)

[1] The percentage of plant feeding observations at Hato Piñero (absolute number in parentheses). Rare, moderate and frequent are subjective evaluations of the use of the species by the capuchins where no quantitative data are available.

[2]The percentage of plant feeding observations at Hato Masaguaral (absolute number in parentheses). Source: Robinson (1986)

subjects and their frequency of use. During the 1989-1991 field season, 28 identified species of plants provided food for the subjects, primarily ripe fruits, supplemented by seeds, leaves and leaf stems, and the nectar of one flowering vine (for more detail, see Miller 1992).

For *Cebus olivaceus* at Hato Masaguaral, Robinson (1986) reports 6739 feeding records in which the item consumed was identified. Of these, 4200 (62%) represented the use of plant foods. These included parts of 66 different plant species. These species, and the frequency of use, are also shown in Table 2. (Further detail on the parts of plants consumed can be found in Robinson 1986.) Table 2 also indicates which of the exploited plant species are known to occur at Hato Piñero, Hato Masaguaral, and at both sites. Errors may exist for those plants for which identification remains uncertain.

Of the 79 plant species listed in Table 2, only 15 (19%) are known to be used by the monkeys at both sites. Fifty species (63%) were used only at Hato Masaguaral; 14 (18%) were used

Photo 1. Adult male (Tolstoy) of the larger focal study group, threatening with the "open mouth, bared teeth" expression. Photo by L. Miller.

Photo 2. Adult female (Lara) of the larger focal study group, looking dazed after having been quite thoroughly copulated. Photo by L. Miller.

Photo 3. Young adult or subadult male (Pasternak) of the larger focal study group, feeding on the juice of *Cassia grandis* (Leguminosae). Photo by S. A. Miller.

Photo 4. Adult male (Oliver) of a large group, contemplating life in the trees. Photo by S. A. Miller.

only at Hato Piñero. Therefore, these two capuchin populations exploit dramatically different diets.

Much of this dietary divergence can be explained by differential resource availability. Of the 79 species in Table 2, only 26 (33%) exist at both sites. Some 12 species (15%) are only known to exist at Hato Piñero, and are thus only used there; 41 (52%) species are found and used only at Hato Masaguaral. (Possible errors in identification make these figures approximations.) On the other hand, species availability is not the only answer. There are nine species which are known to exist at both sites, and yet are used at only one (see, for example, *bototo* [Cochlospermaceae] and *bosu* [Rutaceae] in Table 2).

Differences in diet concern more than just whether or not a given plant species is used; also of interest is the *frequency* with which it is used. For example, *Combretum fruticosum* (Combretaceae) is a flowering vine present and used at both sites. However, monkeys at Hato Piñero were observed feeding on its nectar over 100 times more frequently than were those at Hato Masaguaral (see Table 2). Can these frequency differences be explained by differential *abundance* of the species in question? That is, do the capuchins of Hato Piñero feed on *Combretum* more often simply because there is more of it available? Table 1 provides four examples for consideration. For the monkeys at Hato Masaguaral, *Ficus* and *Copernicia* represent the top two food items in terms of frequency of use, for a total of 41.10% of plant feeding observations (see Table 2). These two genera comprise only 3.85% of plant feeding observations for the monkeys at Hato Piñero. Conversely, *Chlorophora* and *Coccoloba* represent 39.77% of observations at Hato Piñero, but only 1.74% at Hato Masaguaral. Differential use may be explained, at least in part, by differences in abundance (see Table 1): *Copernicia* and *Ficus* are more abundant at Hato Masaguaral, and are more frequently exploited. In contrast, *Chlorophora* and *Coccoloba* are more common at Hato Piñero, and their fruits are eaten more frequently. However, in all four cases, the disparities in use greatly exceed differences in abundance. It seems unlikely that there is a nonlinear relationship between the number of trees present and the volume of food they provide. These data demonstrate that dietary composition - in terms of both the species used and their frequency of use - is not simply a matter of resource availability.

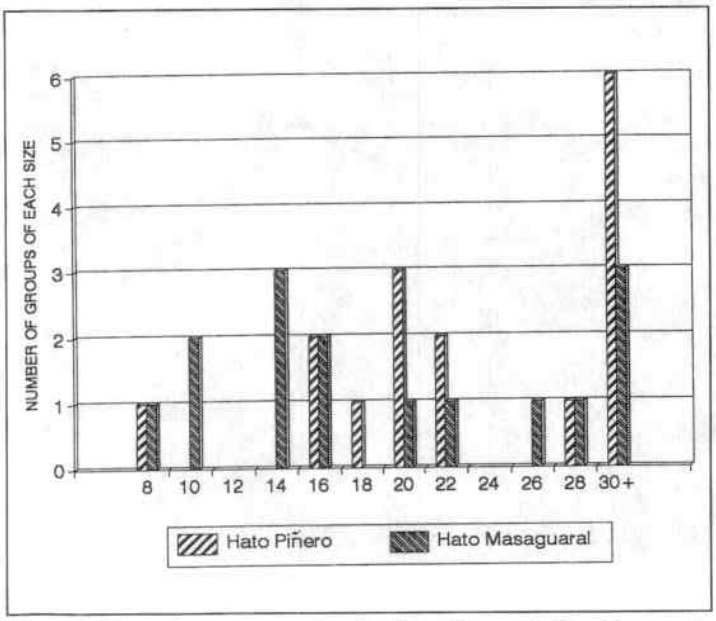

Figure 4. Comparison of group sizes for Hato Piñero and Hato Masaguaral.

The Influence on Social Structure

One goal of socioecology is to understand the complex relationships among social and ecological variables. Intersite comparisons can often help to elucidate how, for example, food distribution influences social structure. Miller (1991) has suggested that the most commonly exploited plant genera at Hato Masaguaral (*Ficus* and *Copernicia*) are dispersed in smaller "patches" than are the important plants at Hato Piñero (*Chlorophora* and *Coccoloba*). This may be an underlying factor in group size. Figure 4 provides a comparison of group sizes in the two capuchin populations (data for Hato Masaguaral provided by J. Robinson pers. comm.). It reveals a greater number of groups of over 30 at Hato Piñero, and more groups under 20 at Hato Masaguaral. Although the disparity in group sizes is not statistically significant, it may represent a trend resulting from the ability of important plant species at Hato Piñero to support larger groups.

Conclusions

This study has shown that two regions, despite their proximity and superficial similarity, are very different in vegetational composition. Hato Piñero and Hato Masaguaral, separated by only 60 km, diverge considerably in species presence and abundance. This disparity may have a considerable impact upon the diets of the local monkey populations, which also differ significantly. However, food availability cannot fully explain disparities in diet: Neither the presence of a plant species nor its relative abundance accurately predicts its frequency of use. This observation suggests that other variables, such as taste preference, food profitability, or even "cultural" predisposition, may play a role in what monkeys choose to eat. Without further investigation, it is very difficult to determine which of these hypothetical influences has greatest explanatory value for these subjects.

In addition, this study has provided a preliminary indication that social structure may, at least in part, depend upon the dispersion of important plant species. Where food patches are small, group size may also be constrained, but where larger food patches are abundant, larger groups may persist. Thus, vegetation differences may have led to a higher frequency of larger groups at Hato Piñero than at Hato Masaguaral. Cross-site comparisons such as this provide important opportunities to assess the effects of ecological variables on primate foraging patterns and social behaviors. Finally, it is hoped that publication of the plant food list will prove valuable to other researchers working with this and other capuchin species.

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Author's Address:
Lynne E. Miller, Department of Anthropology, University of California at San Diego, 9500 Gilman Drive, La Jolla, California 92093-0532, USA.

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The Zanzibar Red Colobus Monkey: Conservation Status of an Endangered Island Endemic[1]

Thomas T. Struhsaker and Kirstin S. Siex

Department of Biological Anthropology and Anatomy
Duke University, Durham, North Carolina, USA

Introduction

The Zanzibar red colobus monkey (*Procolobus kirkii*) (Figs. 1-6) is an endangered species (Oates 1996a) restricted to the island of Zanzibar (Unguja). We have studied this species intermittently from 1991-1996. Our research has concentrated on several issues, including: 1) the floristic correlates of red colobus population density, group size and composition, 2) the effect of red colobus feeding on coconut crops, 3) red colobus distribution, 4) the long-term success of translocated monkeys, and 5) immediate and long-term conservation problems facing the species.

The purpose of this report is to briefly summarize some of our results, with the main emphasis on conservation issues and recommendations.

Status of the Zanzibar Red Colobus

On the basis of craniology, vocalizations, and coat color, we consider *P. kirkii* to be a valid species. The only viable population of this species is restricted to the island of Zanzibar (Unguja). Ten to 12 red colobus may still survive in the Ngezi Forest on Pemba Island, being the remnants of a failed translocation attempt. None are kept in captivity.

Distribution on Zanzibar

We estimate that there are between 1,500 and 2,000 red colobus on Zanzibar. The great majority live in the two contiguous forest reserves of Jozani and Unguja Ukuu, and the agricultural areas immediately to the south (Kichanga, Pete village, Kiungani, Mungwi, and Uzi island) and south-east (Kitogani, Mungoni and Muyuni) of the Jozani Reserve (Figs. 7 and 8). At least half of all the Zanzibar red colobus live outside of the legally protected Jozani and Unguja Ukuu Forest Reserves. The two protected forest reserves are managed by the Zanzibar Sub-Commission for Forestry (SCF, recently renamed the Forestry Sector of the Commission for Natural Resources).

Red colobus occur elsewhere on Zanzibar, but at much lower densities and usually in scattered and isolated populations. The most northerly populations occur in the Kiwengwa area on the east coast and there is a small isolated group in the mangrove swamp of Maji Mekundu just south of Mangapwani on the west coast. The most southerly group we have seen is in the small remnant forest called Mnyambiji (Myambizi), approximately 5 km west of Makunduchi.

Translocation

A translocated population of red colobus lives in the Masingini Forest Reserve on the northern edge of Zanzibar town. This is a small forest (5.5 km²) comprised of 2.3 km² of hardwood forest and 3.2 km² of planted softwoods. In Masingini, we have only seen the red colobus in the hardwood forest. A total of 36 red colobus were reportedly translocated there in 1977, 1978, and 1981 (Silkiluwasha 1981 and SCF records). In June 1994, we counted three groups totaling no less than 56 individuals, indicating that this was a successful translocation.

Habitat Selectivity

The highest population density of Zanzibar red colobus occurs in the southern end of the Jozani Forest Reserve and the small area of perennial gardens (shambas) contiguous with the southern border of the Reserve. Densities are approximately 240 individuals/km² in the southern end of the ground-water forest and nearly 750 individuals/km² in a 14 ha area of adjacent shambas. In other parts of their range, however, red colobus densities are much lower, e.g. most shamba areas, the *Phoenix* palm swamp forest in the northern end of Jozani Forest, coral rag thicket and mangrove swamp.

Conservation Problems

In addition to the intrinsic problems confronting relatively small, isolated, and fragmented populations, there are four basic threats to the Zanzibar red colobus: habitat loss, road kills, hunting, and poorly managed tourism.

[1]This paper has also been published in *African Primates*, 2(2): 54-61, 1996.

Habitat Loss

The coral-rag thicket of Zanzibar is being rapidly destroyed, primarily by woodcutters and secondarily by agriculturalists. Commercial exploitation of these resources is often illegal and this illegal cutting frequently occurs within the government forest reserves. The very great demand for fuelwood and charcoal for cooking in Zanzibar town is the market force driving this destruction. Furthermore, this demand is increasing as the human population increases on Zanzibar due to intrinsic growth (3-4% per year) and immigration in response to employment opportunities associated with the burgeoning tourist industry. Even the construction of tourist facilities contributes to the destruction of the coral-rag thicket because fuelwood is used to produce the lime for white washing the buildings. This tourist-related growth in construction also contributes to excessive exploitation of mangrove swamps because the termite-resistant mangrove poles are widely used in building.

Although red colobus monkeys occur at low population densities in coral-rag thicket forest, this habitat is still the most common natural habitat remaining on Zanzibar. It, therefore, contains an important reservoir of these monkeys. In addition, the coral-rag thicket is the main habitat for a number of other endemic or near-endemic species and subspecies, such as Ader's duiker (*Cephalophus adseri*). Although perhaps not as important for monkeys as coral-rag thicket, the mangrove swamps also contain reservoirs of red colobus, serve as habitat corridors for their dispersal, and play a critical role in marine fisheries.

Vehicles and Road Kills

A major road runs near the southern end of the Jozani Forest Reserve and through the home range of the main group of red colobus that is viewed by tourists. This group, known as the SJF Shamba group, contained 75 individuals in 1996. It frequently crosses the main road, as do at least two other red colobus groups in this area.

In the past, red colobus were occasionally killed by vehicles as they ran across the road. At that time, it was not paved and had many potholes, making it difficult for vehicles to travel at high speeds. Over the past two years, however, it has been gradually improved, and in 1996 it was paved. As a result, vehicles now travel through the home range of these red colobus groups at very high speeds (90-100 km/hour) and the incidence of road kills has increased (Fig. 9). The forest guards resident at Jozani estimate that, since the road was paved, a red colobus is killed by a vehicle about once every 2-3 weeks. If correct, this means a loss of about 18-26 red colobus each year along this single 1.5 km stretch of road. Assuming that approximately 150 red colobus are suscep-

Figure 1.: Juvenile feeding at Jozani. Photo by Thomas T. Struhsaker.

Figure 2. Adult female feeding on *Terminalia catappa,* an exotic tree species in the agricultural systems. Photo by Kirstin S. Siex.

tible to being hit by vehicles on this section of road, then these losses may constitute an annual loss of 12-17% of this subpopulation. Although approximate, these estimates indicate that, in the core area of this endangered species, the most common cause of mortality is the reckless driver.

Hunting

We have no quantitative data on the impact of hunting by humans on the Zanzibar red colobus population. The majority of inhabitants on Zanzibar are Muslim and are thus very unlikely to kill monkeys to eat. There are, however, a number of non-Muslim African immigrants from the mainland. Some of them are said to hunt the Zanzibar red colobus with dogs and spears as a source of food. In addition, we have also heard that villagers, including Muslims, kill red colobus and Sykes monkeys because of the alleged damage they cause to crops.

The National Hunters' Association (Wasasi wa Kitaifa) is an organization under the Prime Minister's Office, the mandate of which is to kill all animals that are potential agricultural pests. The following account was related to us by the forest guards at Jozani. Each weekend the Government of Zanzibar provides two tipper lorries (dump trucks) that travel to a designated area, collecting as many villagers with spears and dogs as the lorries can accommodate. There are usually about 50-60 men and a similar number of dogs involved. Once at the site designated for hunting, they sweep the area killing every undomesticated mammal they encounter. This includes a great many species and individuals that cause little, if any, damage to crops. Furthermore, these hunts are sometimes done in areas where there is little, if any, agriculture.

In January 1996, at least one of these hunts occurred near the southern end of the Jozani Forest Reserve and near the area most frequently visited by tourists to view the red colobus. We were told that the hunters and their dogs killed two red colobus (adult male and adult female). Apparently, the dogs caught the monkeys and the hunters then clubbed and speared them to death. The carcasses were then loaded on a government vehicle and driven off with the hunters and their dogs. The following day one of us (TTS) was taken to a third red colobus (adult male) who had died only an hour or two earlier in the immediate vicinity of the hunting incident. He had bite wounds and perhaps machete (panga) or spear cuts as well, and may have been a victim of these same hunters.

Two days after this hunt near Jozani, a representative from SCF appeared on local television and described the incident, explaining that this was contrary to law. Subsequently, the chairman of the National Hunters' Association apologized and admitted that a mistake had been made by some of the younger and less experienced hunters. No fines or other penalties were levied.

Tourism

As mentioned previously, tourism is increasing rapidly on Zanzibar. Most of this tourism centers on the beaches, particularly those on the east coast. There are two main routes to the east coast, one of which passes the southern end of Jozani Forest Reserve. While traveling to the east coast many tourists stop to view the red colobus at Jozani (12,000 tourists in 1996).

The main group (S. Shamba) viewed by tourists has become so well habituated that a number of the juveniles readily approach and make contact with them, even sitting on their shoulders and heads. This is the result of the forestry and tourist guides actively feeding the monkeys with leaves of an indigenous plant (Mkwamba, *Flueggea [Securinega] virosa*). Although this shrub is very accessible to the monkeys, when a branch of it is held up toward them by a person, they usually descend to feed on it. This initiates the interaction and the juveniles often proceed to climb on the tourists. So far, these interactions have been pacific. To our knowledge, there have been no incidents of tourists being bitten or scratched by the monkeys. The entire interaction between tourists and the colobus is in striking contrast to the aggressive nature of those between tourists and baboons, vervets, and macaques. There is, however, a very real possibility of disease transmission between humans and the monkeys (both directions) and, as these juveniles become adults, the risk of injury to the tourists may increase. Once a tourist is injured by a monkey, there usually follows a demand for the monkey to be killed.

Conservation Recommendations and Implementation

Our recommendations can be roughly ranked according to degree of urgency, but we feel that positive action on all of them is required.

Road Kills

The very substantial mortality of Zanzibar red colobus due to speeding and reckless drivers represents both a serious loss to an endangered species and to the Zanzibar economy. Although one cannot put a monetary value on an endangered species, the red colobus living along the road at Jozani are an important source of revenue from tourists. At least 12,000 tourists came to see these rare monkeys in 1996. Each paid US$2.00 (T. Shs. 1,000) for an annual total income of 12 million T. Shs.

Road kills caused by reckless drivers not only contribute to a possible population decline of this species, but generate adverse publicity for tourism. Most tourists would be greatly disturbed by the sight of a monkey being killed by a vehicle, particularly if no attempt was being made to prevent it. Furthermore, we do not know at what lower size limit a monkey group ceases to be attrac-

Figure 3. Two adult females grooming. Photo by Thomas T. Struhsaker.

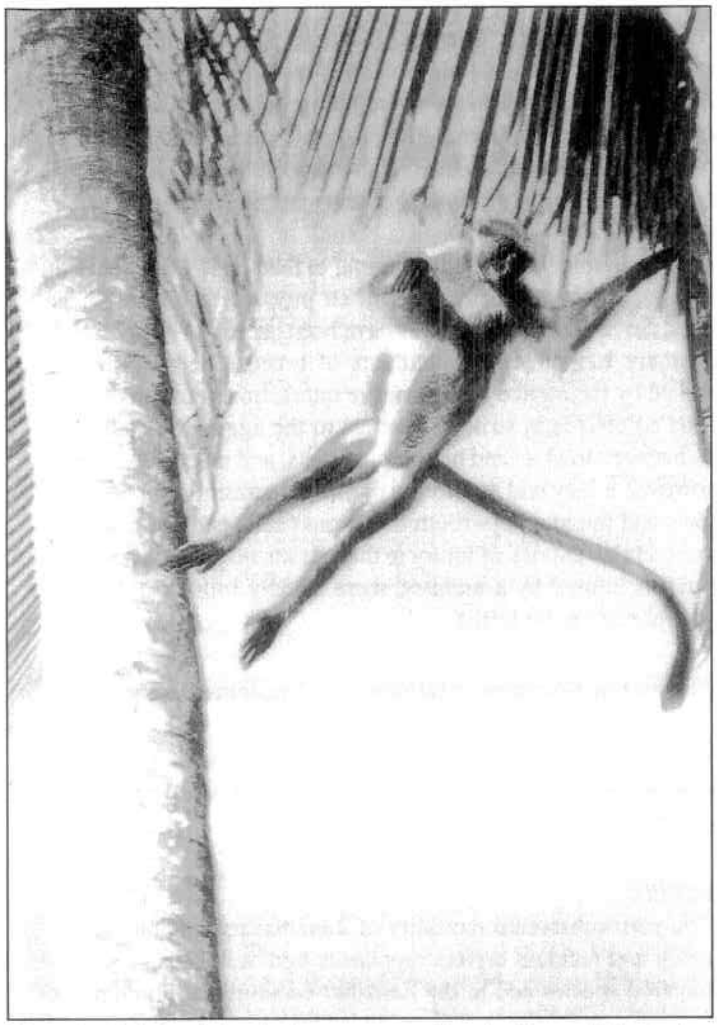

Figure 4. Adult female leaping between trees. Photo by Thomas T. Struhsaker.

tive to tourists. An annual loss of 12-17% of the monkeys due to road kills would appear to exceed the annual recruitment due to births. Given these estimates and unless something is done to reduce red colobus mortality due to reckless drivers, we predict that the red colobus groups living along the road at Jozani will eventually decline to a point where they are unlikely to attract a significant number of tourists.

It must be emphasized that not only are the red colobus threatened by careless and speeding drivers, but so too are the residents and tourists of this area because they walk and cycle along this same road.

In June of 1994 we recommended to the Zanzibar SCF that speed breaks (bumps) be constructed along a 2 km stretch of the main road between Pete and Jozani villages; approximately one kilometer on either side of the entrance to the Jozani Forest Reserve. A minimum of six breaks are required, but ten would be more effective. In 1996 this suggestion was made again in a request to the Deputy Principal Secretary of the Ministry of Agriculture, Livestock and Natural Resources. The suggestion of speed breaks at Jozani was endorsed at the ministerial level; however, as of October 1997 we are led to believe that the suggestion of speed breaks was finally rejected by the roads department.

An alternative of constructing overhead crossings using inexpensive ropes or cables has been suggested. However, it is unlikely to be effective at Jozani because there are few large trees

Figure 5. Medium/large juvenile male giving a "present type I" (a gesture of subordination, see Struhsaker 1975) to an adult male. Photo by Thomas T. Struhsaker.

near the road to which ropes or cables could be attached. Furthermore, these "bridges" would not protect human pedestrians and cyclists. We also think the red colobus might never learn to use rope and cable bridges because they appear not to associate the road and approaching vehicles as a threat. We have watched red colobus crossing this road hundreds of times and have never seen them look for approaching vehicles.

Increase the Size of the Protected Area and Strengthen Its Status

The current area of the Jozani Forest Reserve that is officially protected against all forms of extractive exploitation is only about 22 km². In 1993 one of us (TTS) proposed that this core conservation area be expanded to include the adjacent Unguja Ukuu Forest Reserve, as well as an area of some 2.5 km² to the south of Jozani Forest that is comprised of a mixture of coral-rag thicket, shamba, and mangrove (Fig. 8). This would have resulted in a core area of 57 km² (only 3.5% of the area of Zanzibar Island). Although the issue of land acquisition and expansion of the reserve has been discussed, no tangible action has been taken to date. Because approximately half of the red colobus live outside of legally protected reserves, it is critical to their conservation that adjacent land containing high densities of red colobus be incorporated into the reserve system. Negotiations on this issue are in progress between SCF, individual land tenants, and communities adjacent to the two reserves.

Approximately three years ago the Zanzibar SCF expressed its intention of upgrading the legal status of the Jozani Forest Reserve to a conservation status equivalent to that of a national park. Legislation has now been passed that will make this change possible from a legal standpoint. We hope this change in legal status will occur in the near future.

Regulate Tourists

Greater effort must be made to regulate tourists and to prevent physical contact and close proximity between them and the red colobus. Since we cautioned against the potential risks of this situation in 1994, there has been some progress in preventing contact and increasing the distance between tourists and the monkeys. This has been achieved by improved training of the guides

from the SCF with technical and financial assistance provided by CARE Austria. Nonetheless, in 1996, guides from certain private tour companies still succeeded in persuading the SCF guides to allow occasional violation of regulations.

We recommend that no more than six tourists be allowed to visit a specific social group of red colobus at any one time. Tourists should not be permitted to approach closer than 5 m to the monkeys. Visitors with obvious signs of flu or other respiratory diseases should be excluded from the range of the habituated monkeys.

Conservation Outside Reserves

It is impractical to give total protection to the entire range of the Zanzibar red colobus because of their wide and fragmented distribution over the southern part of the island. Those areas outside forest reserves that still have red colobus require a different approach to conservation. The approach will vary from place to place, but in all areas outside reserves, will depend largely on the cooperation and goodwill of the local people.

In those cultivated areas immediately adjacent to the Jozani Forest Reserve, it has been suggested that the revenue from tourists who come to see the monkeys and the forest should be shared with the local residents. In particular, revenue should be shared with those farmers who lease the land on which live the two main groups of red colobus most frequently visited by tourists. At present, all official fees (US$2.00 or T. Shs. 1,000 per tourist) go to the government central treasury. The tenants on whose land the tourists most often view the colobus receive no part of these fees. Discussions on revenue sharing were first initiated between one of these tenants and SCF in 1993. In 1996, SCF presented a revenue-sharing proposal for approval to the Ministry of Agriculture, Livestock, and Natural Resources. This was rejected and so another proposal was sent directly to the President's cabinet. Our undestanding, as of October 1997, is that the cabinet has agreed to the revenue sharing plan. In the meantime, a request for special donations from tourists visiting Jozani, in addition to the $2.00 fee, has succeeded in raising limited funds to be shared with the local community.

For those areas still having groups of red colobus that are more distant from Jozani it is more difficult to make specific recommendations. In these cases, effective conservation of red colobus is likely to depend more on education that aims to create tolerance and an ethic that is sympathetic to wildlife conservation. This, in turn, will depend on a much greater effort in conservation education of adults and school children in the rural areas that still have red colobus and other wildlife. At present, there is no systematic conservation education program in these areas of Zanzibar.

Improved Management of Natural Resources

As described earlier, violations of the laws regulating the use of natural resources on Zanzibar are common and widespread. There seems to be a poorly developed tradition of law enforcement in this regard. No employee of SCF has powers of arrest. Violators can only be apprehended by the police. We frequently heard allegations of corruption made against the authorities charged with enforcing the laws regulating natural resource use. This is a very serious problem because ineffective or sporadic law enforcement

Figure 6. Juvenile at play. Photo by Kirstin S. Siex.

encourages over-exploitation of the coral-rag forest, mangrove swamps and wildlife, such as duikers, and the killing of totally protected species like the Zanzibar red colobus.

We suggest that the following steps might help alleviate this problem: a) give SCF officers legal powers to arrest offenders; b) increase penalties for offenders; c) levy higher fees for forest products and wildlife (fees should increase annually in accordance with rates of inflation); d) increase salaries of SCF officers to encourage performance; e) create a bonus system for SCF guards and members of the public who report violations leading to the confiscation of illegally acquired forest products and wildlife and/or the arrest and conviction of the offenders; and f) train SCF officers and guards in law enforcement.

An important additional approach to management includes village participation. Here villagers become involved in the management and protection of natural resource use. This is being attempted by SCF with the management of mangrove swamps on Zanzibar. It is too early to evaluate the success and problems of this approach, but it is also being discussed and considered as a means of managing woodcutting in the coral rag and the hunting of duikers. The potential danger of this approach is the obvious conflict of interest. Those who exploit and profit from the resource are also the protectors, managers and regulators. It is likely to be successful only if there is effective supervision by some higher

Figure 7. Unguja Island, Zanzibar. Map provided by the authors.

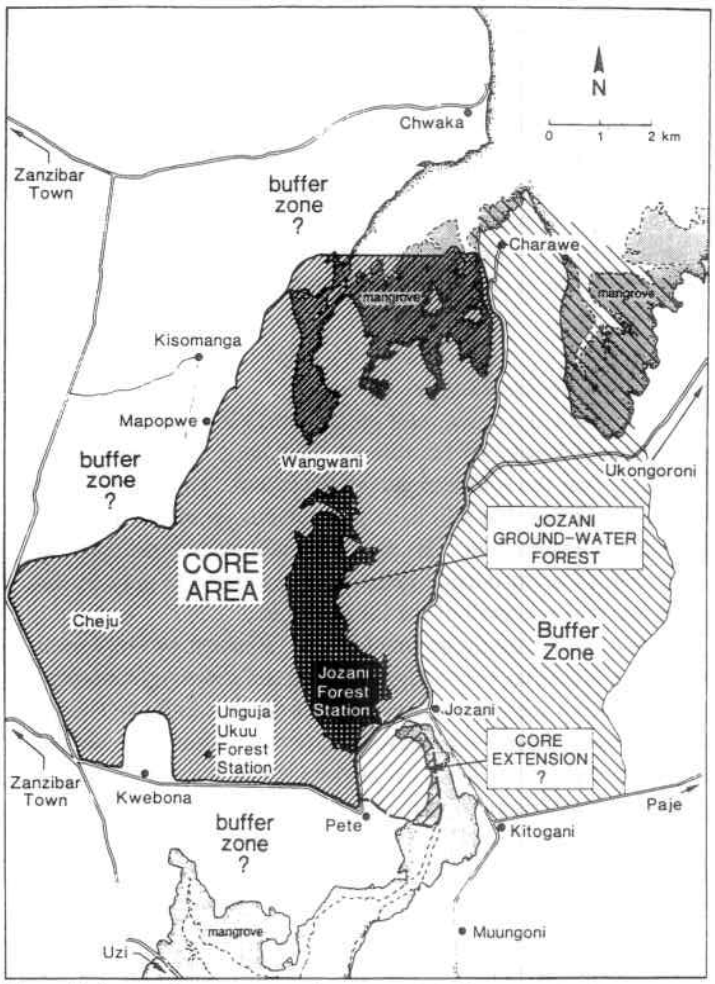

Figure 8. Proposed core conservation area and buffer zones for Jozani Forest Reserve. Map provided by the authors.

authority, such as SCF, to prevent over-exploitation. Such oversight, through regular monitoring by SCF, is included in the formal plan of collaborative management between SCF and the local communities that is currently being developed.

An equally important problem concerns the determination of a sustainable level of harvest. No studies of any natural resource have been done in sufficient detail to determine these levels. Consequently, sustainable exploitation is being attempted in the absence of a solid scientific basis. Similarly, we are not aware of any attempts to scientifically monitor the ecological effects of these attempts at sustainable harvest on Zanzibar.

Village participation in the management of the Jozani Forest Reserve is currently being discussed by SCF, CARE Austria, and the residents of Pete and Jozani villages. Involvement of local residents in the co-operative management of strict conservation areas without extractive exploitation may have fewer problems because there is no question of determining sustainable harvest levels. There is, however, the potential for overuse and degradation of an area by allowing too many tourists to visit it in order to increase profits from gate receipts.

The current practices of the National Hunters' Association should be critically reviewed and revised. In particular, the indiscriminate killing of most, if not all, mammalian species should be terminated immediately as it is contrary to the principles of scientific wildlife management and conservation. If hunting is to be legally sanctioned, then it should be based on a scientific plan, including monitoring of the impact by qualified personnel other than the hunters. We understand that a government-sponsored closed-season on antelope hunting, including the collection of guns and hunting nets by the police and other authorities, has been proposed and will likely be implemented soon.

Training

Conservation is still a very young discipline on Zanzibar. In general, both the Zanzibar SCF and Department of Environment have too few personnel with professional qualifications and practical experience in the areas of conservation biology and natural resource management. Steps are being taken to remedy this situation, primarily through overseas training. In our view, far more attention should be given to practical training on Zanzibar, i.e. training through research and implementation of conservation projects. Here too some progress has been made, such as with the training course in censusing red colobus monkeys that was given in 1996. Assigning SCF and Environment staff members to work with foreign researchers on Zanzibar is likely to be more effective because of the greater investment of time and because they are dealing with the practical problems specific to Zanzibar.

Figure 9. Adult male killed by a vehicle traveling at high speed within the conservation and tourist area at Jozani, Zanzibar. Photo by Thomas T. Struhsaker.

Resolving Human-Wildlife Conflicts

According to SCF officers, there is an increasing number of complaints about crop damage by red colobus on Zanzibar (Fig. 10). Our studies of the impact of red colobus on coconut yields demonstrate that these complaints are generally exaggerated and unwarranted. To the contrary, it would appear that red colobus feeding on coconuts, which is restricted to small and immature nuts, may increase the size of the final crop for the farmers. There is a significant positive correlation between the extent that red colobus feed on young coconuts and the size of the final, harvestable crop (Siex 1995). This is likely due to a pruning effect, a practice recommended by the National Coconut Development Project on Zanzibar and one based on experiments showing the benefits of pruning to final yields (Juma Issa pers. comm.). Not surprisingly, our results are met with disbelief by many farmers.

The impact of red colobus on other crops (e.g., mango, bananas, cassava) may, however, be detrimental to the final harvest. Here is an obvious and necessary area for research, which we strongly endorse. For the results of this research to influence the attitudes of farmers, we believe that they should participate in the research, e.g., as research assistants to qualified scientists who actually work in the field. We understand that a pilot project on this problem has been initiated by SCF. This will help address the disbelief many farmers have in research results. It will also clarify which species is actually doing the crop raiding. We believe that many of the accusations of crop-raiding made against red colobus are unjustified. More likely, they are blamed for the damage caused by the more secretive and less conspicuous Sykes' monkeys, which often accompany the large and noisy groups of red colobus as they pass through agricultural areas.

Figure 10. Adult male eating small, young coconuts. Photo by Thomas T. Struhsaker.

We also have concerns about conservation plans that attempt to integrate conservation with development. Although there has been a definite increase in awareness of the importance of the red colobus monkeys on Zanzibar, particularly in the vicinity of Jozani, we worry about some of the consequences of this increased awareness. Integrated conservation and development projects all too often run the risk of giving so much attention to the demands of the local people that they create a situation which is counter-productive to conservation (e.g., Oates 1996b).

For example, we feel that the complaints and demands made by some of the villagers living near the Jozani Forest Reserve about crop damage by red colobus and other wildlife are often false or exaggerated. The common approach taken by government officials and donor agencies is all too often one of simply asking the local residents about their problems and needs. But there is also a need to study and collect objective data on the problem. Too much uncritical attention raises hopes among the villagers of financial compensation and encourages exaggerated claims.

While we initiated and strongly endorse the concept of sharing tourist revenues generated by Jozani with the local residents, we think that compensation for crop damage is an untenable approach primarily because of the problems of verification. Appeals for removal of red colobus should be resisted because of their very low numbers and limited distribution. Relevant here is the fact that humans are able to use 98% or more of Zanzibar Island as they please, while only 2% or less of the island is totally protected for all the other species against exploitation by people.

Population Monitoring and Island-wide Survey

We recommend that a population monitoring program be established for the Zanzibar red colobus. In this program, attention

would focus on the core area of its distribution, i.e. the Jozani area, but not exclude other areas with smaller populations. Two methods would be employed: line transect censuses and counts of individual social groups. The latter technique would be applied primarily to habituated groups. A capture, mark, and release program would help refine our understanding of trends in dispersal, demography, disease and genetics. These censuses and counts should be conducted at least once each year. The results would provide information on demographic trends and problems of habitat degradation and loss that are critical to anticipating and dealing with conservation problems. Detailed studies and monitoring of the red colobus population in the Jozani area are particularly important because it is the largest and most viable population as well as being a major tourist attraction and generator of revenue.

Related to the monitoring program is a need for more detailed information on the distribution of, and threats to, the red colobus throughout Zanzibar. An island-wide survey has been initiated by SCF and the Department of Environment with a questionnaire that was sent to village leaders throughout the island.

Management and Funding of Conservation Areas

We strongly recommend that the Government of Zanzibar reinvest more funds into the protection and management of Jozani Forest Reserve and its adjacent wildlife areas. Equally important is the need for the Zanzibar Government to create a board or authority to deal specifically with protected areas throughout Zanzibar.

Human Population Growth

Most of the problems described can be attributed to the very rapid growth of Zanzibar's human population (3-4% per year) on an island with inherently low overall potential for agriculture. There are many proximate problems and threats facing the Zanzibar red colobus and some of these are being addressed. However, the ultimate problem of a rapidly expanding human population is not being dealt with. Until this problem is given highest priority, the future of all wildlife on Zanzibar remains problematic at best, as does the quality of life for the people living there.

Conclusion

Although much remains to be done, the Zanzibar Government through the SCF, and with assistance from FinnIDA and CARE (Austria), has taken important steps toward the protection of the Zanzibar red colobus monkey. We hope this paper will help guide and challenge those who are concerned with the conservation of the red colobus and other wildlife on Zanzibar.

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Authors' Addresses:
Thomas T. Struhsaker, Department of Biological Anthropology and Anatomy, Duke University, Box 90383, Durham, NC 27708-0383, USA.
Kirstin S. Siex, Department of Biological Anthropology and Anatomy, Duke University, Box 90383, Durham, NC 27708-0383, USA.

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Conservation Status of Primates in Cameroon

Leonard Usongo

WWF Lobéké Forest Project, Yaoundé, Cameroon

Introduction

Cameroon (*c.* 475,000 km²) is the twenty-third largest country in Africa. With respect to biodiversity, it ranks fifth among African countries, with over forty globally threatened animal species (WRI 1990). Cameroon has almost the same number of primate species as Zaire (first ranking in Africa in this respect) even though it is only one-fifth the size. Cameroon contains savanna and two primate-rich forest communities, Cameroon and Western Equatorial (Oates 1986, 1996). The exceptionally high biological diversity in Cameroon is attributed to the large remaining tracts of relatively undisturbed lowland humid forest (Gartlan 1989). It is also attributed to a broad range of diverse ecological habitats as shown in Table 1. This diversity is produced by gradients in elevation and rainfall, and by geographical affinities with both Western and Central African ecotypes.

Twenty-nine primate species are known to occur in Cameroon. Conservation ratings for the species, using the IUCN/PSG parameters of Oates (1986), are shown in Table 2, with a few modifications based on recent observations (Usongo 1996).

Potential Threats to Species Survival

The greatest threats to primates in Cameroon, as in many other African countries, are habitat destruction and hunting. Most of Cameroon's primates inhabit the rain forest regions of the central and western sectors of the country. The timber trade ranks fourth, after petroleum, cocoa and coffee, in terms of gross national income. Cameroon is the sixth-largest exporter of tropical hardwood in the world, and third in Africa (Amine and Besong 1990).

Both commercial and subsistence hunting are major threats to species' survival. The drop in prices of cash crops, such as coffee and cocoa, coupled with the prevailing economic crisis and devaluation of the CFA franc, have put more pressure on the natural resources. Primates are hunted mostly for food, although a few (*Miopithecus* sp. and *Gorilla gorilla*) are hunted for medicinal purposes, and others (*Pan troglodytes*) for pets.

Protected Areas System

By government law, 20% of Cameroon is to be designated as protected areas under the following categories: national parks, faunal reserves, protection forests and sanctuaries. Cameroon has seven national parks (but only Korup is located in the dense forest zone), and nine faunal reserves. This represents a total area of about 9,730 km². Most of the national parks are concentrated in the northern savannas. Many faunal reserves have suffered from massive degradation or are currently exploited for timber. The national system of protected areas is both extensive and representative of the diverse biotic communities. Unfortunately, poor standards and inefficient management have reduced the effectiveness with which the system functions. Faunal reserves have been proposed for Boumba Bek, Nki and Lobéké (Usongo and Fimbel 1995; Usongo and Curran 1996) in the Congolian semi-deciduous forest region.

Species and Regional Primate Communities

The lack of baseline ecological data on the populations of various species has made it difficult to identify areas of conservation importance. Existing information could be obsolete as most reserves have been abandoned or over-exploited. However, there is some hope for future conservation efforts. The government of Cameroon is developing a long-term conservation program aimed at protecting critical biomes in the country. The high biodiversity of the country, that includes over 40 globally threatened animals (Aipert 1993) associated with a broad range of ecological habitats that include rich lowland humid tropical forest, is seriously threatened by deforestation and conversion of forest land for agricultural purposes. The increasing loss in forest land seriously threatens species survival and more importantly has led to rapid fragmentation and biodiversity loss. Against this background, the government of Cameroon, with support from The World bank through the Global Environmental Facility Program (GEF), other donors, and international NGOs such as the World Wide Fund for Nature (WWF), is working towards the identification, protection and management of key areas of conservation importance within the major

Table 1. Major vegetation types of Cameroon.

Vegetation type	Location	Main subtypes	% country	% protected	% degraded
Savanna (<260,000 km²)	North	Sahelian Sudanese	57	3	70
Montane evergreen forest (<98,000 km²)	West (small isolated areas)		21	<1	>60
Lowland, semi-deciduous forest (>40,000 km²)	Center		9	0	?
Lowland evergreen forest (<150,000 km²)	South	Biafran littoral Congolian Submontane	34	4	60

ecological zones of the country. Inventories are also being conducted in unknown areas suspected to be rich, but with little biological information, to enhance knowledge on the country's biological diversity and potentials within the various ecological zones.

Species

Table 2 presents a listing of the primate species and subspecies currently recognized as occurring in Cameroon. The survival of many of them, with low population densities and/or limited geographical ranges, is seriously threatened by large-scale hunting and commercial logging. Of the 33 primate taxa listed, nine were listed as threatened in *The IUCN Red Data Book* for African Primates of 1988 (Lee *et al.* 1988; see Table 2). Eight Cameroon primates were considered threatened following the evaluation which resulted in the *1996 IUCN Red List of Threatened Animals* (IUCN, 1996). The drill *Mandrillus leucophaeus*, Preuss's monkey *Cercopithecus preussi*, the chimpanzee *Pan troglodytes*, and the gorilla *Gorilla gorilla*, are classified as "endangered", and red-eared guenon *Cercopithecus erythrotis* and the black colobus *Colobus satanas* are classified as vulnerable. Two subspecies occurring in Cameroon, the Fernando Po crowned monkey *Cercopithecus p. pogonias*, and Preuss's red colobus *Procolobus badius preussi* are listed by IUCN (1996) as endangered (see Table 2). The two most important differences between the 1988 classification (Lee *et al.* 1988) and that of IUCN (1996) are that Lee *et al.*(1988) considered *Cercocebus torquatus* and *Mandrillus sphinx* to be "vulnerable", whereas they were given "Lower Risk" status in 1996. In the Cameroon, at least, both *C. torquatus* and *M. sphinx* are vulnerable. Of the other forms considered by Lee *et al.* (1988), those they listed as threatened were likewise considered threatened in IUCN (1996), with some changes in category from vulnerable to endangered or vice versa (Table 2).

More than 19 species are here classified as endangered, highly vulnerable and vulnerable. Considering taxonomic uniqueness, habitat range and especially hunting and habitat destruction, factors that have a direct bearing on species survival, the following classification could be made for species in Cameroon. Five species are considered "endangered" (*M. leucophaeus*, *C. p. preussi*, *P. badius preussi*, *C. torquatus*, and *C. erythrotis*), six are considered "highly vulnerable" (*M. sphinx*, *C. agilis*, *C. satanas*, *C. n. martinii*, *G. g. gorilla* and *C. neglectus*) and the others vulnerable (Table 2). Some of those listed as highly vulnerable such as *C. erythrotis* should perhaps be considered "endangered" due to limited distribution and over hunting in the country (Usongo 1996).

Of the primates occurring in Cameroon, Oates (1986, 1994, 1996) showed that those with the highest conservation priority rating on a continental scale are *M. leucophaeus*, *P. badius preussi*, *P. t. troglodytes*, and *G. g. gorilla* (Table 2). The drill *M. leucophaeus* was ranked by Oates (1996) as the highest priority of any of Africa's primates (see also Butynski 1996/1997). Based on his arguments and recent field observations (Usongo 1996), those of the highest conservation rating in Cameroon would also include *Cercopithecus erythrotis* and *Colobus satanas* (Table 2). Also of high conservation priority for Cameroon are: *Cercocebus torquatus*, *Cercocebus galeritus*, *Mandrillus sphinx* and *Colobus guereza*.

Regions

In Cameroon, the majority of the species are those of two major primate communities, namely the Cameroon region and the Western Equatorial region (White 1983; Gartlan 1989; see also Oates 1996) (Fig. 1). Just three species, *Erythrocebus patas*, *Papio anubis* and *Cercopithecus aethiops*, are typical of the savanna in the north of the country.

The Cameroon region is centered around Mount Cameroon in the north-east of the country. It extends from eastern Nigeria to the River Sanaga in the south, and includes the nearby 2,000 km² continental island of Bioko (formerly Fernando Po) of Equatorial Guinea. Seventeen (51%) of the country's 33 primates occur in

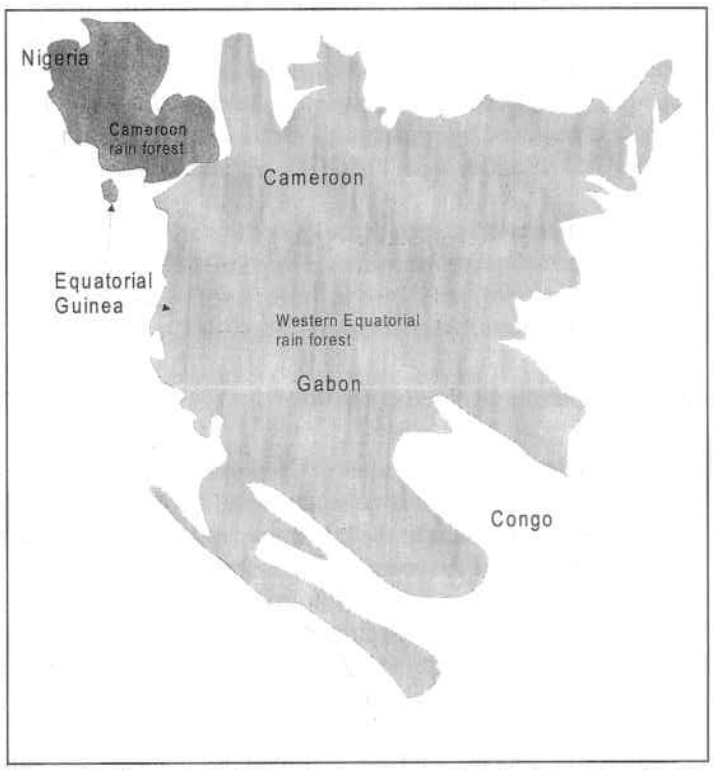

Figure 1. The two distinct primate communities in Cameroon. 1) The Cameroon region centered on Mt. Cameroon and extending from eastern Nigeria to the Sanaga River, and 2) The Western Equatorial Africa region comprising the forest zone of Cameroon south of the Sanaga river, Gabon, mainland Equatorial Guinea, the Congo Republic, the far south of the Central African Republic, and the Angolan enclave of Cabinda and the Mayombe Forest of Zaire, south of the Congo River (from Oates 1996).

Table 2. The primates of Cameroon and their conservation status.

Species	Abundance in range[1]	Status[2] Lee *et al.* (1988)	Status[3] IUCN (1996)	Priority rating[4] Oates (1996)	Status in Cameroon[5] Usongo (1996, this study)	Degree of threat caused by[6] Hunting	Habitat destruction
Family Loridae							
Subfamily Lorinae							
Arctocebus aureus[7]	?	NC	LR	4	NT	1	1
Arctocebus calabarensis	?	K	LR	4	NT?	1	1
Perodicticus potto edwardsi	?	NT	LR	3*	K?	1	1
Subfamily Galaginae							
Galagoides demidoff murinus	xxx	NT	LR	2	NT?	1	2
Galagoides t. thomasi	xxxx	K	LR	2	NT	1	1
Galago alleni cameronensis[8]	xxx	NT	LR	3	NT?	1	2
G. alleni gabonensis	xxxx	NT	LR		NT	1	2
Galago s. senegalensis	xxx	NT	LR	2	NT?	1	2
Euoticus elegantulus	xx	NT	LR	4	NT?	1	1
Euoticus pallidus[9]	xxx	NC	LR	4	NT	1	2
Family Cercopithecidae							
Subfamily Cercopithecinae							
Cercocebus torquatus	x	V	LR	3	EN	3	1
Cercocebus agilis[10]	xx	NT	LR	NC	HVU	3	1
Lophocebus albigena	xxx	NT	LR	3	VU	2	1
Papio anubis	xxxx	NT	LR	2	NT	1	1
Mandrillus sphinx	xx	V	LR	4	HVU	2	1
Mandrillus l. leucophaeus	x	E	EN	5	EN	3	1
Cercopithecus p. preussi	x	E	EN	4*	EN	3	2
Cercopithecus n. nictitans	xxxx	NT	LR	2*	V	3	1
Cercopithecus n. martini	xx	NC	LR	2*	HVU	2	2
Cercopithecus erythrotis	x	E	VU	3	EN	2	2
Cercopithecus cephus	xxx	NT	LR	2	VU	2	1
Cercopithecus mona	xxx	NT	LR	2	VU	2	2
Cercopithecus p. pogonias[11]	xxx	NC	VU	4	VU	2	1
Cercopithecus p. grayi	xxx	NT	LR	2*	NT	1	1
Cercopithecus neglectus	xx	NT	LR	3	HVU	1	1
Cercopithecus aethiops tantalus[12]	xxxx	NT	LR	3*	NT	1	1
Miopithecus sp.[13]	xxxx	NT	LR	4	NT	1	1
Erythrocebus patas	xxxx	NT	LR	3	NT	1	1
Subfamily Colobinae							
Procolobus badius preussi[14]	xx	E	EN	6	EN	3	2
Colobus satanas	xx	E	VU	4	HVU	2	2
Colobus guereza	xxx	NT	LR	2	V	2	2
Family Pongidae							
Pan t. troglodytes	xxx	V	EN	5*	V	2	2
Gorilla g. gorilla	xxx	V	EN	6	HVU	3	1

[1] Abundance within range: ? = Unknown; xxxx = Abundant; xxx = Common; xx = Sporadic; x = Rare.

[2] Conservation status using former IUCN categories (Lee *et al.* 1988): E = Endangered; NC = Not considered; K = Insufficiently known; NT = Not threatened.

[3] Conservation status using the new IUCN Mace-Lande categorization (IUCN 1996): EN = Endangered; VU = Vulnerable; LR = Lower Risk.

[4] Oates (1996) established conservation priority ratings on the basis of degree of threat (a scale of 1-5 based on IUCN [1996], with 1 = Low risk; 2 = At risk; 3 = Vulnerable; 4 = Endangered; and 5 = Critically endangered) summed with taxonomic distinctiveness (a scale of 1-2, with one point for a species belonging to a genus, subgenus or species-group with three or more members and/or its status as a full species is sometimes questioned, and two points for a species with no more than one close relative (a member of the same species group, subgenus or genus). * = rating as for species.

[5] Estimated status in Cameroon: NT = Not threatened; K = Insufficiently known; HVU = Highly vulnerable; VU = Vulnerable; EN = Endangered; ? = Status not well known.

[6] Degree of threat in Cameroon from hunting or habitat destruction: 1 = Small; 2 = Moderate; 3 = Severe.

[7] *Arctocebus aureus*, formerly considered a subspecies of *A. calabarensis*, was recognized as a full species by Maier (1980).

[8] Two subspecies of *G. alleni*, *G. a. cameronensis* from the northwestern Cameroon, occurring between the rivers Niger and Sanaga, and *G. a. gabonensis*, occurring between the rivers Sanaga and Oguooé (Kingdon 1997).

[9] *Euoticus pallidus* was recognized as valid species by Groves (1989).

[10] *Cercocebus agilis* was considered a subspecies of *C. galeritus* until 1978. Considered a valid species by Groves (1978) and Kingdon (1997). Oates (1996) listed *C. galeritus* for Cameroon.

[11] *Cercopithecus p. pogonias* was formerly considered a subspecies of the mona monkey, *C. mona*. *C. mona* is now considered a superspecies of six forms, one of them *C. (mona) pogonias* (see Groves 1993; Oates 1996; Kingdon 1997).

[12] *Cercopithecus aethiops* is considered a superspecies by Kingdon (1997). He listed the form *tantalus* as a full species, *C. (aethiops) tantalus*, the nominate subspecies, *C. (a.) t. tantalus*, occurring in Cameroon.

[13] Kingdon (1997) regards the talapoin monkey of the Western Equatorial region as distinct from *M. talapoin* (occurring south of the River Zaire). He refers to it as *M. ooguensis*, a *nomen nudum* in anticipation of its formal description. Oates (1996) refers to it as the northern talapoin, *Miopithecus* sp.

this Cameroon region; ten are restricted to it, and seven also occur to the east and south of the River Sanaga in the Western Equatorial Region (Table 3).

The Western Equatorial region comprises the forest zone of Cameroon, south of the Sanaga River, the eastern Gabon mainland, Equatorial Guinea, the Congo Republic and the far south of the Central African Republic, together with the Angolan enclave of Cabinda and the Mayombe Forest of Zaire (White 1983; Gartlan 1989; Oates 1996). Nineteen (58%) of Cameroon's primates occur in this Western Equatorial region; 12 of them are restricted to it, and seven also extend north and west into the Cameroon region (Table 3). The region supports the largest populations of *G. gorilla* and probably *P. troglodytes* in Africa (Oates 1986, 1996).

Table 3. The species and subspecies of the primate communities of the portions of the Cameroon Region and the Western Equatorial Region (as defined by White 1983, see also Oates 1996) in Cameroon.

Cameroon	Western Equatorial
	Arctocebus aureus[1]
Arctocebus calabarensis[2]	
Perodicticus potto edwardsi	*Perodicticus potto edwardsi*
Galagoides demidoff murinus	*Galagoides demidoff murinus*
Galagoides thomasi thomasi	*Galagoides thomasi thomasi*
Galago alleni cameronensis[2]	
	Galago alleni gabonensis[1]
	Euoticus elegantulus[1]
Euoticus pallidus[2]	
Cercocebus torquatus	*Cercocebus torquatus*
Lophocebus albigena	*Lophocebus albigena*
	Cercocebus agilis
Mandrillus leucophaeus leucophaeus[1]	
	Mandrillus sphinx[1]
Cercopithecus preussi preussi[1]	
Cercopithecus nictitans martini	
	Cercopithecus nictitans nictitans
Cercopithecus erythrotis[1]	
	Cercopithecus cephus[1]
Cercopithecus mona[2]	
Cercopithecus pogonias pogonias[1]	
	Cercopithecus pogonias grayi
	Cercopithecus neglectus
	Miopithecus ooguensis[1]
Procolobus badius preussi[1]	
	Colobus satanas[3]
	Colobus guereza
Pan t. troglodytes	*Pan t. troglodytes*
Gorilla g. gorilla	*Gorilla g. gorilla*

[1] Endemic to the Region. Taxa in the Cameroon Region not occurring in the Western Equatorial Region extend west into the Southern Nigeria Region (southern Benin and east to the Cross River in Nigeria) (White 1983; Oates 1996).
[2] Primates restricted to the Cameroon Region and Southern Nigeria Region.
[3] Largely endemic, there is also a population of *C. satanas* on Equatorial Guinea's Bioko Island (Cameroon Region).

Areas of Conservation Importance

Important areas for conservation are those known to harbor many primate species or that have a high level of species endemism. Important areas for primate conservation in the country include: Korup National Park, Dja Faunal Reserve, Takamanda Forest Reserve and the bordering forest region of Mamfe-Obudu in the Nigeria Campo Reserve, Mount Cameroon, Rumpi Hill Reserve, Bakossi Mountains, Banyang-Mbo Reserve, Douala-Edea Reserve, and the proposed reserves of the lowland evergreen forest of south-east Cameroon (Lac Lobéké, Boumba Bek and Nki) (Fig. 2). A list of the endangered or highly vulnerable primate species that occur in some of these protected areas is given in Table 4.

About 17 different primate species occur in Korup National Park (1,260 km²), the only rain forest national park. Endangered primates known to occur there include *M. leucophaeus*, *P. badius preussi*, *C. erythrotis* and *C. torquatus*. Other species considered highly vulnerable or threatened occurring in Korup include *P. troglodytes*. The greatest threat facing the populations of these species in Korup is hunting. There are six villages inside the park pending resettlement, and these villagers depend on the forest for their survival. They depend primarily on hunting and fishing as a major source of protein. The park services do frequently undertake anti-poaching missions to curb the trend of hunting, although this is somewhat counterproductive to conservation efforts in the region due to an increasing resentment manifested by the local population towards the park authorities. By Cameroon law no hunting or any form of human exploitation of natural resources is allowed in the national park. However, it is extremely difficult to implement this in an area such as Korup, where people live inside the park and have strong ancestral and cultural links with it. A long-term biological program has been established by the park authorities to monitor especially populations of the various large mammal species that are heavily hunted in the region. The management is also focusing efforts on the development of a buffer zone to meet local needs and check human encroachment.

The Dja reserve (*c.* 5,000 km²) is a Biosphere Reserve, and also considered a World Heritage Site. The primates there are typical of the Western Equatorial Region, and those of conservation importance include: *C. agilis*, *C. satanas*, *G. g. gorilla* and *P. troglodytes*. It is the only reserve in the country known to harbor a large population of the northern talapoin, *Miopithecus* sp. There are a few human settlements in the Dja reserve and a small com-

Table 4. Endangered and vulnerable primate species in some protected areas in Cameroon (see Fig. 1).

Species	Korup	Bakossi Mts.	Takamanda	Douala-Edea	Campo	Dja	Banyang MBo	Mt. Cameroon	SE Cameroon[1]
	1260 km²	400 km²	670 km²	1600 km²	2700 km²	5000 km²	500 km²	1750 km²	6000 km²
Cercocebus agilis	-	-	-	-	-	-	-	-	x
Cercocebus torquatus	x	x	?	-	-	-	x	-	-
Cercopithecus erythrotis	x	x	x	-	-	-	-	?	-
Cercopithecus p. preussi	-	x	x	-	-	-	?	x	-
Procolobus badius preussi	x	-	-	-	-	-	-	-	-
Colobus satanas	-	-	-	x	x	-	-	-	-
Mandrillus sphinx	-	-	-	-	x	-	-	-	-
Mandrillus l. leucophaeus	x	x	x	-	-	-	x	x	-
Pan t. troglodytes	x	x	x	-	x	x	x	x	x
Gorilla g. gorilla	-	-	x	-	x	x	-	-	x

[1]SE Cameroon (Lac Lobéké, Boumba Bek and Nki)

munity of baka pygmies who are known as indigenous forest people and traditional hunter-gatherers. These people largely depend on hunting, although most of the weapons used are traditional spears and bows and arrows. The native Bantus use guns for hunting primates and big game such as elephants, and snares for forest antelopes.

The management of the reserve is supported by funding from the European Union that has greatly assisted in the establishment of both research and management infrastructure. Anti-poaching missions are routinely organized by the game guards in the region. The timber companies operating to the south of the reserve pose a serious threat to the region, with the influx of workers and job seekers who largely depend on hunting as a source of income. These companies also open up large portions of the forest and the paths they cut facilitate access to hitherto unexploited areas.

The Campo Wildlife Reserve (2,700 km²) is of great importance in terms of the endangered or vulnerable primates it protects. Species known to occur there include, *G. g. gorilla*, *P. t. troglodytes*, *C. satanas*, *C. torquatus* and *M. sphinx*. Conservation and species survival in the region is seriously threatened by hunting and timber exploitation that has led to the disappearance of large tracts of forest. The reserve is on the frontier with the Republic of Equatorial Guinea, and the largely unguarded borders has led to an influx of foreign hunters armed with modern weapons.

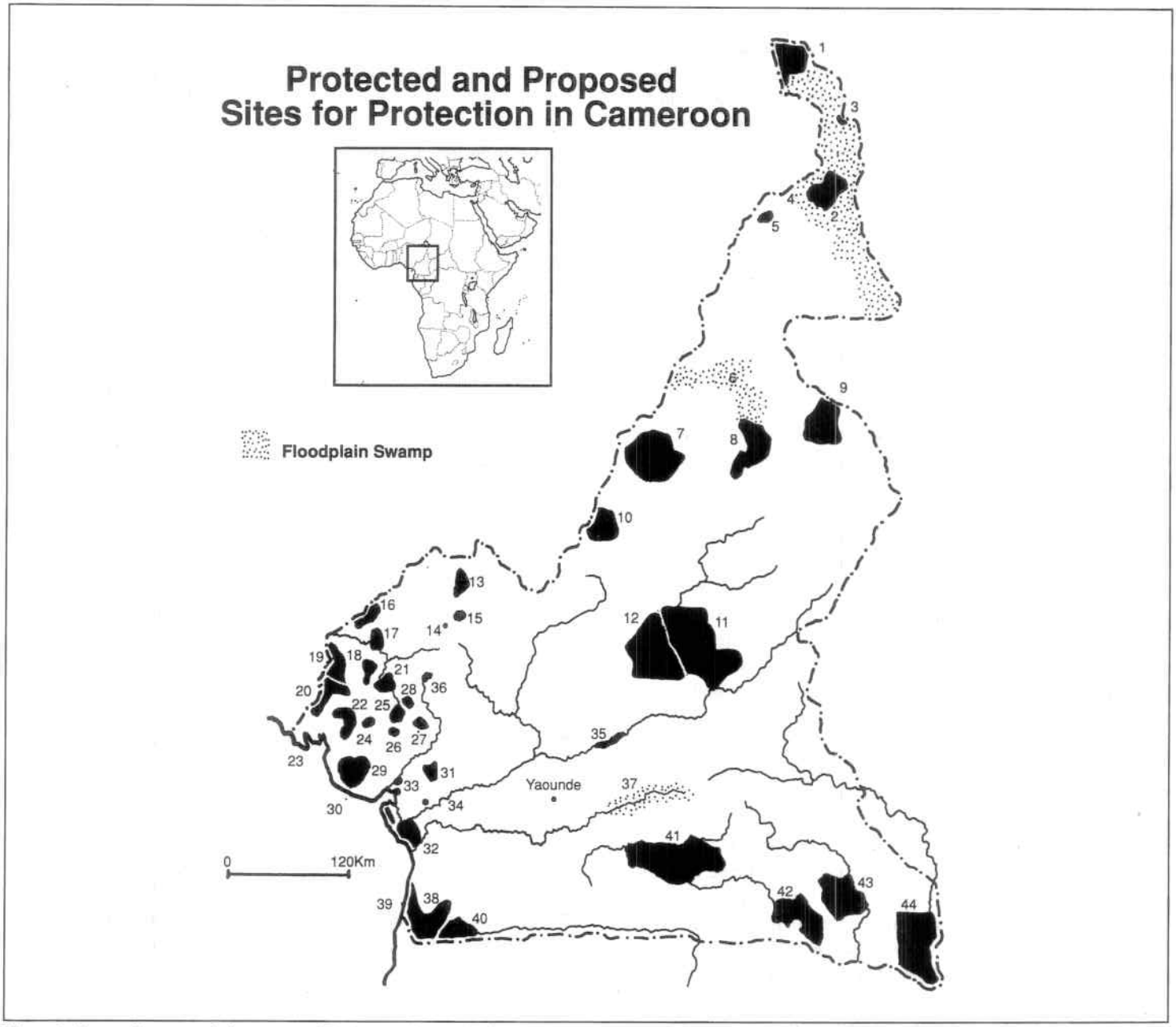

Figure 2. Protected areas, and sites proposed for protected areas in Cameroon. NP = National Park, WR = Wildlife Reserve, FR = Forest Reserve. Areas without a given category are those proposed. 1. Lake Chad, 2. Logone floodplains, 3. Kalamaloué NP, 4. Waza NP, 5. Mozogo-Gokoro NP, 6. Faro/Kebi/Benoué floodplains, 7. Faro NP, 8. Benoué NP, 9. Bouba-Njidah NP, 10. Tchabal Mbabo, 11. Pangar-Djerem, 12. Mbam-Djerem, 13. Kimbi River WR, 14. Mbi Crater WR, 15. Mt. Oku (Mt. Kilum), 16. Takamanda FR, 17. Mawne River FR, 18. Nta Ali FR, 19. Ejagham FR, 20. Korup NP, 21. Banyang Mbo FR, 22. Rumpi Hills FR, 23. Rio del Rey mangroves, 24. Lake Barombi Mbo, 25. Bakossi Mts., 26. Mt. Koupé, 27. Mt. Nlonako, 28. Mt. Manengouba, 29. Mt. Cameroon, Etinde, Mokoko FR, Bambuko FR, 30. Cape Limboh, 31. Bonepoupa FR, 32. Douala-Edéa FR, 33. Lake Ossa FR, 34. Sanaga WR, 35. Nanga Eboko WR, 36. Santchou WR, 37. Nyong swamps, 38. Campo WR, 39. Rocher du Loup, 40. Ma'an FR/Boucles du Ntem, 41. Dja WR, 42. Nki forest, 43. Boumba Bek forest, 44. Lake Lobéké forest. Map drawn by Stephen D. Nash.

The Takamanda reserve and the forested regions between Mamfe and Obudu in Nigeria are of extreme importance to primate conservation. Takamanda has the only remaining significant population of *G. gorilla* (the undescribed western highland form). The region is also important for the occurrence of endangered or vulnerable species such as *C. preussi*, *M. l. leucophaeus* and *P. troglodytes*. However, the current trend of hunting and habitat destruction through farming and logging are of major concern. Law enforcement and management of the reserve is non-existent. The enclave nature of the region makes it difficult to argue strongly for urgent measures to redress the situation.

The Mount Cameroon region is important for the presence of endangered *C. preussi* and *M. l. leucophaeus*. Local people hunt the latter using dogs. Most of the forest within the mountain range has been heavily exploited by the surrounding local population, and some parts have been converted to agricultural land. Being a volcanic area, the soils in the region are extremely dark and rich in humus, which has attracted many farmers and settlers who depend on agriculture for their livelihood. Current conservation efforts in the region are supported by the British Overseas Aid (ODA), The World Bank through GEF, and the German development agency GTZ.

Bakossi Mountain harbors a significant population of *C. preussi*. Other species of conservation concern include: *M. l. leucophaeus* and *P. t. troglodytes*. They are threatened by large-scale clearance of forests for cocoa cultivation and hunting. At present, there is no government investment in the Bacchus region, which makes it difficult to assess the future there in terms of conservation and protection of the primate species.

The Douala-Edea Reserve is important for its significant population of *C. satanas*. Increasing hunting and logging activities in the region seriously threaten the survival of this species and its extermination in the area is a real possibility. Presently a local NGO known as Cameroon Wildlife Conservation Society (CWCS), with funding from the Netherlands committee of the IUCN, is undertaking baseline zoological inventories to assess the populations of the various large mammal species in the reserve and is also carrying out socio-economic surveys to evaluate natural resource use and the impact of the local population. Management of the reserve is poor, with only a conservation officer and a single game guard to coordinate management activities in the entire region.

Banyang-Mbo Reserve is important for *M. l. leucophaeus* and *P. t. troglodytes*. These species are threatened by large-scale clearance of forests for cocoa cultivation and hunting. There are two villages, with an estimated population of about 500 inhabitants, residing in the northern portion of the reserve. Primate hunting is common, using a 12- gauge locally made short gun. Most of the primates hunted are sold locally for markets in the big cities. Conservation and management of the reserve is coordinated by the international New York based NGO Wildlife Conservation Society (WCS). Presently WCS is establishing a long-term wildlife monitoring program for the reserve and developing an education and community extension component to liaise with the local population.

Finally, the forests of south-east Cameroon (Lobéké, Boumba Bek and Nki) covering approximately 6,000 km², are most important for the diverse primate communities occurring there, and include some of the highest densities of *G. g. gorilla* and *P. troglodytes* ever reported in Africa (see Usongo, 1997). Presently, populations of these species are not threatened by hunting, as it is predominantly by the indigenous forest people, the baka pygmies, who use poisoned arrows for hunting. The snares are widely used to hunt other species, notably the small- and medium-sized forest antelopes. The biggest threat to the region is logging, being the source of more than 60% of the tropical hardwood exported by Cameroon. There are more than 29 timber companies operating in the south-east of Cameroon, most of them owned by the French and some by other Europeans (Italians, Belgians, Dutch, for example). Others are owned by Cameroon nationals and a few by multi-national industries.

There is an increasingly effective campaign for sustainable logging along with general conservation measures aimed at protecting this rich forest block of the Congo basin. Support for conservation efforts in the region is provided by GEF, WWF and GTZ.

Recommended Action

Human activities make it inevitable that a large part of the world's primate populations and their habitats will disappear (Oates 1994). Urgent conservation measures should be taken to mitigate the losses. These measures include:

- strengthening forest protection efforts and monitor primate populations;
- the establishment of long-term ecological monitoring programs;
- the establishment of faunal reserves in areas of high primate density and abundance;
- the protection and management of areas identified as harboring endangered or vulnerable species;
- the improvement of the existing infrastructure and management of national parks and reserves;
- encouraging alternative income-generating initiatives in order to reduce hunting pressure on various populations;
- training and the supply of equipment for game guards and other management personnel;
- encouraging local participation and integration in resource management.

Consolidation of these measures requires more field work focusing on:

- systematic and intensive surveys of areas suspected of harboring high densities of endangered or vulnerable species;
- the training of nationals in ecological research and resource management, to ensure long-term management and monitoring of species' populations;
- the development of an integrated conservation strategy for protected areas.

Systematic surveying requires the use of satellite imagery maps to identify and delineate habitats and vegetation types, the evaluation of the extent of habitat destruction and the assessment of areas still covered by relatively intact forest. Ground-truthing aimed

at assessing species' abundance, geographical limits and threats to the primates is also necessary. National capacity-building could be carried out through on-the-job training and supervision. Most existing parks and reserves lack adequate manpower. This has greatly reduced the efficiency of the park management service, run by the Ministry of Forests and Environment (MINEF).

The development of a conservation strategy for protected areas calls for an integrated approach towards resource management. This should address the issue of local participation in resource management within protected areas, especially where they are seen as a burden; only with collaboration from the local populace can effective conservation be possible. When seen as a positive benefit, local communities will become an ally to the authorities, thereby protecting the area from development schemes evidently incompatible with the conservation of the local or regional wildlife.

From a conservation standpoint, Cameroon still maintains a unique position owing to its varied and diverse habitat types and significant populations of endemic and endangered species. However, much work needs to be done to ensure long-term monitoring and management of the critical sites known to have important primate communities. Immediate action should include baseline surveys to identify areas of primate species richness and diversity, as well as primate abundance, geographical distributions, and immediate threats to their survival.

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Author's Address:
Leonard Usongo, Senior Conservation Biologist, WWF Lobéké Forest Project, P.O. Box 6767, Yaoundé, Cameroon.

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Conservation Status of Primates in the Proposed Lobéké Forest Reserve, South-east Cameroon

Leonard Usongo

WWF SE Cameroon Forest Project, Yaoundé, Cameroon

Introduction

The Lobéké forest contains some of the highest population densities of large mammals found in an African forest. They include antelopes, such as the bongo (*Boocercus euryceros*), sitatunga (*Tragelaphus spekei*), yellow-backed duiker (*Cephalophus silvicultor*), and *Cephalophus* spp. The elephant, *Loxodonta africana*, population estimated at 4-6/km² is reportedly the highest in the Central African forest region (Stromayer and Ekobo 1992; Ekobo 1993). Stromayer and Ekobo (1992) provided density estimates for chimpanzees *Pan troglodytes* and gorillas *Gorilla gorilla*, at 0.61 and 2.5 nesting individuals/km², respectively. The Lobéké forest harbors some of the largest populations of the lowland gorilla in Africa. In addition, Ekobo (1993) reported healthy populations for several primate species, although the primate fauna of south-east Cameroon remains poorly known (Masazumi 1991).

The Lobéké forest is well-known internationally due to its contiguity with protected areas in the neighboring Central African Republic (CAR) (Dzangha-Sangha Dense Forest Reserve) and Congo (Nouabale-Ndoki National Park). The designation of the Lobéké Forest Reserve is, therefore, an important step by the government of Cameroon towards the regional tri-national program aimed at protecting the rich fauna of the Congolian forest.

Since 1989, two international NGOs, the World Wide Fund for Nature (WWF) and the Wildlife Conservation Society (WCS) have worked towards the development of a long-term conservation program in the region. The results presented in this paper represent part of a larger research program aimed at developing a management plan for the proposed Lobéké Forest Reserve.

Study Area

The proposed Lobéké Forest Reserve (2,000 km²) is located in the south-eastern part of the Republic of Cameroon (2°05' and 2°30'N and 15°33' and 16°11'E). It is bounded to the east by the Sangha River that serves also as the international boundary between Cameroon, Congo and CAR, to the north by the Lobéké and Longue rivers, in the west by Djombi River, and to the south by rivers Bolou and Moko Paka (Fig. 1).

The climate of the area is characterized by rainfall virtually throughout the entire year. Annual rainfall is about 1,400 mm. The main rainy season is from September to November, and the dry season from December to February.

The vegetation of the area is dominated by semi-deciduous forest. About 60% is represented by species of the families Sterculiaceae (*Triplochiton*, *Eribroma*), Meliaceae (*Entandrophragma*), Mimosaceae, Sapotaceae and Annonaceae. The understorey is rich in herbaceous species that include Maranthaceae (*Megaphryruim*, *Macrostachyus, Sarcophrynium*), Zingiberaceae (*Afromomum*) and Commelinaceae (*Palisota*). The vegetation of the forest is also characterized by single stands of *Gilbertiodendron dewevrei*, a Caesalpiniaceae. These vegetation types are interspersed in a mosaic of forest successional stages, swamps, marshes and forest clearings.

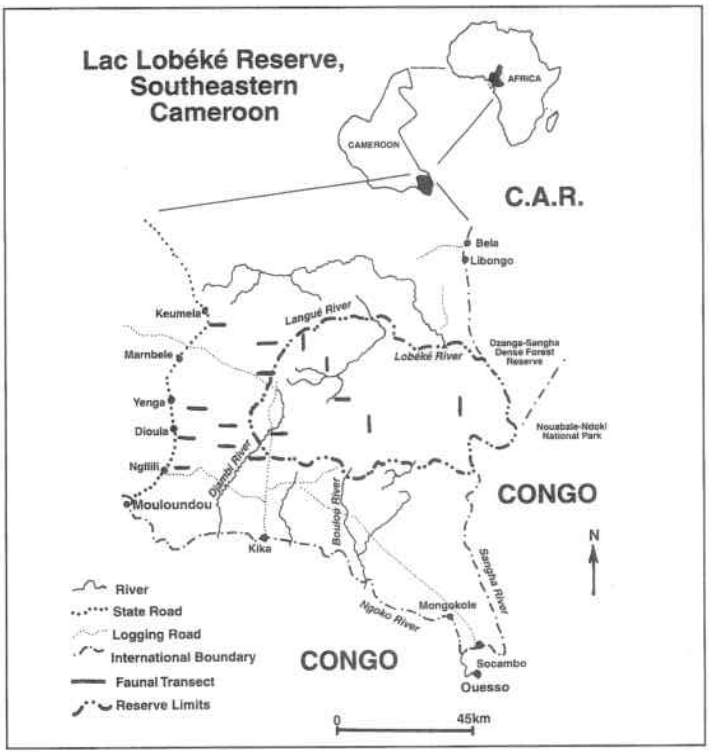

Figure 1. Location of the proposed Lobéké Forest Reserve, Cameroon. Map by Stephen D. Nash.

Table 1. Arboreal primate species recorded in the proposed Lobéké Forest Reserve, south-east Cameroon.

Species	No. of Encounters	No. of vocalizations	Encounters/km	Vocalizations/km
Cercopithecus nictitans	12	19	0.30	0.48
Cercopithecus cephus	7	9	0.18	0.23
Cercopithecus pogonias	1	13	0.03	0.33
Cercocebus albigena	11	16	0.28	0.40
Cercocebus agilis	1	1	0.03	0.03
Colobus guereza	7	1	0.18	0.03
Mean			0.17	0.25

Census Methods

Primate censuses were conducted from February to April 1995. The standard-line-transect method (NRC 1981; Brockelman and Ali 1987; Skorupa 1987; Whitesides *et al.* 1988; White 1994) was employed. Censuses were conducted by one observer accompanied by two guides. Transects were walked at a speed of about 1-1.5km/hr with occasional stops to look and listen for primates. On encountering a primate group, records were taken of: i) species and number of individuals; ii) mode of detection (seen or heard); iii) location; iv) the activity of the group when first sighted; and v) perpendicular distance from the transect to the center of the group. When loud vocalizations were heard the following were recorded: i) observer location; ii) species; iii) time; iv) bearing; and v) estimated distance to caller.

The vocalizations of the species were computed separately from group encounters as shown in Table 1. Gorilla and chimpanzee populations were censused based on nest counts (Aveling and Harcourt 1984; Harcourt and Fossey 1981; Tutin and Fernandez 1984; White 1994; Yamagiva *et. al.* 1993).

Results

Six arboreal primate species were observed in the proposed Lobéké Reserve (Table 1). The overall group encounter rate for the six species was 0.98/km. *Cercopithecus nictitans* and *Cercocebus albigena* were the most common species observed. *Cercopithecus pogonias* was much more scarce, being sighted just once and heard on another occasion. The highly threatened *Cercocebus agilis* was observed only once during transect censuses. The group comprised about 50 individuals. *Cercopithecus neglectus*, reported to be present in previous studies (Stromayer and Ekobo 1992), was not encountered.

Gorillas were more abundant in the logged than the unlogged forest. Thirty-eight gorilla nests were counted in 17 nesting sites along 15 km of transects cut in logged forest. This was an encounter rate of 2.53 nests/km and an average of 2.24 nests/site (Table 2). Data from the 35 km transect in unlogged forest gave a nest count of 17 in 10 sites, with an encounter rate of 1.13 nests/km.

By contrast, chimpanzee nests were more abundant in the unlogged than the logged forest. Twenty-five nests from 16 nesting sites were recorded in unlogged forest giving an encounter rate of 0.71 nests/km as opposed to 0.67 nests/km in logged forest.

Discussion

As reported for most tropical regions (Davies 1987; Wilkie *et al.* 1992), commercial logging constitutes a major threat to the survival of primate populations. About 80% of the proposed Lobéké Reserve area has been logged. Some portions of the reserve are still being exploited by timber companies operating in the region. There was a low species occurrence in the parts of the forest which were heavily logged and with a high human presence. Two species (*C. pogonias* and *C. agilis*) were observed once on the transects. A major problem posed by logging is the opening up of previously inaccessible areas to hunters. However, primate hunting, which in most areas constitutes a serious threat, is still relatively low in the Lobéké area. Most hunting in the region is by use of traditional weapons, spears and poisoned bows and arrows, by the native Bakwelle and Baka pygmies.

Based on nest counts, the gorilla population in the area was high. More nests were encountered in logged (2.5 nests/km) than in unlogged forest (1.13 nest/km). About 85% of the nests were in Maranthaceae forest and light gaps of secondary forest. Similar observations of gorilla preference for herbaceous vegetation was reported for Dzangha-Sangha Dense Forest Reserve, CAR (Caroll 1986), Lopé forest, Gabon (Tutin and Fernandez 1985), and in the Congo (Fay and Agagna 1990). By contrast, chimpanzees are evidently found in higher numbers in unlogged forest. This may be explained by the species' preference for primary forest (Tutin and Fernandez 1984). Nests were occasionally observed at heights of more than 30 m.

In general, Lobéké appears to maintain healthy gorilla and chimpanzee populations. There is little threat from hunting, because methods are mostly traditional. The high cost of guns and ammunition commonly used in most forest areas for hunting has discouraged many natives from engaging in this practice. Logging is evidently seriously threatening the chimpanzee population of the area, mainly because the species is highly dependent on primary forest for its survival.

These results suggest that healthy populations of the various primate species still occur, although chimpanzees, at least, are being affected by logging. The importance of the Lobéké Forest Re-

Table 2. Nest counts of gorilla and chimpanzee recorded in the proposed Lobéké Forest Reserve, south-east Cameroon.

	Logged			Unlogged Forest		
	Nests	Nest sites	Encounter rate (km^{-1})	Nests	Nest sites	Encounter rate (km^{-1})
Gorilla	38	17	2.53	17	10	1.13
Chimpanzee	10	9	0.67	25	16	0.71

A one-way ANOVA computed for nest encounters in logged and unlogged forest demonstrated a significant difference ($p<0.05$) in the distribution of nests between the forest types.

serve for the protection of these primates provides a strong argument for its long-term conservation.

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Author's Address:

Leonard Usongo, Senior Conservation Biologist, WWF SE Cameroon Forest Project, B.P. 6776, Yaoundé, Cameroon.

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Notes on Two Dwarf Galagos (*Galagoides udzungwensis* and *Galagoides orinus*) in the Udzungwa Mountains, Tanzania

Thomas M. Butynski[1], Carolyn L. Ehardt[2] and Thomas T. Struhsaker[3]

[1]*Zoo Atlanta, Africa Biodiversity Conservation Program, National Museums of Kenya, Nairobi, Kenya*
[2]*Department of Anthropology, The University of Georgia, Georgia, USA*
[3]*Department of Biological Anthropology, Duke University, North Carolina, USA*

Introduction

The Udzungwa (also Uzungwa) Mountains (Fig. 1) are arguably Tanzania's most important site for primate conservation. Ten species are found there. The Sanje crested mangabey *Cercocebus galeritus sanjei* and Iringa (or Uhehe or Gordon's) red colobus *Procolobus badius gordonorum* are both endangered subspecies endemic to these mountains (Rodgers and Homewood 1982; Lee *et al.* 1988; IUCN 1996). The Udzungwas are also important for the conservation of the Tanzanian black-and-white colobus *Colobus angolensis palliatus*. Sykes' monkeys *Cercopithecus mitis* (either *monoides* or *moloneyi*, or even a hybrid between the two subspecies [J. Kingdon pers. comm. in Lovett and Wasser 1993]), vervet monkeys *Cercopithecus aethiops rufoviridis*, and yellow baboons *Papio cynocephalus cynocephalus* are the other diurnal primates known to occur in the Udzungwas.

In addition, four species of galagos (bushbabies) are present: large-eared greater galago *Otolemur crassicaudatus*, Senegal galago *Galago senegalensis*, Matundu dwarf galago *Galagoides udzungwensis*, and mountain (or Amani) dwarf galago *Galagoides orinus*. Both dwarf galagos are endemic to the Eastern Arc Mountains of Tanzania, of which the Udzungwas represent the largest and southernmost block. Since information to make a sound conservation assessment of these two galagos has been lacking, they are both classified in *The 1996 IUCN Red List of Threatened Animals* (IUCN 1996) as "data deficient" species.

From 26 September to 25 October 1997 we conducted primate surveys in the Udzungwa mountains as part of a long-term primate monitoring program for this region (Ehardt *et al.* 1998). Here we report on our observations of the two galagos, *G. udzungwensis* and *G. orinus*.

Background

The Udzungwa Mountains (centered on 8°20'S, 35°50'E) extend roughly 200 km north-east/south-west, covering an area of approximately 10,000 km² in south central Tanzania (Figs. 1 and 2). In 1981, about 450 km² (4.5%) of this area was covered with forest (Rodgers and Homewood 1982). There are no recent estimates of forest cover for the Udzungwas, but there has been a continuous loss of forest since 1981. The south-east-facing escarpment rises from 300 m to 2,576 m, and includes lowland, submontane and montane forest. It represents the greatest continually forested altitudinal gradient in East Africa (300-2,250 m) (photo 1). Moist forest extends along much of the south-east scarp, with drier forest, woodland and grassland on the plateau. Mean annual rainfall along the south-east scarp is about 200 cm, while on the western plateau it is about 90 cm. There is a single pronounced dry season from May to December in the west, and from June to October in the east (Rodgers and Homewood 1982; Dinesen *et al.* in prep.).

Although not well surveyed, the Udzungwas are already recognized for their many endemic and rare species, and an extraordinarily high species richness (Lovett and Wasser 1993). As such, they probably represent the biologically most important forest block in East Africa (Rodgers and Homewood 1982; Jensen and Brogger-Jensen 1992; Dinesen *et al.* in prep.).

G. udzungwensis is a 135 g, 377 mm long, gray-brown galago discovered in 1994 by Honess (1996) in the Matundu Forest Reserve of the Kilombero District in the Udzungwa Mountains. This species is known to occur only on the Mahenge Scarp, and in the Udzungwa, East Usambara and Uluguru Mountains (Fig. 1). *G. orinus* (110 g), first described in 1936 by Lawrence and Washburn, has rich brown dorsal parts and a buff-yellow belly. Prior to D. Moyer's discovery of this species in montane forest in the Udzungwas in 1996, it was only known from the Uluguru and East Usambara Mountains. This may also be the species of dwarf galago present in the Kipengere Range near Mbeya (Honess 1996) (Fig. 1). Honess (1996) provides detailed information on the behavior, ecology and vocal repertoire of *G. udzungwensis* and *G. orinus*.

Methods

We conducted 20 "galago surveys" totaling 22 h during 5-24 October, 1997. These were pre-dawn (n = 6) and post-dusk (n = 14) surveys that usually began at about 05:00 h or 18:30 h (dawn occurred at about 05:45 h and dusk at about 18:45 h). The sur-

Table 1. Summary of sites surveyed for galagos in the Udzungwa Mountains, Tanzania, in 1997. Refer to the site number and figure 3 to find the approximate location of each of the survey sites. Sites are listed here in order of increasing elevation.

Site no. and name	Location (elevation)	No. of surveys (total hours)	Galago found (abundance)
1. Mang'ula	07°50.54'S; 36°53.04'E (340 m)	8 (9 h)	*G. udzungwensis* (Common)
2. Matundu	08°03.43'S; 36°19.87'E (370 m)	2 (3 h)	*G. udzungwensis* (Abundant)
3. Sanje Falls	07°45.98'S; 36°53.99'E (760 m)	2 (2 h)	*G. udzungwensis*? (Uncommon)
4. Sonjo River	07°48.32'S; 36°51.09'E (800 m)	3 (4 h)	*G. udzungwensis* (Uncommon)
5. Kihanzi River	08°36.51'S; 35°50.60'E (400-1,070 m)	3 (3 h)	*G. udzungwensis* (Uncommon)
6. Udzungwa Scarp	08°20.60'S; 35°58.43'E (1,800 m)	3 (4 h)	*G. orinus* (Uncommon)

veys lasted a mean of 1.1 h (range = 0.5-1.9 h). In addition, we spent ten nights sleeping in forest (two at the Sanje Falls Camp; two at the Sonjo River Camp; two at the Udzungwa Scarp Masisiwe Camp) or woodland (three at the Norplan Guest House, Kihanzi) under circumstances where the loud calls of galagos, if given, could be heard. Locations were determined using a Global Positioning System (GPS).

During the surveys we moved slowly and/or stood on footpaths or old logging roads while listening and looking for galagos. We observed them with the aid of a spotlight, headlamps and binoculars. A tape recorder was carried at all times and used frequently to record galago vocalizations. We sometimes imitated the loud call of the African wood owl *Ciccaba woodfordii* to elicit additional vocalizations and behavioral responses. No attempt was made to collect systematic data during these surveys, but detailed notes on the galagos were made at the end of each survey. In particular, notes were made on habitat type, height above ground, approximate number of calling individuals per hectare, and other behaviors.

All taped vocalizations were sent to Simon Bearder and Paul Honess to confirm the species of galago making the calls (Nocturnal Primate Research Group, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP, UK).

Survey Sites

Mang'ula and Matundu were the two lowest sites surveyed (340-370 m) (Figs. 2 and 3, Table 1). Both are on fairly flat ground in lowland forest at the foot of the escarpment. Rainfall there is about 200 cm per year. The Mang'ula site is within the Mwanihana Forest (*c.* 59 km² of forest), which is part of the Udzungwa Mountains National Park. The Matundu site lies within the Matundu Forest, most of which also lies within the Park.

The Mwanihana Forest is described in Rodgers and Homewood (1982), Collar and Stuart (1988), and Lovett (1993). Common, large trees in the lower area there include *Erythrophleum suaveolens*,

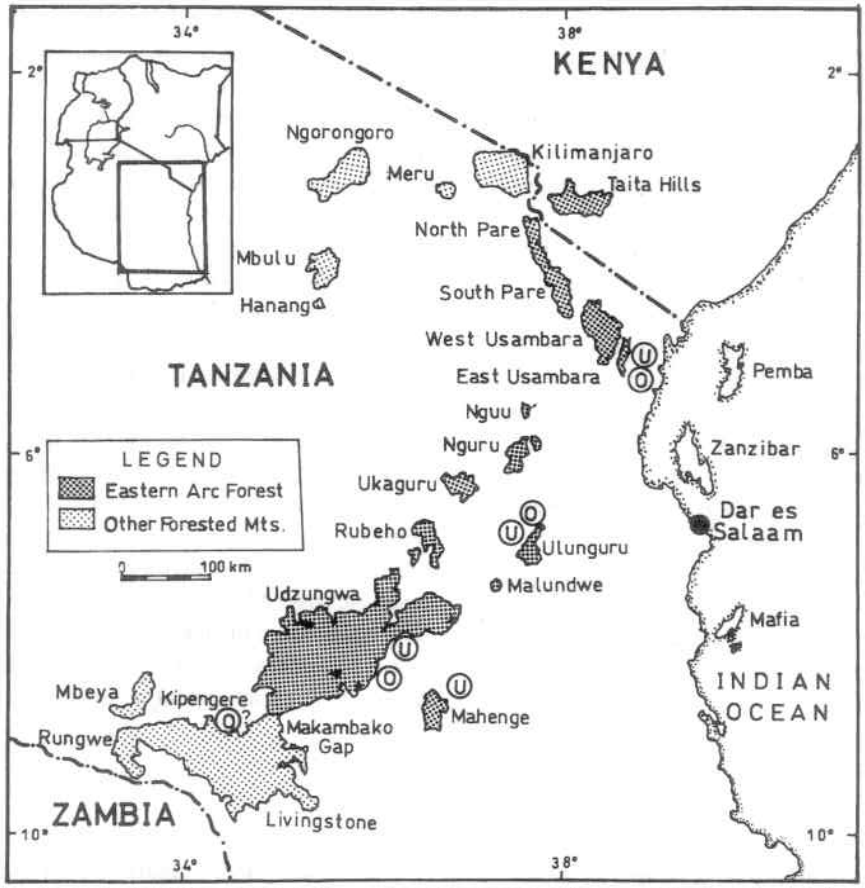

Figure 1. Eastern Arc Mountains and other mountains of eastern Tanzania and southeastern Kenya which support moist forest. This map shows the forests in which *Galagoides udzungwensis* (U) and *Galagoides orinus* (O) are known to occur. Map adapted from Lovett and Wasser (1993).

Dialium holstii, *Parkia filicoidea*, *Albizia gummifera* and *Sterculia appendiculata*.

The Matundu forest is described in Honess (1996) and in Dinesen *et al.* (in prep.). Some common, large trees there are *Khaya anthotheca*, *Milicia excelsa*, *Brachystegia microphylla*, *Brachystegia spiciformis*, *Erythrophloeum flaviolens*, *Newtonia buchananii*, *Anthocleista grandiflora*, *Philiostigma thonningii*, and *Rhodognaphalon* sp.

The Mang'ula and Matundu sites are both in secondary forests, the result of considerable exploitation by loggers, and by local communities for poles and firewood. There is a dense layer of ground vegetation (bushes, herbs, lianas) at these sites, but especially at Mang'ula. The forest canopy at both is at 15-25 m.

The Sanje Falls and Sonjo River sites are in submontane forest (760-800 m) on fairly steep terrain in the Udzungwa Mountains National Park (Mwanihana Forest). Both sites are in high, lightly degraded forest where *Parinari excelsa*, *Newtonia buchananii*, *Albizia gummifera* and *Parkia filicoidea* are among the more common, large trees.

The Kihanzi River site does not lie within a protected area. This site is at an intermediate elevation (400-1,070 m) in a deep gorge with steep sides. This small forest (1.1 km²) is heavily degraded and surrounded by miombo woodland where *Brachystegia spiciformis* and *Julbernardia globifera* are dominant, and pure stands of *Uapaca kirkiania* are present. The area is described by Honess (1996) and Dinesen *et al.* (in prep.). Some common, large trees found in the gorge are *Parinari excelsa*, *Newtonia buchananii*, *Allanblakia stuhlmanni*, *Cola scheffleri*, *Garcinia buchananii*, *Garcinia volkensii*, *Drypetes usambarenses*, *Cyclomorpha parviflora*, *Sorindeia madagascariensis*, *Ochna holstii* and *Filicium decipiens*.

The Udzungwa Scarp (Kihanga Camp) site is in lightly degraded, tall montane forest at 1,800 m, approximately at the midpoint of the Udzungwa Scarp Forest Reserve on a north-south axis. Rainfall there is about 200 cm/year. The forest canopy (30-40 m) is higher than at other sites while the understorey tends to be much less dense than in the lowland forests. This forest is described in Rodgers and Homewood (1982) and in Dinesen *et al.* (in prep.). Common, large trees there include *Parinari excelsa*, *Ficalhoa laurifolia*, *Neoboutonia macrocalyx*, *Polyscias fulva*, *Newtonia buchananii*, *Albizia gummifera* and *Macaranga kilimandscharica*.

Results

Matundu Dwarf Galago

Galagoides udzungwensis is common both at Mang'ula and Matundu and was the only galago found there. Most individuals were seen or heard in dense vegetation at 1-6 m above the ground, but a few were active at 12-18 m. No galagos were seen or heard at Sanje Falls during two surveys, or at Kihanzi River during three surveys. S. Wasser (pers. comm.) has heard galagos call on a number of occasions at Sanje Falls. Only two or three *G.*

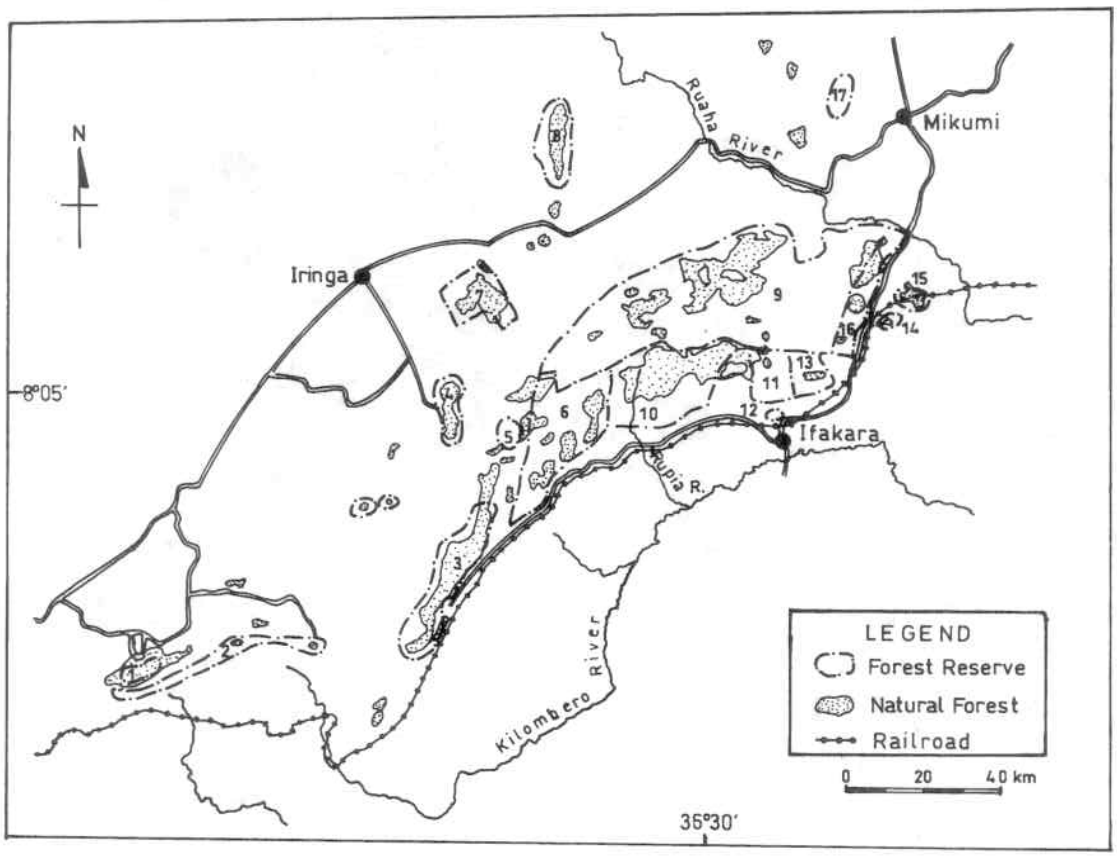

Figure 2. Udzungwa Mountains showing distribution of forest, forest reserve boundaries and other places mentioned in the text. Map adapted from Rodgers and Homewood (1982). Extant forest reserves: 1 = Kibao; 2 = Mufindi Scarp; 3 = Udzungwa Scarp; 4 = Dabaga/Uliangambe; 5 = Kilanze; 6 = Iyondo; 7 = Kisinga Rugaro; 8 = Image; 10 = Matundu; 11 = Iwonde; 12 = Ihangana; 13 = Nyanganje; 14 = Lukoga; 15 = Magombera; 17 = Pala Ulanga. Former forest reserves: 9 = West Kilombero; 16 = Mwanihana.

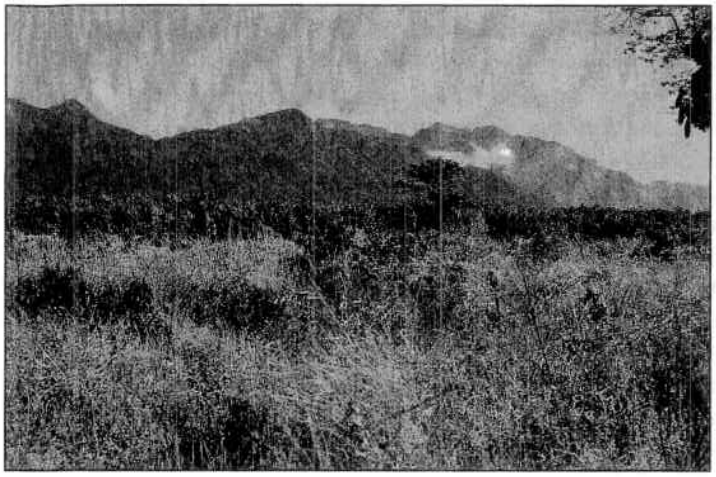

Photo 1. Part of the Mwanihana (northern) portion of the Udzungwa Mountains as seen from the east. Photo taken at 270 m asl in the Kilombero Valley. The highest peaks in this photo lie at about 2,200 m asl. *Galagoides udzungwensis* is common in forest at the base of these mountains. *Galagoides orinus* probably occurs in the higher reaches of this part of the Udzungwas but this requires confirmation. Half (1.7 km²) of one of the last natural forests on the floor of the Kilombero Valley, the Kalunga Forest Reserve, was destroyed in 1981 to establish the rubber plantation seen in the foreground. Photo by Tom Butynski, October 1997.

Photo 2. The greatest threat to *Galagoides udzungwensis* is the loss of its lowland forest habitat to agriculture. This photo shows illegal pit-sawing and agricultural encroachment in the Kalunga Forest Reserve (270 m asl) near Mang'ula. Photo by Tom Butynski, October 1997.

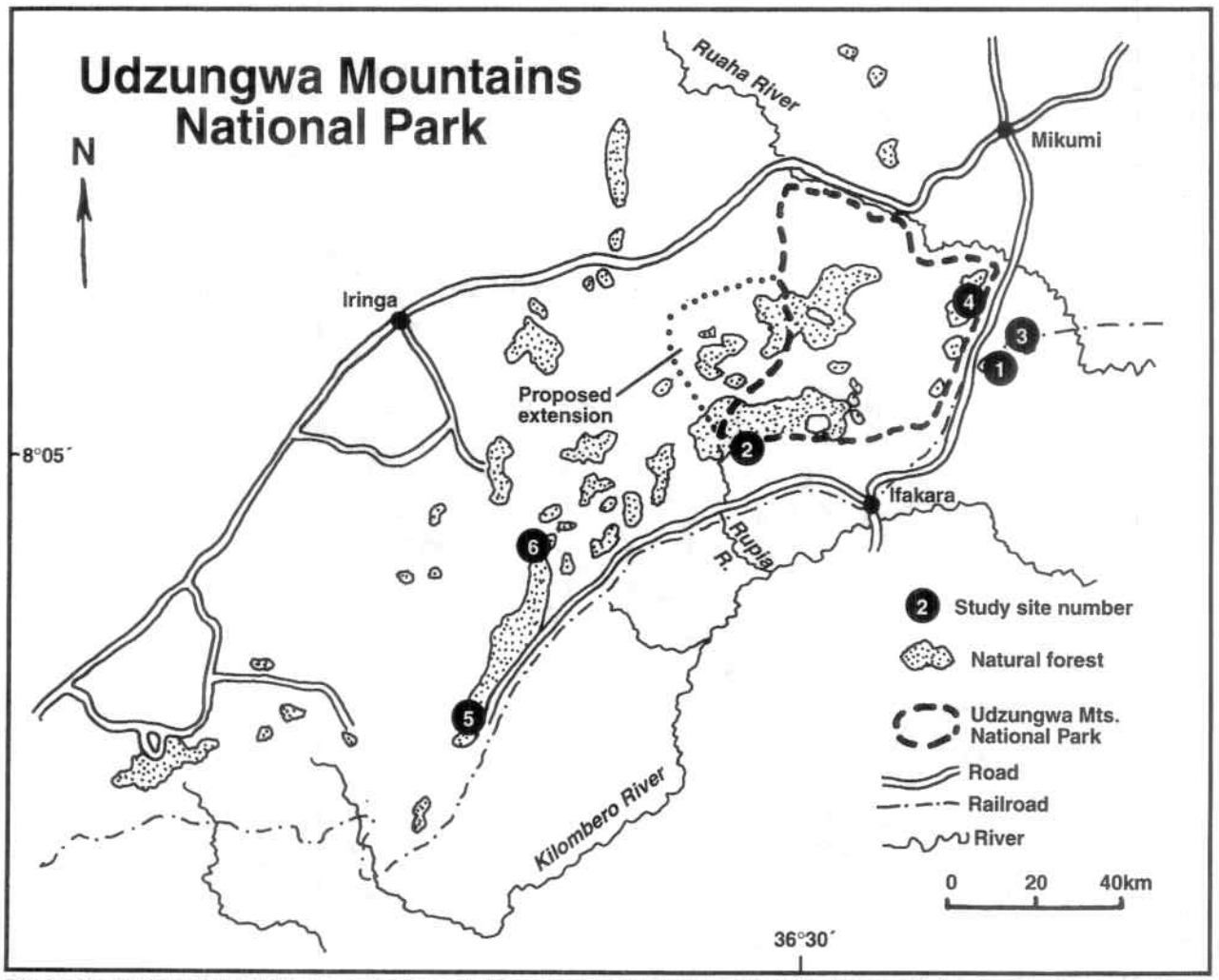

Figure 3. Distribution of forest in the Udzungwa Mountains and the location of the Udzungwa Mountains National Park and of the six survey sites. See Table 1 for background information on each numbered survey site. Also shown is the proposed extension to the Udzungwa Mountains National Park. Map adapted from Rodgers and Homewood (1982). Map drawn by Stephen D. Nash.

udzungwensis were heard at Sonjo River during three surveys (Table 1). It was evident that *G. udzungwensis* was much less common at 700-800 m than at 300-400 m. It may also be that this species prefers secondary forest over primary forest. The known altitudinal limit of *G. udzungwensis* in the Udzungwas stands at 360-800 m.

The loud call of *G. udzungwensis*, which Honess (1996) refers to as the "single unit rolling call", is reminiscent of the cackles of forest francolines (*Francolinus* spp.) when heard at a distance. At both sites, this galago gave a "dusk chorus" which peaked between 18:45 h and 19:00 h, just after the diurnal birds and other primates stopped calling and had become inactive. Some *G. udzungwensis* called as early 18:30 h. At this time, 10 min or so of daylight remains and the diurnal primates and birds are still active. The rate of calling declined sharply between 19:00 h and 19:10 h. The single unit rolling call is given infrequently throughout the night until dawn when there is another, but lesser, chorus from 05:30-05:45 h. The last calls were heard just as the bird dawn chorus reached full strength at about 05:45 h. We estimated that there were sometimes at least five *G. udzungwensis* per hectare calling at the Mang'ula site and 20/ha calling at the Matundu site.

Mountain Dwarf Galago

Galagoides orinus was found only at the Udzungwa Scarp site, the only montane forest site surveyed. This species was encountered during both post-dusk surveys but not during the one pre-dawn survey. Two loud calls of *G. orinus*, which Honess (1996) terms "descending screeches and yaps", were heard most frequently from about 18:30-19:00 h. About four animals were calling from a 1 ha area on a ridgetop. This species was not heard calling in the valley bottom near our camp. E. Mulungu, a field technician with considerable experience at this site, told us that *G. orinus* calls were much more frequent in February than during our visit (October), and that it can then also be heard calling from valley bottoms.

Discussion

Distribution and Abundance

During 60 nights of survey work, Honess (1996) found *G. udzungwensis* to be widespread in the lowland evergreen forest of Matundu, West Kilombero and Kihanzi, being particularly common in the lower parts of the Matundu and West Kilombero Forests. Dinesen *et al.* (in prep.) recorded this species once at Kihanzi at 650 m. *G. udzungwensis* appears to be widely distributed in lowland evergreen forest along most of the southeast scarp of the Udzungwas. All confirmed records to date indicate that this species is limited to lowland evergreen forest on the Eastern Arc Mountains (Honess 1996).

D. Moyer (pers. comm.) and E. Mulungu found *G. orinus* from around 1,750 to 2,000 m in forest and forest/bamboo mosaic in the Udzungwa Scarp Forest Reserve between Kihanga and Masisiwe. Dinesen *et al.* (in prep.) found dwarf galagos which were not *G. udzungwensis* between 1,200 and 1,900 m at West Kilombero and on the Udzungwa Scarp. Given the elevation, it now seems probable that these encounters were with *G. orinus* (L. Dinesen pers. comm). Wherever *G. orinus* is known to occur it seems to be at low densities. This galago appears to be a montane forest specialist restricted to the Eastern Arc Mountains where its known elevational range is 1,200 to 2,000 m.

Vocalizations

The characteristics of advertisement calls of galagos are valuable for assessing taxonomic status (Zimmermann 1990; Bearder *et al.* 1995). The "single unit rolling call" of *G. udzungwensis* was heard frequently, but a similar call was not heard from *G. orinus*. Based upon the various calls heard in the field, *G. udzungwensis* and *G. orinus* are readily distinguished from one another.

The advertisement call of *G. udzungwensis* is also surprisingly distinct from the highly complex, crescendo advertisement calls of the two dwarf galagos we are most familiar with from our studies in several forests of the Albertine Rift: Demidoff's dwarf galago *Galagoides demidoff* (75 g, 310 mm), and Thomas's dwarf galago *Galagoides thomasi* (100 g, 410 mm). *G. udzungwensis* also differs noticeably from *G. demidoff* and *G. thomasi* in the high density of calling individuals at some sites, and in initiating the dusk chorus at least 10 min before dark at sites where densities are high (i.e., Mang'ula, Matundu).

Threats

As far as is known, *G. udzungwensis* and *G. orinus* are confined to, and dependent upon, the forests of the Eastern Arc Mountains (Honess 1996). Most of these forests are under serious threat at this time from loggers, farmers, and others. There has been considerable habitat degradation and destruction in and around the Udzungwas over the past 40 years (Rodgers and Homewood 1982; Rodgers 1993; Lovett and Wasser 1993; Honess 1996, Dinesen *et al.* in prep.). Logging has been particularly extensive in the Matundu Forest, in the higher parts of the Udzungwa Scarp, and from 300-1,200 m in the Mwanihana Forest. Much of the forest that remains is difficult to access and/or on steep slopes. *G. udzungwensis* and *G. orinus* are present in secondary forest, indicating that they can withstand some habitat degradation. The actual impact of logging on these galagos is, however, not known.

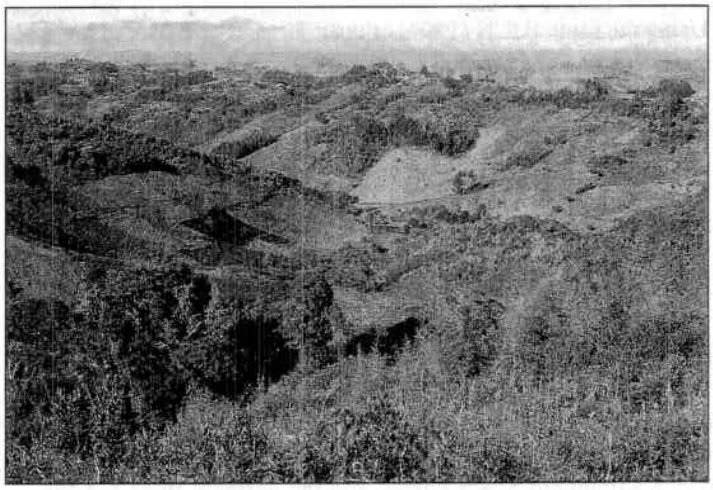

Photo 3. The most serious threat to *Galagoides orinus* is the conversion of montane forest to cropland and pasture. The area shown here is located at 2,000 m asl off the western boundary of the Udzungwa Scarp Forest Reserve. Remnant patches of montane forest can still be seen scattered arcross the landscape. Photo by Tom Butynski, October 1997.

Habitat loss within their restricted range is the most serious threat for *G. udzungwensis* and *G. orinus*. There has been an extensive, rapid removal of montane forest and bamboo to make way for agriculture along the western edge of the Udzungwa Scarp, and nearly complete removal of evergreen, lowland forest for rubber, sugar and rice production schemes, and mixed farming on the floodplain of the Kilombero Valley up to the main Mikumi-Ifakara road. This probably represents the loss of large areas of habitat for *G. orinus* on the Udzungwa Scarp and for *G. udzungwensis* in the lowlands.

S. Bearder (pers. comm.) noted that the type locality for *G. orinus*, the Bagilo area in the Uluguru Mountains, is being rapidly cleared, with tree felling occurring on 70 degree slopes.

Conservation Status

G. udzungwensis is known to occur in at least four populations, all within the Eastern Arc Mountains (Fig. 1). Given the considerable fragmentation of the forests of the Udzungwas, there may be several isolated populations in this region. The observed high densities of this species in lowland evergreen forest strongly suggests that there must be at least several thousand *G. udzungwensis* in the Udzungwas alone.

G. orinus is known to be present in at least three populations, all within the Eastern Arc Mountains. The distribution of this galago in the Udzungwas is poorly known but its presence on the Udzungwa Scarp, and probable occurrence in West Kilombero (two of the largest forest blocks in the Udzungwas) suggest that it is widespread in the montane forests of the Udzungwas, although perhaps everywhere at low densities.

Using the IUCN (1994) criteria for assessing Red List Categories, we suggest that *G. udzungwensis* and *G. orinus* qualify as "endangered" species under both "Criterion B1" and "Criterion B2c". That is: B1 - the extent of occurrence is estimated to be less than 5,000 km² or area of occupancy is estimated to be less than 500 km² and populations are severely fragmented or known to exist at no more than five locations. B2c - the extent of occurrence is estimated to be less than 5,000 km² or area of occupancy estimated to be less than 500 km² and there is a continuing decline observed or projected in the area, extent and/or quality of habitat.

Using the same IUCN (1994) criteria, Honess (1996) also rated both species as "endangered". Obviously, much more information is needed on the number of populations of *G. udzungwensis* and *G. orinus*, the distributions of these populations, and their sizes. We suspect that, with more research, additional populations will be found, and that both species may eventually be classified as "vulnerable". At present, however, it is imperative that the degree of threat be assessed on what we know, rather than upon what we suspect.

Conservation Action

The Udzungwa Mountains National Park (1,900 km², of which about one-fifth is forest) was established in 1992 to include the Mwanihana Forest, the Iwonde Forest, the northern two-thirds of the West Kilombero Scarp Forest, and the northern three-fourths of the Matundu Forest (Fig. 3). This is an extremely important achievement for the conservation of Tanzania's primate fauna as all ten species of primates known for the Udzungwas are present in this park, including both dwarf galagos. This park is also important in that it includes virtually continuous forest cover from 300 to 2,600 m containing a rich and unique assemblage of plant and animal species.

Serious consideration should be given to extending the boundary of this park to the west to include all of the West Kilombero Area (25 km² of forest), including the Nyumbanitu and Ndundulu Mountains. There lies the second highest point (2,350 m) in the Udzungwas, a major water catchment, and forest of considerable importance for species conservation, particularly birds. A newly discovered genus and species, the Udzungwa partridge *Xenoperdix udzungwensis*, is endemic to the forest on these two mountains (Dinesen *et al.* 1994). Primates found there include *P. b. gordonorum*, *C. a. palliatus*, and a dwarf galago (probably *G. orinus*) (Dinesen *et al.* in prep.). *C. galeritus* probably also occurs there (Ehardt in press).

All forest reserves in the Udzungwas require current, formal management plans, and increased participation of local stakeholders in their protection. Other important recommendations for the conservation of the Udzungwas and the other forests of the Eastern Arc Mountains are provided in Rodgers and Homewood (1982), Rodgers (1993), and Dinesen *et al.* (in prep.).

Future Research

The priority for further research on the dwarf galagos of the Udzungwas is to undertake additional surveys to better determine their distribution and conservation status. Primates have yet to be surveyed in a number of large forest tracts, particularly in those montane areas where *G. orinus* is likely to occur. We are in the process of conducting further surveys in these areas (Ehardt *et al.* 1998). It is also necessary to determine whether *G. udzungwensis* is present in the two small forests remaining on the Kilombero floodplain. These are the Magombera Forest Reserve (6 km² of forest) (Decker 1994) and the Kalunga Forest Reserve (2 km² of forest) (Struhsaker *et al.* 1997). Both hold important, high density, populations of *P. b. gordonorum* and *C. a. palliatus*.

There is a great need for vegetation mapping of all of the Udzungwa forests. The tree species composition and distributional limits of these extremely diverse forests remain poorly known. The lack of adequate vegetation maps will continue to compromise all research, management and protection activities in the Udzungwas until this need is met.

Acknowledgments

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Authors' Addresses:
Thomas M. Butynski, Zoo Atlanta, Africa Biodiversity Conservation Program, National Museums of Kenya, P.O. Box 24434, Nairobi, Kenya.
Carolyn L. Ehardt, Department of Anthropology, The University of Georgia, Athens, Georgia 30602-1619, USA.
Thomas T. Struhsaker, Department of Biological Anthropology, Duke University, Box 90383, Durham, North Carolina 27708-0383, USA.

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A Brief Report on Yunnan Snub-Nosed Monkeys, *Rhinopithecus (R.) bieti*, at Bamei in Northern Yunnan Province, China

T. Zhong[1], L. Xiao[1], R. C. Kirkpatrick[2] and Y. C. Long[3]

[1]*Research Office, Baimaxueshan Nature Reserve, Deqin, Yunnan, China*
[2]*Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego, California, USA*
[3]*Center for Biological Conservation, Kunming Institute of Zoology, Kunming, Yunnan, China*

Introduction

The Yunnan snub-nosed monkey *Rhinopithecus (Rhinopithecus) bieti* (Colobinae) lives in high-altitude, temperate forests at the eastern edge of the Himalayas (Long *et al.* 1994). The species is highly endangered, with a world population of only 1000 to 1500 individuals, which appear to be distributed in about 13 distinct sub-populations, or "groups" (Long *et al.* in press a, b). Unlike most other arboreal primates, snub-nosed monkeys form large groups of up to 200 individuals, and the monkeys also take lichens as their primary food (Kirkpatrick 1996). Recent reports have given information on the ecology and conservation of this little-known species (Wu *et al.* 1988; Wu 1993; Long *et al.* 1994; Kirkpatrick 1996; Long *et al.* in press a, b). All systematic information on the ecology of Yunnan snub-nosed monkeys has come, however, from only one sub-population: the group of monkeys at Wuyapiya in Yeri township. In this report, we provide preliminary information on two groups in Bamei township, one which we call the Shalin group and one which we call the Bamei group. Information from the Shalin group provides tentative support for the hypothesis that sub-populations of snub-nosed monkeys are subject to local extinction and subsequent recolonization from neighboring sub-populations, and information from the Bamei group shows the consistency of ecological adaptations of *R. (R.) bieti* throughout its range.

Study site

Bamei township is located between longitude 98°38' to 98°47'E and latitude 28°50' to 28°58'N, in northern Yunnan Province, China. The township covers about 1800 km², and elevations span from 2200 to 5268 meters above sea level (masl). The climate is temperate and cold, with average annual temperate in Deqin City (100 km south of Bamei and at 3300 masl) of 4.8°C, precipitation of 525 mm, and 148 days per year with frost (Deqin County Weather Bureau, ZT pers. comm.).

Forest covers approximately 38% of the township's area, and most of the forests are "primary". Canopy trees include oak (*Quercus* spp.), birch (*Betula* spp.), poplar (*Populus* spp.), fir (*Abies* spp.), pine (*Pinus* spp.) and larch (*Larix* spp.). The Yunnan snub-nosed monkey is primarily associated with fir/larch forest (Long *et al.* 1994, in press a). Oak forest is the main forest type in Bamei, however, and only about 20% of the township's forest is of the fir/larch type.

Methods

The main study took place in October 1994. Other observations at Bamei were made over two days in May 1987, and for two weeks in November 1989. Informal interviews were conducted with villagers to gather initial information on the monkey's distribution. Ground surveys (20 days in October 1994) were then conducted along local trails, using signs (primarily scat finds) to estimate the limits of their range. The scats of snub-nosed monkeys are easily distinguished; see Zhao *et al.* 1988, for description and illustration. No other species of monkeys are known for the region. The principal author was responsible for all data reported here concerning the monkeys in Bamei township.

When monkeys were contacted, they were observed with binoculars and followed as long as possible. The behavior of individual animals was recorded through systematic group scans taken at hourly intervals. Behavior was divided into four categories (feed, rest, move, other), and individuals were assigned, when possible, to one of four age/sex classes (adult male, adult female, juvenile, and infant). In addition, individual animals seen in scans were recorded as to whether they were on the ground or in a tree. At each scan, a record was made of the general forest-type in which the group was located.

Ratios of age/sex classes were estimated by comparing the total number of individuals of particular age/sex classes seen in all scans combined.

Results and Discussion

Home Range

There were at least two groups of monkeys in the Bamei township during October 1994. At that time, the distance between them was about 14 km. The range of the "Bamei group" appeared

to center on 98°46'E and 28°54'N, the same general location in which monkeys were seen in 1987 and 1989. Combining local records and scat finds from 1987, 1989 and 1994, the area used by the Bamei group was about 46 km², between altitudes of 3600 and 4300 masl. In 1989, the group was estimated to have under 50 members, but in October 1994, it appeared slightly larger and may have had more than 60 members. The range of the "Shalin group" appeared to center on 98°51'E and 28°58'N. It was not detected during the surveys of 1987 and 1989, and residents of local villages had no awareness of it until about 1991 or 1992. From scat finds, the area used by the the Shalin group was estimated to be about 4 km². This group, observed for only nine hours, appeared to contain at least 20 individuals. If the Bamei group contains 60 individuals and has a range of 46 km², the population density is 1.3 monkeys/km². For the Shalin group, 20 individuals and a range of 4 km² is a population density of 5.0 monkeys/km².

The finding of two groups in the forests of the Bamei township is in contrast to the finding of the one group we have reported previously (Long *et al.* 1994, in press a, b). In 1987 and 1989, local reports and our investigations indicated only the Bamei group. The appearance of the Shalin group after 1991, along with its small size, suggests that it may be an offshoot of the Bamei group. If so, it may be recolonizing a region in which monkeys had been locally extinct, perhaps due to extremes of climate or the depletion of food resources. Temperate mammals undergo severe fluctuation in population numbers, and local extinctions are common (Gunn *et al.* 1991; Caughley and Gunn 1993), and such may also be the case for temperate populations of snub-nosed monkeys (reviewed in Kirkpatrick in press). Whatever the history of the Shalin group, it has not been reported in previous, comprehensive surveys for Yunnan snub-nosed monkeys (Bai *et al.* 1988; Long *et al.* 1994, in press a, b). This illustrates well that any distribution survey should be seen as an estimate rather than as absolute.

It is difficult to estimate the size of large groups of arboreal monkeys and so the short contact time of the current study means that the group-size estimates should be treated with caution. The population densities calculated for the Bamei and Shalin groups are, nonetheless, broadly consistent with those reported for other groups of Yunnan snub-nosed monkeys. Bai *et al.* (1987) estimated population densities of 1.1 to 2.5 monkeys/km² for six groups of *R. (R.) bieti*, for example, while Kirkpatrick *et al.* (in press) estimated a population density for the Wuyapiya group of 7.0 monkeys/km².

Differences in population density estimates may result from differences in the time-scale for estimates of home range size (cf. Smallwood and Schönewald 1996). The relatively high density estimated by Kirkpatrick *et al.* (in press), for example, resulted from the use of only two year's of data on range size, with the 175-member Wuyapiya group covering 25 km² over two years. Kirkpatrick *et al.* (in press) estimated, however, that the Wuyapiya group might cover 100 km² over the course of a decade. If this range estimate is used for the Wuyapiya group, the population density is reduced to 1.7 monkeys/km² - similar to that estimated for the Bamei group. The range size presented here for the Bamei group was estimated from local reports and scat finds from between 1987 to 1994. If, as it appears, the Shalin group was founded in 1991 or 1992, the range estimate of 4 km² is for a two or three-year period; the estimated population density of the Shalin group is similar to that of the Wuyapiya group when the two-year estimate for range size is used. In summary, it appears that the varying estimates of population densities for snub-nosed monkeys (reviewed more fully in Kirkpatrick in press) is primarily a result of varying time-scales for the estimation of range size.

Individual groups of snub-nosed monkeys cover large areas, and they may take a decade or more to cover all the parts of their range. (These aspects of range use appear to result from the use of lichens as a primary food; lichens have a replenishment rate measured in decades [Kirkpatrick 1996].) Further, it is possible that groups go extinct due to the depletion of food resources, the severe stress of below-zero (Celsius) temperatures, and/or other stochastic forces. This means that the size and location of areas set aside for conservation cannot be determined simply by looking at where monkeys are located at any one time.

Much larger areas must be preserved, and corridors between forest tracts - some of which contain monkeys and some of which do not - must be maintained. This will allow for the nomadic movements of groups and the recolonization of "empty" forest patches. Conservation managers must consider the long term in determining areas to be set aside for the survival of snub-nosed monkey populations. In particular, low-lying forests that provide corridors between forest patches must be protected, even if the

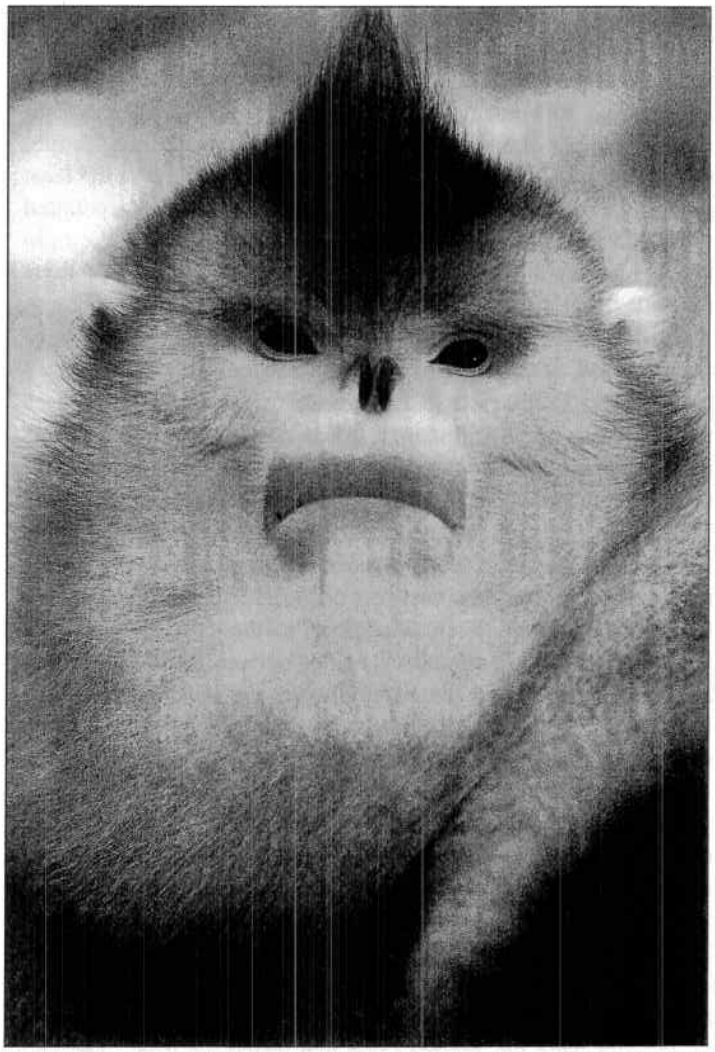

Figure 1. A young male Yunnan snub-nosed monkey, *Rhinopithecus (R.) bieti*. Photograph by Xi Zhi-Nong.

monkeys are rare there.

Behavior

Behavior estimates for the Bamei group come from 45 hours of observation in October 1994. To compare the Bamei monkeys with those at Wuyapiya, we have used a data set collected at Wuyapiya with identical methods (by ZT and XL). Behavior estimates for this group come from 32 hours of observation in October 1993.

In October 1994, the Bamei group was seen primarily in cypress forest (72% of forest-type records for the group). Monkeys were on the ground for 20% of the individual location records. They spent 40% of their time feeding, 31% resting, 11% moving, and 17% in other activities, such as grooming and play. Juveniles were the age/sex class that spent the most time feeding (75% time). Adult females were the age/sex class that spent the least amount of time resting (28%). Activity was concentrated in two periods: in the morning between 0700 and 0930, and in the afternoon between 1600 and 2100. Beard lichens accounted for the majority of feeding records (86%), and the monkeys also fed on oak acorns (6% of feeding records). They appeared to manually peel the acorn nut, eating the kernel while discarding the shell. The ratio of adult males to adult females was 1.0:3.0, and the ratio of infants to females was 1.0:2.8.

In October 1993, the Wuyapiya group spent most of its time in fir/larch forest (84% of forest-type records). Individuals were seen on the ground 70% of total time. They spent 42% of their time feeding, 30% resting, 11% moving, and 16% in other activities. As with the Bamei group, juveniles spent more time feeding (83% time) than other age/sex classes, and females spent the least amount of time resting (25%). Feeding on beard lichens accounted for 92% of feeding records. Within the Wuyapiya group, the ratio of adult males to adult females was 1.0:3.7, and the ratio of infants to females was 1.0:3.4.

Comparison of the behavior of the Bamei and Wuyapiya groups is confounded by the difficult observation conditions and the short contact times. Differences in the data sets for Bamei and Wuyapiya may also arise because different forest types may present different observation conditions. Clearly, the different sub-populations used different sub-types of forest within the general fir/larch type. This is to be expected because the forests differ greatly within the total distribution range of *R. (R.) bieti*. For example, the forests at Longma (the southern-most part of the distribution range) have 20 species of canopy trees in addition to the core species of fir (*Abies* spp.), larch (*Larix* spp.), oak (*Quercus* spp.) and *Rhododendron* spp., while the forests at Hongla (the northern-most part of the range) are much less diverse, with no canopy species outside the core species of the fir/larch forest type (Long *et al.* 1994).

Although it is possible that the monkeys at Bamei and Wuyapiya spend grossly different amounts of time on the ground, differences in estimates of terrestriality for the two sites could be due to differences in observation conditions or by the wide across-month variation within populations in this respect (see, for example, Kirkpatrick *et al.* in press). Estimates of time spent in various behaviors show strong correspondence across sites, however, and at both sites juveniles were the age/sex class that fed the most, and females were the age/sex class that rested the least. Demography estimates for the Bamei and Wuyapiya groups were generally similar, which is significant considering the roughness of the methods used.

Figure 2. A female with infant Yunnan snub-nosed monkey, *Rhinopithecus (R.) bieti*. Photograph by Xi Zhi-Nong.

The current study adds further support to previous findings, all from Wuyapiya, that beard lichens are an important part of *R. (R.) bieti*'s diet (Wu and He 1989; Kirkpatrick 1996). The study at Bamei also suggests that there may be local differences in the non-lichen foods eaten at various sites. Oak acorns accounted for 6% of the feeding records at Bamei, for example, but oak acorns were never implicated as a food during 11 months of observation at Wuyapiya (Kirkpatrick 1996). Additional evidence for local differences in non-lichen foods comes from cafeteria-style feeding trials on two captive adult monkeys of the Guomorong group, resident for two months at the headquarters of Baimaxueshan Nature Reserve (RCK and ZT, unpublished). While the monkeys at Wuyapiya appeared to actively search for the leaves of *Sorbus rehderiana* (Rosaceae) and the seeds of *Chesneya nubigena* (Leguminosae), these food items were ignored by the Guomorong captives, although these captives freely consumed lichen, the leaves of *Malus* sp. (Rosaceae) and the seeds of *Cotoneaster adpressus* (Rosaceae). These data, taken together, suggest that non-lichen foods may show substantial divergence between monkeys at different sites, perhaps due to differences in local forests.

Conservation Status

During the survey of October 1994, a review was made of the conservation status of the monkeys in Bamei township. The human pressure on these monkeys is intense. They are disturbed by hunting, by logging and the collection of other forest products, as well as by free-ranging cattle.

The human population of the Bamei township is composed primarily of two ethnicities: Tibetan and Naxi. Both these ethnic groups have a tradition of hunting, often for products sold as wildlife medicine such as deer musk, deer horn and bear gallbladder. The price of wildlife products has increased dramatically in the last 10 years, and recently a market for bush meat started up in Deqin City (the market center for the Bamei township). Illegal hunting is a serious problem. Within the range of the Bamei group, 32 small wooden shacks of the type typically used by hunters were found during October 1994, and in one of these the skin of a snub-nosed monkey was found. In addition, 216 snares were collected in October 1994, and two of these had, what appeared to be, hairs from snub-nosed monkeys. Five hunters were encountered during the October survey; all knew of regulations against hunting snub-nosed monkeys, but none appeared concerned about enforcement.

The forests used by the monkeys are logged by local villagers. Seven villages have logging rights in the range of the Bamei group. Villagers cut firewood and take timber to build new homes. Local reports suggest that the seven villages together build between 25 and 30 new homes each year, with each using an average of 60 m^3 of wood. In addition, villagers run cattle in the forests during the summer, at times cutting and burning forest to create new pasture. Between 1989 and 1994, ten new pastures were created in the range of the Bamei group. Further, in August and September (thought to be the monkeys' breeding season, at least at Wuyapiya, see Kirkpatrick *et al.* in press.), local villagers stop almost all other work to collect mushrooms for sale (particularly *Tricholoma* spp., which fetch up to US$100 per kilogram [over a year's wage] due to Japanese interest). The range used by the Bamei group can have up to 1300 people actively working in the area. Local reports suggest that the monkeys travel to the southern part of their range during August and September, apparently in response to heavy human presence in the northern part during that time.

Although staff of the local forestry office have informed villagers of regulations protecting snub-nosed monkeys, there is no enforcement in remote areas such as the Bamei township. We suggest that local forestry personnel should travel to the region more often, and perhaps try to disseminate information about conservation and the value of wildlife in collaboration with local educational and religious institutions (for example, see Nash 1987). In any event, there should be enhanced enforcement of laws and regulations: illegal logging should be severely punished, (legal) logging for the building of new homes should be under stricter supervision, guns should be better regulated, and the use of snares and hunting dogs should be prohibited. Greater adherence to the laws and regulations that protect snub-nosed monkeys will require stronger institutions for both education and enforcement. An important first step would be to employ several local, part-time staff to be directly involved in the conservation of Yunnan snub-nosed monkeys within the Bamei township.

Conclusion

This report is based on a limited number of observation hours, but nonetheless substantially broadens our understanding of the ecology of the Yunnan snub-nosed monkey. The occurrence of a small, new group of monkeys at Shalin appears to be the colonization of a new tract of forest, perhaps one where monkeys previously went extinct due to the depletion of lichens. Findings for the Bamei group show that use of lichens as a primary food is not confined to the monkeys at Wuyapiya. Acorn-feeding at Bamei adds further to our knowledge of dietary diversity in these monkeys. The heavy human pressure at Bamei, however, serves as a reminder that we have little time to save this extraordinary animal.

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Authors' Addresses:

T. Zhong, Research Office, Baimaxueshan Nature Reserve, Deqin, Yunnan 674500, China

L. Xiao, Research Office, Baimaxueshan Nature Reserve, Deqin, Yunnan 674500, China

R. C. Kirkpatrick, Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego, California 92112-0551, USA.

Y. C. Long, Center for Biological Conservation, Kunming Institute of Zoology, Kunming, Yunnan 650223, China.

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Current Status and Conservation Strategies of Primates in China

Shu-Yi Zhang

Institute of Zoology, Chinese Academy of Sciences, Beijing, China

Introduction

The information currently available indicates that 18 primate species are found on the Chinese mainland and including such as Hainan Island (Table 1). Three of these, all of the genus *Rhinopithecus*, are endemic: the Yunnan snub-nosed monkey (*Rhinopithecus [Rhinopithecus] bieti*), the Guizhou snub-nosed monkey (*Rhinopithecus [R.] brelichi*) and the Sichuan snub-nosed monkey (*Rhinopithecus [R.] roxellana*). There are also three endemic subspecies: the Hainan black gibbon (*Hylobates concolor hainanus*) of Hainan Island, the Yunnan white-handed gibbon (*H. lar yunnanensis*), and the white-headed leaf monkey (*Semnopithecus francoisi leucocephalus*). In this paper I briefly report on the current status of these primates.

Status of Chinese Primates

Table 1 lists the species of primates occurring in China. The taxonomy of the colobines follows Brandon-Jones (1984, 1995, 1996), except in his placing the snub-nosed monkeys in the genus *Pygathrix* (subgenus *Rhinopithecus*). Here we follow Ren *et al.* (in press) in continuing to refer to them as of the genus *Rhinopithecus*. Another point of contention is the taxonomic status of Phayres' leaf monkey, here listed as *Trachypithecus (T.) phayrei* but considered by Brandon-Jones (19841996) be a subspecies of the dusky leaf monkey, *Semnopithecus (Trachypithecus) obscurus*.

Also listed in Table 1 is the status of each species, worldwide according to the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge 1996), and using the same categorization (IUCN 1994), their status in China. According to the 1996 IUCN Red List, none of the Chinese primates are critically endangered, three are endangered (*Hylobates concolor* and two of the snub-nosed monkeys), seven are vulnerable, and a further three are listed as "Lower risk; near threatened". As such 10 of China's 18 species (55%) are threatened worldwide and a further three are near threatened. Considering just the populations in China, four (22%) are critically endangered; the pygmy loris, *N. pygmaeus*, and three gibbons, *H. lar*, *H. leucogenys* and *H. hoolock*. Four are endangered, a further four are vulnerable, four are "Lower risk; near threatened", and too little is known of the Hanuman langur, *S. entellus*, for it to be categorized. Overall, therefore, 67% of China's primate species are threatened, 22% near threatened, 5% data deficient, and only the Rhesus macaque, *M. mulatta*, is considered widespread and under no immediate threat.

Critically Endangered

Four species, the pygmy loris (*Nycticebus pygmaeus*), the Hoolock gibbon (*Hylobates hoolock*), the white-cheeked black gibbon (*Hylobates leucogenys*) and the white-handed gibbon (*Hylobates lar*), are critically endangered in China, with each being represented by fewer than 150 individuals.

Endangered

The pigtailed macaque (*Macaca nemestrina*), the capped langur (*Semnopithecus [T.] pileatus*), the Guizhou snub-nosed monkey (*Rhinopithecus [R.] brelichi*) and the black gibbon (*Hylobates concolor*) are endangered, with populations of 150 to 1,000 individuals.

The Guizhou snub-nosed monkey is endemic, being found only in the region of Fanjingshan (about 108°E, 280°N) in the province of Guizhou. The species was described in 1903 (Thomas 1903), but it was only in 1967 that the first living individual was captured and subsequently sent to the Beijing Zoo (Quan and Xie 1981). In 1978, a nature reserve was established specifically to protect this remarkable primate. An intensive field study was carried out between 1991 and 1992, and its population size was estimated at 550 to 800 individuals (Bleisch 1995; Xie pers. comm.).

Vulnerable

A further four of the 18 primate species, the slow loris (*Nycticebus coucang*), the Assam macaque (*Macaca assamensis*), Francois' leaf monkey (*Semnopithecus [T] francoisi*), and the Yunnan snub-nosed monkey (*Rhinopithecus [R.] bieti*) are classified as vulnerable, with populations estimated at between 1,000 to 10,000.

The endemic Yunnan snub-nosed monkey was discovered more than one hundred years ago (Allen 1938), but it was only in 1979 that the first field study was carried out. The most recent survey has suggested that the population of Yunnan snub-nosed monkeys is divided into 13 distinct sub-populations, and totals between 1,000 to 1,500 individuals (Long 1995; Ren *et al.* in press). Here it is listed as vulnerable on the basis of the total known population, although it is considered endangered by Baillie and Groombridge (1996) due to the extreme fragmentation of the population.

Lower Risk, Data Deficient and Widespread

Four species, the stump-tailed macaque (*Macaca arctoides*), the short-tailed Tibetan macaque (*Macaca thibetana*), Phayre's leaf monkey (*Trachypithecus [T.] phayrei*) and the Sichuan snub-nosed monkey (*Rhinopithecus [R.] roxellana*) are of "Lower risk", with each species numbering from 10,000 to 20,000 individuals. The Sichuan golden monkey is also endemic to China, and the most recent estimate of its population size suggested an overall figure of about 15,000, distributed through the provinces of Sichuan, Shaanxi, Gansu and Hubei.

Little is known of the status of the Hanuman langur (*Semnopithecus [S.] entellus*) which is classified accordingly as "Data deficient". Only one species, the Rhesus macaque (*Macaca mulatta*) is still widespread in southern China, and not considered threatened, although the 1996 IUCN Red List lists it as "Lower Risk: near threatened" overall, mainly due to commerce.

Three Endemic Subspecies

Three subspecies endemic to China are in urgent need of protection. The known population of the Hainan black gibbon

Table 1. The primate species occurring in China, their distribution, their status in China and their status according to the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge, 1996). The terms used for status follow the IUCN (1994) categories.

Species	Status in China	IUCN 1996 Red List	Distribution[1]
Lorisidae			
Nycticebus pygmaeus Pygmy loris	Critically Endangered	Vulnerable	China, Cambodia, Laos, Vietnam.
Nycticebus coucang Slow loris	Vulnerable	-	China, SE Asia.
Cercopithecinae			
Macaca arctoides Stump-tailed macaque	Lower Risk: near threatened	Vulnerable	China, SE Asia.
Macaca assamensis Assam macaque	Vulnerable	Vulnerable	China, Nepal to Vietnam.
Macaca mulatta Rhesus macaque	Widespread	Lower Risk: near threatened	China, Afghanistan, India to N Thailand.
Macaca nemestrina Pig-tailed macaque	Endangered	Vulnerable	China, Malay peninsula, Borneo, Sumatra, Burma, Thailand, Laos.
Macaca thibetana Tibetan macaque	Lower Risk: near threatened	-	China, E Tibet.
Colobinae			
Semnopithecus(Semnopithecus) entellus[1] Hanuman langur	Data Deficient	Lower Risk: near threatened	India, Nepal, South Tibet, Sri Lanka, Pakistan, Kashmir.
Semnopithecus (Trachypithecus) francoisi[2] Francois' leaf monkey	Vulnerable	Vulnerable	China, Laos, Vietnam.
Semnopithecus (T.) pileatus[3] Capped leaf monkey	Endangered	Vulnerable	China, Bangladesh, Burma, India.
Trachypithecus (T.) phayrei[4] Phayre's leaf monkey	Lower Risk: near threatened	-	China, Laos, Burma, Thailand, Vietnam.
Rhinopithecus (Rhinopithecus) bieti[5] Yunnan snub-nosed monkey	Vulnerable	Endangered	China.
Rhinopithecus (R.) brelichi[5] Guizhou snub-nosed monkey	Endangered	Endangered	China.
Rhinopithecus (R.) roxellana[5] Sichuan snub-nosed monkey	Lower Risk: near threatened	Vulnerable	China.
Hylobatidae			
Hylobates concolor Black gibbon	Endangered	Endangered	China, Laos, Vietnam.
Hylobates lar White-handed gibbon	Critically Endangered	Lower Risk: near threatened	China, Thailand, Maly peninsula, Sumatra, Burma.
Hylobates leucogenys White-cheeked black gibbon	Critically Endangered	-	China, Vietnam.
Hylobates hoolock Hoolock gibbon	Critically Endangered	-	China, India, Burma.

[1] Sources: Groves (1993), Rowe (1996), Brandon-Jones (1984, 1995, 1996).
Formely in the genus *Presbytis*, Brandon-Jones (1984, 1996) and Groves (1993) placed the species in the genus *Semnopithecus*, subgenus *Semnopithecus*.

[2] Groves (1993) uses the generic name of *Trachypithecus* (subgenus *Trachypithecus*) whereas Brandon-Jones (1984, 1995) regards *Trachypithecus* to be a subgenus of *Semnopithecus*. Groves (1993) lists five forms which he commented may be raised to full species on further study. Brandon-Jones (1984, 1996) regarded four to be full species (*delacouri, hatinhensis, laotum* and *poliocephalus*), and the fifth (*leucocephalus*) to be an albinistic morph of *S. francoisi*.

[3] Groves (1993) uses the generic name of *Trachypithecus* (subgenus *Trachypithecus*), whereas Brandon-Jones (1984, 1995) regards *Trachypithecus* to be a subgenus of *Semnopithecus*.

[4] Brandon-Jones (1984, 1996) lists this leaf monkey as a subspecies of *Semnopithecus (Trachypithecus) obscurus*.

[5] Groves (1993) and Brandon Jones (1984, 1996) and Rowe (1996) list *Rhinopithecus (Rhinopithecus) bieti, Rhinopithecus (R.) brelichi* and *Rhinopithecus (R.) roxellana* in the genus *Pygathrix* (subgenus *Rhinopithecus*). The taxonomy here follows Ren *et al.* (1997).

(*Hylobates concolor hainanus*) from Hainan Island does not exceed about 20 individuals (Wang 1995), and the Yunnan white-handed gibbon (*Hylobates lar yunnanensis*), with about 10 individuals (Guo and Wang 1996), is in an even more dire situation. The white-headed leaf monkey (*Semnopithecus francoisi leucocephalus*) is more numerous, although still critically endangered with about 500 individuals (Huang pers. comm.). However, it should be noted that the validity of this race has been questioned recently by Brandon-Jones (1995), who argued that it is an albinistic morph of *Semnopithecus francoisi* and not a valid subspecies.

Primate Conservation in China

There is an urgent need for greater investment in the conservation of primates and their habitats in China, with programs being urgently required most particularly for the endangered and endemic species and subspecies. Our specific recommendations are as follows.

Education of local people about wildlife conservation. In China, people in remote mountain districts are honest and kind. If they are informed about the importance of wildlife conservation and the punishment to poachers, most people will abide by the Wildlife Protection Law.

Nature reserve management should be strengthened, which includes encouraging villagers to resettle outside of reserves, stopping activities that cause harm to protected animals and their habitats. In China, most nature reserves are inhabited by local people, resident before the establishment of the nature reserve. In general, they may cause harm to the habitats because of their logging, farming and herding. Moreover, some industrial activities such as mining still exist in some reserves such as Fanjingshan, which not only destroy habitats but are also a major source of water pollution.

Some remedial measures include the establishment of corridors for forests which are severely fragmented, with the result that many of the endangered species survive in isolated areas. Based on the most recent study, the 13 known groups of the Yunnan snub-nosed monkeys are all isolated from each other (Long 1995; Ren *et al.* in press), prohibiting genetic exchange between them, and resulting in the possible deleterious effects of inbreeding and the loss of their genetic diversity.

Hunting and poaching should be strongly controlled and punished. Poaching is frequent in the nature reserves. This can be a serious threat to rare and endagered primates even though they are not specifically hunted. Sichuan snub-nosed monkeys, for example, are found killed from time to time by wire snares which are used to capture musk deer.

Ex situ conservation is an important tool when natural habitats are severely threatened and degraded. Captive breeding programs need to be carefully structured and monitored, however, considering that wild animals have been captured from nature reserves in the past under the name of *ex situ* conservation, but were subsequently traded.

Scientific research should be carried out, especially regarding the population densities and dynamics of the most endangered species, to establish estimates of the carrying capacity of the forests where they remain, to evaluate the possibilities of translocation and reintroduction programs, and for an understading of the factors threatening these animals and their habitats. Information of this sort is vital for the adoption of effective conservation measures.

Wildlife research has declined in recent years. Two major factors have contributed to this. The first is a lack of funds, and the second is that many research workers have changed their professions. The two are linked. For example, Long Yongcheng unfortunately curtailed his study on Yunnan snub-nosed monkeys and has taken up other work, because no funds were available to support his research. In China, the salary of a young scientist is about one hundred dollars per month, while a taxi driver earns ten times more. For this reason, many scientists are forced to change their careers, entering into business, for example.

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Author's Address:
Shu-Yi Zhang, Institute of Zoology, Chinese Academy of Sciences, 19 Zhongguancun Road, Haidian, Beijing 100080, China.

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Behavior of Two Groups of Hanuman Langur (*Semnopithecus entellus*) During a Solar Eclipse in 1995 at Medinipur, West Bengal, India

A. Murmu, S. Chaudhuri and J. R. B. Alfred

Zoological Survey of India, New Alipur, Calcutta, India

Introduction

The total solar eclipse of October 24, 1995, occurred in certain parts of West Bengal, India. In order to study the behavior of the Hanuman langur (*Semnopithecus entellus*) during the eclipse, two camps were set up at Medinipur, one of the districts where the eclipse was complete. Medinipur town is situated at a latitude of 22°25', longitude of 87°20' and an altitude of 45 m above sea level. The eclipse started in this district at 0700 hr 31 min 19 sec. The totality of the eclipse began at 0800 hr 47 min 51 sec. The greatest phase was recorded at 0800 hr 48 min 05 sec, and the total eclipse ended at 0800 hr 48 min 20 sec, and the entire eclipse ended at 1000 hr 15 min 38 sec. Two camps, one at Medinipur town proper and the other at Murasthi 30 km from Medinipur, were set up for observation.

The bisexual group of langurs at Medinipur was classified as a city group and the all-male group of Murasthi live around a village. The nine member group of Medinipur contained one male, four females, one juvenile and three infants, whereas the Murasthi group contained five adult males and two sub-adult males.

Observations

The main activities of the langurs were studied from early morning to twelve noon on October 24 and 25, 1995. Observations were recorded at 15 minute intervals using the instantaneous scan sampling technique, from 0600 hr to 0840 hr and again from 0850 to 1200 hours. Continuous observations were made during the total ecplise time from 0840 hours 0850 hours. The main activities of the langurs were restricted to feeding, traveling and resting, but play and grooming were also recorded, mostly in the bisexual group. The times spent by the two groups in the various activities are shown in Table I.

Feeding

On the day of the eclipse, the time spent by the all-male group in feeding between 0600 and 0840 hr varied from 9.57% to 24.43%, whereas in the Medinipur bisexual group it varied from 11.11% to 27.00%. On the following day, October 25, 1995, feeding time varied from 24.49% to 60.71% in the Murasthi group and 5.56% to 39.68% in the Medinipur group during the same period.

No feeding was recorded in either of the groups from 0840 to 0850 hours during the 10 minute period when the eclipse reached totality, although at the same time the following day the Murasthi group spent 50% of its time and the Medinipur group 29.62% in feeding.

On the eclipse day, after the totality was over, and between 0850 hours to 1200 hours, the Murasthi group spent only 2.4% in feeding, whereas the Medinipur group spent 1.33% to 32.45% in feeding. During the same period on the following day the Murasthi group spent 6.14% to 23.80% in feeding, and the equivalent figures for the Medinipur group were 9.26% to 24.07%.

Traveling

The time the Murasthi group spent traveling on the eclipse day from 0600 to 0840 hr, was 6.14% to 12.50%, while in the Medinipur group it varied from 22.22% to 27.11%. During the same period on the following, non-eclipse, day the Murasthi group spent 4.08% to 16.71% traveling, whereas the estimates for the Medinipur group were between 8.33% to 19.05%.

During the 10 minutes of the eclipse totality, the Murasthi group spent 7.14% and the Medinipur group 1.89% of their time in traveling, but the predominant activity was resting. At the same time on the following day the groups spent 7.14% (Murasthi) and 14.82% (Medinipur) in traveling.

The Murasthi group traveled a short distance after the eclipse, comprising only 3.57% of time in traveling for the rest of the morning. They also traveled little during the same period on the next day during the same period (0850-1200). The Medinipur group spent 4.89% to 14.78% in traveling during the eclipse day, and 3.17% to 9.25% on the next day.

Resting

Times spent resting by the Murasthi and Medinipur groups on the day of eclipse between 0600 and 0840 hr were 69.43% to 84.15% and 28.56% to 50.00%, respectively. On the day after the eclipse the equivalent figures for resting were 21.44% to 71.43% (Murasthi) and 22.22% to 52.78% (Medinipur).

Table 1. Percentage of time spent by the langurs in various activities in periods before (0600-0840 hr), during (0840-0850 hr) and after (0850-1200 hr) the solar eclipse on 24 October 1995, and during the same periods the day after (25 October 1995).

Date	Time period	Feeding (%)		Traveling (%)		Resting (%)		Grooming (%)		Play (%)	
		Murasthi	Medinipur	Murasthi	Medinipur	Murasthi	Medinipur	Murasthi	Medinipur	Murasthi	Medinipur
24/10/95	0600-0700	24.43	27.00	6.14	15.90	69.43	28.56	-	3.16	-	25.38
25/10/95	0600-0700	24.49	39.68	4.08	19.05	71.43	22.22	-	-	-	19.05
24/10/95	0700-0800	9.57	11.11	6.28	27.11	84.15	34.56	-	9.89	-	17.33
25/10/95	0700-0800	38.00	25.92	16.71	9.25	31.00	40.75	4.71	9.25	9.58	14.83
24/10/95	0800-0840	14.29	12.45	12.50	22.22	73.21	50.00	-	15.33	-	-
25/10/95	0800-0840	60.71	5.56	10.71	8.33	21.44	52.78	-	11.11	7.14	22.22
24/10/95	0840-0850	-	-	7.14	1.89	92.86	98.11	-	-	-	-
25/10/95	0840-0850	50.00	29.62	7.14	14.82	28.58	37.05	-	-	14.28	18.51
24/10/95	0850-0950	2.40	32.45	3.57	14.78	72.61	25.89	2.38	7.33	19.04	19.55
25/10/95	0850-0950	23.80	24.07	2.40	9.25	73.80	33.35	-	11.11	-	22.22
24/10/95	0950-1050	-	1.33	-	4.89	96.82	90.12	-	-	3.18	3.66
25/10/95	0950-1050	14.30	9.26	2.40	14.81	69.00	53.70	14.30	5.56	-	16.67
24/10/95	1050-1200	-	1.58	-	14.28	100.00	79.38	-	-	-	4.76
25/10/95	1050-1200	6.14	9.53	4.00	3.17	69.43	80.96	20.43	3.17	-	3.17

Eclipse day - 24/10/95; Non-eclipse day - 25/10/95; Duration of eclipse - 0731 hr to 1016 hr; Greatest phase - 0840 hr to 0850 hours.

Resting was predominant during the 10 minutes of the eclipse totality. The Murasthi group rested 92.86% of the time and the Medinipur group 98.11%. During the same period on the following day these figures dropped to 28.58% (Murasthi) and 37.05% (Medinipur).

The Murasthi group spent 72.61% to 100% in resting on the eclipse day between 0850 and 1200 hr, and 69% to 73.08% of time in resting during the same period the next day. The Medinipur group spent 25.89% to 90.12% of their time in resting at this time on the eclipse day, and 33.35% to 80.96% of their time resting during the same period on the non-eclipse day.

Playing and Grooming

Both groups spent little time in grooming and playing. The Murasthi group spent only 4.71% and 9.58% of its time in grooming and playing, respectively on the non-eclipse day, and no such activities were recorded during the eclipse day. The bisexual group of Medinipur spent 3.16% to 9.89% in grooming and 14.83% to 25.38% in playing during the eclipse day. Time spent by this group in grooming during the non-eclipse day varied from 9.89% to 15.33%, whereas play varied from 14.83% to 22.22%.

A small amount of traveling and, predominantly, resting were the only activities observed during the 10-minute eclipse totality. During the same period the next day, however, 14.28% (Murasthi) and 18.51% (Medinipur) were dedicated to play.

The Murasthi group spent only 2.38% of its time in grooming between 0850 and 0950 hr on the eclipse day, but this activity accounted for 14.30% to 24.43% of their time between 0850 and 1200 hr during the eclipse day. The Medinipur group spent 7.33% of its time in grooming on the eclipse day, again during the hour following the eclipse totality, but spent 3.17% to 11.11% of its time in the same activity during the non-eclipse day. Play, which is uncommon in all-male groups of Murasthi was restricted 3.18% to 19.04% of time during the eclipse day (0850-1200 hr), and was not recorded at all on the non-eclipse day. The Medinipur group, on the other hand spent a considerable time in play during this period on both days, varying from 3.66% to 19.55% on the eclipse day to 3.17% to 22.22% on the following day.

Discussion

Studies on the behavior of rhesus macaque and hanuman langur during the total solar eclipse of 1980 were carried out by Mukherjee (1984). Dixit *et al.* (1981) studied the rhesus macaque at Jaipur, and Mohnot observed the hanuman langur at Jodhpur in Rajasthan in 1980, where the eclipse was partial. At neither of these sites was there was much evidence of any change in behavior, although Mukherjee (1984) noticed marked changes in the behavior of rhesus macaques at Puri, where the eclipse was total.

During the present study at Medinipur, marked changes were recorded in the all male group and bisexual groups of hanuman langur. During the totality period of the eclipse, the langurs remained quiet, resting accounting for 92.86% of time for the Murasthi group and 98.11% for the Medinipur group. Moving about accounted for the remaining spent 7.14% in the Murasthi group and 1.89% in the Medinipur group. No other activity was recorded during this time. On the next day both the groups were found feeding, traveling, resting and playing, and the time spent resting was considerably less. Behavior was apparently normal however before and after the 10 minutes of the total eclipse.

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Authors' Addresses:
A. Murmu, Zoological Survey of India, M Block,New Alipur, Calcutta 700 053, India.
S. Chaudhuri, Zoological Survey of India, M Block,New Alipur, Calcutta 700 053, India.
J. R. B. Alfred, Zoological Survey of India, M Block,New Alipur, Calcutta 700 053, India.

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The Conservation Status of Two Sulawesian Tarsier Species: *Tarsius spectrum* and *Tarsius dianae*

Sharon Gursky

Department of Anthropology, Queens College,
City University of New York (CUNY), Flushing, New York, USA

Introduction

The conservation status of the Sulawesian tarsier species are presently classified as data deficient due to a lack of information concerning their population density, their distribution, and even the number of species that exist. Historically, the spectral tarsier, *Tarsius spectrum* (Pallas 1778) was believed to be the only tarsier distributed throughout Sulawesi and several small adjacent islands, including Bangaii, Togian and Sanghir (Hill 1955; MacKinnon and MacKinnon 1980; Niemitz 1984). Recent studies, however, have identified at least two additional species within the range previously attributed to the spectral tarsier (Musser and Dagosto 1987; Niemitz *et al.* 1991) (Fig. 1).

Based on museum specimens, Musser and Dagosto (1987) identified the pygmy tarsier, *T. pumilus*, as distinct from other specimens of *T. spectrum* due to its significantly smaller body size and the presence of laterally compressed nails. This species is believed to be present in the high altitude montane mossy forest of central Sulawesi (Miller and Hollister 1921). Likewise, Niemitz and colleagues (Niemitz *et al.* 1991) recently identified *T. dianae* in Kamarora, central Sulawesi, as distinct from *T. spectrum*. They suggested that it can be distinguished from the spectral tarsier on the basis of numerous characteristics of the ear and the pelage as well as its vocalization patterns. According to Nietsch's research (1995, 1996) on the vocalization patterns of Sulawesian tarsiers, *T. dianae* is the predominant species in central Sulawesi.

In addition, Groves (1993) has also suggested that the population of tarsiers on the island of Sanghir, north of Sulawesi, previously believed to be *T. spectrum* should be distinguished as a distinct species, *T. sangirensis*. The morphological analysis of Shekelle *et al.* (1997) agrees with this interpretation. Nietsch (1996) has also recently suggested the presence of a fifth species, *T. togianensis*, located in the Togian islands between northern and central Sulawesi, and Gursky (1997) believes that there is another as yet unidentified tarsier species in central Sulawesi, this based on preliminary observations and the number of different forms recognized by the local indigenous human population, the Wana (M. Alvard pers. comm.).

If we accept that there are now at least three tarsier species distributed through Sulawesi and possibly as many as eight (MacKinnon and MacKinnon 1980; Groves 1993; Gursky 1997; Musser and Dagosto 1987; Niemitz *et al.* 1991; Shekelle *et al.* 1997), there is a concomitant decrease in the geographic distribution of each, and the threat of extinction for each species becomes more real as areas of localized deforestation expand and the hunting and pet trade continues (pers.obs.).

A major goal for the conservation of potentially endangered species such as the Sulawesian tarsiers is the estimation of their population densities. The aims of this paper, therefore, are twofold: 1) to present population density for two of the tarsier species: *T. spectrum* and *T. dianae*; and 2) to discuss the implications of this new information for the conservation status of both.

Methods

Data were collected at two sites on the island of Sulawesi in Indonesia: Lore Lindu National Park (*Tarsius dianae*) and Tangkoko Dua Saudara Nature Reserve (*Tarsius spectrum*) (Fig. 1). Whereas Tangkoko Nature Reserve encompasses a substantial amount of lowland rain-forest, more than 70% of Lore Lindu National Park is between 1000-1500 m altitude (The Nature Conservancy 1994; World Wildlife Fund 1980). Notable differences between the two sites include a much higher proportion of *Ficus* trees at Tangkoko Nature Reserve and a higher proportion of rattan species in Lore Lindu National Park (Bynum 1995; Gursky 1997). Rainfall at Lore Lindu National Park averages 3100 mm per year whereas Tangkoko Nature Reserve is much drier, averaging only 2300 mm per year (World Wildlife Fund 1980; Gursky 1997). The forest canopy at Tangkoko Nature Reserve is broken and very discontinuous compared to the relatively thick continuous canopy observed at Lore Lindu National Park (Bynum 1995; Gursky 1997). Additional details concerning the habitat type at Lore Lindu National Park and Tangkoko Nature Reserve can be found in Bynum (1995) and Gursky (1997), respectively.

Population density was estimated using a modified form of the fixed point count and quadrat census methods (Eisenberg and Struhsaker 1981). This method allowed the computation of the

total number of groups present per hectare, which in turn allowed an estimate of density for the sampled area. According to Eisenberg and Struhsaker (1981), the sample space should be chosen randomly and should equal a minimum of 15% of the total area surveyed. In this study, 17 (Lore Lindu National Park) and 25 (Tangkoko Nature Reserve) one hectare plots were sampled. This amounts to 17% and 25% of the study areas, respectively. Plots were chosen randomly within a 1 km² study area using a random block design.

The following procedures were used. Prior to dawn, my field assistant and I would stand on the periphery of a hectare plot. The tarsiers give loud vocal calls when they return to their sleeping site and when at their sleeping site, and for three to five minutes they can be heard from a distance of 300-400 m (MacKinnon and MacKinnon 1980; Niemitz 1984; Gursky 1997). The location of all tarsier groups within each one hectare plot was determined from these loud vocal calls. All groups were then traced to their sleeping site. My field assistant and I then returned to the sleeping site prior to dusk to count the number of individuals leaving each sleeping tree, and record their relative age and sex.

The altitude of each one-hectare plot was also recorded using an altimeter (±5 m). In addition, each hectare plot was also categorized according to habitat type using the gross categories of primary or secondary forest (Brower *et al.* 1990).

Results

The results indicate that Dian's tarsier is relatively abundant within the sampled area at Lore Lindu National Park (Table 1). Nine groups were located in the 17 one-hectare plots. A total of 22 individuals was observed within nine of the one-hectare plots. The mean number of groups per sampled hectare was 0.53. The mean number of individuals per sampled hectare was 1.29. The number of groups estimated in the entire study area (100 ha) was 53, and the population density 129 tarsiers per km².

Spectral tarsiers were also relatively abundant in the sampled area at Tangkoko Dua Saudara Nature Reserve (Table 1). A total of 14 groups was located in the 25 one-hectare plots. Thirty-nine individuals was observed in 14 of the one-hectare plots. The mean number of groups per sampled hectare was 0.56. The mean number of individuals per sampled hectare was 1.56. The number of groups estimated in the entire study area (100 ha) was 56, and the population density was 156 tarsiers per km².

Table 1. The effect of habitat type and altitude on the population density of spectral tarsiers at Tangkoko Dua Saudara Nature Reserve and Dian's tarsiers at Lore Lindu National Park in Sulawesi, Indonesia. N = number of one-hectare plots.

Variable	*Tarsius spectrum* Density (per km²)	N	*Tarsius dianae* Density (per km²)	N
Overall Density	156	25	129	17
Habitat Type				
Primary	100	12	22	9
Secondary	208	13	250	8
Altitude				
<500 m	166	15	-[b]	0
500-1000 m	175	8	180	12
1000-1500 m	0[a]	2	57	5

[a] Only two sites (habitats) were sampled in Tangkoko Dua Saudara Nature Reserve that were above 1000 m, and no tarsiers were found in either, but this result is believed to be due to small sample size.

[b] There was no tarsier habitat below 500 m altitude at Lore Lindu National Park, all had been converted to coffee plantations.

The population density of the spectral tarsier was estimated to be 166 individuals per km² below an altitude of 500 m, and 175 individuals per km² between 500-1000 m. Similarly, the population density of Dian's tarsier was estimated to be 180 individuals per km² between an altitude of 500-1000 m, and 57 individuals per km² between an altitude of 1000-1500 m. Whereas the population density of the spectral tarsier was not influenced by altitude, the population density of Dian's tarsier decreased noticeably at the higher altitudes. There was only a minor difference in the density between spectral tarsiers and Dian's tarsiers between 500-1000 m (175 vs. 180 individuals per km²).

For both species, polulation densities were higher in the secondary forest than in the primary forest. The population density for spectral tarsiers in the secondary forest was estimated to be 208 individuals per km², but was only 100 individuals per km² in the primary forest. Likewise, the population density for Dian's tarsier was estimated at 250 individuals per km² in the secondary forest, but was only 22 individuals per km² in the primary forest. While there was only a minor difference in the density between spectral tarsiers and Dian's tarsiers in secondary forest (208 vs. 250 individuals per km²), there was a more noticeable difference in primary habitat between the two species (100 vs. 22 individuals per km²).

Discussion and Conclusions

At first glance, the population density estimates presented in this paper suggest that neither the spectral tarsier nor Dian's tarsier are in imminent danger of extinction. Nonetheless, according to the World Conservation Union (IUCN) and the Asian section of the Species Survival Commission (SSC) Primate Specialist Group, several additional factors must be taken into consideration when discussing the conservation status of primate species (IUCN 1996). These include: 1) major population reductions in recent years, 2) the species' distribution, and 3) the species' total population size.

Although the results of this study indicate that spectral tarsiers are relatively abundant within the protected areas sampled, the overall population density estimate obtained in this study, 156 individuals per km², is only one half of the lower estimate given by MacKinnon and MacKinnon (1980) and Bearder (1987) of 300-800 individuals per km². This comparison suggests that there may have been a severe reduction in the population density of spectral tarsiers over the last 15 years.

The spectral tarsier also has a very small distribution which is becoming even more limited as new Sulawesian tarsier species are identified. Although several reasonably large protected areas have been set up within its range in Sulawesi, these reserves are still undergoing serious deforestation. For example, when Tangkoko Nature Reserve was initially set up it in 1980, it comprised almost 9,000 ha and was surrounded by a similar amount of forest in the form of a buffer zone (World Wildlife Fund 1980). By 1990, the buffer zone was completely destroyed, and the amount of forest in the reserve was recognized to be down to 7,800 ha due to encroaching coconut plantations of the neighboring villages (Y. Muskita pers. comm.). More recently (1995), an additional 1,300 ha was downgraded from nature reserve to recreation forest, thereby removing protection from an additional segment of the forest. Thus,

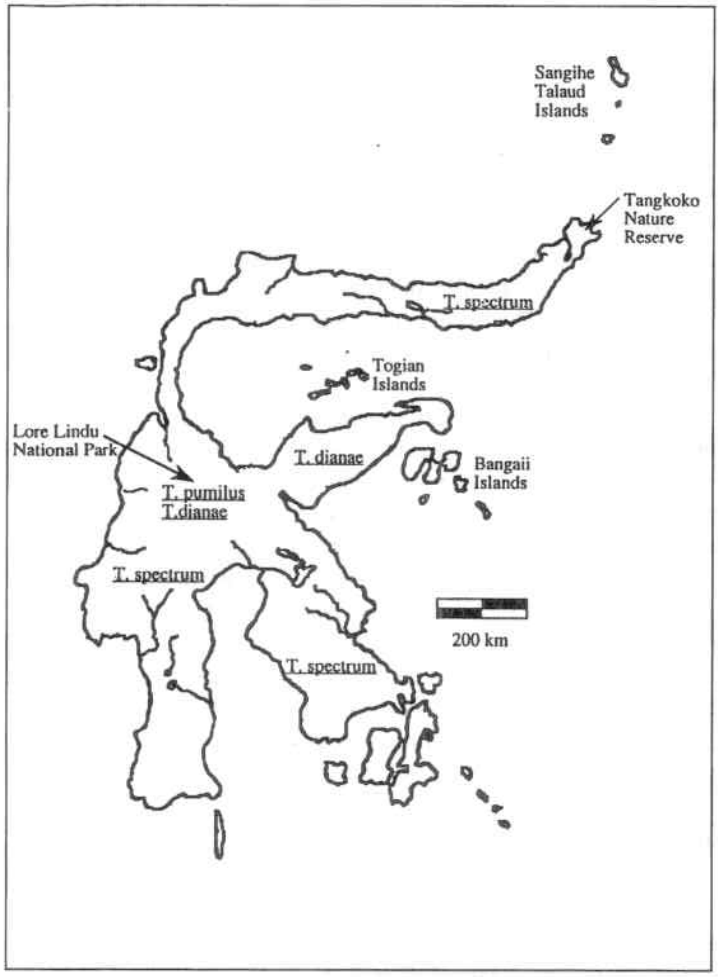

Fig. 1: Distribution of Sulawesian tarsier species and localities mentioned in the text.

although the spectral tarsier is presently found in relatively large numbers within protected areas in Sulawesi, habitat destruction remains a significant threat.

The results of this study suggest that the conservation status of the spectral tarsier should be changed from "Data deficient" (Wolfheim 1986; IUCN 1996) to "Lower risk; near threatened". Its classification within the low risk category should be near threatened (nt) due to the substantial decrease in the spectral tarsier's density over the last 15 years, its limited distribution, and the increasing threat of habitat destruction. If additional taxonomic analyses indicate that the geographic boundaries of the Sulawesi tarsier species parallel the geographic distribution of the Sulawesi macaque species, then their conservation status will need to be re-evaluated.

Dian's tarsier, the lowland Sulawesian tarsier species in central Sulawesi, occurs in two large protected areas in central Sulawesi: Lore Lindu National Park and Morowali Nature Reserve (The Nature Conservancy 1994). Although the animals are in protected areas, the tarsiers are opportunistically hunted and the forest is still undergoing major deforestation and destruction (pers. obs.; M. Alvard in press). For example, Lore Lindu National Park is surrounded by agrarian communities that still hunt within the park's boundaries, obtain most of their income from both the timber and rattan industry and also burn the forest to convert it to cocoa and coffee plantations. Similarly, a group of traditional slash-and-burn horticulturalists reside within Morowali Nature Reserve. Not only do the Wana opportunistically hunt the tarsiers with dogs and blowguns, but they also burn large tracts of land for dry rice agriculture. Thus, although Dian's tarsier is presently found in relatively large numbers within protected areas in Sulawesi, habitat destruction and hunting are significant threats. Similarly, although Dian's tarsier is found at high densities at the lower altitudes, it occurs at noticeably lower densities at higher altitudes. This discrepancy needs to be considered in any determination of the species' conservation status because approximately 70% of the protected areas in which Dian's tarsier occurs is between 1000-1500 m (The Nature Conservancy 1994). As a result, I believe that the conservation status of *T. dianae* should be changed from Data deficient to "Lower risk: conservartion dependent". Its classification within the low risk category should be conservation dependent (cd) due to the hunting pressure, intensive habitat destruction within the protected areas, and the substantially lower densities of this species at higher altitudes (most of its range).

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Author's Address:
Sharon Gursky, Department of Anthropology, City University of New York - Queens College, 65-30 Kissena Boulevard, Flushing, New York 11367, USA.

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Jörg Ganzhorn
Institute of Zoology, Ecology and Conservation
Martin Luther King Platz 3
20146 Hamburg
Fax: +49 (40) 4123 3937
E-mail: ganzhorn@zoologie.uni-hamburg.de

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Ardith A. Eudey
164 Dayton Street
Upland
California 91786
U.S.A
Fax: +1 909 982 9832
E-mail: eudey@aol.com

Neotropical Region - *Neotropical Primates*

Anthony B. Rylands
c/o Conservation International do Brasil
Av. Antônio Abrahão Caram 820/302
31275-000 Belo Horizonte
Minas Gerais
Brazil
Fax: +55 (0)31 441 1795
E-mail: a.rylands@conservation.org.br

or, and for contributions in Spanish,

Ernesto Rodríguez-Luna
Instituto de Neuroetología
Universidad Veracruzana
Apartado Postal 566
Xalapa
Veracruz 91000
Mexico
Fax: +52 2812 5748
E-mail: saraguat@speedy.coacade.uv.mx

African Region - *African Primates*

Thomas M. Butynski
Zoo Atlanta
Africa Biodiversity Conservation Program
P.O. Box 24434
Nairobi
Kenya
Fax: +254 289 0615
E-mail: butynski@thorntree.com

Back cover. The collared titi or widow monkey, *Callicebus torquatus lugens*, from Colombia. Photographed at Caparú, Río Apaporis, the study site of Thomas R. Defler, in 1995 by Russell A. Mittermeier.

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